Jiayuan Wang · Zhikun Ding
Liang Zou · Jian Zuo *Editors*

Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate

中華建設管理研究會
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Springer

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ISBN 978-3-642-35547-9 ISBN 978-3-642-35548-6 (eBook)
DOI 10.1007/978-3-642-35548-6
Springer Heidelberg New York Dordrecht London

Library of Congress Control Number: 2013945173

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

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Part I
Sustainable Construction

Chapter 1
The Necessity and Feasibility Study for Private Capital Participation in Urban Redevelopment

Xia Qi, Bingcai Zhang, and Xinbo Zhao

Abstract Urban redevelopment is important and meaningful to promote city ecological environment and economic development. However it accounts commonly huge investment and the current finance mainly relies on fiscal investment, bank debt, and bond issued by government financing platform. And the generous government debts cause great fiscal pressure. The article explores whether the private capital can be solution to urban redevelopment financing problem. Combined with the existing private capital development and urban redevelopment analysis, it discusses the necessity of private capital to participate in urban redevelopment. Based on the existing Chinese policies, social and economic factors, it analyzes the feasibility of private capital participation in urban redevelopment, provides political suggestions for government to expand urban redevelopment financing ways and also offers reference decision for private capital to participate in urban redevelopment.

Keywords Private capital • Urban redevelopment • Feasibility • Necessity

1.1 Introduction

Along with the rapid urbanization of China, the governments at all level are confronted with urgent demand to improve the city image and people's livelihood for harmonious development of the society. Nowadays, China's urban redevelopment finance mainly relies on fiscal investment, bank debt, and bond issued by government financing platform. However, under the circumstance of fiscal

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_1, © Springer-Verlag Berlin Heidelberg 2014

difficulties itselves, the generous government loans cause great fiscal pressure and debt risk. The fund is still the bottleneck of urban redevelopment.

In order to solve the finance problem of urban redevelopment and promote its steady development, the private capital highlight itself for its enormous quantity and development potential. In 2010, the State Council promulgated ***The Advices on Encouraging and Guiding the Healthy Development of the Private Investment***, which allows the participation of private capital in infrastructure construction and also offers a series of policy support corresponding as well. Under this circumstance, the article gives a necessity and feasibility analysis on urban redevelopment to explore the possibility of private capital whether can be urban redevelopment financing source, thus providing policy suggestions to promote urban redevelopment financing for government and give private capital decision-making reference to participating in such field.

1.2 Necessity Analysis for Private Capital Participation in Urban Redevelopment

1.2.1 The Chinese Existing Urban Redevelopment Problem Analysis

1.2.1.1 The Fund Become the Bottleneck of Urban Redevelopment

Recently in China, the current urban redevelopment finance mainly relies on fiscal allocation, bank debt, and bond issued by government financing platform. By the end of June 2010, according to the audit of 18 provinces, 16 cities and 36 counties by auditing administration, it has 7 provinces, 10cities and 14 counties of debt rate over 100 %, the highest reaching 364.77 % [1]. By the end of 2010, the local government debt balance has 1.84 trillion RMB due in 2012, of which the government has repaid responsibility for 1.298 trillion RMB. As to the shortfall, it will be aggravated from 2012, and even considering “borrowing new loans to repay the old” behavior, there probably occurs a shortfall of 1.18 trillion RMB in 2012 [2].

1.2.1.2 The Lack of Public Participation in Urban Redevelopment

Public participation refers that public exercise more extensive democratic rights based on legal protection of fundamental rights (right to equality, the right to know, right of disposition and so on) in social economic activity involving public interests. It’s actually a kind of “non market power” in addition to government power oriented to make up for the market mechanism deficiency [3]. Public participation in urban redevelopment can take advantage of public capital and popularity to release the government’s financial pressure, and reduce the difficulty of relationship coordination. However, public participation in urban redevelopment is still at a low level and broad market resources are not fully utilized. According the investigation of public participation in urban redevelopment by Dr. Chuankun Rao of Zhejiang University, presently in China, only 30 % residents think they enjoy the right to know, 25 % have enjoyed the right of supervision, 14 % have enjoyed the right to participate [4].

1.2.1.3 The Low Management Level of Urban Redevelopment

In Chinese urban redevelopment, the private capital and other social forces although participate to a certain extent, yet still remain at a low level. The management in urban redevelopment is still dominated by government power [5]. This management model is, in a manner, better for government's control to project and public welfare. However contrast with the professional management in market economy, it produces the serious problem for lack of government management staff, management experience, and low management efficiency. And the failure project as a result of government management inefficiency is often the case.

1.2.2 The Advantage of Private Capital Participation Urban Redevelopment to Solve Existing Problems

1.2.2.1 Help to Improve the Capital Input of Urban Redevelopment

Private capital can make full use of its quantity advantage to raise the investment input in urban redevelopment. By the China Statistic of 2011, the household savings has amounted to 30.33 trillion RMB by the end of 2010, and over 35 trillion RMB by the end of 2011; all kinds of security finance 46.04 trillion RMB with a growth of 23 % by 2009; stock issued 1.19 trillion RMB with a growth of 95.4 % by 2009 [1]. The financial strength and development potential provide the strong guarantee for private capital to participate in urban redevelopment.

1.2.2.2 Help to Guild Public Participation in Urban Redevelopment

Public participation has been the mainstream in urban redevelopment in the western and also will be the development trend of Chinese urban redevelopment. In urban redevelopment, the personal demolition compensation, savings and endowment insurance account a large amount. If it can be reasonably guided to investigate in the urban redevelopment, it will help improve the residents' investment income, and avoid the opportunity cost loss. Meanwhile, it will also enable the residents role change from the project supervisors to the project investors; facilitate the relationship cooperation in project construction and the optimization in project construction environment.

1.2.2.3 Help to Improve Professional Management Level in Urban Redevelopment

Private enterprises have attained rich practical experience and management experience in market economy, and obviously have advantages in respect of profession staff and management in contrast with government organizations. They operate more types of projects, and pay more attention to competitive indexes such as economic profitability and technique applicability. Therefore, it will help release the government pressure in use of private capital, and improve the core competitiveness of redevelopment project, while guiding the private capital participate in urban redevelopment. And it will also adapt Chinese urban redevelopment to market economy, and facilitate its sustainable development

In summary, the participation of private capital in urban redevelopment provides a solution to fund shortfall, release the government management pressure and improve the professional management level. In this regard, the private capital participation in urban redevelopment is not only necessary but also meaningful in long term.

1.3 Feasibility Analysis of Private Capital Participation in Urban Redevelopment

1.3.1 The Policy Environment Analysis of Private Capital Participation in Urban Redevelopment

The policy environment is the premise to fulfill the participation of private capital in urban redevelopment. Since 2004, a series of policies and regulations have been promulgated and executed by central and local governments, which facilitate the legal involvement of private capital in such projects.

In 2004, authorized by the State Council, the State Council General Office promulgated the ***Several Suggestions About Accelerating Capital Market Reforming And Developing Stably***. It points "the country will continue vigorously develop the security investment fund. And it supports the insurance fund in a variety way to directly invest in capital market, and gradually improve the investment ratio of social security fund, enterprise supplementary pension fund, and commercial insurance fund in capital market. And a number of honest, legal and professional institutional investors will be developed, of which the fund management companies and insurance companies will lead to dominate the capital market." The regulation opens the policy gate of private capital participation in urban redevelopment and takes the precedent of society insurance fund and pension fund participating in the social investment.

After allowing the private capital participation in social investment, in July 2004, the State Council promulgated ***The Decision on the Reform of the***

Investment System. The decision the further relaxes the field for private capital investment, and defines the invest areas. It specifies: "the government investment mainly applies in the area involving the country safety and the area where the market functions inefficiently." In addition, the decision also points out: "it allows the private capital participating in the infrastructure, public utilities and other industries and fields without legal probation. And the private capital should be encouraged and guided, in ways of solo founded, joint Venture, cooperation, PPP, etc. to participate in the operational utilities and infrastructure projects. Establish and improve the investment system to ensure the investment agent's interests." The decision further emphasizes the importance of private capital and expands the investment area of private capital.

Based on the relevant policy of 2004, the State Council promulgated ***the Advices on Encouraging***, ***Supporting and Guiding the Development of Individual and Private***, ***and Other Non-public Economic***. The Advices points out clearly: the non-public capital investment area "support non-public capital to participate in the urban water supply, gas supply, heat supply, public transportation, sewage disposal, public utilities and infrastructure." Given the regulatory transfer behavior, the public utilities and infrastructure with all conditions permitted can transfer operation rights or property rights to non-public enterprises.

In 2010, the State Council promulgated ***The Advices on Encouraging and Guiding the Healthy Development of Private Capital by the State Council***. The Advices expand the investment allowed by previous policy, provide tax reduction and exemption preferential loans, and simplify approval procedures and other preferential measures.

1.3.2 The Social Environment Analysis of Private Capital Participation in Urban Redevelopment

The social environment is strong guarantee for private capital participation in urban redevelopment. Recently, the private capital has already a series of qualifications for participation in urban redevelopment.

In theory, the theory analysis of private capital participation in urban redevelopment has been quite mature in western world. USA, UK, France and Germany and other western countries have already developed a theory system for private capital participation in urban redevelopment, which facilitate such behavior in China. In China, the research in such area is rich with different conceptions. For e.g. Fu Hongyuan in Chongqing University thinks: it should adopt the industrial fund model to execute the urban redevelopment and it will release the government pressure, strengthen the private enterprises' core competence, and make it possible for residents to enjoy the benefits of city development [6]. Meanwhile, Qiu Licheng in Tianjin University thinks that: the asset securitization could be applied to finance for urban redevelopment and is a solution to the financing problem; and it will create the open, fair, and justice environment for urban redevelopment and guarantee the legal rights of stakeholders [7]. In addition, Huang Xiaobu also proposes that housing cooperative fund can be used to finance for urban redevelopment and it will make full use of private capital and allow the benefits and interests available for all residents.

In practice, the policies encouraging and guiding private capital to participate in urban redevelopment have been promulgated in such cities as Chongqing Guangzhou, Beijing, Shanghai and so on, which include: simplifying the private investment approval procedures, partly tax reduction and exemption, optimizing the private investment environment etc. It clears the way for private capital to participate in urban redevelopment. In addition, the trust fund model has been adopted in Chongqing and Tianjin to finance for redevelopment. In Chongqing, the phase one urban redevelopment of Gangqiao in Yongchuan district had raised RMB 387,000,000 by way of trust fund. The Tianjin Infrastructure Investment Corporation Company (found by government), CITIC, and CITIC Trust jointly established the "CITIC Shengjing Tianjin District Development Fund", which is applied for urban redevelopment finance and other urban construction finance. Undoubtedly, the private such as individual investment fund, enterprise fund, social security fund has gradually participated in urban redevelopment.

1.3.3 The Economical Environment Analysis for Private Capital Participation in Urban Redevelopment

The economical feasibility is the essential factor for private capital to participate in urban redevelopment. Nowadays, China exists in urbanization period. According to the Chinese Urban Development Research Report by National Bureau of Statistics, the Chinese urbanization ration is 45.7 % in 2008, and grows by the annual rate of 0.8 %, and will reach 50 % by 2015. In this background, the pressure from urban redevelopment increases as well as the financial demand for such projects. However, nowadays, the Chinese urban redevelopment mainly relies on local government investment, which aggravates the financial pressure on local fiscal. According to relevant statistic, during the 12th 5-year-plan period, the infrastructure investment still needs approximately 10 trillion RMB. However, the central and local government just can afford 1–2 trillion RMB and a gap of 8–9 trillion still exists [8]. According to the central bank statistics, the debt raised by the local governments has grown from 1.7 trillion RMB at the beginning of 2008 to the 7.38 trillion RMB at the end of 2009. In the regard, the conflict between shortfall of urban redevelopment and limited competence of local government offers the opportunities private capital to participate in urban redevelopment.

Contrast with the limited government competence, the private capital has great potentials both in quantities and development. In 2006, the domestic bank savings exceeded 40 trillion RMB, security assets over 2 trillion RMB, and all kinds of social security funds over 1.8 trillion RMB. In addition, the security assets and social security fund both keep the growth by a considerably high rate of 20 % [1]. The financial strength and development potential provide the strong guarantee for private capital to participate in urban redevelopment.

From the above analysis, the private capital has been entitled to a preferential political, social, and economical environment to participate in urban redevelopment, which makes it possible and feasible for private capital participate in urban redevelopment.

1.4 Efficiency Analysis of Private Capital Participation in Urban Redevelopment

1.4.1 Economic Efficiency

Private capital can make full use of its quantity advantage to raise the investment input in urban redevelopment. By the China Statistic of 2011, the household savings has amounted to 30.33 trillion RMB by the end of 2010, and over 35 trillion RMB by the end of 2011; all kinds of security finance 46.04 trillion RMB with a growth of 23 % by 2009; stock issued 1.19 trillion RMB with a growth of 95.4 % by 2009 [1]. Considering the private capital development itself, after a series of real-estate control and Wenzhou folk loan crisis, the private capital really need a healthy and sustainable development change from the speculation and short term operation model ever before. In this respect, the private capital, given its quantity advantages and development experiences and investment demand, make it possible and reasonable for participation in urban redevelopment.

1.4.2 Social Efficiency

Private capital participation in urban redevelopment can attracts the pubic to participate in such program, and take full use of social forces to achieve the city development. Public participation in urban redevelopment is the mainstream in western countries and will also lead our country's urban redevelopment. In urban redevelopment, the personal demolition compensation, savings and endowment insurance hold a large amount. If it can be reasonably guided to investigate in the urban redevelopment, it will help improve the residents' investment income, and avoid the opportunity cost loss. Meanwhile, it will also enable the residents role change from the project supervisors to the project investors; facilitate the relationship cooperation in project construction and the optimization in project construction environment.

1.4.3 Management Efficiency

Private enterprises have attained rich practical experience and management experience in market economy, and obviously have advantages in respects of profession staff and management in contrast with government organizations. They operate more types of projects, and pay more attention to competitive indexes such as economic profitability and technique applicability. Therefore, it will help release the government pressure in use of private capital, and improve the core competitiveness of redevelopment project, while guiding the private capital participate in urban redevelopment. And it will also adapt Chinese urban redevelopment to market economy, and facilitate its sustainable development

1.5 Conclusion and Prospect

To conclude, nowadays, the private capital participation in urban redevelopment has realistic necessity in China, which will certainly promote the healthy development of urban redevelopment. Meanwhile, the current policy, social and economic environment also provide feasible conditions for private capital to cooperate with government. However, there also exist some obstacles and problems to be solved in details for private capital to participate in urban redevelopment. Therefore, in the future the government should make more detailed and applicable regulations to facilitate private capital participation, and promote the private capital to be an important new force in urban redevelopment.

Acknowledgments This research is supported by Young and Middle-Aged Scientists Research Awards Funding of Shangdong Province(No. BS2011SF012)、Scientific Planning Research Grant(No. 2011YK047), Housing and Urban-Rural Development Bureau of Shandong Province.

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Chapter 2
China's Provincial Energy Efficiency of Construction Industry in 2005–2010: An Empirical Study Based on the DEA Model

You-zhi Zhang and Hong-chun Gu

Abstract In China's construction industry there exist high consumption and low energy efficiency, and improvement of energy efficiency has an important significance for the sustainable development of construction industry. According to the framework of total factor energy efficiency, a DEA model was developed to study China's provincial energy efficiency of construction industry during 2005–2010. The results have shown that, during this period, the average energy utilization efficiency of China's construction industry has increased to a certain extent, but technology progress only has limited impact on the improvement of construction energy efficiency; there are significant differences in regional energy efficiency, generally the construction energy efficiency in eastern coastal areas is relatively higher, while inefficient utilization of energy in construction industry has been observed in central-western regions. Finally, the impacts of industrial structure, energy consumption structure, enterprises strength and technology level on the provincial construction energy efficiency have been studied.

Keywords DEA • DEA effectiveness • Energy efficiency • Technology innovation • Energy-saving

Energy is an important factor to promote and constrain economic development, improving energy efficiency has been accepted as national consensus. According to statistics, construction industry has become an important pillar industry of China's economy, the value added of construction industry reached 6.7 % in 2010; on the other hand, despite energy consumption of construction industry accounted for only 1.5 % of the total energy consumption, the total energy consumption of construction industry has increased year by year, has increased from 25.36 million tons of

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_2, © Springer-Verlag Berlin Heidelberg 2014

standard coal in 2005–47.88 million tons of standard coal in 2010. Therefore, continuous improvement of energy efficiency in the construction industry has an important impact on economic growth.

In 1978, Charnes and Cooper created Data Envelopment Analysis (DEA), as a non-parametric estimation methods, which was suitable to evaluate relative production efficiency of multiple Decision-Making Units (DMU) [1]. DEA model has been widely used to study energy efficiency, eco-efficiency, innovation and sustainable development capacity [2–6].

Although the DEA model also was used, some improvement was made in this paper: in existing literatures the energy efficiency of the iron and steel, mining and other heavy industrial sectors was usually discussed, energy efficiency of construction industry became theme in this paper; existing studies focused on national or regional energy efficiency, while provincial energy efficiency of construction industry will be comparatively studied; the cross-sectional data was widely used in existing research, the panel data will be used to analyze temporal characteristics of energy efficiency among inter-provincial construction industries.

The main content of this paper is divided into three parts: First, a brief introduction of DEA models and research methods; Then, empirical research on energy efficiency of China's inter-provincial construction industry by using DEA model; finally, after discussion of empirical results, some recommendations to energy-saving are made.

2.1 Research Method

2.1.1 The DEA Model

There are many different kinds of DEA models, and C^2R and BC^2 are most commonly used. In C^2R model relative efficiency of a DMU is calculated under the condition of constant returns to scale (CRS). While in BC^2 model it is assumed that DMU is under the condition of variable returns to scale (VRS), and the convexity assumption $\left(\sum_{j=1}^{n} \lambda_j = 1\right)$ will be added to C^2R model, thus technical efficiency is decomposed into pure technical efficiency and scale efficiency. Although it is suitable for C^2R model to measure comprehensive efficiency of a DMU, it is unable to discern technical inefficiency or scale inefficiency when a DMU is DEA inefficient.

When measuring production efficiency of a DMU, the DEA model can be divided up into input-oriented and output-oriented categories. For the input-oriented model input realizes minimization under the condition of output unchanged; while in output-oriented model output achieves maximization under the condition of input unchanged. Taking into account that energy-saving is the basic principle of energy use, and also to control inputs is more practical than to control output. Therefore, in this paper the BC[2] input-oriented model is used to identify pure technical efficiency and scale efficiency of energy in construction industry.

Where very province is treated as a DMU, the DMU uses input ${x_{mj}}^t$ to achieve output${y_{sj}}^t$, thus given input the linear programming equation is shown as following:

$$\min \theta$$
$$s.t.\ \sum_{j=1}^{n} x_{mj}^{t}\lambda_j \le \theta x_0,\ \sum_{j=1}^{n} y_{sj}^{t}\lambda_j \ge y_0,\ \sum_{j=1}^{n}\lambda_j = 1; \quad \text{where},\ \lambda_j \ge 0,\ j = 1,2,\ldots n. \tag{2.1}$$

According to Eq. (2.1), pure technical efficiency (*Pte*) can be calculated, and technology efficiency (*Te*) can be also solved when removing the convexity assumption.

2.1.2 Malquist *Productivity Index*

According to Caves' ideas (1982), *Malquist* productivity index is a useful tool for analyzing the total factor energy efficiency of construction industry. By using *Malquist* index, interregional technical progress changes (*Techch*) can be examined, but also the technical efficiency change (*Effch*) can be decomposed into pure technical efficiency change (*Pech*) and scale efficiency change (*Sech*), thus total factor energy efficiency (*Tfpch*) can be solved.

Assuming that (x_t, y_t) and (x_{t+1}, y_{t+1}) is respectively the relationship of input-output for period t and t+1, thus the change in input-output relationship from (x_t, y_t) to (x_{t+1}, y_{t+1}) is the productivity change, which may be resulted from the changes in technology level or in technical efficiency. Supposing that $D_t(x_t, y_t)$ and $D_{t+1}\left(x_{t+1}, y_{t+1}\right)$ is separately the distance function of a DMU on given period t technical reference, thus *Malquist* productivity index is shown as following:

$$M_t\left(x_t, y_t, x_{t+1}, y_{t+1}\right) = \left[\frac{D_t\left(x_{t+1}, y_{t+1}\right)}{D_t\left(x_t, y_t\right)} \times \frac{D_{t+1}\left(x_{t+1}, y_{t+1}\right)}{D_{t+1}\left(x_t, y_t\right)}\right]^{1/2} = Pech \times Sech \times Techch \tag{2.2}$$

If $M_t\left(x_t, y_t, x_{t+1}, y_{t+1}\right) > 1$, it means that the total factor productivity raises; *Techch* represents technology boundary change from period t to $t + 1$, if *Techch*>1 which indicates that there is technical progress; *Effch* refers to relative technical efficiency change from period t to $t + 1$, when *Effch*>1 indicating improvement of relative technical efficiency; *Pech* is the pure technical efficiency change, if *Pech*>1 indicates that the DMU has improved its management efficiency; *Sech* is the changes in scale efficiency, when *Sech*>1 it means that the DUN is approaching to the optimal production scale.

2.1.3 The Analysis Data

According to analytical framework of the total factor energy efficiency, the value-added of construction industry is treated as output factor in the DEA model, and then energy, capital and labor are treated as input factors. Finally there is some explanation of these data as following:

1. **Output factor**. The value added of provincial construction industry is the output variable in DEA model, which would be conversed to 2005 fixed price by using the GDP deflator.
2. **Capital stock**. Usually capital stock is estimated by using perpetual inventory method [7], where the fixed assets investment of provincial construction industry is used to replace the capital stock, which also would be translated into 2005 unchanged price.
3. **Labor input**. The average number of employees of provincial construction enterprises is used to calculate labor input index.
4. **Energy input**. Construction industry will consume coal, oil, natural gas and hydropower, which would be converted into standard coal with reference coefficient of standard coal.

Because there is no complete data of Tibet, Hong Kong, Macao and Taiwan regions, study object will be energy efficiency of construction industry in 30 provinces mainland China, and study period is 2005–2010 considering of the availability and quality of the data. The original data all come from China Statistical Yearbook, China Energy Statistical Yearbook and China Construction Industry Statistical Yearbook in 2006–2011.

2.2 Empirical Study of Provincial Energy Efficiency of Construction Industry

2.2.1 The Analysis of Total Factor Energy Efficiency of Construction Industry

Firstly, the software DEAP 2.1 will be used to estimate 2005–2010 energy efficiency of provincial construction industry under the condition of constant returns. According to the estimated results, some findings can be found as following:

1. The total factor energy efficiency of provincial construction industry was averagely 0.6–0.7, which meant that as a whole the energy utilization in China's construction industry still stood on a low level without meeting DEA efficiency. It is worth noting that during this period the energy efficiency of construction industry experienced a U-type process (first decreased and then increased), but overall the energy efficiency undergone a downward trend.

2. There was significant regional difference in the total factor energy efficiency of provincial construction industry, China could be divided into high grade, middle grade and low grade according to energy efficiency level. Generally the energy efficiency of construction industry was highest in eastern coastal areas, while the energy efficiency of construction industry is relatively lower in the western-middle regions. Specifically, the energy efficiency of construction industry in some provinces reached to DEA efficiency, which was Beijing, Heilongjiang, Shanghai and Zhejiang, the energy efficiency of Ningxia, Jiangsu and Liaoning was also more than 0.9 approaching to DEA efficiency, these seven provinces were regions with highest energy efficiency. On the other hand, those provinces with lower energy efficiency mostly concentrated in the western-central regions, and the construction energy efficiency in Shanxi, Shandong, Hubei, Gansu and Hainan was less than 0.5 during most of 2005–2010, which were regions with lowest energy efficiency.

2.2.2 *Total Factor Energy Efficiency of Construction Industry Based on* Malquist *Index*

Malquist model was solved by using software DEAP2.1, and total factor energy efficiency would be respectively decomposed by time and region, as shown in Tables 2.1 and 2.2.

Some results could be found from the decomposition of construction energy efficiency by time and region (Tables 2.1 and 2.2):

1. Total factor energy efficiency of provincial construction industry arrived to 1.042 averagely, indicating that energy efficiency experienced a upward trend generally. However the progress in energy efficiency was undergoing a downward trend, declining from 1.068 in 2006 to 1.016 in 2010, which meant that it was difficult to continuously maintain energy efficiency.
2. During the same period, the average of technical efficiency in construction industry was 0.977, despite of high-speed growth of 9.4 % in 2009, while it still experienced a downward trend. The decomposition of technical efficiency indicated a falling trend in pure technical and scale efficiency, and they all experienced a change process (first decline, and then rise, again down).
3. Thus, during this period, the improvement in energy efficiency of China's construction industry mainly came from technology progress; except that the average of technological progress index was only 0.95 in 2009, during most time the technology progress was greater than one, which indicated a widespread technology progress in energy efficiency was reached during the period of 2005–2010, as shown in Table 2.1.
4. According to the decomposition of total factor construction energy efficiency by region (Table 2.2), except of Fujian, Jiangxi, Guangdong and Shanxi, the construction energy efficiency raised on varying degree, where Guangxi

Table 2.1 The decomposition of total factor construction energy efficiency in 2005–2010 (by time)

Year	2006	2007	2008	2009	2010	Average
Technical efficiency	0.966	0.923	0.933	1.094	0.98	0.977
Technology progress	1.106	1.185	1.069	0.952	1.037	1.067
Pure technical efficiency	0.978	0.959	0.956	1.074	0.989	0.993
Scale efficiency	0.988	0.963	0.973	1.018	0.991	0.986
Total factor energy efficiency	1.068	1.094	0.995	1.039	1.016	1.042

Table 2.2 The decomposition of total factor construction energy efficiency in 2005–2010 (by region)

Region	Technical efficiency	Technology progress	Pure technical efficiency	Scale efficiency	Total factor energy efficiency
Beijing	1	1.095	1	1	1.095
Tianjin	0.927	1.121	0.923	1.004	1.039
Hebei	0.999	1.068	0.999	1	1.067
Shanxi	0.984	1.076	0.982	1.004	1.059
Neimenggu	0.952	1.119	0.946	1.004	1.063
Liaoning	0.977	1.058	0.994	0.983	1.034
Jilin	1.021	1.107	1.045	0.977	1.131
Heilongjiang	1	1.022	1	1	1.022
Shanghai	1	1.066	1	1	1.066
Jiangsu	1.014	1.039	1	1.014	1.054
Zhejiang	1	1.031	1	1	1.031
Anhui	0.989	1.041	0.991	0.998	1.031
Fujian	0.902	1.045	0.903	0.999	0.942
Jiangxi	0.937	1.016	0.938	0.999	0.952
Shandong	0.952	1.132	1.062	0.895	1.073
Henan	0.978	1.042	0.976	1.002	1.019
Hubei	0.943	1.063	0.942	1.001	1.003
Hunan	0.975	1.043	0.974	1.001	1.017
Guangdong	0.923	1.045	1.034	0.892	0.965
Guangxi	1.085	1.055	1.062	1.022	1.145
Hainan	0.948	1.088	1	0.948	1.031
Chongqing	0.994	1.065	0.996	0.998	1.058
Sichuan	0.995	1.023	0.994	1.001	1.015
Guizhoou	0.995	1.077	1.003	0.991	1.071
Yunan	0.983	1.041	1.009	0.974	1.023
Shanxi	0.919	1.073	0.929	0.989	0.986
Gansu	1.012	1.065	1.038	0.975	1.078
Qinhai	0.982	1.096	1.016	0.966	1.076
Ningxia	1	1.071	1	1	1.071
Xinjiang	0.944	1.138	0.978	0.966	1.074
Average	0.977	1.067	0.993	0.986	1.042

experienced the highest growth rate of 14.5 %. It could be found that the improvement in construction energy efficiency mainly came from technological progress, all provinces had technical progress in construction industry, and highest speed of technological progress in Xinjiang reached 13.8 %.

However, the enhancement in technical efficiency only was observed in eight provinces, accordingly technical efficiency declined in 22 provinces, thus low technical efficiency would become a main constraint of improvement in construction energy efficiency.

2.3 Impact Factors of Construction Energy Efficiency

Energy efficiency may be affected by many factors, such as industrial structure, energy consumption structure, and etc. where the impact of industrial structure, energy consumption structure, the technical level of construction enterprises and enterprise strength on the construction industry energy efficiency would be briefly analyzed in this paper.

Where, the proportion of service sector, the ratio of industrial to service sectors will be used for estimating industrial structure; the consumption proportion of the coal, oil and electricity to would be used to measure the energy consumption structure of regional construction industry; the rate of technical equipment would be used to reflect the technical level of regional construction enterprises; and finally the proportion of special-class and first-class construction enterprises would be used to reflect the corporate strength of regional construction companies.

To simplify the discussion, we only calculated *Pearson* correlation coefficient between construction energy efficiency and its influencing factors in 2010, by which the indirect impact of these four factors on the construction energy efficiency would be studied, as shown in Table 2.3.

According to Table 2.3, we can reach the following conclusions:

1. Industrial structure have an important impact on construction industry energy efficiency, the correlation coefficient of service sector reached 0.378, while the correlation coefficient of the ratio of industrial to service sector arrived to −0.226. It indicates that service sector with lower energy consumption has a positive role in improving energy efficiency; correspondingly industrial sector with high energy consumption would be harmful to improving energy efficiency.
2. Also the energy consumption structure have a significance on construction energy efficiency. Where, the more the primary energy consumption ratio of coal, petroleum products consumption, the lower the energy efficiency; oppositely, as a secondary energy increase in electricity consumption will have an active part in improving construction industry energy, whose correlation coefficient reaches 0.450.

Table 2.3 *Pearson* correlation coefficient of construction energy efficiency and relevant factors

Factor	Indicator	Correlation coefficient
Industrial structure	The proportion of service sector	0.378
	The ratio of industrial to service sector	−0.226
Energy consumption structure	The consumption ratio of coal	−0.137
	The consumption ratio of petroleum	−0.179
	The consumption ratio of electricity	0.450
Technology level	The rate of technical equipment	0.138
Enterprise strength	The proportion of special-class and first-class enterprise	0.197

3. The technology level has a positive impact on the improvement in construction industry energy efficiency, and the correlation coefficient arrives to 0.138. It is consistent with usual anticipation, higher rate of technical equipment means higher technical level; thus more modern construction machinery and equipment are used, less labor input but more high productivity, accordingly more conducive to improvement in energy efficiency.
4. Qualification grade is an important indicator to measure the strength of construction enterprises, the higher qualification grade, the greater financial strength, technical level and personnel quality. Consistent with usual expectations, the stronger the enterprise strength the higher energy efficiency of construction industry, and the correlation coefficient reaches 0.197.

2.4 Conclusion

By the analytical framework of total factor energy efficiency, a DEA model was designed study China's provincial energy efficiency of construction industry during 2005–2010. The results have shown that, during this period, the average energy utilization efficiency of China's construction industry has increased to a certain extent, but technology innovation only has limited impact on the improvement of construction energy efficiency; there are significant differences in construction energy efficiency among regions, generally the construction energy efficiency in eastern coastal areas is relatively higher, while inefficient utilization of energy in construction industry has been observed in central-western regions. Finally, industrial structure, energy consumption structure, enterprise strength and technology level have important impacts on the provincial construction energy efficiency, thus adjustment of industrial structure and energy consumption structure, enhancement of enterprise strength and technology level would have significance on the energy efficiency in provincial construction industry.

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Chapter 3
Study on Sustainable Development Social Influence Elements of Construction Project

Jun Kou and Jun Shen

Abstract Study on sustainable development social influence elements of construction project is great significance to promote the implementation of the sustainable development strategy. Based on the current researchers are mainly concentrated on studying on the sustainable development social evaluation method of construction project. This paper use expert investigation method and reliability analysis method to design the sustainable development social influence elements frame system of construction project, provide the following researchers more clearly evaluation content.

Keywords Construction project • Sustainable development • Social influence elements • Reliability analysis

3.1 Introduction

With the sustainable development of construction project increasingly importance in today's society, many international organizations, research institutions, experts and scholars are actively carry out the strategy of sustainable development theory and research in the world. Until now has made the distinct progress and the success [1]. Through the Literature study found that researchers' research is focused on the social evaluation methods of construction projects and evaluation

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_3,

methods of construction projects sustainable development. For instance, some discussions on the construction project sustainable development use life cycle environmental impact analysis [2]. Sustainability assessment was first introduced on the construction project that used the ecological footprint method and energy analysis method [3]. However, there are few studies on sustainable development social influence elements of construction project. Therefore, to design a authoritative, normative framework system of construction project sustainable development that can cover the social influence elements, to offer some basic research materials for sustainable social evaluation indicators and methods of construction project.

3.2 The Selection Principle and Research Methods of Social Influence Elements

3.2.1 Selection Principle

The social influence elements of construction project sustainable development are different depending on the project category. The project involves a very wide, and must reflect the need on sustainable development. Therefore, the design of social influence elements can not cover everything. You must grasp the public factors, and select those core elements of the construction project sustainable development from the social point of view.

3.2.2 Research Methods

By collecting and reading the literature, analysis the domestic and foreign research situation, drawing on the latest research results in the field of sustainable development in construction project, summed up the social influence elements of construction project sustainable development, and designed questionnaire. Mainly research methods: literature research, expert survey, etc.

The paper mainly used reliability analysis of SPSS 17.0 software for dealing with the results of the expert survey data, and filtering out the social influence elements of construction project sustainable development. At last, to design a scientific and comprehensive social influence elements framework system of construction project sustainable development. Mainly research methods: mathematical statistics, reliability analysis, etc.

3.3 The Social Influence Elements Framework System of Construction Project Sustainable Development

3.3.1 The Social Influence Elements Connotation of Construction Project Sustainable Development

The framework system of construction project sustainable development include five parts: social influence elements, economic influence elements, environmental influence elements, technology influence elements and management influence elements. This paper illustrates the connotation of construction project sustainable development only from the social influence perspective. The connotation means the analysis of construction project based on as far as possible an equitable distribution, achieving the goal of development of human society.

3.3.2 The Social Influence Elements Framework System

The social influence elements framework system includes the following four aspects. As is indicated in Fig. 3.1:

- Social benefits elements
  Social benefits elements include three aspects: benefit to society environmental, benefit to regional development and benefit to residents around the project. Specifically as shown in the Table 3.1:
- Social mutual adaptability elements
  Social mutual adaptability elements include three aspects: adaptability to national and regional development objectives, adaptability to the needs of local residents and the attitude of relevant groups. Specifically as shown in the Table 3.2:
- Social justice elements
  Social justice elements consist of two parts: The first part, the fairness of the distribution of social resources in order to ensure the fairness of the allocation of resources such as land and space; The second part, the fairness of the distribution of other interests in order to ensure the fairness of distribution benefits of the construction project, and bring the parties to the coordinated development. Specifically as shown in the Table 3.3:
- Social risk elements
  Social risk elements include two aspects: social risk of human and social risk of system, from the integration of the project local cultural and the perfection degree of the project supporting system to evaluate the project. Specifically as shown in the Table 3.4:

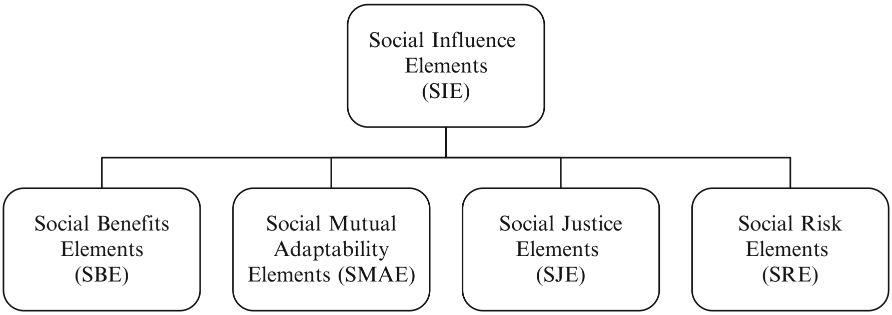

Fig. 3.1 The social influence elements framework system of construction project sustainable development

Table 3.1 Social benefits elements

Level 2 elements	Level 3 elements
SBE1 benefit to society environmental	SBE1.1 Benefits to the social cultural and education
	SBE1.2 Benefits to the political and social security
	SBE1.3 Benefits to the image of cities and regions
SBE2 benefit to regional development	SBE2.1 Benefits to regional land resources development and utilization
	SBE2.2 Benefits to urban infrastructure
	SBE2.3 Benefits to the local technical development
	SBE2.4 Benefits to urban process and service facilities
SBE3 benefit to residents around the project	SBE3.1 Benefits to social population
	SBE3.2 Benefits to life quality
	SBE3.3 Benefits to residents' income and employment
	SBE3.4 Benefits to vulnerable groups
	SBE3.5 Benefits to interpersonal relation

Table 3.2 Social mutual adaptability elements

Level 2 elements	Level 3 elements
SMAE1 adaptability to national and regional development objectives	SMAE1.1 Consistency of the project objectives and the regional development strategy
	SMAE1.2 The importance of the project for countries and regions
SMAE2 adaptability to the needs of local residents	SMAE2.1 The adaptability of the local population needs
	SMAE2.2 Acceptability of the project culture and technology
SMAE3 the attitude of relevant groups	SMAE3.1 The attitude of the different interest groups
	SMAE3.2 The attitude of the local types of organizations

Table 3.3 Social justice elements

Level 2 elements	Level 3 elements
SJE1 the distributive fairness of social resources	SJE1.1 The fairness of the land and space allocation of resources
	SJE1.2 The fairness of the public utilities
SJE2 the distributive fairness of other interests	SJE2.1 Degree of information disclosure
	SJE2.2 The fairness of the stakeholders
	SJE2.3 The fairness of the compensation object
	SJE2.4 The fairness of the project object
	SJE2.5 The fairness of income distribution

Table 3.4 Social risk elements

Level 2 elements	Level 3 elements
SRE1 social risk of human	SRE1.1 The integration degree of project with the local customs and religious
	SRE1.2 The damage degree of the local cultural landscape
	SRE1.3 The integration degree of settlement and local residents
SRE2 social risk of system	SRE2.1 The improvement degree of information publicity system
	SRE2.2 The improvement degree of information publicity system
	SRE2.3 The improvement degree of social risk accountability system

3.4 The Elements Reliability Analysis

3.4.1 Respondents and Research Stages

3.4.1.1 Respondents

The respondents are all researchers about the sustainable development of construction project, and they have senior professional titles or above the master's degree. A total of 30 people, including 14 (four Doctor, six masters) professors (professors and associate professors), accounting for 47 %, and 16 senior engineers (six Doctor, six masters), accounting for 53 %. Thirty questionnaires were sent out and 30 available questionnaires were retrieved. The recovery rate is 100 %.

3.4.1.2 Research Stages

The design of questionnaire. This questionnaire includes 31 questions, divided into specific four domains. There are social benefits elements, social mutual adaptability elements, social justice elements and social risk elements. The questionnaire options are divided into five levels. “1” is “very unimportant”, “3” is “unimportant”, “5” is “the general important”, “7” is “the more important”, “9” is “very important”.

The distribution and the callback of questionnaires. The Scoring results of 30 experts were classified statistic.

Statistical data processing. The data was analyzed by SPSS 17.0 software and obtain the Cronbach's Alpha reliability coefficients.

3.4.2 The Results of Reliability Analysis

Through the SPSS 17.0 software got that Cronbach's Alpha of SBE is 0.83, Cronbach's Alpha of SMAE is 0.78, Cronbach's Alpha of SJE is 0.70, Cronbach's Alpha of SRE is 0.85, Cronbach's Alpha of overall is 0.89. Specifically as shown in the Table 3.5:

Table 3.5 The results of reliability analysis

Domain	Item	Corrected item-total correlation	Cronbach's alpha if item deleted	Cronbach's alpha
SBE	SBE1.1	0.70	0.82	0.83
	SBE1.2	0.74	0.81	
	SBE1.3	0.40	0.83	
	SBE2.1	0.84	0.80	
	SBE2.2	0.80	0.81	
	SBE2.3	0.89	0.79	
	SBE2.4	0.80	0.81	
	SBE3.1	0.82	0.80	
	SBE3.2	0.90	0.80	
	SBE3.3	0.80	0.80	
	SBE3.4	0.74	0.80	
	SBE3.5	0.58	0.82	
SMAE	SMAE1.1	0.67	0.75	0.78
	SMAE1.2	0.55	0.80	
	SMAE2.1	0.63	0.73	
	SMAE2.2	0.55	0.73	
	SMAE3.1	0.56	0.76	
	SMAE3.2	0.73	0.73	
SJE	SJE1.1	0.59	0.68	0.70
	SJE1.2	0.69	0.62	
	SJE2.1	0.53	0.66	
	SJE2.2	0.41	0.75	
	SJE2.3	0.57	0.64	
	SJE2.4	0.57	0.63	
	SJE2.5	0.52	0.69	
SRE	SRE1.1	0.68	0.82	0.85
	SRE1.2	0.78	0.79	
	SRE1.3	0.14	0.89	
	SRE2.1	0.54	0.83	
	SRE2.2	0.75	0.80	
	SRE2.3	0.68	0.81	
Overall	All of the above	–	–	0.89

Table 3.6 Reliability results of each dimension and overall

Domain	Cronbach's alpha	Range	Implied reliability
SBE	0.83	0.8~0.9	Very good
SMAE	0.78	0.7~0.8	Respectable
SJE	0.70	0.7~0.8	Respectable
SRE	0.85	0.8~0.9	Very good
Overall	0.89	0.8~0.9	Very good

3.4.3 Analysis of Results

The overall and component reliability coefficients are very good or respectable range. Therefore, this questionnaire fully meets the requirements, and the elements are reliable. As is indicated in Table 3.6.

But there are some problems in the questionnaire: Some elements (e.g. SMAE1.2, SJE2.2 and SRE1.3) have a large room for improvement. The Cronbach's Alpha reliability coefficients become larger if item deleted. Therefore, if you want to improve the reliability coefficient of the questionnaire, the primary consideration should be given to modify or delete these elements in order to raise the level of reliability (refer to Table. 3.5).

3.5 Conclusions

Sustainable development is a new human development thinking and development strategy. It requires the development of human civilization with a new outlook, values and morals. The sustainable development of the construction project is an important indicator of human civilization. Through designing the social influence elements framework system of construction project sustainable development, this paper solves the blindness of the construction project sustainable development social evaluation. It provides reference for construction project sustainable development research, and has important theoretical significance.

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Chapter 4
Sustainable Construction Project Life-Cycle Management Based on Building Information Modeling

Guiyou He, Guangbin Wang, and Honglei Liu

Abstract Initial construction costs are overly concerned in traditional construction projects and the economic, social and environmental impacts are neglected during their whole life cycle. The application of Life Cycle Management (LCM) is fundamental in pursuing sustainability and improvements in the construction industry. Based on the current situation of LCM and Building Information Modeling (BIM), this paper proposes a theoretical model of BIM-based information integrated platform for sustainable construction projects. Process models for LCM and the design phase implementing BIM-based information integrated platform are built using IDEF0 modeling method. Then, the whole process of using BIM-based information integrated platform in sustainable construction projects is analyzed through its application in a real-life construction project in Shanghai. This paper analyzes the function and application methods of BIM to promote sustainability in each phase. Meanwhile, some important best practices are analyzed and discussed, which are significant to future projects. The results of applying BIM-based LCM method are evaluated through one-to-one expert evaluations interviews. The findings show that applying BIM-based information integrated platform to the full building life cycle is vital to reduce environmental loads and improve sustainability.

Keywords Building information modeling • Sustainable construction • Life cycle management • IDEF0

4.1 Introduction

The construction, operation and demolition of a building have tremendous impacts on the global energy and environment. With the facilities contributing 40 % of the carbon emissions to the atmosphere and 20 % of material waste to landfills, the

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_4, © Springer-Verlag Berlin Heidelberg 2014

construction industry has a responsibility to use the earth's resources as efficiently as possible [1]. Initial construction costs are overly concerned and the economic, social and environmental impacts are often neglected in traditional construction projects. It is much more cost-effective to design and build from the ground up rather than retrofit afterwards because of the long life of buildings. As such, advanced design and management tools are needed to justify the initial investment for sustainable construction.

LCM has been introduced into the management of construction projects in recent years [2]. It is believed that LCM can be applied to the whole construction process, thus making it possible to improve sustainability indicators and also minimize the environmental loads of the full building life cycle [3]. The application of LCM is fundamental in pursuing sustainability and improvements in the construction industry. However, the life cycle of construction projects is traditionally separated into several independent and contiguous phases, e.g., planning, design, construction, operation, etc., and there are almost no communication or interaction between participants in each phase [4]. This frequently leads to numerous reworks and changes during the construction and hence reducing the sustainability. LCM approach can integrate all phases of the project lifecycle and support information sharing and intra- and inter-organizational collaboration. On the one hand, this promotes realization of the three traditional objectives (time, cost and quality). On the other hand, it enhances the sustainability of construction products and processes.

BIM is a building lifecycle management tool of well understood information exchanges, workflows, and procedures used throughout the building lifecycle [1]. BIM can also fulfill new requirements which are brought by the interdisciplinary and hence complex nature of sustainable constructions. The increased complexity of the sustainable construction project results from the objective diversity and from inter-organization collaboration, where participants from different disciplines and different organizations need to work together to construct a sustainable product. Because of the complexity nature of sustainable project, a great deal of information should be managed and the information should be open, transparent, consistent, and easy to access. Two-dimensional (2D) drawings cannot fully meet the demands of information communication and cooperation among different parties. This challenge can be mastered by using BIM-based approach in the lifecycle of sustainable projects. To demonstrate this, a case study has been carried out based on the application of the BIM-based LCM approach.

4.2 BIM-Based Life-Cycle Information Integrated Platform

A construction project consists of several phases from planning to demolition. Succar [5] argues that construction projects pass through three major phases: Design, Construction and Operations. Focusing on the effects of BIM on various phases, this paper adopts a simplified subdivision and includes five major phases: Planning (P), Design (D), Construction (C), Operation and Maintenance (O&M), Demolition (De).

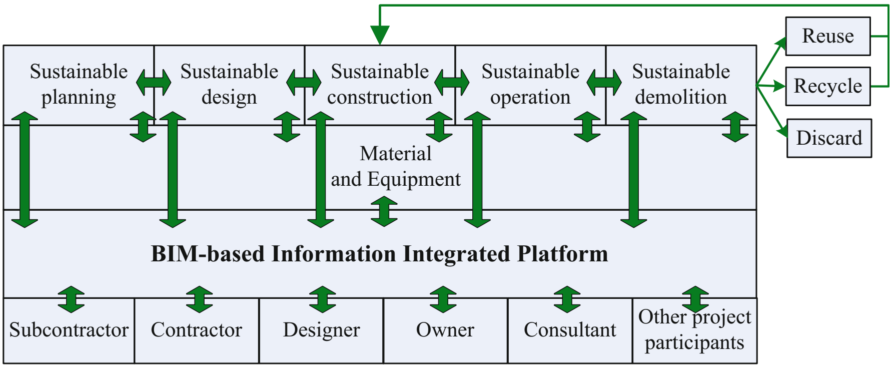

Fig. 4.1 Model of BIM-based information integrated platform

Despite a wide range of positions and opinions on the subject of sustainability, there is a general agreement that the current paradigm of linear development, which disregards constraints to material or energy consumption, is unsustainable. The life cycle of traditional project is an unsustainable linear process and the material and waste in the demolition phase are discarded. The life cycle of sustainable project presented in Fig. 4.1 highlights a cyclic sustainable process. In order to produce a sustainable project, LCM is useful as an overall planning, co-ordination and control approach. A theoretical model of BIM-based information integrated platform for sustainable construction project is developed as shown in Fig. 4.1. Through this information platform, inter-organization communication and collaboration would be more efficient.

Based on the model in Fig. 4.1, process model of the BIM-based information platform for sustainable construction project is developed using IDEF0 modeling method. The IDEF0 modeling method is employed to develop a visual representation of the processes in the modeled system. For this research, IDEF0 diagrams are used to give a formal representation of the processes of BIM-based LCM for sustainable project. IDEF0 diagram includes the FUNCTION component which represents the main activity that is taking place and is used to transform the INPUT, which is an object or data, into the OUTPUT. The CONTROL component represents the constraints on the system and the MECHANISM is the means of which the activity can take place [6].

The process model show clearly, in a readable and understandable format, the processes that BIM is implemented in different lifecycle phases (see Fig. 4.2). Also, these diagrams allow project participants to visualize the important constraints and mechanism in each phase. Meanwhile, the outputs can easily be modified and stored on the BIM-based information integrated platform. The cooperative practices among various organizations in the building sector to produce sustainable products, can be modeled as an inter-organizational collaboration process. The team can be called an inter-organization and multidisciplinary collaboration team (see Figs. 4.2 and 4.3). It is formed around the goal of producing sustainable building. Owner, BIM consultant, sustainable building consultant, designer, general contractor and

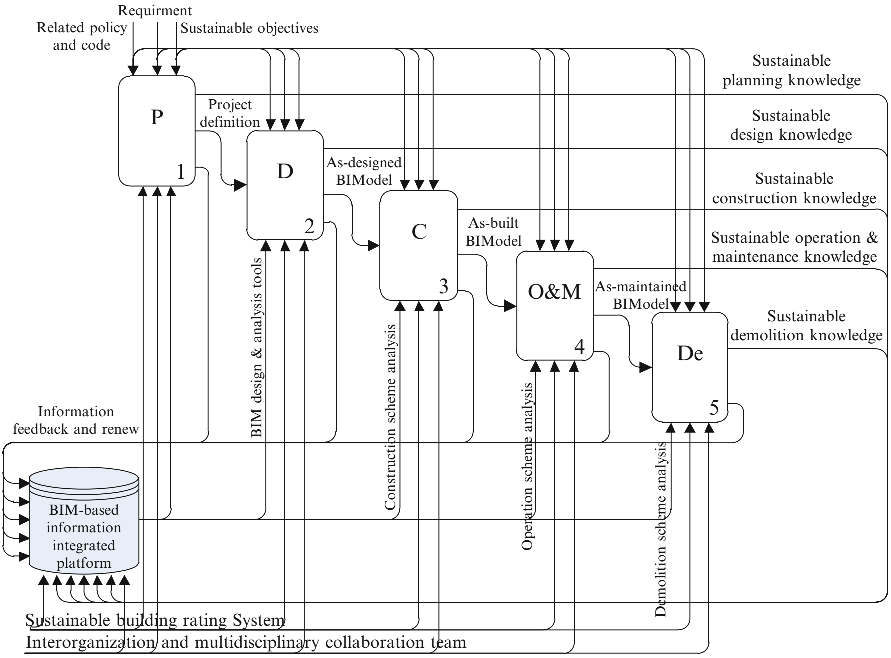

Fig. 4.2 Process model of the BIM-based LCM for sustainable construction project

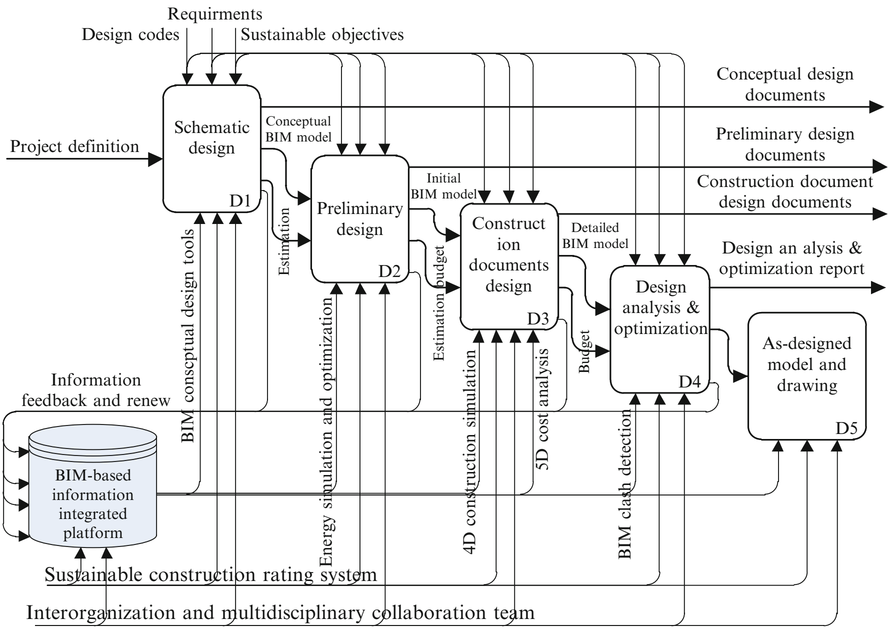

Fig. 4.3 Process model of BIM-based sustainable design

the key subcontractors work together. The inter-organization collaboration results in the sharing of critical resources and facilitates sustainable knowledge transfer among organizations. It also facilitates the creation of new knowledge and produce synergistic solutions [7]. The knowledge of the sustainable best practices generated in each lifecycle phase can be shared among the inter-organization and multidisciplinary collaboration team (see Fig. 4.2). This is the key to the success of a sustainable project.

4.3 Process of Using BIM-Based LCM: A Case Study

The whole process of using BIM-based LCM platform in sustainable construction projects is analyzed through its application to a real-life construction project in Shanghai–South Underground Plaza and North–south Corridor project (SUPNSC) of Shanghai West Railway Station Transportation Hub. This project is a mega project in Shanghai. The owner (Putuo district government) plays the leading role in promoting sustainability of the project and committed to constructing green building by applying BIM at the beginning of the project. Research institutions of sustainable building formulated 'sustainable construction standards' for the owner at the beginning of the project. Following this, they made the 'sustainable construction guidelines' based on the standards to make it more easily used in the project life cycle management process. Both the standards and the guidelines provide a detailed plan for keeping sustainability in whole process of project implementation, including design, construction and operation. Based on the commitment of sustainability, the owner establishes an inter-organization collaboration mechanism and the key participants designate the related field experts to work in this team, like a multidisciplinary organization. Life cycle management thinking is implemented in each project decision-making process. The project adopts a General Contract Management mode.

4.3.1 Planning

At the beginning of the planning phase of the SUPNSC project, BIM is a powerful tool in Sunken Plaza planning. Figure 4.4 shows the final layout of south plaza ground. As shown in Fig. 4.4, Sunken Plaza is to sink the plaza and then decorate the sunken level with mosaic floors, fountains, flowers in an attempt to make the area as attractive as possible. Such an arrangement will increase natural ventilation and lighting, and hence reduce energy consumption. BIM model provides a platform for the designer to obtain the requirements and ideas of the owners quickly, while the owners find it easy to understand the digital model provided by the designer. The digital model improves communication among consultant, designer and owner. The information captured in the planning phase will guide the following design activities.

Fig. 4.4 Planning of the South Underground Plaza

4.3.2 Design

Figure 4.3 shows the general design process based on BIM, which is not a fixed process. The design of SUPNSC project uses products from Autodesk Inc. The BIM-based information integrated platform is customized using the software, such as Autodesk Revit Architecture, Autodesk Revit Structure, Autodesk Revit MEP and Autodesk Navisworks. Revit is the best known and current leader for the use of BIM in building design and was introduced by Autodesk in 2002. Owing to the feature of the design software, architecture model, structure model and MEP/FP model are separately developed in SUPNSC project (see Figs. 4.5, 4.6 and 4.7). This method will lead to conflicts between different systems. As such, an integrated model is produced by combining sub-models into a single model for whole-project review. Inter-organization collaboration is very important to a sustainable project in design review and analysis. Through the BIM-based information platform, the clash and interface detection activities are carried out to find any clashes and interferences before the construction process. As shown in Fig. 4.8, Autodesk Navisworks is used to identify the clashes based upon the integrated model, e.g. the clash between air duct and two beams in the SUPNSC project (see Fig. 4.8).

Sustainable building rating system guides every design processes. Green building research institute worked with designer to do energy simulation analysis and main equipment selection analysis, e.g. air conditioner and air blower, etc. The virtual building is built and tested in the computer and many design errors and constructability issues are identified and solved. Reworks and unsustainable plans are reduced or eliminated because of the application of BIM. Additionally, the final simulation can capture and save much knowledge for future projects and support future maintenance [4].

The green building standard and guideline developed in the planning phase guide the whole design and design analysis process. For example, under these guidelines of sustainability, this project also adopts rainwater harvesting technology. The rainwater will be used to irrigate the landscape plants and flush toilets in SUPNSC project,

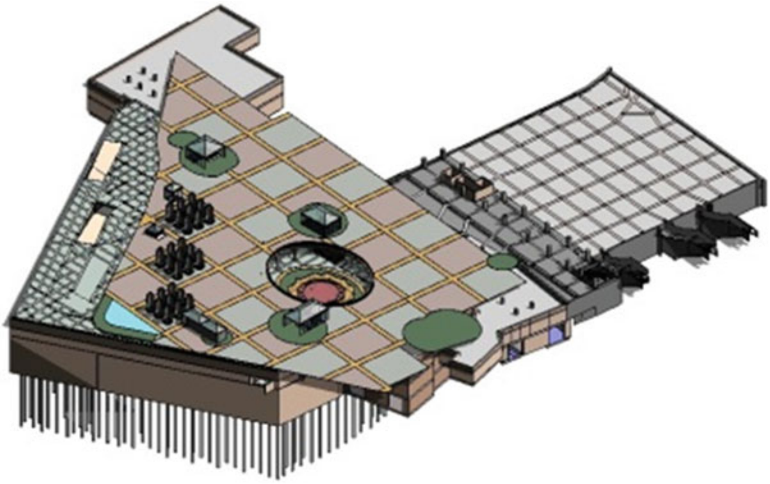

Fig. 4.5 Architecture model of SUPNSC

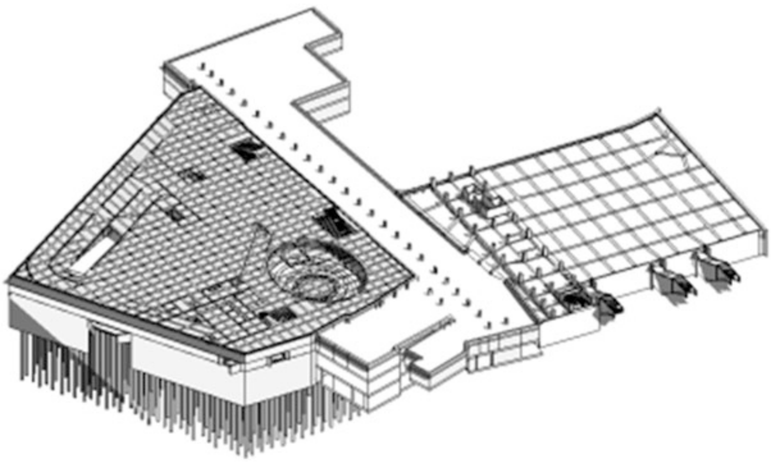

Fig. 4.6 Structure model of SUPNSC

which will help to achieve an excellent rating of sustainable building rating system in terms of water conservation. The pipeline design of the rainwater gathering system will use Autodesk Revit MEP.

4.3.3 Construction

In the construction phase, the focus of the BIM-based LCM is on constructability analysis and sustainable construction analysis. 4D construction simulation and 5D

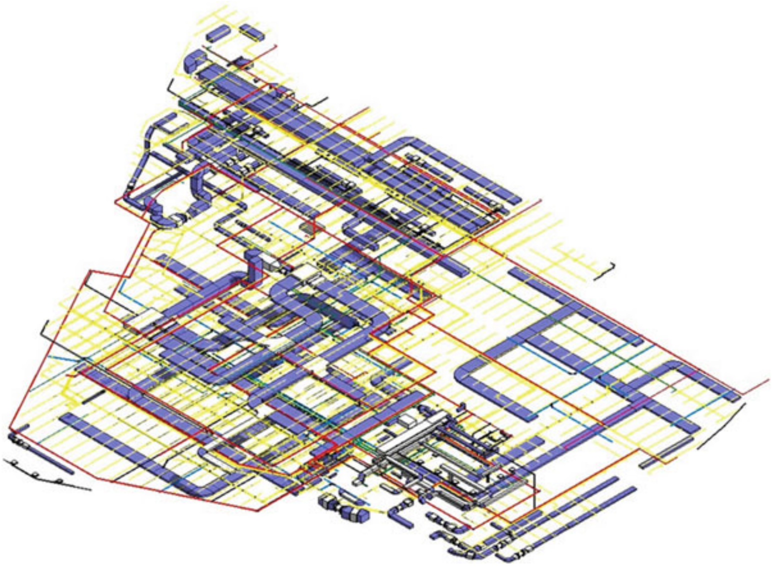

Fig. 4.7 MEP model of SUPNSC

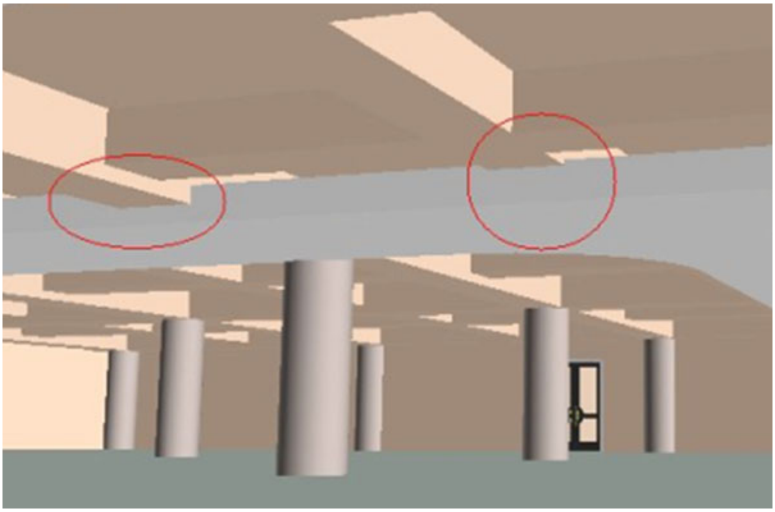

Fig. 4.8 Collision between air duct and beams

cost analysis are conducted to find the optimal construction method in the SUPNSC project which uses an inverse sequence construction approach. Instead of adopting bottom-up construction method, the project employs a top-down construction method. The primary purpose of this method is to ensure the safety of surrounding buildings and facilities, such as Metro Line 11, Railway Line and Shanghai west

Railway Station. As the project is located in the downtown area and the space of the construction site is limited, there is not enough space for the building material and construction equipment. The top-down construction method can solve the construction site layout problem as well. The General Contractor Manager and the key sub-contractors work with designer using 4D construction simulation method to analyze constructability. This cross-organization collaboration mode can reduce the rework and the number of request for information (RFI).

4.3.4 Operation and Maintenance

After the delivery of the project, the platform provides an as-built BIM model for the operation and maintenance of the building (see Fig. 4.2). The as-built model is a 'digital makeup' of the project and provides visual information for facility manager to organize the operation and maintenance of the building. Contrast with traditional 2D drawings, the digital model is easy to be understood by facility manager. It also can help facility manager to make a reasonable operation and maintenance plan. BIM-based facility management software is already developed. At the same time, the as-built model stores the parameters and production information of equipment, such as performance parameter, manufacturer's name, contact information, etc. The facility manager can easily access the relevant information.

Regarding the operation and maintenance phase, this part takes into account the activities needed to keep the building in good condition during the occupation phase. Proper plan of operation and maintenance can increase the service life of a building, reduce the material and energy consumption, and enhance the sustainability of the building.

4.3.5 Demolition

The demolition phase often results in waste disposal or recycling of building materials such as concrete, wood, drywall and metal. At the end of building lifecycle, based on the as-maintained model (see Fig. 4.2), the key structures, materials and equipment can be identified and can be fully reused or recycled. Although the cost could be higher because of the extra effort required in selecting the materials for reuse or recycle, the negative impacts to the environment will be effectively reduced. The 'sustainable construction standards' and 'sustainable construction guideline' have made a detailed plan and provide a meaningful guide to the demolition. From the view point of the LCM, these have been taken into account in the design and construction phase. Although this phase generates a lot of environment effects, the demolition phase is not usually significant considering the implementation scope of BIM.

4.4 Questionnaire Survey and Analysis Based on SUPNSC Project

The LCM research of sustainable construction project is a longitudinal study, which needs several years from implementation to results. This project was in progress at the time of writing; therefore a complete evaluation of the sustainable benefits of the BIM-based LCM is not feasible. The results of applied BIM-based LCM are evaluated through a questionnaire survey (see Table 4.1) during the construction process. After completing the questionnaire survey, five experts from each organization are chosen for an one-to-one expert evaluations interviews. The experience of the respondents in the construction industry is quite respectable. Thirty-eight percent of survey respondents have more than 10 years' experience in sustainable construction and the others have more than 5 years' experience. All the respondents are from the inter-organization team of the SUPNSC project and take part in the process of using BIM. So, opinions and views on the relevance of BIM-based LCM approach obtained through the survey can be regarded as important and reliable.

Since the Brundtland Report, the concept of sustainability has been further developed to include three aspects, or pillars: the environmental, economic and social pillars [8, 9]. Based on Triple Bottom Line (social, environmental and economics)) of sustainable development, China's Evaluation standard for green building (GBT50378-2006), LEED and related research literature and evaluation indicators are developed (see Table 4.2). Likert-scale items are commonly used to investigate the attitudes of respondents to a series of written or verbal statements (items). The response scales represent the contribution of BIM-based LCM to the sustainable project and are defined by endpoints such as 'extremely important' to 'least important'. Severity index analysis is selected in this study to rank the criteria according to their relative importance. The following formula is used to determine the severity index [10]:

$$\text{Severity Index(S. I.)} = \frac{1}{5}\left(\sum_{i=1}^{5} \omega_i \frac{f_i}{n}\right) \times 100\% \tag{4.1}$$

where i is the point given to each criterion by the respondent, ranging from 1 to 5; ωi is the weight for each point (=rating in scale of points, which "1" is the least important and "5" is the extremely important); fi is the frequency of the point i by all respondents; n is the total number of responses. Four important levels are transformed from S.I. values: More ($0.75 \leq$ S.I. ≤ 1), Much ($0.4 \leq$ S.I. < 0.75), Little ($0.2 \leq$ S.I. < 0.5), and Less ($0 \leq$ S.I. < 0.25). More, Much, Little and Less represent the degree of contribution of BIM-based LCM approach to SUPNSC project.

As a simple questionnaire survey of using BIM-based LCM approach, the contribution to the sustainability is analyzed (see Table 4.2). The results show that BIM is a powerful technology to promote the sustainability of the project during the entire life cycle. As shown in Table 4.2, BIM-based LCM approach has a tremendous impact on the three traditional objectives (time, quality and cost). Meanwhile, it also has many advantages to En-KPIs and So-KPIs. The five experts

Table 4.1 Questionnaires and responses

Respondents	Number of questionnaires: Final sent-out	Number of questionnaires: Valid responses	Percentage (%)	Response rate (%)
Owners/Developers	6	3	18.75 %	50.00 %
Designers	8	4	25.00 %	50.00 %
Contractors	10	4	25.00 %	40.00 %
Key subcontractors	6	2	12.50 %	33.30 %
Green building consultants	8	3	18.75 %	37.50 %
Total	38	16	100.00 %	42.11 %

Table 4.2 Contribution of BIM-base LCM approach to the sustainable project

Key performance indicators (KPIs) Based on TBL	Sub-indicators	Severity index	Impact
Environmental Indicators group (En-KPIs)	En1: Energy effciency	0.775	More
	En:2 Water consumption and water conservation	0.788	More
	En3: Materials consumption	0.525	Much
	En4: Land use and site selection	0.575	Much
	En5: Pollution generation	0.638	Much
	En6: Resuable/recycle elements	0.363	Little
Socio-Cultural Indicators group (So-KPIs)	So1: Workers' health and security	0.613	Much
	So2: Functionality, usability and aesthetic aspects	0.600	Much
	So3: Labor availability	0.238	Less
	So4: Indoor environmental quality	0.575	Much
	So5: Architectural considerations – cultural heritage integration and the compatibility with local heritage value	0.225	Less
	So6: Innovation and design process	0.763	More
Economic Indicators group	Ec1: Construction time	0.563	Much
(Ec- KPIs)	Ec2: Initial construction cost	0.663	Much
	Ec3: Maintenance cost	0.500	Much
	Ec4: Disposal cost	0.363	Little
	Ec5: Whole lifecycle value	0.613	Much

participated in the interview quite agree with the findings and propose that BIM is a mega trend and will play crucial roles in improving sustainability in the construction industry.

4.5 Conclusions

LCM has not been successful in its applications as yet. That is because it lacks an effective information platform to support information sharing between different participants [4]. This paper proposes a model of BIM-based information integrated platform and its application is presented via process models using IDEF0 modeling method. Through a real-life project, the application processes of BIM-based LCM are demonstrated. The detailed sustainable advantages of the BIM-based LCM are tested using questionnaire survey and interview method. These models are developed toward sustainable projects, but can also benefit the traditional construction projects.

The SUPNSC project demonstrates a unique, yet successful example of BIM technology. Inter-organization collaboration team is composed of experts from well-known corporations in SUPNSC project and the owner plays a leading role in the team. Although this is a single case study, the five experts' strong agreement with the survey results is sufficient to partly validate that a BIM-based LCM approach can improve the sustainability indicators of construction project. To further validate BIM-based modeling approach, additional research is required to use multiple case study method.

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Chapter 5
BIM for Sustainable Construction: A Strategic Framework for Handling Challenges of the International Green Construction Code

Wei Wu and Hui Zhou

Abstract The 2012 edition of International Green Construction Code (IgCC) is the first model code dedicated to provide clear and specific requirements with provisions to promote sustainable construction in an integrated fashion within the International Code Council (ICC) family of codes. Unlike voluntary based green building rating systems, e.g. Leadership in Energy and Environmental Design (LEED), the IgCC will be enforced once adopted by local jurisdictions. To deal with the impacts and challenges posed by the IgCC, stakeholders will need a strategic framework. The paper proposed a building information modeling (BIM) leveraged approach. It reviewed the regulatory environment of sustainable design and construction, and successful implementations of BIM in meeting such regulatory requirements. The strategic framework was constructed by: (1) analyzing the structure, contents and enforcement of the IgCC to delineate the typical code compliance workflow; and (2) identifying the critical tasks and desired project submittals for the IgCC compliance, stressing on project information generation, exchange, collection and management facilitated by the evolving project BIM model(s). Detailed IgCC compliance guidelines can then be further developed based on this strategic framework.

Keywords International green construction code • Building information modeling • Compliance workflow • Strategic framework

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_5,

5.1 Introduction

Internationally, code officials recognize the need for a modern, up-to-date code governing the impact of buildings and structures on the environment [1]. The promulgation of the 2012 International Green Construction Code (IgCC) lays a solid foundation for the architecture, engineering, construction, owner and operator (AECOO) community to enforce sustainable practices at large. The IgCC is a collaborative effort of the International Code Council (ICC), the American Institute of Architects (AIA), ASTM International, American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), U.S. Green Building Council (USGBC) and the Illuminating Engineering Society (IES). As a model code, the IgCC encompasses a comprehensive set of provisions to address natural resources, materials, water and energy conservations, as well as indoor environmental quality and comfort, building commissioning, operation and maintenance for both new and existing buildings. What sets it apart in the world of green building is that it is created with the intent to be administered by code officials and adopted by governmental units at any level as a tool to drive green building beyond the market segment that has been transformed by voluntary rating systems [1].

Implementation of the IgCC is compatible with other applicable ICC building codes. But it does not prevent the use of any material, method of design, construction, system or innovative approach. In contrast, the provisions and enforcement of the IgCC are subject to the context of local jurisdictions, which affords them flexibility to meet their unique environmental and regional needs and goals. A tradeoff is that there will be no universal template for code compliance: jurisdictions, code officials, and project stakeholders have to work together to determine a realistic scenario in the IgCC adoption and enforcement. This research intends to investigate the possible leverage provided by recent development of building information modeling (BIM) in facilitating compliance with the IgCC. Base on established literature of BIM integration in sustainable design and construction, it is anticipated that jurisdictions, code officials, owners and project teams can all benefit from the BIM-centric approach. The goal of this research is to create a strategic framework of facilitating the compliance with the IgCC upon an information-rich and green construction oriented BIM platform. Detailed IgCC compliance guidelines can then be further developed based on this strategic framework.

5.2 Background

5.2.1 Regulatory Development of Sustainable Design and Construction

As of today, sustainable design and construction has developed from a specialty of a handful forward-thinking designers and constructors in the early 1990s into a gradually mainstreaming practice. This market transformation is partially attributed to increased awareness of anthropogenic impacts on the natural environment, while a major driver of the transition stems from commitments of policy makers and regulatory bodies, and eventually the advent of green building regulations. For instance, the USGBC's Leadership in Energy and Environmental Design (LEED) certification and similar programs (e.g. Green Globes by Green Building Initiative), which are voluntary in most jurisdictions, have elevated the level of design for many building types across the country. Often perceived as a de facto code, LEED has been adopted by many local jurisdictions and even federal agencies as a comprehensive green standard [2]. ICC has also been publishing the International Energy Conservation Code (IECC) since 2000, which have already been adopted in many jurisdictions. Newer and greener industrial standards have been taking on a comparable momentum. The ICC 700 National Green Building Standard [3] and the ANSI/ASHRAE/USGBC/IES Standard 189.1 [4] were milestones of these initiatives. In 2011, the first set of official mandatory sustainable design measures, named CALGreen was instated in California. Nevertheless, movement toward a model green code has been long in the making, for the sake of the following three major reasons:

- The increased importance of sustainable design and construction and the acceptance of sustainability in the mainstream of the AECOO industry.
- The imperative need to translate green aspirations into enforceable regulations.
- The need for consistency across jurisdictions to allow robust and well-informed decision-making in adopting and enforcing sustainability.

The IgCC addresses all three of these needs. It recognizes the centrality of sustainability in design and construction; it provides readily adoptable and enforceable language; and it allows for greater consistency in both its current application and its evolution. The IgCC is coordinated with the other I-codes, especially the IECC, providing the clarity and consistency of interpretation that all parties seek when designing, constructing, and inspecting a building (Fig. 5.1, [2]).

5.2.2 BIM for Sustainable Design and Construction

The integration of BIM in sustainable design and construction is witnessed along with the continuous improvement of software applications and enrichment of industry best practices. As Krygiel and Nies [5] pointed out, BIM could aid in the following aspects of sustainable design:

- Building orientation (to select the best building orientation that results in minimum energy costs)
- Building massing (to analyze building form and optimize the building envelope)
- Daylighting analysis
- Water harvesting (to reduce water needs in a building)

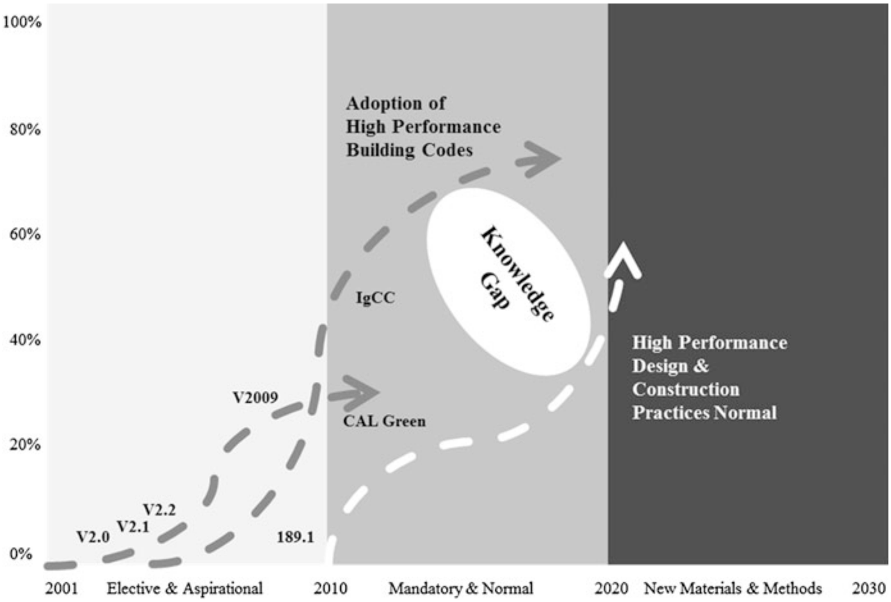

Fig. 5.1 U.S. overview – path of regulatory development in sustainable design and construction [2]

- Energy modeling (to reduce energy needs and analyze renewable energy options such as solar energy)
- Sustainable materials (to reduce material needs and to use recycled materials)

Energy performance is a major focus of green building design and construction. Policy mandates are driving increased stringency in energy codes (e.g. IECC) and standards (e.g. ASHRAE 90.1 and 189.1). Computerized simulation tools have long been utilized to configure and predict building energy performances. Traditionally, this is a laborious and expensive process. Major obstacles include the redundant input of parameters (e.g. geometry, materials and climate data) needed for the simulation from a design model into a simulation model, and the complexity of the simulation algorithm. Built upon parametric modeling principles, BIM offers designers an integrated and robust user interface, and an underlying database that captures standardized, structured building lifecycle information. Simulation results thus become more comprehensive, valid and accurate [6]. The easy linkage of BIM with Geographical Information System (GIS) empowers designers with regional specific climate information and realistic utility rates, producing meaningful energy consumption and cost scenarios according to owner's preferences. Perceived benefits like these have engendered strong uptake and implementation of BIM in green projects – noticeably the LEED projects as reported by McGraw-Hill Construction [7, 8]. Software vendors have recognized the unique business opportunities brought by the rapid engagement of BIM in the green building market

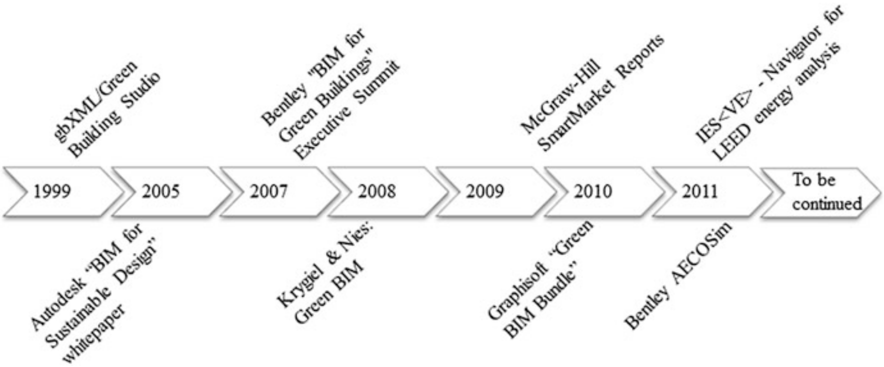

Fig. 5.2 A chronicle of BIM integration in sustainable design and construction [18]

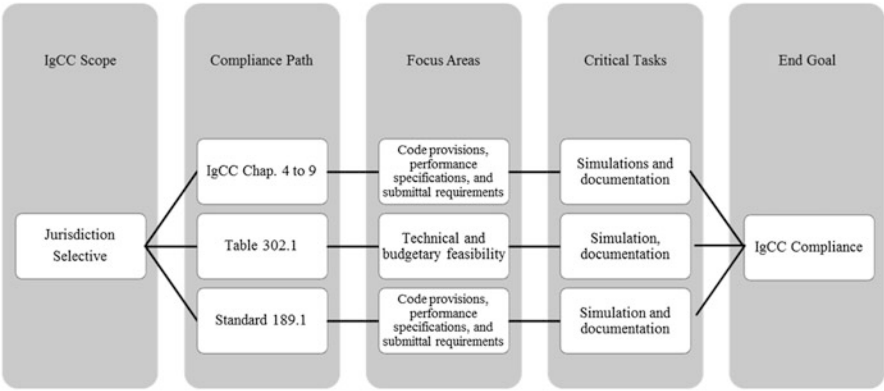

Fig. 5.3 The IgCC compliance workflow

transformation. Specialized software packages and enhancement in the forms of add-ons and plug-ins tailored for sustainability are proliferating. Fig. 5.2 illustrates a snapshot of this chronic development of the synergies between BIM and sustainable design and construction.

5.2.3 BIM and Code Compliance

When designers create a building information model in conformity with the code provisions, this highly dictated and rule-based BIM is likely to be utilized for code-compliance checking purpose. As Raslan and Davies [9] conjectured, BIM might become important digital assets that are not only key instruments in communicating design but also in obtaining approval from statutory bodies. The traditional manual checking of building designs for compliance against building codes was complex

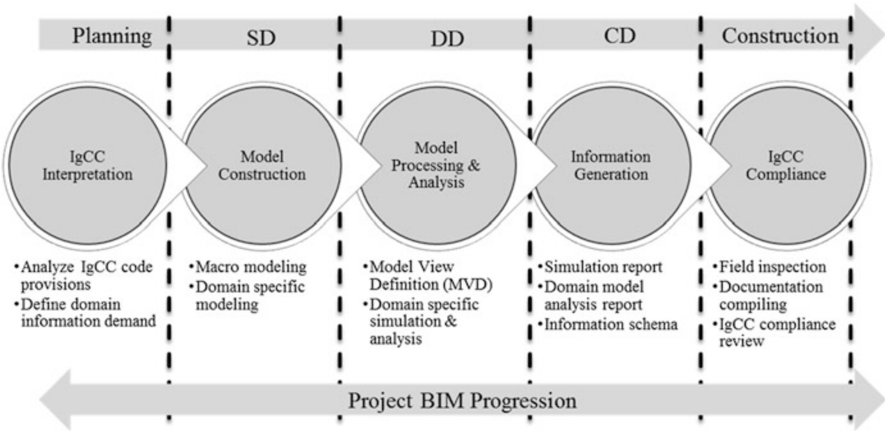

Fig. 5.4 The IgCC compliance – a BIM facilitated strategic framework

and prone to human error with significant cost implications [10]. Tan et al. [11] claimed that automated compliance checking would not only prove beneficial to designers but to also building certifiers, consultants, building code authorities, specification writers and builders.

Approaches to developing automated building code-checking have been reported in the literature for the last two decades [12]. The Construction and Real Estate NETwork (CORENET) was one of the first initiatives in automated code-checking, funded by the Singapore Ministry of National Development and carried out by the Construction and Real Estate Network since 1995 [13]. CORENET was later on emulated in Norway with the ByggSok system [14]. Driven by the Norwegian Building and Construction industry and supported by Standards Norway and Norwegian buildingSMART, the ByggSok system was heavily based on the industry foundation class (IFC) standard – an open standard of interoperability for information exchange across BIM software packages. In Australia, both the Solibri Model Checker (SMC) and Express Data Manager (EDM) were considered as possible platforms for automated code checking [15]. In the U.S., similar work on code-checking began in the United States around 2000, and a major driver of BIM and validation of BIM models is the U.S. General Services Administration (GSA). SmartCodes is another key project driven by the ICC, in conjunction with AEC3 and Digital Alchemy. This project has focused largely on addressing the problem of transforming paper-based codes into machine-interpretable rules. The rules can currently be executed using either Solibri Model Checker, or AEC3 XABIO [10]. The SmartCodes project does not support building code specific information that is not currently implemented by BIM vendors [12]. Most recently, in 2010, Fiatech launched the AutoCodes project with the objective of developing both the optimal methodology and the consistent guidelines necessary to transform the regulatory process, via applying the technology to enable automated code checking of BIM models. As of 2012, Phase 1 of the AutoCodes project focused on the

Accessibility and Egress (A&E) provisions of the ICC International Building Code Version 2009 [16].

It should be noted that BIM is a much bigger concept than conventional 3D CAD. Other than the pure representation of building geometries, BIM literally captures all the information of a building over its lifecycle in a standardized and structured manner. Based on specific query request, a unique set of information, or in a more technical term, a Model View (MV) could be isolated and extracted from BIM. When applied in code compliance, ideally each code provision might find a corresponding group of property sets in the BIM model representing the information need to validate the compliance. Truly automated code-checking is yet in development, but even in today's coexistence of manual and semi-automated code checking process, information harvested from the BIM model has proved to be valuable in facilitating consistent and accurate regulatory review.

5.3 Methodology

An overview of the IgCC structure was conducted. The general code compliance workflow was illustrated, highlighting the focus areas, critical tasks that project stakeholders ought to accomplish, and the expected outcomes. This strategic code compliance plan was emulated from the Compliance Planning Assistance (CPA) program directed by the Building Codes Assistance Project (BCAP) and the Texas State Energy Conservation Office (SECO) in their efforts to achieve 90 % energy code compliance with the 2009 International Energy Conservation Code (IECC) by 2017 [17]. In each phase of this code-compliance workflow, the possible leverage of the project BIM model(s) was outlined and discussed. Finally, the strategic framework for the IgCC compliance was established, followed by conclusions and general discussions.

5.4 Results and Analysis

5.4.1 IgCC Overview

Overview of the IgCC focused on the following aspects: (1) the scope; (2) the contents and (3) the compliance paths. IgCC applies to all occupancy-types except low-rise residential buildings under the International Residential Code. It is not applicable to equipment or systems used primarily for industrial or manufacturing purposes either (Chap. 1). The major code provisions were delineated in Chap. 4 through Chap. 11. Chapter 2 clarifies the key definitions. Chapter 3 is the core of the IgCC. It is formatted to facilitate the customization of this code to address local issues; provide options for construction which exceed the minimum requirements of this code; and provide for the implementation of best practice. Chapter 3 also suggests the overall compliance paths. Stakeholders should pay attention to the following facts:

- IgCC is a model code: it is not mandatory or enforceable until a jurisdiction elects to adopt it in that particular area
- IgCC is an adaptable code: a jurisdiction can opt to adopt part or all of the code, or even add customized amendments to it
- IgCC is an overlay code: IgCC is built upon the ICC code families (e.g. IBC, IRC, IECC) and cannot serve as a standalone code

Extra care is needed to understand the two important selectives: jurisdiction selective and the project selective. Jurisdiction selective refers to flexibility for the jurisdictions to define the scope of the IgCC to be adopted locally. The project elective refers the specific compliance path undertaken by the project team. It is important to know that an exception to Section 101.3 of the IgCC allows ASHRAE 189.1 Standard for the Design of High Performance Green Buildings, to be used to comply with the IgCC. For project teams that look for extra challenges, they may also consider Table 302.1 of the IgCC to pursue exemplary performance in sustainable design and construction. Chapter 12 and Appendix A-D provide supplementary information of the code.

5.4.2 IgCC Compliance Workflow

To elaborating the IgCC compliance workflow, this research focuses on new construction projects only, which filters out the provisions in Chaps. 10 and 11 of the IgCC. Once the local jurisdiction has established the general scope of the IgCC that is applicable to this particular area, project teams need to think about the project selective, whether they should opt to use Standard 189.1, or does the owner requires the inclusion of Table 302.1. This should happen as early in the process as possible. Ideally, a kick-off charrette should take place to involve as many project stakeholders (e.g. owner, architects, consultants, general contractors, commissioning agent, MEP contractors) as possible, to clearly define Owner's Project Requirements (OPR), and ensure the understanding of the Basis of Design (BOD) and the sustainable criteria incorporated into this project. Code officials may also be invited to clear off confusions on particular code provisions. Critical tasks in each phase of the project, especially during design, construction and inspection, need to be identified and allocated. Documentation and submittals for each set of code provisions should be proactively planned and closely managed through the project delivery. Communication and collaboration between project stakeholders should be facilitated and appreciated. Figure 9.3 summarizes the generic compliance workflow for the IgCC.

5.4.3 *BIM Facilitated Strategic Framework for the IgCC Compliance*

Leverage of BIM in the IgCC compliance workflow stems from the fact that BIM plays dual roles in a project delivery process: the information reservoir and the communication portal. As of today, most BIM software (authoring and analyzing) have been programmed to conduct sophisticated design, allow real-time responsive design option analysis, perform rigorous building simulations, and streamline extensive project information management. Interoperability standards make it also possible for stakeholders using different specialized software packages to exchange domain-specific information. Usually, a set of organically interrelated BIM models will be produced for a project, instead of a single colossal model. These distributed and specialized BIM models often fulfill a dedicated task in the project delivery, for instances, energy simulation model, water analysis model, daylighting model, quantity takeoff (QTO) model, and to name a few. The advantage of this methodology is that it significantly reduced the size of the model being handled by different discipline thus greatly increased the productivity of the job allocated to these individuals.

When a project is targeting the IgCC compliance, it is feasible for the project team to break down the compliance workflow discussed previously into critical tasks. Through a certain categorization and/or grouping, these critical tasks could be accomplished through constructing these distributed yet interrelated BIM models. These sub-models, usually called the Model Views (MVs) of the final, confederated BIM, are the key in developing automated code compliance. Besides, documentation generation has been a standardized functionality of most BIM software applications. The trick is to determine which piece of information in what form and format (schema) should be extracted. This constitutes the other critical challenge of automating code checking using BIM. Figure 9.4 illustrated the BIM facilitated strategic framework for the IgCC compliance.

5.5 Conclusions

This paper discussed the possible challenges for stakeholders in the AECOO industry to meet the compliance of the newly released IgCC. As the first international green model code, the IgCC provided an integral and consistent regulatory environment for sustainable design and construction practices. The structure, contents and enforcement of the IgCC were reviewed. A strategic framework of directing the stakeholders in the IgCC compliance workflow was created via the leverage of BIM. The key of this framework was the information generation, exchange, collection and management. The foundation to this framework was an integral project information reservoir and a robust collaboration portal enabled by BIM. Detailed IgCC compliance guidelines could be further developed based on this strategic framework in future research.

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Chapter 6
Measures of Developing Low-Carbon Building in China and Analysis of the Relative Evaluation Indexes

Jun Yang

Abstract It is very difficult to develop low-carbon economy in China, and it is an important part of decreasing the carbon emissions of the construction industry. For better development of low-carbon buildings, this paper puts forward some measures including developing low-carbon technology, perfecting legal system constantly, introducing necessary economic measures, advertising and promoting low-carbon life, strengthening low-carbon consulting services. This paper also points out that it is necessary to establish a reasonable housing security system to guide the healthy development of real estate industry. This paper suggests to overall considerate the development of low-carbon building by bringing building into the community or town category. Finally we discuss the relevant evaluation index of low-carbon building.

Keywords Low-carbon building • Measures • Evaluation index

6.1 Introduction

As the continuous growth of global population and economic scale, the environment problems due to energy use are recognized unceasingly. Especially the global warming becomes a serious threat to human's survival and development, and reducing carbon emissions has become a global target. The United Nations puts forward to cut 60 % of the carbon emissions by 2050.

China has paid much attention to the work about climate change, and has issued a series of laws and regulations. The *2009 China's Sustainable Development Strategy Report* by Chinese Academy of Sciences in March 2009 proposes that

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_6, © Springer-Verlag Berlin Heidelberg 2014

China's energy consumption of per unit GDP will reduce 40–60 % in 2020 than in 2005, and CO_2 emissions of per unit GDP will reduce 50 % or so (with an average annual 3.33 % reduction) [1]. China's task of developing low-carbon economy is very difficult.

The construction industry is one of the main industries which consumes resources and energy, and is also an important cause of the greenhouse effect. At present the building energy consumption accounts for one third of the total energy consumption of the whole society in China, and it is already become the three major energy consumptions together with industrial energy consumption and traffic energy consumption. China's level of building energy conservation is far behind the developed countries, and 99 % of the existing nearly 43 billion m^2 building is belong to high energy consumption building. Now more than 95 % of the new building is still belong to high energy consumption building. If strong measures were not taken, China's building energy consumption will be three times higher in 2020 than now. Research shows that the potential of greenhouse gas emission reduction is huge and the cost is lower in the construction industry. Developing low-carbon building and promoting low-carbon development of real estate industry have positive role to reduce carbon emissions and reduce global warming, and it becomes an important aspect of developing low-carbon economy in China.

6.2 Measures of Developing Low-Carbon Building in China

6.2.1 Pay Special Attention to Basic Work of Low-Carbon Building Development

1. Vigorously develop low-carbon technology

   The development of low-carbon building first needs the support of low-carbon technology. The life cycle of building consists of materials production, construction design, construction, use and the demolition. Development of low-carbon building needs technological change of the upstream and downstream relevant work. As the idea of low-carbon building is new, the level of low-carbon technology in China is still in the primary stage, and has a large gap with the developed countries. The government should advocate and support the research of low-carbon technology, encourage building materials enterprise to improve energy efficiency by improving existing energy technology, and promote using low-carbon materials and equipment; strengthen international exchanges and cooperation, research in low-carbon design and construction technology; develop solar energy, wind energy, biomass energy, geothermal energy and other new energy technology according to local conditions, and increase the use of renewable energy; study energy saving transformation technology of old buildings, and decrease the cost of reform. Through establishing good cooperation mechanism between research institutions and related enterprises, speed up the transformation and application process of low-carbon technology. These areas of technology development can lay solid foundation for the development of low-carbon building.

2. Constantly perfect the legal system

   The United States, Japan, the European Union and other countries have issued relevant laws and regulations, and let them land on feet to promote the sustainable development of buildings [2]. This provides a good reference for China to promote low-carbon building. At present only related laws and regulations on building energy efficiency and green building are issued in China, almost no special laws or standards on low-carbon building are issued, therefore a set of perfect low-carbon building legal system is needed to set up. First, the authentication and evaluation system of the low-carbon building materials and equipment is needed; secondly, we need to design standards, construction and acceptance standards of low-carbon building, then to promulgate evaluation standard of low-carbon building, and strengthen the approval and supervision in building land supply, planning and design, select of material and construction [3]. Rewards and punishment on low-carbon building should be issued to clear the responsibility, right and interest of the participants of low-carbon building. Clear laws and regulations are needed to effectively provide proper guidance for real estate developers and the ordinary citizen, and promote the development of low-carbon buildings.

6.2.2 Do Indemnificatory Work Well Which Is in Favor of Low-Carbon Building Development

1. Introduce the necessary economic measures

   Cost increasing is one of the main reasons why most domestic real estate developers don't want to develop low-carbon real estate. According to the measurement, developing buildings of 50 % energy-saving needs to increase 10 % of construction cost. At present in China, the construction fund of low-carbon building is paid by the developer, and because of market uncertainty, the investment of developer is lack of security. If there is not relevant policy guide and inspire, the developer's enthusiasm of investing low-carbon building cannot be aroused. The government shall develop policy and subsidies those economic subjects which actively construct low-carbon building. The government shall give taxation, finance preferential and support to low-carbon industry and enterprise, consider reducing real estate taxes fcbd or the residents who buy low-carbon building products, and encourage consumers to buy low-carbon buildings, so as to promote the spread and application of low-carbon building.

2. Advertisement and promotion low-carbon life

   Promotion of low-carbon building is inseparable from the extensive publicity. The government should propagate and promote low-carbon building, and make the idea of low-carbon life supported by most people, and improve social approval of low-carbon life. On one hand, it can improve the developer's social responsibility of constructing low-carbon building. On the other hand, it can improve the consumer's cognitive and approval degree on low-carbon building, and let them to take the initiative to buy low-carbon building. Thus it can guarantee a good development trend of supply and demand situation of low-carbon building. With the development of China's economy, people's living standards gradually improved, the carbon emissions of building have a growing trend in using stage. It is needed to popularize the related knowledge of carbon emissions in using stage, guide and encourage the residents to practice low-carbon lifestyle in daily life, so as to save resources and energy effectively and reduce carbon emissions.
3. Strengthen the low-carbon consulting services

   The government should foster low-carbon consulting services agencies to solve the issues on carbon emissions of the low-carbon building for all participants, including carrying on the consultation of national low-carbon policy for enterprise, providing low-carbon technology training and guiding the enterprises to choose low-carbonization solutions, evaluating the low-carbon level of enterprise, etc. At the same time the low-carbon consulting service agencies will also face ordinary citizens, and roll out low-carbon household consulting services. On one hand, they popularize the low-carbon knowledge, and on the other hand, they solve citizen's questions on carbon emissions in daily life, and help them to measure the carbon, and provide low-carbon technical services.

6.2.3 Optimize the External Environment for the Development of Low-Carbon Building

1. Establish a reasonable housing security system to guide the healthy development of real estate industry.

   The government should strengthen land supervision, restrain land speculation, and strictly control the land supply. It is necessary to adjust the land supply structure and give priority to ensuring the development of low-carbon building block [4]. Land vacant tax is needed to improve the investment cost of hoarding and encourage the holder to invest positively. Improve housing guarantee system, strengthen the construction of affordable housing, Do low-carbon building demonstration by popularizing and using low-carbon technology in the affordable housing first. Strengthen the supervision and management on allocation and using stage of affordable housing, and actively develop housing rental market to prevent overheating in housing prices and guide residents to consume rationally housing, and lower housing vacancy rate.

2. Overall considerate the development of low-carbon building by bringing building into the community or town category

   "The twelfth five years" Core Problem Research Report is released in Beijing on October 17, 2009 pointed out that low-carbon cities construction will guide direction for the city's development in "the twelfth five years" period.

   The Ministry of Finance, Ministry of Housing and Urban-Rural Development and National Development and Reform Commission jointly issued the notice about pilot demonstration of the first batch of green and low-carbon small towns on September 26, 2011.

   Construction of Low-carbon city is a systematic engineering, and it implies all aspects of human life. And healthy development of low-carbon construction industry is an important part of the construction of low-carbon cities. We should regard ecological city construction as the turning point, and actively promote the system construction and innovation of low-carbon building, and establish the dominant role of low-carbon building in the urban and rural construction in the future, and create good external environment for the overall development of low-carbon building [5]. In practice, the construction of low-carbon cities and low-carbon building should reference each other and promote each other.

6.3 Evaluation Indexes of Low-Carbon Building

1. The amount of CO_2 emissions reductions and CO_2 emission reduction rate in the total life cycle

   The amount of the total CO_2 emissions of the life cycle can be achieved by summarizing CO_2 emissions of each stage of low-carbon building life cycle. With reference building to the selected, calculating respectively CO_2 emissions of low-carbon building and reference building, CO_2 emission reductions ΔP of the low-carbon building in the total life cycle can be determined according to the difference. At the same time, CO_2 emission reductions rate R of the low-carbon building in the total life cycle can also be calculated.

$$\Delta P = P_0 - P \tag{6.1}$$

$$R = \frac{\Delta P}{P_0} \tag{6.2}$$

   In the formula, P_0 and P is respectively CO_2 emissions of low-carbon building and reference building.

2. CO_2 emissions of the unit area and annual average CO_2 emissions of the unit area

   CO_2 emissions of the unit area $\bar{P}$ is the ratio of the total Life cycle CO_2 emissions of building and the building area. Annual average CO_2 emissions of the unit area $\bar{P}_a$ is the ratio of CO_2 emissions of the unit area and service life of building, and it brings service life of building into consideration range.

$$\bar{P} = P/S \tag{6.3}$$

$$\bar{P}_a = \bar{P}/n = P/(S \times n) \tag{6.4}$$

In the formula, P is the total life cycle CO_2 emissions of building; S is building area; n is service life of building.

3. Incremental cost for emission reduction

   Incremental cost for emission reduction is an index which can evaluate the effect of CO_2 emissions reduction of different low-carbon building schemes and help to choose the scheme with the minimum cost through cost analysis of all schemes that can realize CO_2 reduction target [6]. Incremental cost for emission reduction is the ratio of incremental cost and the amount of CO_2 emissions reduction in the total life cycle. It can evaluate an emissions reduction technology, and it also can evaluate the whole building.

$$C_i = \frac{\Delta C}{\Delta P} \tag{6.5}$$

   In the formula, C_i is the incremental cost for emission reduction; ΔC is incremental cost in the total life cycle; ΔP is the amount of CO_2 emissions reduction in the total life cycle. It states the cost of CO_2 emission reduction is smaller if C_i is smaller.

4. Relative CO_2 payback time

   Relative CO_2 payback time is the time with annual CO_2 emissions reduction in the using stage to counter increased CO_2 emission in the initial building stage [7]. The index can evaluate an emissions reduction technology, and it also can evaluate the whole building.

$$CPT = \frac{\Delta P_1}{\Delta P_2} \tag{6.6}$$

   In the formula, CPT is relative CO_2 payback time; ΔP_1 is increased CO_2 emission in the initial building stage; ΔP_2 is annual CO_2 emissions reduction in the using stage. Relative CO_2 payback time should be less than service life of building or equipment. It states the effect of CO_2 emission reduction is better if CPT is shorter.

5. Benefit of CO_2 emissions reduction

   Carbon budget can be stated by two methods. One method is to use the CO_2 emissions equivalent, and the other is to monetize the value of the carbon. With the implementation of the Kyoto protocol, carbon trading market is developing rapidly. It is predicted that the global carbon trading market will reach \$3.5 trillion by 2020, and developing countries are becoming leading role of carbon seller's market [1]. As China gradually assume corresponding obligation of carbon emissions reduction, it will be imperative to bring economic benefits of CO_2 emissions reduction into economic evaluation scope.

The benefit of CO_2 emissions reduction of Low-carbon building in the life cycle is monetized by calculating respectively CO_2 emissions reductions of each stage and combining carbon market price. The benefit of CO_2 emissions reduction of Low-carbon building in the life cycle I_{CO_2} is

$$I_{CO_2} = P_{CO_2}(\Delta P_M + \Delta P_P + \Delta P_C) + \sum_{j=1}^{n} P_{CO_2}(1+\beta)^j \Delta P_{Uj}(P/F, i, j) + P_{CO_2}(1+\beta)^n \Delta P_F(P/F, i, n) \tag{6.7}$$

In the formula, P_{CO_2} is the CO_2 market price in the initial building stage; β is annual growth rate of CO_2 market price(assume uniform growth); ΔP_M, ΔP_P and ΔP_C is respectively the amount of CO_2 emission reductions in materials production and transport stage, design and construction preparation stage and construction stage; ΔP_{Uj} is the amount of CO_2 emissions reductions of the j year in use and maintenance stages; ΔP_F is the amount of CO_2 emissions reductions in demolishing and reclaim stage; n is service life of building.

Because international carbon market price is not stable and CO_2 market price and its annual growth rate have great influence on the benefits of CO_2 emissions reductions, sensitivity analysis should be did to these two aspects for better understanding the benefits of CO_2 emissions reductions.

6. The ratio of renewable energy in total energy

   The ratio of renewable energy in total energy is the ratio of the total amount of used renewable energy and total used energy. The index can let users have direct-viewing understanding to the energy situation of the buildings, and it is good for users to accept and approve low-carbon building.

$$R_E = \frac{E}{E_n} \tag{6.8}$$

   In the formula, R_E is the ratio of renewable energy in total energy; E and E_n is respectively the amount of used renewable energy and total used energy.

7. Per capita CO_2 emissions

   The index compares the CO_2 emissions with personnel quantity. The index shows the fair between people, and helps people to choose the suitable low-carbon buildings.

$$\bar{P}_P = P/(N_P \times n) \tag{6.9}$$

   In the formula, $\bar{P}_P$ is per capita CO_2 emissions; P is the total Life cycle CO_2 emission of building; N_P is personnel quantity of using the building; n is service life of building.

8. Cost savings amount of standard year in the using process of building and increased investment payback time of low-carbon technology

   Cost savings amount of standard year is the difference of every year cost between with low-carbon technology and without low-carbon technology in use process of the building. The index makes the benefit of low-carbon technology clear.

   Increased investment payback time is the needed time with saving of using cost by low-carbon technology to counter initial increased investment. It can measure investment profitability and capital recovery speed of the low-carbon technology. When annual saving of using cost is equivalent, it can be calculated by using the following formula (dynamic).

$$\Delta P_t^* = \frac{\lg \frac{\Delta C}{\Delta C - \Delta I \times i_c}}{\lg(1 + i_c)} \tag{6.10}$$

   In the formula, ΔP_t^* is dynamic increased investment payback time, ΔC is annual saving of using cost; i_c is benchmark discount rate; ΔI is the initial increased investment. Increased investment payback time is the shorter, the better.

6.4 Conclusions

It has becomes a global goal to decrease the carbon emissions in the global warming and shortage of energy resources. The potential is huge to decrease carbon emissions in construction industry and the cost is relatively low, and developing low-carbon building is an important component of developing low-carbon economy in China. In the current situation, China needs to take measures to ensure the good development of low-carbon buildings by developing low-carbon technology, and constantly perfecting the legal system, introducing the necessary economic measures, advertising and promoting low-carbon life, strengthening low-carbon consulting services. It is an important aspect to establish a reasonable housing guarantee system to guide the healthy development of real estate industry. China should take low-carbon cities construction as the turning point, and overall considerate the development of low-carbon building by bringing building into the community or town category. The evaluation index can provide important reference for people to choose and construct low-carbon buildings; the paper finally analyses and puts forward several relevant evaluation indexes of the low-carbon building.

Acknowledgments The research was supported by Guangdong Social Science Funds (GD10JYY04) and Shenzhen Polytechnic University Research Fund (2209S3080002).

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Chapter 7
Optimize Water Efficiency and Cost Effectiveness by Using the Alternative Sustainable Innovations in Residential Dwellings

Vivian W.Y. Tam, L.Y. Shen, and Andrew Brohier

Abstract Utilising alternative sustainable innovations, such as water efficient showerheads, waterless composing toilets, aerated faucets, water efficient dishwashers and steam washing machines opposed to the standard devices, has the ability to optimise water efficiency and reduce living expenses, while helping conserve this natural resource. This paper is to investigate if the alternative sustainable innovations can optimise water efficiency and cost effectiveness in residential dwellings. Water consumption, life cycle cost and payback periods are compared between the standard and innovative devices over a 15-year period. Local cost from the major cities in Australia is used for the calculation. It is found that $7,295–28,785 per occupant can be saved over 15 years if all devices are used across Australia, saving of up to 78.5 % can be achieved and with the minimal of only 0.10 year of payback period.

Keywords Sustainable innovations • Water efficiency • Cost effectiveness • Residential • Australia

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_7, © Springer-Verlag Berlin Heidelberg 2014

7.1 Introduction

It is predicted that by 2025, about 63 % of the planets population will be experiencing water stress, which impacts the dam levels and hence the overall water supply to residential dwellings around the world [1]. As a result, water price is increasing at an alarming rate and expected to increase by 50–100 % over the next 5 years [2]. Even with the aid of government water saving policies such as water restrictions and incentives to implement more efficient water usage, the water is predicted to become increasingly scarcer over the next few years [3]. It is for this reason that further research in regard to innovation and water efficient mechanisms need to be conducted to counter the impact of this decline, to benefit future generations.

7.2 Aim and Objectives

This paper investigates the water efficiency and cost effectiveness of alternative sustainable innovations in respect to residential dwellings. Five alternative sustainable innovations, including water efficient showerheads, waterless composing toilets, aerated faucets, water efficient dishwashers and steam washing machines opposed to the standard water facilities, are investigated in relation to the number of occupants within a dwelling across major cities in Australia, including Sydney, Canberra, Brisbane, Melbourne, Perth, Adelaide and Darwin. Water consumption, life cycle cost saving and payback periods are compared between the standard water facilities and the alternative sustainable innovations over a 15-year period.

7.3 Methodology

To calculate the water consumption of the water facilities, it is assumed that two showers (use twice per day per person for 8 min per cycle), two toilets (use five times per day per person for one full flush per cycle), two basins (use five times per day per person for 0.25 min per cycle), two sinks (use three times per day per person for 12 min per cycle), one dishwasher (use once per day per person for one full cycle) and one washing machine (use once per day per person for one full cycle) are installed for a typical residential dwelling [4, 5].

It is also assumed a maximum of 1 h work from a plumber (about AUD 80 / GBP 53.5) for the installation of fixtures and appliances, and on-going cost of about AUD 50/GBP 33.5 annually for hygiene and cleaning products associated with the functioning of the devices, along with any maintenance expenses that may arise for the calculation of life cycle cost of the water facilities. Inflation incurred for the on-going cost is assumed as 3 % and future water rate rises are based on the average price increase in the past 10 years (2001–2010) from the relevant water authorizes [6–11].

After calculating the life cycle cost for the individual water facilities, the following equation is used to calculate the percentage of saving in using a particular alternative sustainable innovation.

$$\text{Percentage of saving} = \frac{(LCC_{sustainable} - LCC_{standard})}{LCC_{standard}} \times 100\ \%$$

where $\mathrm{LCC_{standard}}$ is the life cycle costing for using the standard water facilities over 15 years; and $\mathrm{LCC_{sustainable}}$ is the life cycle costing for using the alternative sustainable innovations over 15 years.

The payback period for the use of the alternative sustainable innovations is then calculated based on the comparison of the life cycle cost for implementing the standard water facilities and the alternative sustainable innovations. The year with the same life cycle cost is the payback period.

7.4 Findings

Table 7.1 summaries the water consumption of different types of standard water utilises and the alternative sustainable innovations. It is clearly exemplified that using the standard water utilised can result in a substantial amount of water being consumed, compared to a residential dwelling incorporating the alternative sustainable innovations. This difference in water consumption is about 233.6 kL a year for only one resident and about 1,297.7 kL a year for six occupants in a dwelling if all the alternative sustainable innovations are employed.

If all standard water facilities are replaced with the alternative sustainable innovations, the life cycle cost from AUD 7,294.6 / GBP 4,881.9 (in Perth) to AUD 28,785.4 / GBP 19,264.6 (in Adelaide) could be saved over a 15-year period per person (see Table 7.2).

The alternative sustainable innovations are predominately the most suitable devices to be used across Australia, except waterless composting toilets (with negative saving). This is due to a long term cost being saved. It is clear that cost can be saved up to 78.5 % and increases in respect to occupants (see Table 7.3).

If the residential dwelling is using all the alternative sustainable innovations, Occupants can save between 26 % (in Perth) and 51 % (in Adelaide) over a 15-year period. This is a prime indicator that cost effectiveness can be optimised by using the alternative sustainable innovations.

Table 7.1 Difference in water consumptions for the standard water utilises and the alternative sustainable innovations

	Standard water facilities (kL) (A)	Alternative sustainable innovations (kL) (B)	Difference in water consumption (kL) (A–B)
A standard showerhead versus a water efficient showerhead			
1	146.0	35.0	111.0
2	292.0	70.1	221.9
3	438.0	105.1	332.9
4	584.0	140.2	443.8
5	730.0	175.2	554.8
6	876.0	210.2	665.8
A single flush toilet versus a waterless composting toilet			
1	21.9	0.0	21.9
2	43.8	0.0	43.8
3	65.7	0.0	65.7
4	87.6	0.0	87.6
5	109.5	0.0	109.5
6	131.4	0.0	131.4
A standard basin outlet versus a basin aerated faucet			
1	3.4	0.9	2.5
2	6.8	1.8	5.0
3	10.3	2.7	7.5
4	13.7	3.7	10.0
5	17.1	4.6	12.5
6	20.5	5.5	15.1
A standard sink outlet versus a sink aerated faucet			
1	98.6	26.3	72.3
2	197.1	52.6	144.5
3	295.7	78.8	216.8
4	394.2	105.1	289.1
5	492.8	131.4	361.4
6	591.3	157.7	433.6
A standard dishwasher versus a water efficient dishwasher			
1–4	7.3	3.7	3.7
5–6	36.5	18.3	18.3
A standard washing machine versus a steam washing machine			
1–4	50.4	28.1	22.3
5–6	251.9	140.5	111.3

The alternative sustainable innovations not only can achieve life cycle cost saving, but also with reasonable payback periods between 0.10 year (for the water efficient shower in Adelaide) and 57.79 year (for the basin aerated faucet in Perth) (see Table 7.4). The payback periods vary in different cities and are dependent on their local water prices.

Table 7.2 Life cycle cost saving for the alternative sustainable innovations compared to the standard water facilities in a typical residential dwelling for one occupant (in AUD)

Device	Sydney	Canberra	Brisbane	Melbourne	Perth	Adelaide	Darwin
Shower	$7,242.5	$7,698.9	$11,408.2	$8,003.9	$2,472.6	$12,131.7	$3,295.4
Toilet	−$315.0	−$224.9	$507.2	−$164.7	−$1,256.4	$650.0	−$1,094.0
Basin	$28.5	$186.7	$270.6	$193.6	$68.6	$287.0	$87.2
Sink	$4,391.7	$4,836.9	$7,252.8	$5,035.5	$1,432.9	$7,724.1	$1,968.8
Dishwasher	$1,390.5	$1,405.5	$1,527.5	$1,415.6	$1,233.6	$1,551.3	$1,260.7
Washing machine	$3,967.3	$4,058.8	$4,803.1	$4,120.1	$3,010.1	$4,948.3	$3,175.3
Total	$17,907.3	18,922.7	$27,175.5	$19,601.3	$7,294.6	$28,785.4	$9,125.4

Table 7.3 Percentage of saving for using the alternative sustainable innovations for the major cities in Australia

Device	Number of occupants (Percentage of saving)					
Sydney	1	2	3	4	5	6
Shower	73.7%	74.8%	75.2%	75.4%	75.5%	75.6%
Toilet	-10.3%	23.8%	41.8%	52.9%	60.5%	66.0%
Basin	27.2%	39.2%	46.0%	50.6%	53.9%	56.3%
Sink	68.9%	71.1%	71.8%	72.2%	72.4%	72.6%
Dishwasher	15.6%	17.3%	18.8%	20.2%	21.4%	22.6%
Washing machine	31.4%	33.9%	35.6%	36.9%	37.8%	38.5%
Canberra						
Shower	73.9%	74.9%	75.3%	75.4%	75.6%	75.6%
Toilet	- 7.1%	.26 8%	44.4%	55.2%	62.5%	67.7%
Basin	28.7%	40.3%	47.1%	51.6%	54.7%	57.1%
Sink	69.2%	71.2%	71.9%	72.2%	72.5%	72.6%
Dishwasher	15.7%	17.5%	19.1%	20.5%	21.8%	23.0%
Washing machine	31.6%	34.2%	35.9%	37.1%	38.0%	38.7%
Brisbane						
Shower	74.5%	75.3%	75.5%	75.6%	75.7%	75.7%
Toilet	13.1%	44.5%	59.2%	67.7%	73.3%	77.3%
Basin	35.3%	47.1%	53.3%	57.1%	59.7%	61.6%
Sink	70.5%	71.9%	72.4%	72.6%	72.7%	72.8%
Dishwasher	16.6%	19.1%	21.2%	23.0%	24.7%	26.1%
Washing machine	33.0%	35.9%	37.6%	38.7%	39.5%	40.1%
Melbourne						
Shower	73.9%	74.9%	75.3%	75.5%	75.6%	75.6%
Toilet	-5.1%	28.7%	46.0%	56.6%	63.7%	68.8%
Basin	29.3%	41.0%	47.7%	52.1%	55.3%	57.6%
Sink	69.3%	71.3%	71.9%	72.3%	72.5%	72.6%
Dishwasher	15.8%	17.6%	19.3%	20.7%	22.1%	23.3%
Washing machine	31.7%	34.4%	36.1%	37.3%	38.2%	38.9%

(continued)

Table 7.3 (continued)

Perth						
Shower	69.7%	72.5%	73.6%	74.2%	74.5%	74.8%
Toilet	-59.4%	-32.5%	-13.4%	0.8%	11%	20.8%
Basin	14.0%	21.1%	26.7%	31.2%	35.0%	38.1%
Sink	61.0%	66.5%	68.6%	69.8%	70.4%	70.9%
Dishwasher	14.3%	14.9%	15.5%	16.0%	16.6%	17.1%
Washing machine	28.7%	30.0%	31.2%	32.1%	32.9%	33.7%
Adelaide						
Shower	74.6%	75.3%	75.5%	75.6%	75.7%	75.8%
Toilet	16.2%	46.9%	61.2%	69.4%	74.8%	78.5%
Basin	36.4%	48.1%	54.2%	57.9%	60.4%	62.2%
Sink	70.7%	72.0%	72.4%	72.6%	72.8%	72.9%
Dishwasher	16.8%	19.4%	21.6%	23.5%	25.2%	26.6%
Washing machine	33.3%	36.2%	37.9%	39.0%	39.7%	40.3%
Darwin						
Shower	71.2%	73.4%	74.2%	74.6%	74.9%	75.1%
Toilet	-4.8%	-17.5%	2.5%	16.7%	27.3%	35.5%
Basin	16.9%	25.5%	31.8%	36.6%	40.5%	43.6%
Sink	63.9%	68.3%	69.9%	70.7%	71.2%	71.6%
Dishwasher	14.6%	15.3%	16.1%	16.8%	17.5%	18.2%
Washing machine	29.2%	30.9%	32.2%	33.3%	34.2%	35.0%

Table 7.4 Payback periods for the alternative sustainable innovations compared to the standard water facilities

	Number of occupants					
Facilities	1	2	3	4	5	6
Sydney						
Shower	0.77	0.39	0.26	0.19	0.15	0.13
Toilet	21.27	10.64	7.09	5.32	4.26	3.55
Basin	17.64	8.82	5.88	4.41	3.53	2.94
Sink	1.64	0.82	0.55	0.41	0.33	0.27
Dishwasher	10.19				5.10	
Washing machine	5.16				2.58	
Canberra						
Shower	0.78	0.38	0.26	0.19	0.15	0.13
Toilet	20.54	10.27	6.85	5.14	4.11	3.42
Basin	16.35	8.17	5.45	4.09	3.27	2.72
Sink	1.64	0.82	0.55	0.41	0.33	0.27
Dishwasher	10.24				5.12	
Washing machine	5.19				2.59	

(continued)

Table 7.4 (continued)

	Number of occupants					
Facilities	1	2	3	4	5	6
Brisbane						
Shower	0.67	0.34	0.22	0.17	0.14	0.11
Toilet	15.38	7.69	5.13	3.84	3.08	2.56
Basin	13.54	6.77	4.51	3.39	2.71	2.26
Sink	2.68	1.34	0.89	0.67	0.54	0.45
Dishwasher	10.61				5.30	
Washing machine	5.45				2.73	
Melbourne						
Shower	0.84	0.42	0.28	0.21	0.17	0.14
Toilet	19.63	9.81	6.54	4.91	3.93	3.27
Basin	16.82	8.41	5.61	4.21	3.36	2.80
Sink	1.51	0.76	0.50	0.38	0.30	0.25
Dishwasher	10.24				5.12	
Washing machine	5.12				2.56	
Perth						
Shower	1.37	0.69	0.46	0.34	0.27	0.23
Toilet	38.19	19.10	12.73	9.55	7.64	6.37
Basin	57.79	28.90	19.26	14.45	11.56	9.63
Sink	1.32	0.66	0.44	0.33	0.26	0.22
Dishwasher	11.45				5.72	
Washing machine	6.33				3.17	
Adelaide						
Shower	0.60	0.30	0.20	0.15	0.12	0.10
Toilet	15.90	7.95	5.30	3.97	3.18	2.65
Basin	12.02	6.01	4.01	3.00	2.40	2.00
Sink	0.89	0.44	0.30	0.22	0.18	0.15
Dishwasher	10.72				5.36	
Washing machine	5.59				2.79	
Darwin						
Shower	1.20	0.60	0.40	0.30	0.24	0.20
Toilet	37.65	18.83	12.55	9.41	7.53	6.28
Basin	26.53	13.26	8.84	6.63	5.31	4.42
Sink	2.12	1.06	0.71	0.53	0.42	0.35
Dishwasher	9.53				4.77	
Washing machine	6.38				3.19	

7.5 Conclusion

This paper demonstrated that the alternative sustainable innovations optimise water efficiency and cost effectiveness in residential dwellings, by reducing water consumption and wastage. The alternative sustainable innovations studied were low flow showerheads, waterless composting toilets, flow restricted/aerated faucets, water efficient dishwashers and steam washing machines. Achieving this in households today is becoming imperative, as demand and population continue to put stress on water supply across the vast majority of Australia. Portray comparisons between the standard water facilities and the alternative sustainable innovations in the cities of Sydney, Canberra, Brisbane, Melbourne, Perth, Adelaide and Darwin were conducted on their water consumption, life cycle costing, payback period and percentage of saving. It was found that the savings over the 15-year period ranged from $7,294.565 to $ 28,785.369 between cities, which is a considerable saving as this value is for a dwellings with a single occupant. It is clear that sustainable innovations can optimise water efficiency and cost effectiveness in residential dwellings. Overall, the results obtained illustrate that water efficiency and cost effectiveness can be improved, by adopting the use of the alternative sustainable innovations.

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Chapter 8
Corporate Social Responsibility on Global Construction Supply Chains

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Abstract The role of the corporation has shifted in a way that the public has come to expect more ethical accountability of business operations and responsibilities that branch beyond legal and economic responsibilities. However there is a lack of research that acknowledges how the international procurement of materials by construction companies exposes construction supply chains to ethical risks that may be attributed to the purchasing company. There is a need to consider the extent to which companies are responsible for the impact of their purchasing decisions upon international suppliers and if it warrants corrective action through corporate social responsibility. This paper answers this question and suggests a method by which construction companies may ascertain their responsibilities owed, formulate policy and implement their initiatives. It was found that the connected nature of the supply chains necessitates construction companies to analyse the extent of their influence in order to ascertain the level of responsibility. Strategies such as stakeholder management and strategic analysis are appropriate for companies to identify CSR policies whilst companies may enact their policies using codes of conduct. With high levels of public scrutiny and a reputation of social and environmental degradation the construction industry needs to consider how its actions impact external stakeholders such as international suppliers. This study therefore aims to outline a method by which construction companies can procure international supplies with due responsibility and accountability.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_8,

Keywords Corporate social responsibility • Sustainability • Construction supply chains

8.1 Introduction

Corporate social responsibility (CSR) is a response to the idea that the corporation has a responsibility to society beyond maximising its own financial performance. The construction industry (CI) has been targeted by pressure groups and commentators as one which needs significant remedial action in terms of its interaction with the environment and the community in the delivery of its product [1]. CSR has been taken up by construction companies to varying degrees by those companies wishing to demonstrate their commitment to social and environmental causes and shift the emphasis away a purely profit-driven agenda. This action is largely lacks consistency in approach and has had mixed results in its implementation, with some accusing the efforts to be superficial [2]. A big driver for CSR is that it has come to be expected of corporations from citizens. As CSR becomes expected from the CI, it is important for the industry to come to terms with the responsibility it owes in a consistent way [3]. This includes the application of CSR policy to those stakeholders who support the survival of a business, including international suppliers that the CI have come to rely upon.

Globalisation has resulted in the liberalisation of economies resulting in a greater flow of resources between developed and developing countries. Large construction companies in developed countries increasingly rely on global trade to meet its material supplies. Imported materials are a necessary and unavoidable source of supplies for the delivery of successful construction projects [4]. The connected and interdependent contracts that make up the supply chain means that the actions of the purchasing firm influence upstream suppliers. The way in which the CI engages in the global supply chain raises environmental and social concerns in regards to the sourcing and manufacture of products due to conflicting ethical standards. Yet global outsourcing of supplies gives firms the ability to control production in foreign countries without exercising ownership and thus evade responsibility [5]. These global suppliers are not covered by a company's CSR policy unless those suppliers are acknowledged as stakeholders to whom the company owes responsibility. Thus the industry is faced with the decision of whether their global suppliers figure as stakeholders. If this is the case, the company must then decide how and to what extent they are responsible for their interaction with their suppliers.

By considering the role of the corporation, this paper will question the extent of responsibility that is owed by construction companies to their international suppliers. This paper aims to review the current level of CSR practice in the CI and identify the issues that need to be addressed in order to fulfil CSR towards global suppliers. The findings of this paper will help identify the strategies most appropriate to applying to the CI and in particular, upon global outsourcing of construction supplies, which is the subsequent stage of the research project. In the following section, a brief review of its historic development will contextualise the driving philosophy and aims behind CSR. The current practices of CSR in the CI will then be reviewed. This will be followed by a discussion on the issues encountered in the construction supply chain due to globalised trading. Finally, conclusions are drawn together with recommendations for future research.

8.2 Theories and Development of Corporate Social Responsibility (CSR)

The definition for CSR has developed over time, and there is no universally accepted definition. In this paper CSR is defined as the initiatives that it enacts to fulfil its ethical responsibilities. This idea is grounded in the idea of corporate citizenship, which maintains that CSR is action to correct environmental and social impacts of business operations in the fulfilment of being an ethically bound citizen. Because this paper aims to investigate a CSR for specific business operation of globally sourced materials, the stakeholder and strategic theories will be used to define that the responsibilities owed are towards the company's most important stakeholders and issues. The paper will also carry forward the idea of strategic CSR where initiatives must balance ethical responsibilities whilst also maintaining its economic and legal obligations.

The idea of CSR first emerged in the 1950s, best characterised by the belief of the imbalance of power between the corporation and society and its effect on the lives of individuals. Historic events such as the Great Depression and the excesses of business developed an attitude for the need of 'social control of business' ([6], p. 25). Such regulation of corporations and the aim of CSR to redress social problems brings to mind the role of corporation versus the role of the government. CSR represents a distinct shift over time of governments regulating the social ills of corporations to corporations regulating themselves [7]. Thus social imbalances and environmental degradation, traditionally issues for governments to address, is partially borne by the CSR of a firm insofar as their actions influence the society they operate in [5].

In the 1970s and 80s, the definition for CSR was dominated the idea of using stakeholder theory to identify stakeholders to whom responsibility is owed. Stakeholder theory requires that an organisation to acknowledge that it operates within and affects a network of stakeholders with converging, competing and interacting interests [4]. Thus the company may use stakeholder theory to decide to whom it owes responsibility, to what extent and the actions that it decides to carry out – broadening the base of its involvement beyond shareholders and official authorities.

Stakeholder theory continues to heavily influence CSR policy formulation since it was first outlined by Carroll and Freeman. Stakeholder theory has evolved into the need for stakeholder management. Stakeholders are identified and their needs analysed, which then become the drivers of CSR initiatives. Stakeholder theory can therefore be a measure of corporate social performance by the extent to which stakeholders' needs are being satisfied. However, Porter and Kramer [8] argue that stakeholder approach gives too much power of CSR to outsiders, turning CSR into an exercise of constantly pleasing parties that never fully understand the business objectives of the company. Kovacs [9] and other supporters of applying CSR to supply chains argue that suppliers, due to their contractual bind to the company, are necessary and salient stakeholders whose actions reflect the engaging company. Thus stakeholder theory can extend the focus of CSR initiatives outside company boundaries and onto suppliers.

Shareholder theory advocates a different view on the role of a corporation as owing responsibility only to shareholders. A contemporary of Carroll, economist Milton Friedman was the loudest objector to CSR. The difference between Carroll and Friedman is most apparent where Friedman confines responsibilities only to those obligatory ones defined by Carroll whereas Carroll emphasises the responsibilities a company should adopt if it is in their power to do so. Both different views stem from different perceptions of the role of companies and form a significant underlying tension between the responsibilities owed towards the financial performance the responsibility for the ethical implications that result from business activities that has underscored CSR theory ever since. The discussed tension between business and ethical responsibilities has developed into a popular modern requirement for CSR initiatives to have a compelling business case. Thus CSR initiatives should not be advocated purely on the basis that they are worthwhile in their own right but should enhance financial performance and social performance together [2]. Randles and Price [10] believe that the best way to practise business ethics is to incorporate it into the business' core operations.

The lack of a universally accepted definition for CSR has resulted in many, sometimes conflicting, theories. However Porter and Kramer [8] believe that CSR approach should not be standardised but customised to each industry, or even, to each company in order to be most effective and most mutually beneficial between company and society. Similarly, Ward and Smith [11] argue that CSR needs to be localised at both the conceptual and operational levels so that it becomes more manageable and embedded within an organisation. Both views discourage the general approach that would be demanded by a standardised theory for CSR due to the fear that resulting solutions will be unfocused and irrelevant to both the business' operations and to the community that stands to benefit from CSR. Since CSR reflects society's expectations of an organisation's obligations in its environment [7], this suggests that CSR is defined by local expectations specific to a time, culture and place. Managers must therefore be mindful of the how the circumstances inform CSR policy and in particular, policy to be applied upon international stakeholders.

8.3 Issues with Internationally Procured Construction Supplies

The World Trade Organisation's principle behind globalisation is to focus increasingly on opening markets to each other [12]. Globalisation and financial deregulation have increased foreign direct investment. Much research has concentrated on the participation of construction companies in overseas projects. Raftery et al. [13] concentrate on the effect of globalisation in the Asian region, of which they noted increased foreign participation in domestic projects. Yet there is very little written on the how the increasingly open markets have allowed construction companies in developed countries to source material supplies from foreign countries and the effect it has had on either party.

Historic data has shown that increased trade due to access to the global market showing a link between free trade and economic growth [12]. A developing country with comparative advantage can produce goods to the mutual advantage of exporter and importer, thus leading to increases in overall standard of living in the producing country [13]. This also points to the reason why imported supplies from global sources are a gaining popularity as a competitive option in the CI. Moodley et al. [4] acknowledges that the supply chain in recent years has become increasingly global with people, materials and components.

The basis for CSR has been defined has deriving from the idea that a firm must be accountable for how its actions influences the parties with whom it interacts with. The construction supply chain is a network or interdependent activities that is complex and involves many actors in multi-staged, geographically dispersed – often international – locations [14, 15]. The result is that firms have reconfigured their role over a wider configuration of organisations and there is increased permeability between organisational structure and relationships through supply sourcing and contracting arrangements [9, 15]. At the same time, construction purchases are buyer-driven value chains where the buyer controls the delivery dates, quality, standards and specifications of the supplied products [5].

All factors point to a level of accountability of construction firms over their transactions with suppliers. Yet purchasing construction firms typically frame their actions towards buying a single product with little understanding of the supply chain that produces a product [16]. The added physical and contractual distance of global outsourcing of supplies gives firms the ability to control production in foreign countries without exercising ownership and thus evade responsibility over the implications of their transaction [5]. Indeed, the prominence of builders' merchants who act as an intermediary between buyers and suppliers add to the distance and detachment felt between these two parties [17]. CSR policy needs to be underscored by the idea that the construction firm is accountable for its interactions with suppliers. It needs to be acknowledged that these interactions are different for every transaction. Thus, which suppliers they are accountable for will be discussed later under strategies for formulating CSR policy.

Utilising the global supply chain creates the risks of exposing supply chain to ethical, environmental and human rights issues. Increased openness of markets have resulted in the polarisation of the financial strength and technical superiority of developed countries on one hand, and the inferiority of the developing countries on the other [13]. Whilst global trade has brought much wanted business to developing countries, Lewis [12] points out that competitive advantage is not a fair or economically sustainable. Globalisation keeps wages low in developing countries in order that they may preserve their competitive advantage; putting labourers at a continual disadvantage. Examples of social issues include forced into labour, engagement of child labour, unreasonable working hours, unsafe working environments and denial of rights such as collective bargaining and freedom of association [18].

The political and cultural differences between the home country and the host country can also gives rise to conflicting environmental standards [4]. This results in inconsistencies between the standards expected in developed countries and those allowed in organisations abroad. Environmental management of the supply chain may be required to ensure the environmental protection and sustainability of material production and supply which can potentially be applied along the whole production chain [19]. Both social and environmental policies point to the CI being able to prove better traceability along its supply chain in order to extend influence [10]. The issues are compounded by the tendency for purchasing contractors to be driven by short-term profits and to develop strategies that do not help to develop the host countries' industries as well as the aim of the supply chain to achieve overall value and competitive advantage [16, 20]. These characteristics of the construction industry must be recognised and addressed in the execution of CSR on global supply chains.

8.4 Corporate Social Responsibility in the Construction Industry

The importance of elevating the importance and value of CSR initiatives by tying it a compelling business case has been discussed. There are generally three reasons for CSR is good for business: (1) reputation and standing; (2) competitiveness and (3) risk management [6]. The power of CSR to improve the reputation of a company is not unrecognised in the CI. Companies may adopt CSR as a proactive or reactive measure in order to communicate through their company values their commitment to CSR and thus generate an image of a morally sensitive company. The significance of branding and corporate reputation and the increased transparency of company operations means that reputation is an especially strong driver for CSR. This is more the case with large construction companies with recognisable brands than small to medium enterprises (SMEs) [5]. There is a concern however, that over prioritisation of reputation will mean CSR initiatives fall in to the danger of only projecting a desirable public image rather than aiming for real business and social results [8].

Construction companies may apply CSR initiatives upon their global suppliers for to reap same benefits as when they apply it to their internal operations. A healthy working environment encourages a positive and effective workforce and an improved product [3]. Green supply chains can create competitive advantage in the form of saved resources, elimination of waste and improvement of productivity [19]. Additionally, it can be argued that it is a form of risk mitigation that offsets the likelihood of imposed regulation [18]. Operating in an international context brings technical, political and social risks from operating with different actors with different objectives. Self-regulation may pre-empt and treat these risks. Arguably, being responsible for the actions of suppliers in a supply chain may expose a principle firm to unlimited responsibility and for which there is too much risk and not enough benefit.

The definition of CSR as being society's expectations of a corporation alludes to the pressure that external groups and stakeholders place upon corporations to be more accountable for the consequences of their business operations [21]. Pressure can come from customers, employees, unions, shareholders, media, governments and non-government organisations (NGO). Petrovic-Lazarevic [3] writes that construction companies that do not respond to external pressure for more responsibility and accountability risk boycotting of their products. However, her view is largely contested by the observation that the realisation of construction projects is typically dominated by the needs of the client [1]. Part of the challenge of enacting CSR on global supply chains is then balancing ethical responsibilities with responsibilities towards clients, one of the most salient stakeholders.

Large companies often express their CSR philosophies through their corporate values. It is important to communicate these shareholders, stakeholders and the general public to demonstrate a company's strategy is compatible with the community's ethical values. Australian construction companies have values that are dominated by trying to achieve a healthy and safety work environment in response to the high rate of on-site deaths and injuries. Whilst a study of the corporate values of engineering and construction firms in the US reveals that the most common concern communicated are to do with environment, sustainability and community [22]. This shows an imbalanced concentration towards the environmental aspects of CSR and a reflection of the public perception of the CI's degradation to the environment [7]. Murray and Dainty ([2], p. 5) cynically observe that communication of company values or vision in the CI can be guilty of 'rhetorical statements and grandiose claims'. Woolley [23] similarly warns that overuse of words such as 'sustainable' and 'green' is diluting the meaning and potential for meaningful remedial action. Conversely, the majority of SMEs lack the grand corporate strategy and resources required to express their values and to formulate and communicate policy [18].

The general consensus in the literature is that the CI has been slow in its uptake of CSR. Myers [1] writes that even though the industry has a sustainability agenda, relatively few companies have changed their business paradigm. He also points out that the majority of the industry – SMEs – lack the power and resources to execute CSR. Randles and Price [10] blame the conservative nature of the industry for resisting or ignoring the CSR movement that has taken place in other industries and sectors. The fragmented nature of the industry is a barrier to CSR implementation. A construction company may operate at three different levels: corporate, strategic business unit and project levels [4]. By the time CSR policy formed at the corporate level filters down to projects it is possible the policy no longer reflects the narrower focus of projects. And because of the temporary nature of projects, it is arguable whether corporate citizenship values has a chance of developing to the point where it can have an impact on the implementation of CSR at all. Different groups with different perspectives and goals have so far resulted in environmental policy that addresses 'greening' rather than sustainability.

Liu et al. [7] also point out that the building projects overly focus upon the client, creating a barrier to the company exerting their own CSR policies upon the project. They also argue that the nature of project work as having 'power-based opportunism towards self-orientated profitability…among participants' means that CSR is seldom realised. Similarly, Green ([6], p. 49) blames the industry's 'obsession with narrowly defined efficiency' as being a hindrance to developing concerns outside of profitability. Petrovic-Lazarevic [3] highlights that the construction companies' approach to CSR is predominately a one-sided communication with the company communicating its values and policy with little or no community input. She also notes that none of the companies interviewed had a representative of suppliers or community on its board of directors.

On a positive note, the industry's performance in ensuring the health and safety of its onsite activities has been responsive and fundamental. This indicates the potential for the industry to change its corporate governance and responsibility practices in response to external legal pressures and reputation. Initiatives limit their coverage to internal employees, despite that the same policy should extend along the supply chain. Literature recommends the application of CSR to external stakeholders such as suppliers [10]. However the literature reveals a gap in the focus of CSR as it applies to external stakeholders such as suppliers. It is apparent that the existing limitations of the industry must be addressed when considering how it may progress to extend CSR policy upon its global suppliers.

8.5 Conclusion and Recommendations

The connected nature of the supply chains and therefore the potential for construction companies' purchasing habits to impact upon their global suppliers warrants the necessity for construction companies to analyse the extent of their influence in order to ascertain the level of responsibility owed. It has been revealed that the complex nature of these relationships differ for each company so that the use of strategies such as stakeholder theory and strategic analysis are appropriate for formulating policy that is relevant to each company and its business interactions It is preferable to create company specific CSR initiatives rather than general, in order to marry the policy with business strategy. Only then can the ethical responsibilities of CSR and responsibility towards business profitability be simultaneously met. However, it is acknowledged that those companies without the resources to formulate their own CSR initiatives may rely adequately upon internationally recognised standards or if available industry wide codes of conduct. Implementation of CSR should similarly be crafted by the company into codes of conduct in order to impose upon suppliers their requirements for improved social and environmental practices. The ability to enact such codes, however, highly depends on the power exerted upon the supplier. It is evident that codes may not be applied to all suppliers, but only the most salient and strategic.

Literature exists that evaluates the performance of CSR in the CI. However there is little investigation into the key success factors of CSR implementation and how to measure it. The ethical concerns involved in engaging international suppliers are a subject well researched in other industries. However there is an apparent absence of such research specifically in construction supply chains – despite much research suggesting that construction suppliers are an appropriate area upon which to practice CSR. Many actors in the chain between the construction purchaser and their global suppliers may the reason for this gap. Although much research highlights the barriers that front the implementation of CSR in globalised trading and the cultural issues encountered, there is little to suggest how a business might overcome these barriers.

The findings of this paper will form the basis of the next stage of the research, during which the strategies available to construction companies to identify the issues or stakeholders that will drive the formulation of policy will be explored, as well as some of the strategies that can be applied in the implementation of such policies. The findings will also help investigate and discuss the execution methods of CSR on supply chains.

Acknowledgments The authors are grateful to Miss. T. Bui for assisting in this study.

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Chapter 9
Exploring Energy Efficient Procurement Options in Building Construction

Sandeep Shrivastava and Abdol Chini

Abstract There has been a significant increase in interest and research activities in energy efficient building construction in recent years. In the construction phase of building's life cycle, contractors provide resources and select means and methods of construction. To make the construction phase less energy intensive, the contractor has to purchase the required resources from the jobsite proximity to minimize the transportation energy. Sometimes, it might not be possible to analyze and practice energy saving measures for the whole project because of time and budget constraints during this phase. Therefore, it will be helpful to a contractor if he can focus on the most energy consuming activities on the project. This is possible, if the contractor has access to energy data of the project to identify which activity's resources consume the most energy. The contractor may then explore less energy intensive alternatives, and procurement methods that are available for those resources. This research focuses on applying IT to tackle the issue by developing a spreadsheet-based tool to estimate energy consumption in material and equipment procurement for construction activities of a project. The proposed method uses the project's bill of quantity, and data related to materials transportation and equipment operation to estimate the probable energy consumption during construction. A case study was performed to demonstrate the application of the tool and discuss possible alternatives to save energy consumption. The proposed method allows contractors to identify energy intensive activities during construction and deploy energy efficient procurement to reduce energy consumption of a particular project.

Keywords Energy efficient construction • Energy information system • Construction contractors • Embodied energy

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_9, © Springer-Verlag Berlin Heidelberg 2014

9.1 Introduction

The building construction project imposes loads on the environment in various forms, namely depletion of resources, contamination of air, soil, and water. These loads are generated while various demands, such as materials and energy are met to construct the building. The construction industry uses more materials by weight, than any other industry in the United States [1]. Moreover, the environmental impacts of building construction, partly caused by large consumption of energy, are imposed during the whole life cycle of a building [2, 3]. Energy consumed during the life cycle of a building may be divided into operational energy, embodied energy, and decommissioning energy [4–6]. Operational energy is required for heating, cooling, ventilation, lighting, equipment and appliances. Embodied energy is non-renewable energy required to initially produce a building and maintain it during its useful life. It includes energy used to acquire, process, manufacture the building materials, including any transportation related to these activities (indirect energy); energy used to transport building products to the site and construct the building (direct energy); and energy consumed to maintain, repair, restore, refurbish or replace materials, components or systems during the life of the building (recurring energy). Embodied energy is measured as a quantity of non-renewable energy per unit of building material, component or system. The embodied energy makes about 15–20 % of the total energy consumption during building life cycle. However, the share of the embodied energy will become more significant when buildings become more energy efficient, as shown in Fig. 9.1 [5, 7].

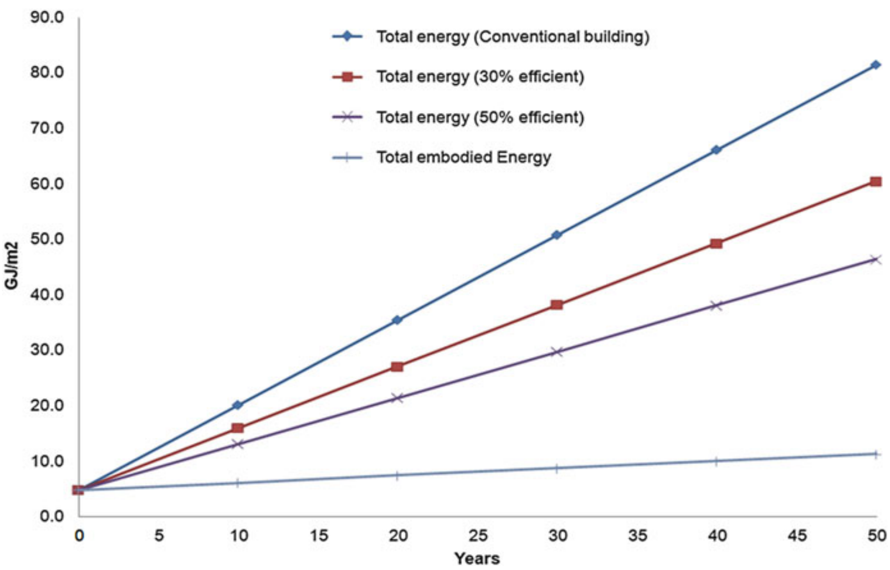

Fig. 9.1 Energy use in buildings: the changing relationship between embodied and operational energy (50 years life cycle)

Among various phases of embodied energy, energy consumption during construction phase is less explored [8]. In the construction phase, contractors provide resources and select the means & methods of construction. To make the construction phase less energy intensive, the contractor has to purchase the required resources from the jobsite proximity to minimize the transportation energy or to purchase more energy efficient resources. This is possible, if the contractor has access to energy-profile of the project to identify which material procurement and equipment transportation & operation consume maximum energy. The contractor may then seek less energy intensive alternatives that are available. This work focuses on developing a spreadsheet tool to estimate energy consumption in material procurement and equipment transportation & operation for construction activities of a project.

9.2 Energy Estimation Tool

The construction phase of a building life cycle involves numerous activities such as construction of temporary structures, transportation and installation of building materials and components, site work, etc. These activities consume energy and affect the environment. The aim of this research work was to develop an energy estimation tool for a contractor, hence only energy consumptions for transportation of materials from manufactures to a jobsite, and on-site equipment transportation and operation were taken under consideration.

When a building construction project is started, the general contractor prepares a detailed estimate for the materials, workers and equipment required. A bill of quantities (BOQ), which is not only a list of materials but also a list of tasks/items required for the execution of the project, is prepared. The framework for the proposed tool (Fig. 9.2) uses a project's bill of quantity, and data related to materials transportation, and equipment transportation and operation to estimate energy consumption during construction. Materials, transportation modes, their purchase distances; equipment, transporting distance, and per hour fuel consumption are assigned to each project activity.

An estimation of amount of energy consumed in transporting of a material is dependent on mode of transportation, energy consumption to transport 1 kg of material to 1 km distance, quantity of material required to finish the activity, and the distance of material manufacturing unit to the job site. In a construction process, an activity might include different materials transported from different distances using different transporting modes. The total sum of these energy requirements will be the total energy required to transport the materials for that activity. The system calculates total energy required and arranges the activities of BOQ in a descending order to identify energy intensive activities.

An estimation of amount of energy consumed in transporting a heavy equipment is dependent on transporting vehicle fuel consumption and transporting distance, while operating a piece of equipment is dependent on hourly energy consumption of

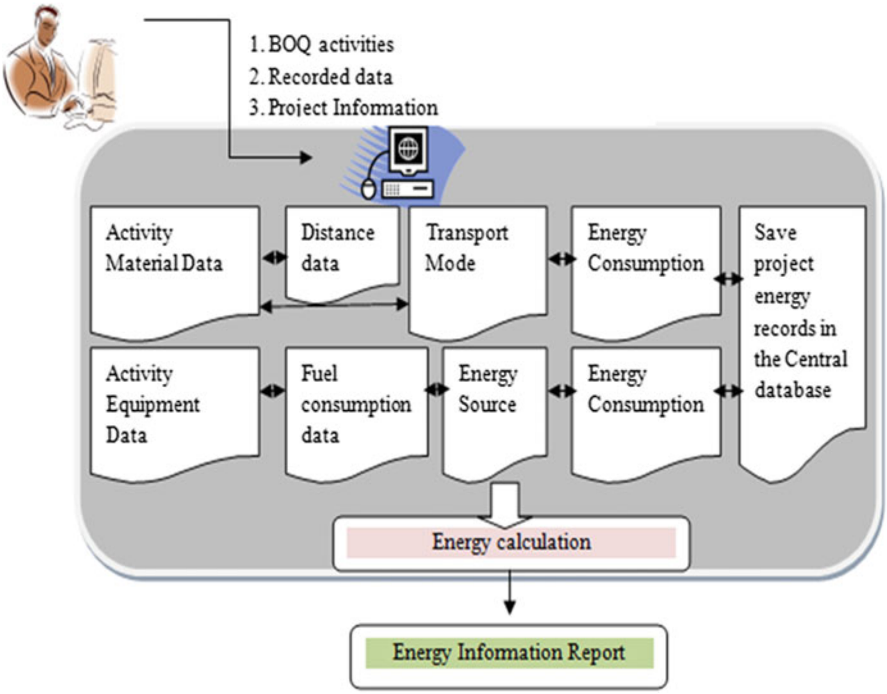

Fig. 9.2 The framework to estimate material transport energy and equipment energy consumption

a piece of equipment and number of operating hours to finish the activity to which it is assigned. In a construction process, an activity might include various pieces of equipment of different strengths and energy sources. Equipment were assumed to be transported within 80 km from the jobsite. The total sum of these energy requirements will be the total energy required to operate these equipment to finish the activity. The system calculates total energy required and arranges the activities of BOQ in a descending order to identify energy intensive activities.

At the end of the estimation process, a report containing information about energy consumption of each activity and high energy-demanding activity is generated. This report can be utilized by the contractor to consider alternative sources for energy intensive procurements for the project.

Many researchers have mentioned the lack of project related energy and environmental data to accurately assess energy consumption and environmental impacts [8, 9]. Currently, most of the work at this phase is performed by researchers using a case study and applying LCA application packages, which might use data on a national level average. These data might be good to get an overall picture, but could be less meaningful if a contractor wants to improve its supply chain at local level or for a project. In order to do so, he needs a system that can estimate and record the relevant data to improve energy estimation on future projects. The framework as shown in Fig. 9.2 can be extended to record the related data by adding one more sheet that saves data for various activities for various projects. Figure 9.3 shows the

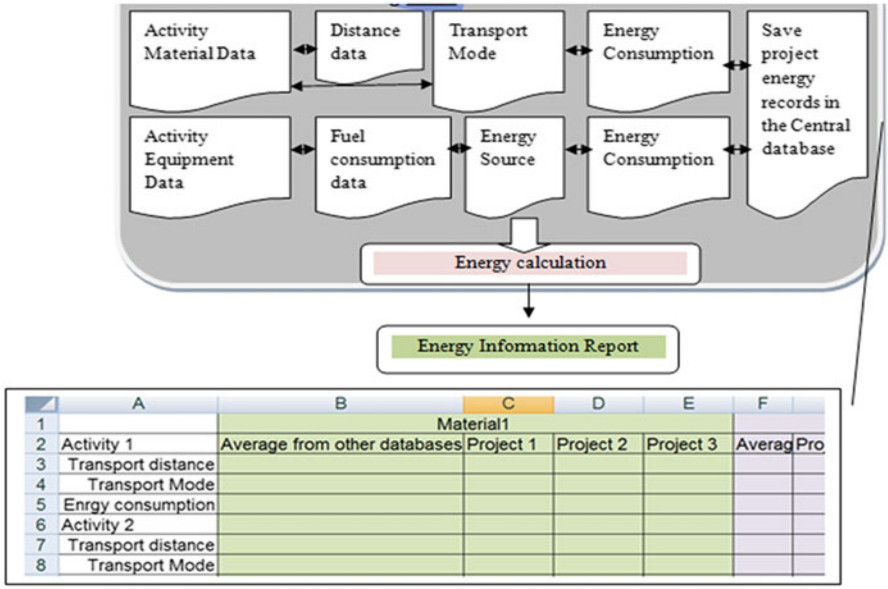

Fig. 9.3 The extended framework to estimate and record material transport energy

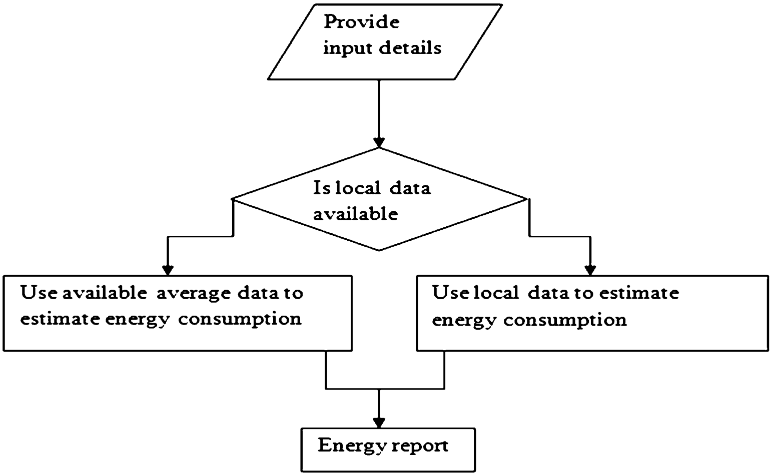

Fig. 9.4 The flowchart to implement the tool on a project

extended framework with a snippet of spreadsheet to record data for projects. It shows an attached spreadsheet for materials only, however the complete sheet contains the details for equipment, too.

Figure 9.4 shows the flow chart to implement the tool on a project. The tool can be used to estimate energy consumption using national average data collected from various databases and available literature, if more reliable and local data is not available for any activity. Once the required data is recorded for some projects the database is now rich with the data used for local construction practices and a company's procurement system. Therefore, the next estimation for a similar project could be done based on the recorded data.

9.3 Case Study

Based on the framework shown in Fig. 9.2, a simple spreadsheet based tool was developed. A repair garage case study is presented here to demonstrate the application of the tool. An example of a repair garage was taken from Means Scheduling Manual [10]. The garage was of 30 × 12 m size, with a reinforced concrete footing, concrete slab on grade, concrete block bearing walls, offices and restrooms, mezzanine over the offices, bar joist and steel deck, built-up roof, sky lights, mechanical and electrical systems, and doors and windows. Figure 9.5 shows a snapshot of the bill of quantities for construction of the garage. The Means Scheduling Manual could be referred for additional details of the repair garage.

Each activity was assigned materials and equipment required to finish one unit of the activity. Each of the materials was assigned distance to transport from the manufacturing units to the job site. At this stage, the distances were considered uniform for all the material. The calculations of energy consumptions were forwarded to the energy data report sheet, which presents the total energy consumed against each activities in the bill of quantities sheet, project related information (Fig. 9.4).

A	B	C	D	AP	AQ	AR
Bill of Quantities (BOQ)				Project Information and Material distance (Uniform)		
Ref . No.	Description	Quantity	Unit			
311110100020	Clear and grub	4050	sq m	Project Information		
312316130060	Excavation footings/utilities	141	cu m	Building Footprint (L m x B m)	30	12
312323131400	Backfill mechanical	103	cu m	Site Dimension (L m x B m)	36	14
312323130015	Backfill manual	34	cu m	Building Stories	1	Storey
310516100100	Bank run gravel	57	cu m	Project Duration (Calendar Days)	80	days
312216101150	Hand Grade finish	372	sq m	Project ID	GarageEx1	
312323130500	Air Tampering	34	cu m	Construction Manager	XYZ	
31113450020	Footing Forms	56	sq m	Project Description	Example	
32110600500	Reinforcement	4.55	Tonnes	Default values		
33105701900	Conc 20 MPA	16	cu m	Workers transport	75	kms
31113651000	Bulkhead Forms	24	L m			
32205500100	WWF 6.6 10/10	420	sq m			
33105704300	Concrete slab 25 MPA	40	cu m			
33529300250	Finishing Concrete stl twl	400	sq m			
34113500050	PreStresses slabs 150 mm	50	sq m			
42210260350	300 mm foundation Block	75	sq m			

Fig. 9.5 Input data used in the spreadsheet tool

9.4 Results and Discussions

Figure 9.6 shows the output of the energy estimation system for the construction of the repair garage.

The output demonstrates the energy consumption details of the top five material energy intensive activities and the top five equipment energy intensive activities, out of all the given activities in the BOQ. It is clear (Fig. 9.6a) that materials for bearing wall construction were consuming the maximum amount of energy. Therefore, a contractor can focus on this activity while purchasing materials to reduce the transportation distance or ask manufacturers to use energy saving mode of transport to reduce energy consumption and associated carbon emissions. The recommendation to search for a nearer purchasing location might not be satisfied, if the material recommended by the project architect is available only at that location. This limits the application of energy saving recommendations. However, the recommendation could be sent to the owner to discuss this issue with the architect. Another alternative with similar performance could then be selected.

It is also clear from Fig. 9.6b that the equipment used to clear and grub the site were consuming maximum energy. As presented in [11], a variation in equipment transporting distance does not have much impact on total energy consumption. Therefore, a contractor who is looking for reducing energy should focus on reducing transportation distances for materials, but can rent equipment from a more distant place if they are more energy efficient. If it is not possible to find an energy efficient model, a model with an alternative fuel type such as natural gas,

a

M	N	O	P
Bill of Quantities Energy Consumption (MJ)			
SI	ID	Description	Material Transport Energy
1	42210344300	Bearing Wall 300 mm	11,199
2	33105704300	Concrete slab 25 MPA	6,864
3	33105701900	Conc 20 MPA	2,772
4	42210260350	300 mm foundation	1,975
5	75113200200	T&G roofing	1,610

b

Bill of Quantities Energy Consumption (MJ)			
SI	ID	Description	Equipment energy
1	311110100020	Clear and grub	12731
2	52119100440	Open web joists	8090
3	310516100100	Bank run gravel	7612
4	312323131400	Backfill mechanical	6902
5	312316130060	Excavation footings/utilities	4099

Fig. 9.6 Energy estimation report: activities in descending order. (**a**) Material transport energy. (**b**) Equipment transport and operation energy

rather than diesel, could be recommended. This might not save energy, but would be helpful in minimizing environmental impact due to construction equipment. Although, the final decisions should be made based on a detailed analysis, but these information can help in focusing on energy intensive activities and hence promoting energy saving practices.

The potential for reducing energy consumption might not be high, however. Limitations may arise due to a specific material being available at certain locations only, which is not in the contractor's control. Generally, contractors buy the least expensive products (including transportation) and available local machinery to deliver the work that satisfies the contract specifications and schedule. The contractors might not want to break old and long-term relations for saving energy on a project. Moreover, the contractors may not be financially motivated to reduce energy consumption when purchasing materials and deploying energy efficient models. In these situations, the project owner may require a maximum distance for material purchase in the specification or provide some incentive for purchasing materials from local vendors and deploying energy efficient equipment. The U.S. Green Building Council LEED rating system already provides credit for materials that are purchased within an 800 km radius. However, a low cost might not be the only reason in the selection of resources at times. The availability of resources, the production rate of a manufacturing unit for materials, specialty in manufacturing a particular item, availability of machinery, and/or relations between parties may play a role in the selection process. In some of these cases, energy efficient construction may be given priority if contractually required. In cases where several providers with some variation in purchase cost are available, the selection could be based on optimization technique.

9.5 Summary

In summary, contractors can play a major role in development of energy efficient means and methods to reduce energy consumption, hence carbon footprint during construction phase of the building. The proposed framework allows contractors identify energy intensive activities during construction and deploy energy efficient procurement to reduce energy consumption of a particular project. In addition, collecting energy consumption data during construction and updating the database will increase the accuracy of estimating energy consumption for the future projects.

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Chapter 10
The Future of Sustainable Building Assessment Tools: A Case Study in Australia

Jian Zuo, Bo Xia, George Zillante, and Zhenyu Zhao

Abstract Sustainability issues in built environment have attracted an increasingly level of attention from both the general public and the industry. As a result, a number of green building assessment tools have been developed such as the Leadership in Energy and Environmental Design (LEED) and the BRE Environmental Assessment Method (BREEAM), etc. This paper critically reviewed the assessment tools developed in Australian context, i.e. the Green Star rating tools developed by the Green Building Council of Australia. A particular focus is given to the recent developments of these assessment tools. The results showed that the office buildings take the biggest share of Green Star rated buildings. Similarly, sustainable building assessments seem to be more performance oriented which focuses on the operation stage of buildings. In addition, stakeholder engagement during the decision making process is encouraged. These findings provide useful references to the development of next generation of sustainable building assessment tools.

Keywords GBCA • Green Star • Sustainable building rating tools

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_10,

10.1 Introduction

The construction activities have significant environmental impacts on society. The building stock is one of biggest energy consumer and greenhouse gas emitter over the world [1]. The statistics from the U.S. Department of Energy (USIEA) showed that the carbon emission of buildings in 2035 will surge to 42.4 billion metric tonnes, 42.7 % higher than the 2007 level [2]. In most countries, the building sector accounted for more than 40 % of energy consumption globally [3]. Therefore, it is imperative to reduce and mitigate the environmental loads of buildings, e.g. energy consumption and carbon emissions. In fact, the World Business Council for Sustainable Development identified the building sector as one of nine key sectors contributing towards a sustainable future [4]. As a result, a number of sustainability assessment tools have been developed to assist the industry for the green building developments. These include: the Leadership in Energy and Environmental Design (LEED) (US) and the BRE Environmental Assessment Method (BREEAM) (UK), Comprehensive Assessment System for Built Environment Efficiency (CASBEE) (Japan), Green Building Index (GBI) (Malaysia) and Hong Kong Building Environmental Assessment Method (Hong Kong). These rating tools are similar to each other to a certain degree. It is well recognized that a green building rating, even well developed, needs to be tailored when applying in another country than the original context the tool was developed. For instance, the LEED and BREEAM assessment tools have been adapted in some exhibition buildings of the Shanghai World Expo 2012 and contribute towards the sustainable performance of the entire World Expo facilities portfolio [5].

This study aims to provide a critical review of the Green Star rating tools developed by the Green Building Council Australia. The particular focuses of this study are to investigate the current status of green building market and the future trend of green building certification in Australia.

10.2 GBCA Green Star rating tools suite

The Green Building Council Australia has developed a number of rating tools for various types of buildings since 2003. As shown in Table 10.1, apart from a handful of released rating tools, there are three pilot tools and two tools under development. These rating tools cover a wide variety of buildings, such as education buildings, industrial buildings, commercial buildings, retail buildings and hospital facilities. The Green Star Office rating tools gained comparatively more advancement, with V3 released in 2008.

The released Green Star rating tools share very similar structure. The hierarchy of the GBCA Green Star rating tools is shown in Fig. 10.1. The rating tools consisted of some common categories such as management, emissions, land use and ecology, etc. (the new developments will be discussed in later sections). Each category covers a certain number of credits which has some points available for project to apply for.

Table 10.1 Rating tools developed by the Green Building Council Australia, source: GBCA website, www.gbca.org.au

Released tools	Pilot tools	Tools under development
Green Star Education	Green Star Communities	Green Star Performance
Green Star Industrial	Green Star Convention Centre	Green Star Interiors
Green Star Healthcare	Green Star Public building	
Green Star Office		
Green Star Office interiors		
Green Star Multi unit residential		
Green Star Retail Centre		

Fig. 10.1 Structure of GBCA Green Star rating tools (Source: GBCA website, www.gbca.org.au)

Fig. 10.2 Three levels of GBCA Green Star certification (Source: GBCA website, www.gbca.org.au)

The Green Star rating tools mainly focus on the environmental aspects of sustainability. Taking Green Star Healthcare V1 as example, more than 87 % of points available (unweighted) are environmental sustainability related, e.g. indoor environmental quality, emissions, energy, etc. The credit with highest points available is Greenhouse Gas Emissions (Ene-1) with 20 points (unweighted). The total number of points achieved will be weighted to a maximum of 105 points (i.e. 100 points plus 5 points for Innovation). The Green Building Council Australia certifies three levels of green building depending on the points project achieved during the certification process. There three levels are: 4 Star, 5 Star and 6 Star, indicating "Best Practice", "Australian excellence" and "World leader" respectively (see Fig. 10.2). There are two rounds of submission and assessment where the project team has the second chance to provide clarification and responses to certification panel's queries (Table 10.2).

Table 10.2 Categories, credits and points available in the Green Star Healthcare V1 rating tool, source: GBCA website, www.gbca.org.au

Categories	Credits	Points available
Management	11	17
Indoor environment quality	19	32
Energy	6	29
Transport	5	12
Water	6	14
Materials	13	35
Land use and ecology	4	8
Emissions	9	20
Innovation	3	5

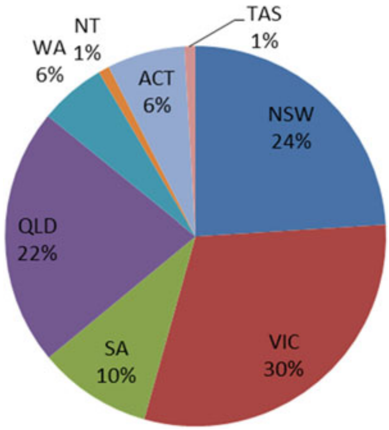

Fig. 10.3 Distribution of Green Star rated projects in Australia (Source: GBCA website, www.gbca.org.au)

10.3 The Green Building Market in Australia

At time of this study, 472 projects have been certified nationwide with a floor area of more than 7.3million m^2. Office buildings take the biggest share of the green building market in Australia, accounting for 82.2 % of the total number of GBCA Green Star rated projects (Fig. 10.3).

As shown in Fig. 10.2, most of Green Star rated projects are located in eastern states, i.e. New South Wales, Victoria and Queensland (76 %) (Fig. 10.4).

Figure 10.3 shows that nearly half of GBCA Green Star rated buildings obtained 5 Star rating while 6 star rated projects only accounted for 16 % of the share. This indicates comparatively smaller number of green building developments in Australia is considered as the cutting edge over the world (Fig. 10.5).

Office buildings (combining Office and Office Interiors ratings) dominate the green building market in Australia. Education sector showed a strong take-up in last 3–5 years, accounting for 10 % of total amount of GBCA Green Star rated buildings. Other sectors, e.g. healthcare, industrial and retail seem to slower to take up green building certification.

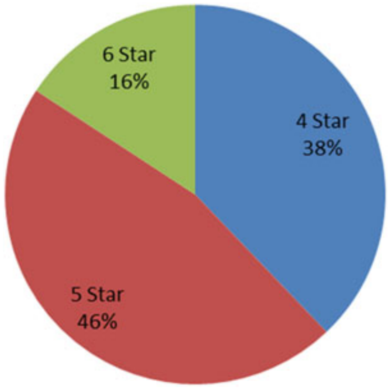

Fig. 10.4 3 Star, 4 Star and 5 Star rated green building projects in Australia (Source: GBCA website, www.gbca.org.au)

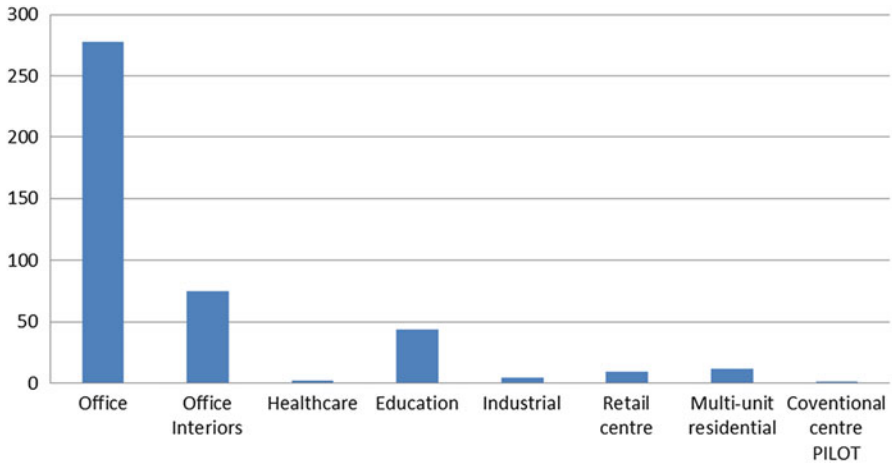

Fig. 10.5 Distribution of Green Star rated project across rating tools (Source: GBCA website, www.gbca.org.au)

10.4 New Developments

Traditionally green building rating tools focus on environmental sustainability, e.g. whether or not buildings meet the environmental performance criteria (Kua and Lee 2002). With a growing awareness of social impacts of construction activities, green building assessments need to address how human beings and entire community will benefit from the development as well [6, 7]. Similarly, Wu and Low [8] asserted, green building is "a holistic solution to achieve the concept of sustainable development in the project life cycle including project planning, designing, constructing, and operating" (p. 64).

The critical review of the GBCA Green Star rating tools showed some issues exist such as:

- Issue 1: There is lack of assessment of building performance during operating stage within current released GBCA Green Star rating tools. At the moment, the Green Building Council Australia provides two types of Green Star ratings, i.e. Design and As Built to validate the documentation during design and construction stage has fulfilled the relevant requirements.
- Issue 2: The current focus of GBCA Green Star rating tools is placed on individual buildings. In other words, all assessment criteria are based on building, e.g. materials used, waste generation and management during the construction and demolition stages, water and energy consumption of the building, etc. There is lack of consideration of how tenants and the entire community may benefit from the green building certification.

The recent developments of GBCA Green Star rating tools include: Green Star Communities and Green Star Performance. Green Star Performance rating tool is developed to address the growing demand on building's operational performance during the operating stage (to address the Issue 1). The rating tool has yet been announced however the critical review of the scoping paper has highlighted the following major features that are considered in the GBCA Green Star Performance [9]:

- Similar structure and holistic approach to the existing rating tools, i.e. nine categories, followed by credits and points
- Allowing the assessment at both individual building level and the portfolio level
- Linking to external guidelines such as the Property Council Australia and the National Australian Built Environment Rating System (NABERS) energy and water ratings
- The assessment made available to 1–3 Star rating as well (currently GBCA only certify 4 Star and above rated buildings)
- Consideration of embodied energy in material related credits

Green Star Communities PILOT rating tool is designed to go beyond the traditional boundary of green building rating tool which is primarily focusing at building level (to address Issue 2). Six categories are covered in this tool, i.e. Governance, Design, Liveability, Economic Prosperity, Environment and Innovation (see Fig. 10.6).

Compared to the released rating tools, the GBCA Green Star Communities rating tool places more focuses on other aspects of sustainability than environmental. This is evidenced by that environment related credits only account for 26 % of total points available. Other key features of this rating tool include:

- Governance category is a bit overlapping with the Management category of released tools however throws a number of company and community level criteria such as: corporate responsibility, engaging stakeholder and educating community. For instance, three points will be awarded if a GRI reporting is implemented at both project and company level.
- Twenty-three percent of points are allocated to health and safety performance of green building delivery (i.e. livability category). The criteria included: provision

Fig. 10.6 Structure of GBCA Green Star Communities rating tool (Source: GBCA website, www.gbca.org.au)

of recreational facilities, local food production, adaptability of dwellings and access to the public transport.

- Nineteen percent of points are assigned to the economic sustainability of green building developments. There has been a long debate on the cost and benefits associated with green building projects. The GBCA Green Star Communities rating tool specifically addressed this issue by introducing criteria such as: affordability of dwellings; opportunities for skills development and local employment opportunities; return on investment.

10.5 Conclusions

This study critically reviewed the Green Star rating tools developed by the Green Building Council Australia. The officially released GBCA Green Star rating tools are similar to each other in terms of the structure. At this stage commercial sector seems to be keen on green building certification whereas other sectors such as the health sector, industrial sector and retail sector seem to be a bit slow up-taker.

The critical analysis of existing rating tools highlighted some issues, e.g. lack of consideration of operational performance of buildings and the lack of assessment of impacts of building on community. These issues are being considered by the Green Building Council Australia in the recent developments of Green Star Performance and Green Star Communities rating tools. Apart from considering the building performance during the operating stage, there is an emerging trend of next generation of green building assessment tool that more focuses will be given to social aspects of sustainability such as stakeholder engagement; health and safety performance and sustainability reporting.

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Chapter 11
Sustainable Education Buildings in Australia: A Green Star Review

Bo Xia, Jian Zuo, Martin Skitmore, and Albert Chan

Abstract In order to promote green building practice in Australia, the Green Building Council of Australia (GBCA) launched the Green Star rating tools for various types of buildings built since 2003. Of these, the Green Star-Education rating tool addresses sustainability issues during the design and construction phrases of education facility development. It covers a number of categories, including Management, Indoor Environment Quality, Energy, Transport, Water, Materials, Land Use & Ecology, Emissions and Innovation. This paper reviews the use of the Green Star system in Australian education facilities construction and the potential challenges associated with Green Star- Education implementation. Score sheets of 34 education projects across Australia that achieved Green Star certification were collected and analyzed. The percentage of green star points obtained within each category and sub-category (credits) for each project were analyzed to illustrate the achievement of credits. The results show that management-related credits and ecology-related credits are the easiest and most difficult to obtain respectively. The study also indicted that 6 Green Star education projects obtained particularly high percentages in the Innovation category. The investigation of points obtained in each category provides prospective Green Star applicants with insights into credit achievement for future projects.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_11, © Springer-Verlag Berlin Heidelberg 2014

Keywords Sustainable building • GBCA • Green star • Education projects

11.1 Introduction

Sustainability aims to improve the quality of life within the carrying capacity of supporting ecosystems. It is widely accepted that the building sector plays a crucial role in achieving sustainability goals as it is the biggest energy consumer and greenhouse gas emitter globally [1]. According to the World Business Council for Sustainable Development (WBCSD) [2], the building sector accounts for approximately 40 % of the energy consumption of most countries. In order to reduce the negative impact of buildings on the environment, therefore, it is necessary to incorporate sustainable planning, design, construction, and operation practices into building projects.

Within the building sector, education buildings play an important role, not only in terms of environmental impact, but also in determining the health of students and teaching staff. In Australia, there are more than 3.5 million full time students in 9,435 schools. In addition, the number of teaching staff across government and non-government sectors rose to 290,854 in 2011 [3]. Most conventional education buildings do not provide a comfortable and healthy work environment for students and teachers as they were only designed to meet the minimum standards of the building codes [4]. As a result, many students and teachers spend every day in classrooms with poor indoor air quality and limited access to daylight, which affects the students' academic performance, the teachers' morale and productivity, and the health of all concerned.

In order to support the design and construction of high-performance, sustainable education buildings, the Green Building Council of Australia (GBCA) released the Green Star- Education rating tool in 2008. This enables owners of education facilities to minimize the environmental impact of their developments and achieve their design goals. Evidence shows that green schools offer significant benefits for facility owners, students, staff and the environment, by lowering operational costs, improving the wellbeing of students and teachers, etc., through to reputational equity [4].

In Australia, several schools have already received Green Star ratings, and others are currently in the process to doing so. However, there are significant challenges involved in the introduction of green education buildings. The Green Star Education rating tool assesses nine environmental categories (such as indoor environment quality, energy, land use and ecology) of new and refurbished education facilities. Different categories and their subsequent indicators represent different requirements for sustainable education buildings, and pose different challenges for the applicants. Additionally, although the Green Star Education rating tool has many indicators in common with the other major Green Star tools, it is unique to the education sector. Project contractors need to take into consideration the specific requirements of the intended recipients of education facilities.

In order to investigate the potential challenges and barriers associated with the application of Green Star in education buildings, this research analyzed the percentage of points awarded to each Green Star category/indicator for 34 projects certified at the time of the study. Although the number of projects is too small to draw general conclusions, the points frequency of the rating categories and indicators (used to depict the achievement of credits by each project) can, according to Silva and Ruwanpura ([5], p. 38), provide decision makers "with information on credits awarded in the past and insight into credit implementation in future projects with similar goals".

11.2 The GBCA Green Star Education Rating Tool

In order to drive the Australian property industry's transition into sustainability, the GBCA launched its Green Star rating tools in 2003 for various types of buildings, including educational, healthcare, industrial, offices, retail and multi-unit residential. Green Star is a "national, voluntary environmental rating system that evaluates the environmental design and construction of buildings and communities" [4]. It assesses the sustainability of projects and community against nine categories, comprising: Management, Indoor Environment Quality, Energy, Transport, Water, Emission, Materials, Land use & Ecology, Innovation. These Green Star 'categories' are divided into credits (indicators), each of which address a specific aspect of sustainable performance. For each Green Star project, points are then awarded to these indicators based on the extent to which each indicator's objective is met.

Launched in 2008, the Green Star Education V1 rating tool assesses the sustainability of new and refurbished education buildings in Australia. It can be applied from the design phase of a project and up to two years after practical completion [4]. Within this rating system, there is a total of 156 (unweighted) points available for distribution to eight categories (see in Table 11.1).

Environmental weightings are then applied, to a maximum of 100, to the total number of points awarded. Five extra points are available for the Innovation category if the building has innovative strategies and technologies exceeding the Green Star benchmarks and environmental design initiatives. GBCA certifies three different levels of "Star" ratings:

- 4 Star: 45–59 points, indicating "Best Practice"
- 5 Star: 60–74 points, indicating "Australian Excellence"
- 6 Star: 75–100 points, indicating "World Leader"

During the Green Star Certification process, the project team applies the Green Star rating tool to guide the design or construction process, and documents are submitted as proof that this has been done. The GBCA commissions a panel of third-party Certified Assessors to evaluate the documentation and establish whether all the claimed indicators meet the requirements outlined in the Technical Manual

Table 11.1 Summary of indicators and points for Green Star education V1

Categories	Number of indicators	Points available (unweighted)
Management	9	14
Indoor environment quality	14	26
Energy	10	30
Transport	5	13
Water	6	16
Materials	15	32
Land use and ecology	5	8
Emissions	8	17

of each rating tool. Project teams are then notified of their final score based on the recommendation of the Assessment Panel. If the scores are within the range of the Green Star levels, the project team receives the corresponding rating certificate along with an award letter, marketing kit and relevant Green Star logos.

11.3 Research Method

With the approval of GBCA, the database of 34 score sheets of Green Star education projects was accessed and analyzed. Similarly to Silva and Ruwanpura [5], the point frequency was analyzed for each category/indictor to measure the categories/indicator values for each project. The points claimed (PC) and points obtained (PO) for each indictor were retrieved from the score sheets. The point achievement degree (PAD) is be calculated as

$$\mathrm{PAD} = \frac{\mathrm{PO}}{\mathrm{PC}} * 100\,\% \qquad (11.1)$$

11.4 Data Analysis

11.4.1 Project Landscape

Table 11.2 summarizes the geographical distribution of the 34 projects, with Victoria and Queensland accounting for approximately 77 % of the total number of buildings involved. The majority of these projects were awarded a 5 Star rating, with only 6 (18 %) buildings being certified as 6 Star (Table 11.3).

Table 11.2 Certified projects across states and territories in Australia

Locations	Number of education projects	Percentage
Victoria (VIC)	17	50
Queensland (QLD)	9	26.5
South Australia (SA)	3	8.8
New South Wales (NSW)	2	5.9
Australia Capital Territory(ACT)	2	5.9
West Australia (WA)	1	2.9

Table 11.3 Number of projects for each Green Star rating

Green Star rating	Number of education projects	Percentage
4 Star	8	23
5 Star	20	59
6 Star	6	18

11.4.2 Overall Percentage Awarded: Point Achievement Degree (PAD)

The overall percentage awarded for each rating category is shown in Fig. 11.1. The results range from 55 % to 97 %. The Management category, addressing the adoption of sustainable development principles from project conception through design, construction, commissioning, tuning and operation, is the most frequently used category, with 97 % of the claimed points being awarded. This includes 9 indicators with a total of 14 unweighted points to measure Management performance. With a percentage as high as 97 %, Management is clearly regarded as the most easy category to obtain in the Green Star Education rating tool.

The category of Water addresses the reduction of potable water consumption of building occupants, landscape irrigation, building cool systems, fire protection and essential water storage systems. In order to reduce the consumption of potable water, the project teams should provide an efficient design of building services, water reuse and substitution with other water sources. Given the high percentage of points awarded in this category (94 %), it can be concluded that most of the education buildings in Australia are water efficient.

With 92 % of the points awarded, the Innovation category obtained far better results than most other types of Green Star buildings, whose frequency of points awarded is normally lower than 50 %. The Innovation category, with a total of 5 points, includes three indicators, namely, innovative strategy and technologies, exceeding the Green Star benchmark, and environmental design initiatives. According to GBCA [4] (2011), the Innovation category helps to foster the industry's transition towards sustainable building.

The categories of Material, Emissions, and Transportation were awarded more than 80 % of the claimed points. With 85 % point frequency, the category of Material addresses resource consumption through material selection, reuse initiatives and efficient management practices. The Emissions category (84 %)

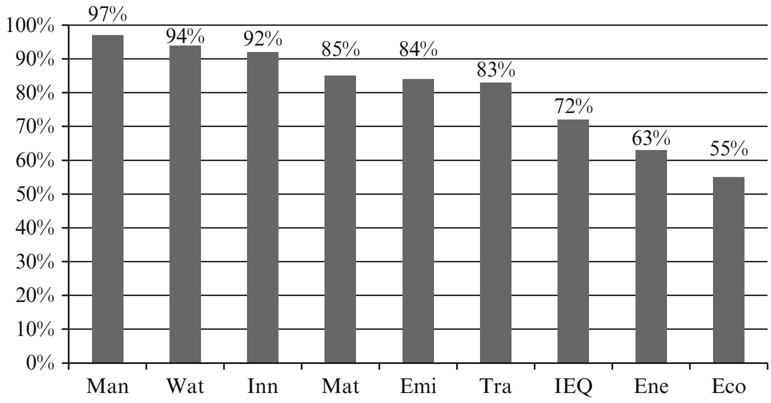

Fig. 11.1 Point achievement degree for Green Star education rating categories

targets pollution emission from buildings and building services to the atmosphere, watercourse, and local ecosystems. It encourages and recognizes reduction of light pollution, water pollution and potential damage to the earth's atmosphere. The category of Transportation, with 83 % of points awarded, recognizes the reduction of demand for individual cars by both discouraging car commuting and encouraging the use of alternative transportation.

The categories of Indoor Environmental Quality (IEQ), Energy and Ecology were awarded between 50 % and 80 %, which are comparatively lower ranges. IEQ is important for education buildings as students and staffs spend a long time in classrooms. This category addresses the HVAC system, lighting, occupant comfort and pollutants. Education buildings should provide a healthy indoor environment and improve the wellbeing of students and staff. The Energy category, with 63 % of points awarded, recognizes the reduction of greenhouse emissions by addressing energy demand reduction, use efficiency, and energy generation from alternative sources. The category of Ecology addresses the project's impact on the ecosystem. It reveals the challenges involved in increasing the ecological value of project sites, as only 55 % of the claimed points were awarded in this category.

11.4.3 Cross-Sector Comparison: Green Star Ratings

The average percentage of points awarded for 4 Star, 5 Star and 6 Star green projects is shown in Table 11.4. This provides a clear impression of the level of difficulty involved in acquiring different Green Star ratings for education buildings.

The distribution of the percentages awarded within different categories for 4 star, 5 star, and 6 star certified green projects is shown in Table 11.5 and Fig. 11.2.

As Table 11.5 indicates, projects with higher certified ratings generally have a higher percentage of points awarded. In particular, for the category of Energy, the

Table 11.4 Point frequency for different Green Star ratings

Green Star rating	Percentage of points awarded
4 Star	75 %
5 Star	78 %
6 Star	86 %

Table 11.5 Percentage of point awarded for different categories within Green Star levels

–	Man	Wat	Inn	Mat	Emi	Tra	IEQ	Ene	Eco
4 Star	97	91	100	89	84	86	63	54	53
5 Star	98	94	88	83	86	85	71	58	56
6 Star	98	99	100	86	81	78	82	88	52

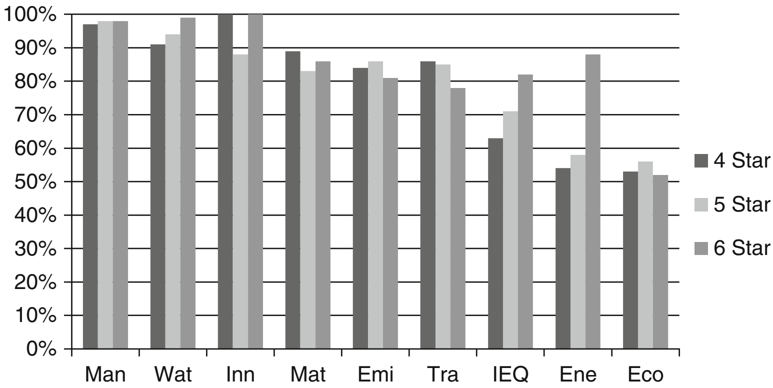

Fig. 11.2 Percentage of point awarded for different categories

point frequency for 6 Star education buildings is 30 % higher than for 4 Star and 5 Star buildings. Similarly, the indoor environment quality in higher level Green Star buildings is much better than the lower level ones.

For the category of Material and Transportation however, 4 star buildings have more points awarded than 5 and 6 star buildings. It is also worth noting that there is virtually no difference between 4, 5 and 6 star buildings in terms of being awarded points under the Management category. Land Use & Ecology remains the most difficult category, with all the certified projects being awarded less than 60 % of the claimed points.

11.5 Discussion and Conclusions

The Green Star Education rating tool was released in 2008 to promote green building practice in the provision of Australian education facilities. Similar to other Green Star rating tools, it covers nine categories, including Management, Indoor Environment Quality, Energy, Transport, Water, Materials, Land Use and Ecology, Emissions and Innovation. Different categories target different sustainable requirements and present different challenges to project teams.

This study reviewed the score sheets of all education projects certified by the GBCA. The results show that Victoria has the most green schools, which account for half of the total number in Australia. This reflects the higher acceptance of sustainability for education buildings in this region. In addition, only 18 % of these buildings were awarded a 6 Green Star rating-regarded as "World Leader" level in sustainable development. Further research is required to investigate the difficulties involved in obtaining a world class level of green buildings in Australia.

The analysis of the points awarded in each category shows the different level of challenges involved in achieving different sustainable objectives. This can provide potential project teams with insights into the application of Green Star guidelines for future projects. The results show that Management, Water and Innovation are the most frequently awarded categories. This is similar to Silva and Ruwanpura's [5] findings-that indicator points in the innovation and design process and water efficiency are comparatively easier to obtain. Additionally, points relating to Energy and Indoor Environmental Quality categories are difficult to secure in these two studies. The study also found that points in the Material category are comparatively easier to obtain under GBCA rules compared with the much lower frequency awarded in LEED certified projects in Canada. Considering the Land Use & Ecology is the most difficult to be awarded points and poses the greatest challenges to the applicants, a further study is required to investigate the potential reasons.

The study is the first to review the project performance in the implementation of Green Star education buildings. With the support of the GBCA, it was possible to access the full 34 population of their green certified buildings at the time the research was undertaken (February 2012). By assessing different levels of challenges in obtaining points for different rating categories, the study helps developers and project teams in better understanding the rating scheme and increases the chances of obtaining claimed points and a desired rating level.

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Chapter 12
Roadmap to Sustainable Road Construction in Hong Kong

Dan Chong and Yuhong Wang

Abstract Road construction and maintenance is one of the largest government administered construction programs in Hong Kong. The large scale of the road construction and maintenance work has significant implication on economic, environment and society. A research question that should be emphasized by the administrators in Hong Kong is: what policy should be framed road construction and maintenance can achieve the most beneficial. This study aims to lay out a roadmap to the sustainable road construction and maintenance in urban environment based on Hong Kong case study. Four basic components were identified such as criteria, data, models and optimization. According to each component, several methods were explained to address the research questions. It is hoped that the present research has made a contribution to assist policy making for the road administers.

Keywords Sustainable • Road construction and maintenance • Urban environment

12.1 Introduction

About 1,900 km of roads and streets in Hong Kong (HK) are built with bituminous (asphalt) pavements. As the pavements become old, they will develop distresses such cracking, rutting, raveling, etc. These distresses affect ride quality and structural integrity of the pavements. Therefore, the bituminous pavements need to be maintained and rehabilitated periodically by resurfacing technique in HK.

With an annual resurfaced area of 1.2 million m^2, road resurfacing is one of the largest government administered construction programs in HK. However, there is still lack of a systematic policy on when, where, and how to resurface the 1,900 km

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_12,

of bituminous road and street pavements, which are currently divided into thousands of sections. Pavement resurfacing in a busy and crowded city such as HK involves multiple stakeholders and has great impacts on economy, environment, and society.

A question that has been interested by the administrators in HK is: What resurfacing policy should be made so that the road maintenance and rehabilitation are the most beneficial for the society?

In order to satisfy the sustainable development principles, this study plans to draw a roadmap to the sustainable road construction and maintenance in urban environment regarding Hong Kong as a case study. The aim of this study is to identify and develop four basic components to assist managing the pavement resurfacing program in HK under the principles of sustainability. The research results will provide valuable information and tools to aid the decision makers to further improve pavement management and promote sustainable development in HK.

12.2 Sustainability Considerations for Road Construction and Maintenance

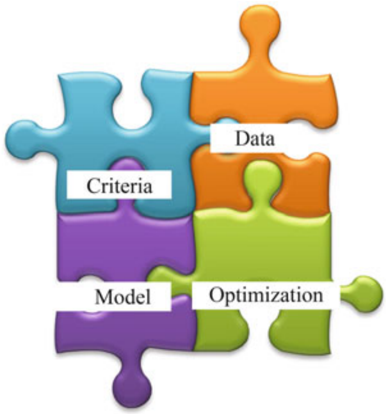
To develop sustainability indicators for road in Hong Kong, one needs to identify the general requirements of sustainability, which can then be refined and adapted for road practices. According to UN's commission on sustainable development (CSD) – theme indicator framework, sustainability is categorized into four dimensions: social, environmental, economic, and institutional. Under these dimensions, there are 15 themes, 38 sub-themes, and 58 indicators, which are based on voluntary national testing and expert group consultations [1]. According to World Bank, sustainable transportation must satisfy three main requirements: economic and financial, environmental and ecological, and social [2]. The VTPI also divided sustainability considerations into three groups: economic, social, and environmental, which is agreed by a lot of other literature [3].

From the life-cycle view, there are great variations on what constitutes sustainability under these dimensions. The indicators developed in the previous section represent a wide spectrum of possible sustainability considerations for road facilities. In order to encourage or enforce their applications, additional steps are required, which include identifying a subset of indicators, developing measurable objectives, evaluating actual practices, and synthesizing the evaluation results.

12.3 Four Basic Components for Sustainable Road Construction and Maintenance

It is expected that a right combination of when, where, how to perform maintenance will maximize the sustainability contributions in road resurfacing and rehabilitation. To find answers to these questions, four major components need to be

Fig. 12.1 Major research components



identified (Fig. 12.1), including criteria, data, model, and optimization, which consist of the whole roadmap for the urban road construction and maintenance. An important goal of this study is to develop these four major components and their sub-components and systematically integrate them to assist decision making in pavement resurfacing. The four components will be proposed in line with an incremental approach. The first part of the criteria will derive and prioritize optimization criteria for the road construction and maintenance program based on the sustainability considerations in HK. Secondly, in the roadmap, it is inevitable to collect and integrate data related to road performance and data related to sustainability in the construction and maintenance program. In the third step for laying out the roadmap, several mathematical models should be developed and evaluated to assists the multiple decisions for the HK government. Finally, following the above three components, it is necessary to optimize the road construction and maintenance decisions based on the chosen criteria, data and models. The whole roadmap for the decision-maker will be then demonstrated.

12.3.1 Criteria

As HK is embracing sustainability as its future development strategy, the implications of this large-scale work for HK's sustainability goals need to be carefully reviewed. Several criteria should be considered when optimizing the pavement resurfacing program. One of the important criteria is pavement condition, an indicator of its performance. HK starts collecting pavement condition data in 2011 by using a comprehensive pavement condition index (PCI). Besides PCI, multiple criteria need to be brought into consideration to cover many aspects of sustainability, including mobility, energy and resource, waste and pollution, life-cycle costs, etc. Variations in different functional areas in HK also need to be considered.

According to the Sustainable Development for the 21st Century in HK (SUSDEV 21), sustainability is defined by eight guiding principles and 39 indicators [4]. The guiding principles include economy, health and hygiene, natural resources, society and social infrastructure, biodiversity, leisure and cultural vibrancy, environmental quality, and mobility. The unique characteristics of the road resurfacing program in HK and its relationship to the guiding principles are discussed as follows.

12.3.2 Data

Complete and accurate data is another basic component for making valid decisions. The Highways Department currently has a pavement management system (PMS) on the platform of Geographic Information System (GIS). The system provides information on PCI (currently limited to HK Island but will be expanded), division of pavement sections, materials, structures, resurfacing history, traffic, etc. However, other important information such as construction cost, waste and pollutant generation, impacts of construction on traffic need to be found in other sources.

12.3.3 Model

Estimation and prediction models are the core component in Fig. 12.1. The models capture the systematic patterns from the data and link the data to decision variables. Four groups of models need to be developed and evaluated in the literature review, including economic models, performance prediction models, environmental impact models and social impact models etc.

The economic models are used to evaluate the life-cycle costs (LCC) of different resurfacing options. As mentioned, the LCC can be divided into user costs and agency costs (Walls and Smith [5]), and a detailed cost breakdown. The user costs can be further divided into vehicle operating costs (VOC) during normal operation and work zone road user costs (RUC). The VOC in normal operation refers to costs such as fuel and lubricant consumption, tire wear, etc. to the travelers when the road is free of construction and maintenance activities [5, 6]. VOC in normal operation is affected by many factors, but regarding pavement conditions, it is mainly affected by roughness (e.g., [6, 7]). The relationship between the VOC in normal operation and road conditions in HK has not been studied. The RUC is the increased VOC, delay, and crash costs caused by road work [5]. The estimate of RUC ranges from finding values from tables (e.g., [8]) to using computer programs, such as QuickZone [9], MicroBENCOST [10], and Construction Congestion Cost System (CO3) [11]. There is also lack of study on work zone RUC in HK.

The agency costs, including indirect and direct costs, are the costs incurred by the government. The indirect costs are caused by engineering designs, quality assurance (QA), inspection, etc. Most of these costs are absorbed within the agency, although sometimes they are paid to consultants. Recently, Hollar [12] developed models to estimate the agency's indirect costs, but such models cannot be readily used in HK because the data for building the models are from the U.S. For pavement resurfacing, direct costs refer to those paid to contractors. Although HK has historical resurfacing cost data, costs of resurfacing projects are affected by many factors, particularly by market bitumen and fuel prices [13, 14]. There is no model to predict the long-term prospect of resurfacing project costs in HK. In summary, the economic models for optimizing resurfacing decisions are currently unavailable in HK.

Besides indirect and direct costs, the LCC of a pavement section also depends on the performance period of each resurfaced layer. From the historical data, resurfacing cycles on the majority of roads can be obtained. However, the resurfacing frequencies in the past not necessarily mean that the same ones will be followed in the future. Therefore, performance models are needed to predict the lifespan of a resurfaced layer in different pavement condition levels and under various influencing factors. Many techniques have been used to develop performance models for the resurfaced layers, a.k.a. overlays. For example, in the Mechanistic-Empirical Design Guide for New and Rehabilitated Pavement Structures (MEPDG) in the U.S., mechanistic-empirical models are used to predict the overlay performance [15]. A set of staged survival models are developed by Wang and Allen [16] to predict overlay conditions based on pavement management data in Kentucky. Dynamic panel data models are also developed by Wang et al. [17] to dynamically predict the overlay performance.

The environmental impacts of bituminous pavement resurfacing mainly fall into four areas: waste materials generation, energy consumption, greenhouse gas (GHG) emission, and construction noise. The waste generation model is straightforward: The amount of waste generated is equal to the total amount of milled materials subtracting the recycled ones. The energy consumption in extraction, production, and placement of bituminous pavement materials is roughly estimated to be 3.783 $\times 10^6$ MJ per ton [18], in which raw materials extraction and mixture placement account for 8.46 % of the total energy consumption and mixture production accounts for 91.54 %. However, the data on which the estimate is based show great discrepancy in different parts of the world, and the energy consumption in material transportation is not included. Various studies have also been conducted to estimate emissions in bituminous pavement construction (e.g., [19, 20]), but the results vary greatly, too. Therefore, both the energy consumption and GHG estimation models for resurfacing projects need to be developed. Noise of the resurfacing operation perceived by residents may depend on many factors, such as tasks and timing of the operation, construction location, background noise, etc. At the moment, there are no basic data and models for environmental assessment of the resurfacing operation in HK.

The social impacts may include delays, inconvenience, and loss of business caused by temporary road closures. Some of the impacts are related to the economic impacts. These impacts highly depend on the location of the project. The social impacts of conducting road resurfacing on a busy street will be different than those on a rural road. Because the transportation characteristics and urban layouts are unique in HK, specific models are needed to assess the social impacts.

12.3.4 Optimization

Many different approaches can be used to optimize multi-criteria pavement resurfacing decisions. One approach is to consolidate the different criteria into one criterion, which is often a monetary value. For example, in LCCA, the effects of user delay and work-zone safety are represented by the user costs [5]). It may be possible to assign monetary values to the other environmental and social factors assessed in this study. However, to avoid awkward conversion of everything into money, this study prefers to directly use different criteria.

Multi-criteria decision making (MCDM) involves choosing the best candidate(s) from aset ofoptions. There are numerous MCDM methods [21] and many are used in managing highway assets. Wu [22], in his Ph.D. dissertation, provides a summary of the most popular MCDM methods in highway asset management, including the weighted sum method (e.g., [23]), multi-attribute utility theory (MAUT) (e.g., [24]), generic algorithm (GA) (e.g., [25]), etc. Wu [22] also developed hybrid multi-criteria optimization models for pavement preservation in Virginia, U.S. [22].

The existing literature indicates that the use of MCDM models in managing pavement assets is promising. These models differ in concepts and complexity. It is unknown which models are appropriate for the particular application in this study and if different models will yield similar or quite different results. This part of the study is to identify the MCDM models to make resurfacing optimization decisions.

12.4 Research Methodology

It is essential to combine different methods to accomplish the roadmap to the sustainable road construction under the urban environment. According to the Sect. 2, there are four methods regarding to each components.

12.4.1 Identification and Prioritization of the Criteria

The chosen criteria for this study are based on the 8 guiding principles and 39 indicators for sustainable development in HK [26]. We will analyze these principles and indicators and use the 'mapping' technique [13, 14] to translate the general sustainability principles into concrete criteria related to the pavement resurfacing program. For example, one of the general principles is mobility. We will analyze how and to what extent the resurfacing projects will affect mobility.

12.4.2 Data Fusion

Data related to this study will be obtained from different sources and then be integrated by a data fusion process. A significant portion of the research data have already been secured, including traffic counts and percent commercial vehicles on the road network, pavement structures, types of materials, part of the pavement condition index (PCI), and resurfacing histories, etc. Other types of data can be obtained with moderate efforts, such as resurfacing costs, waste generation, energy consumption and GHG emission generated in resurfacing, and construction noises. For example, we plan to contact the four bituminous mixture plants and different road contractors in HK to find fuel consumption data, which can be further used to estimate GHG emission. The output of the data fusion process is an integrated research database, which not only benefits this study, but also provides a reference for the government.

12.4.3 Model Building and Assessment

The models developed in this study include deterministic models and stochastic models, both of which will be based on the collected research data. Relationships between certain types of data are subject to less variation; hence, deterministic models may be adequate to capture the interdependence of the data. For example, waste generated in the process of milling should be a percentage of the total milled materials, which can be calculated by the road geometry, thickness, and material density. This may be well modeled by a deterministic model. Similarly, energy consumption, GHG emissions, and noise may be modeled by deterministic models. On the other hand, performance of resurfaced pavements is influenced by many factors and their interactions; therefore, a deterministic model cannot reflect the random variations. Besides the models developed in this study, existing models will also be assessed and used. The particular group of the existing models that will be evaluated in this study is the impact of road closure to road users.

12.4.4 Optimization Based on Different Techniques

Different optimization techniques will be compared and used in this study. The selection of the optimization techniques will follow a four-step process. First, trial optimizations will be performed based on different techniques and software (e.g., The GMAS, AIMMS). Secondly, the optimization results obtained from different methods will be compared. Thirdly, the results from step 2 will be discussed with the Highways Department and industry practitioners; their feedback will be used to improve the optimization. At last, the chosen optimization technique(s) will be used to conduct the final optimization.

12.5 Conclusions

The purpose of this study is to draw a roadmap for sustainable road construction in urban environment. Several conclusions can be drawn from this study that deserves consideration. There are four basic components for optimizing road construction decisions including criteria, data, models and optimization. According to each component, several methods are suggested to achieve the roadmap with the principles of sustainability. These findings will hopefully influence the highway administrators in HK on making a pavement resurfacing policy in line with the principles of sustainability. Despite much effort, it remains that this study has focused only on the guideline for the sustainable road construction in urban environment regarding HK as a case study. More studies are recommended to quantify the optimization of sustainable road construction.

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Chapter 13
Cost-Benefit Analysis of Stakeholders for Low-Carbon Building

Yan-yan Wang, Hong Ren, and Chang-heng Li

Abstract The research, development and application of low-carbon technology and low carbon building materials will bring about the increasing costs. In the promotion process of low-carbon building, it needs the participation of stakeholders to share the incremental costs included in the new technology and materials. By the cost – benefit analysis of government, developers, consumers, we find out the focused content by the parties. According to this analysis, this paper puts forward some policy proposals about interest rates, taxation, financial subsidies and environmental protection, which can guide the stakeholders to use low-carbon technology self-consciously.

Keywords Stakeholders • Low-carbon building • Cost-benefit • Incremental cost • Life cycle

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_13,

13.1 Introduction

Based on low power consumption, low pollution economic model, low-carbon economy aims at reducing greenhouse gas emissions, Its essence is the efficient use of energy, clean energy development and the pursuit of green GDP. The core is the innovation of energy technologies and emission reduction technologies, industrial structure and institutional innovation and the fundamental change of human survival and development. Corresponding to the concept of low-carbon economy, low carbon building can be defined as the architecture providing people with a reasonable degree of comfort, with low power consumption, low pollution, low emissions, in the construction of the full life cycle.

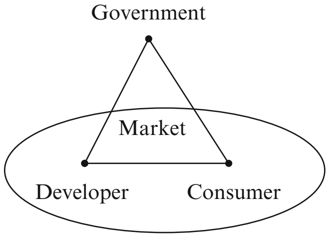
However, who will pay the increased costs brought about by the low-carbon technology research and development and low carbon building materials? Who will promote the development of low carbon buildings? What are the implementation rules? Who will set the standard and who enforces them? And so on. This series of questions have to be considered systematically from the industrial policy, consumer awareness, market conditions and other areas with the purpose of making a reasonable mechanism and institutional arrangements. After all, to promote low-carbon construction is a system work in relation to economic, social, cultural, technical and other aspects, not a simple technical piling up. This need to establish and improve relevant rules and regulations, consumer awareness training and the participation of all stakeholders.

13.2 Stakeholders' Analysis in Low Carbon Building Industry

"Stakeholder" was first proposed that the word can be traced back to 1929, General Electric Company, a manager in his inaugural speech [10]. After decades of research, the scholars had not a clear concept about "stakeholders". In the "Enterprise Growth Theory" published in 1959, Penrose proposed the concept which is "Enterprise is a collection of human assets and human relations". This view laid the cornerstone for establishing stakeholder theory. Until 1963, the scholars, from Stanford Research Institute, put forward clearly the stakeholder definition which was "a number of stakeholders are the groups that, without their supports, organizations can not survive." Freeman [11] pointed out that the stakeholders were the person or group who can affect organizational behavior, decision-making, policies, activities or objectives or the target person or group who were impacted by the factors.

Consumer, development agencies, design agencies, construction agencies, and many other interest agencies exist simultaneously in the low-carbon buildings market, as well as government and the third party. Different stakeholders have

Fig. 13.1 The relationships between the decision-making bodies in the popularization of low carbon building



different goals. Developing and constructing low-carbon buildings, developers hope they will bring more profits. Because low-carbon buildings can lead to better living conditions, consumers choose to purchase them to improve the life quality and work efficiency. Promoting low-carbon buildings, Government mainly aims at environmental protection.

To facilitate the analysis, we first make the following assumptions: (1) The promotion of low carbon building involves two aspects of government and market; (2) The market includes the developers and consumers; (3) developer orients the short-term benefits, government is guided by the long-term benefits, and consumers concern both short and long term interests.

Thus, the relationships between the decision-making bodies in the popularization of low carbon building can be represented by Fig. 13.1. The government and the market play their respective roles in allocating resources. Market is formed by developers and consumers, and the price of the building depends on the supply-demand relationship. Developers mainly concern in the short-term's profit, while consumers mainly concern about the price of a building in the short-term. Moreover, operating costs and quality are also concerned by consumers in the long-term. Environmental issue is a long-term problem which is the main target of the government. In order to achieve its goals, the government will Take measures such as taxes or subsidies, when necessary, to adjust the behavior of consumers and developers.

13.3 Cost-Benefit Analysis of the Stakeholders of Low-Carbon Building

The main decision-makers including government, developers and consumers have some problems about the distribution of benefits. That is, the benefit objects of the investors, implementers and beneficiaries of low-carbon building technology are inconsistent. How to configure reasonably the responsibilities, rights and obligations of the parties concerned and find a balance between relevant stakeholders are the key to popularization and application of the key technology of low-carbon buildings. Here, we take the case of the residential buildings and have a comparative analysis on incremental costs and benefits among government, developers and consumers.

13.4 Government's Cost-Benefit Analysis

As shown in Table 13.1, In the process of implementing the low-carbon buildings the incremental cost of the government mainly lies in the tax relief (T1-T2, Where T1 is the developer of tax payable and T2 is the tax paid), the developers subsidies (B1) and consumer subsidies (B2). The incremental benefit obtained by government is mainly the environmental benefits and social benefits. Because social accounting of income is difficult to quantify, here we only think about tax benefits and environmental benefits (TLEC).

13.5 Developer's Cost-Benefit Analysis

As shown in Table 13.2, adoption of new technologies, new materials in constructing low-carbon building brings about an increase in the incremental cost of the developers, which mainly is the change of construction cost. C1 and C2 are the construction costs of low-carbon building and the general building respectively. Incremental revenue of developers also includes two parts that one is the low-carbon housing developing subsidies or tax incentives provided by government and the other part is the incremental revenue obtained through selling the low-carbon housing. P1 is the sales income of low-carbon building while P2 is the sales income of general building.

13.6 Consumer's Cost-Benefit Analysis

As shown in Table 13.3, due to consumer purchasing low-carbon housing, the incremental cost is the additional expenditure comparing with buying the general building. The incremental revenue consists of two parts that one is the government subsidies (B2) and the other is the savings in energy costs or the reduction in heating costs (TLEC).

Table 13.1 Government's cost-benefit analysis

Incremental cost(Short-term)	Incremental benefit(Long-term)
Subsidies + Tax relief $(B1 + B2 + T1 - T2)$	Environmental benefit(TLEC)

Table 13.2 Developer's cost-benefit analysis

Incremental cost(Short-term)	Incremental benefit(Long-term)
Low-carbon building construction cost –general building construction cost (C1−C2)	*Economic benefits* $(P1 - P2 + B1 + T1 - T2)$

Table 13.3 Consumer's cos t-benefit analysis

Incremental cost(Short-term)	Incremental benefit(Short-term)	Incremental benefit (Long-term)
Low-carbon building sales price – general building sales price (P1−P2)	Government subsidies (B2)	Economic benefits (TLEC)

Judging criteria are followed: when incremental income is greater than or equal to the incremental cost, program is feasible. Otherwise, the scheme does not work. It should be noted that there often has such a big difference between theoretical analysis and the reality. Theoretically, the optimum condition is that the incremental benefits of all stakeholders are greater than or equal to their incremental costs. However, due to the complexity of the problem, in fact it is difficult to obtain a theoretical optimum. Then, we can only achieve a sub-optimal solution or satisfactory solution, even the smallest regret solution.

13.7 Countermeasures and Suggestions

If we want to promote constantly the residential building energy efficiency, it is not enough to achieve the development that we solely rely on the market or just rely on the development of mandatory standards. We must implement the bi-directional management about economic incentives of research and development and policy guiding consumption. To stimulate the potential low-carbon construction market, it needs economic incentives and perfect policy assurance system which not only stimulate the producer's enthusiasm but also attach importance to increase the low-carbon demand. At the initial stage of low-carbon building implementation, it needs the regulation of economic policy make the government, developers and consumers share the incremental costs.

13.8 Tax Policy Proposals

The incentive intensity of raising tax rates is greater than the lower tax preferential policy. In general, the effect of tax policy on developers is greater than consumers and the impact on low-income households is greater than higher-income families. For low-carbon buildings, various taxes imposed on stakeholders (developers, construction companies and buyer), including business tax, income tax, urban maintenance and construction tax, land value increment tax, house property tax, contract tax and so on, should be cut back appropriately. For ultra low energy consumption buildings which can reach more than energy-saving 80 %, the developers and the consumers can enjoy higher standards of tax relief. The institutional policies should be different for developers and consumers. Firstly, we should adopt the most stringent building standards for high-end residential. Secondly, the developers should be imposed on a heavy tax if they construct the buildings which don't meet the criterion of CO_2 reduction emission. Thirdly, the preferential tax policies should tilt toward affordable housing and low-rent housing.

In order to encourage the social fund to participate in the energy conservation and enhance the investment income level, the government can implement the preferential tax policy. In the initial stage of popularizing the building energy saving policy, it can exempt the enterprise income tax. When the market comes to the mature stage, it can implements the halving or preferential enterprise income tax.

13.9 Financial Subsidies Proposals

Comparing with tax policy, financial subsidies can also achieve favorable results in a short period. Penalties whose incentive intensity is significantly greater than financial subsidies' may be regarded as negative subsidies. In general, the impact of subsidies and penalties on developers is greater than on consumers, and the impact on low-income families is greater than on high-income families. Government subsidies include two forms that are direct subsidies and interest payments on loans. Consumer-oriented financial subsidies should be based on the change from the implicit subsidies for enterprises to the explicit subsidies for low-income urban families. Then it should straighten out the relationship between costs and prices. Through providing the loan discount to the low-carbon building investors, Government has a small amount of financial expenditure to guide a large number of social funds flowing into the low-carbon building market. This policy,which can effectively resolve the problem of insufficient government input, not only has lower risk but also can avoid or reduce the "crowding-out effect" of financial investment on social capital.

13.10 Proposals of Environmental Protection Incentives and Penalties

Low carbon construction can reduce the emission of pollutants, protect the environment and devote to the sustainable development of the whole society. When buyers purchase the low-carbon buildings, the government can give them some preferential economic policies. In the following 50-year life cycle housing using phase, according to energy-efficiency labeling and individual household heat metering, every year the difference between the actual energy consumption and the baseline energy consumption can be measured, which can be used to measure the energy-saving degree. If the actual energy consumption is lower than the baseline energy consumption, tenants can enjoy a certain amount of annual environmental protection award. On the contrary, tenants will be punished. Such measures can improve the subjective wishes of buyers to purchase the low-carbon buildings. In addition, government can increase appropriately the charge standards of pollutant emission. Heating enterprises should allocate the increased costs into the variable heating charges and reduce suitably the price of a fixed charge for heating. This can make non-low-carbon building users to pay for this part of the costs.

13.11 Summary

The promotion of Low-carbon building needs establish and improve the low-carbon building cost accounting system, set up proper economic levers, improve cost-benefit structure, allocate reasonably the responsibility, rights, and profit. Comparing with general building, low-carbon buildings have the characteristics that their initial investment costs are higher and operation and maintenance costs are lower. This needs clear policy guidance. By the cost – benefit analysis of government, developers, consumers, we find out the focused content by the parties in the promotion process of low-carbon building. From the perspective of stakeholders, some policy proposals about interest rates, taxation, financial subsidies and environmental protection have been put forward, which can guide the stakeholders to use low-carbon technology self-consciously and put foreword a clear idea for the popularity of low-carbon building.

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Chapter 14
Plan and Practice of the National Low Impact Development Demonstration Area

Nian Ding, Xinxin Ren, Aibing Hu, and Weizhen Tang

Abstract The low impact development (LID) approach has been recommended as a significant innovation in urban planning and design, which can mitigate the effects of flooding, runoff pollution, water resource shortage and ecology deterioration, and can also promote sustainable utilization of urban water resources and virtuous cycle of water system. Guangming New District, Shenzhen City was ranked as the first national LID demonstration area by Ministry of Housing and Urban-Rural Development. The overall scheme of LID demonstration area in Guangming New District was formulated for the construction of LID demonstration area, the work of which will be divided into three stages. By the end of June 2012, with the stringently implementing of this overall scheme, some substantial progresses had been made on the LID demonstration area planning and construction, technical specification formulation, and basic research.

Keywords Low impact development • Stormwater utilization • Demonstration area • Overall scheme

14.1 Introduction

Low impact development (LID) techniques, developed based on Best Management Practices (BMPs) 20 years ago, is an innovative stormwater management approach with a basic principle that the runoff and pollution of the stormwater should be controlled using decentralized and micro-scale controls and techniques, and that the natural hydrology of the developed site should be kept as close as possible to predevelopment levels [1]. LID techniques could mitigate the effects of rapid urbanization on flooding disaster, runoff pollution, water resource shortage,

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_14,

ecology deterioration, and promote sustainable utilization of urban water resource and virtuous cycle of water system

LID construction pattern has been received increasing attention by governments at all levels because of the advantage of accelerating the harmonious development between urban construction and aquatic ecosystem. Currently, LID demonstration projects have been planned and carried out in Beijing, Shenzhen, Jiaxing, Kunming, Foshan, Sanya, Hefei. However, these projects are difficult to obtain enough attentions owing to the limitation of a residential district or a road. Thus, not enough experiences about some critical problems such as the influence of LID construction pattern on urban stormwater system could be provided.

Aiming at the lack of large-scale applications and experiences in LID construction pattern, Ministry of Housing and Urban-Rural Development (MHURD) and Shenzhen Government begun to promote the formation of national LID stormwater utilization demonstration area in Guangming New District, and launched the formulation of the overall scheme of LID demonstration area in Guangming New District since 2009 [2].

Shenzhen Government agreed to implementation of the overall scheme of LID demonstration area in Guangming New District in November 2010. In September 2011, the MHURD organized the experts to verify the overall scheme of LID demonstration area in Guangming New District, and agreed to rank Guangming New District as national LID stormwater utilization demonstration area. Meanwhile, the MHURD required that Shenzhen Government should stringently implement this work, strengthen scientific research and associated projects construction, and summarize experiences in time, make the demonstration for national LID stormwater utilization [3].

14.2 Overall Objectives and Stage Works Arrangement

The overall scheme of LID demonstration area in Guangming New District defined that the overall acceptance time of the formation of LID stormwater utilization demonstration area is the year of 2020, and the works will be divided into three stages which is orderly, coordinately and steadily promoted.

The first stage: from 2010 to 2012, the typical demonstration projects would be constructed and evaluated in terms of water saving effectiveness, water cycle improving, stormwater volume and runoff pollutants reduction, peak flow reduction, landscape and eco-environment improving, and life cycle investment-effectiveness. Base on summarizing experiences, the temporary management regulations and technical manuals would be formulated.

The second stage: from 2013 to 2015, the appropriate new government-investing projects should be comprehensively constructed with LID facilities. Moreover, the management regulations and technical manuals would be laid down and improved through universally application.

The third stage: from 2016 to 2020, LID stormwater utilization would be comprehensively popularized in construction projects through improving supporting policies and applying incentive methods. Furthermore, Guangming New District would be constructed into LID demonstration district, which would provide foundations and guidance for the popularization of LID stormwater utilization in Shenzhen and other cities.

By the end of June 2012, some substantial progress had been made in the planning and construction, and technical specification.

14.3 Demonstration Area, Projects Planning and Construction

According to recent construction planning and strategic development planning of Guangming New District, the overall scheme of LID demonstration area in Guangming New District defined that the surrounding area of Guangzhou-Shenzhen-Hong Kong Express Rail Guangming Station (Guangming railway demonstration area) is the demonstration area.

Guangzhou-Shenzhen-Hong Kong Express Rail Guangming Station, as one of the important transportation links for connecting Shenzhen, Hong Kong, Guangzhou, Dongguan and other cities, located in the Gongming river basin which is in the upstream of the Maozhou River and edge region of mountain transition to the basin with good ecological background. Recently, part of the site have been graded, but large-scale construction has not yet been carried out. The industry planning of this demonstration area are modern service industries, such as high-tech industry, business and commerce. The composition include software park, technology enterprise, medium-sized and small enterprises headquarters park, and multi-functional development area (Fig. 14.1).

The comprehensive runoff coefficient of Guangming railway demonstration area in 2000 and 2010 were estimated as 0.30 and 0.36 according to the underlying surface analysis of the Satellite images above. Without any effective protection measures, the comprehensive runoff coefficient of Guangming railway demonstration area would increase to approximately 0.70 with the current construction pattern, and finally lead to the imbalance.

Currently, a special plan of LID application have been formulated in this demonstration area [4]. According to this planning, a series of policies and supporting management mechanisms would be adopted to ensure that the proportion of LID techniques in new government-investing projects is not less than 80 %, and that the runoff coefficient of the Guangming railway demonstration area is not greater than 0.36 after construction. Meanwhile, the integrated, large-scale LID applications would be implemented.

Twenty-three roads, located in the south area of Guangming railway demonstration area, were designed and constructed using LID concepts. The main techniques contain permeable asphalt (roadway), bioretention cells (concave green), permeable pavements (Fig. 14.2).

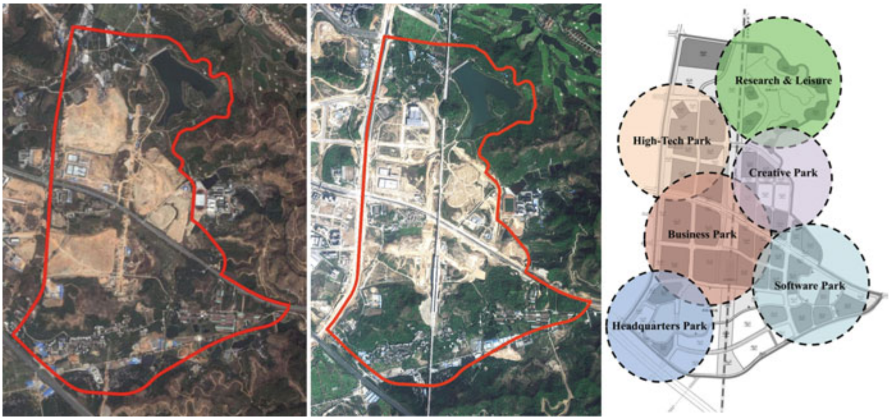

Fig. 14.1 Satellite photographs of demonstration area in 2000 and 2010 and schematic diagram of industry planning

Fig. 14.2 The LID facilities in Guangming railway demonstration area

14.4 Technical Specification

According to the functions of Shenzhen governmental departments, the overall scheme of LID demonstration area in Guangming New District suggested that the research and standard formulation of LID facilities could be organized by Shenzhen Water Affairs Bureau. During the last 2 years, Shenzhen Water Affairs Bureau have completed the formulation of Water quality specifications for reclaimed water & stormwater utilization in. Shenzhen (SZJG32-2010) and Technological Specification for Rain Water Utilization in Shenzhen (SZDB/Z 49-2011). At present, it is promoting the formulation of Technical specifications for low impact development in. Shenzhen [5].

The main content of Technical specifications for low impact development in. Shenzhen include LID design process, design objective, design criteria, design method, construction and installation, quality control and acceptance, operation and management. Additionally, it also provides some detailed information such as design information, general material requirements, general LID design models, engineering drawing of LID facilities, and LID design cases.

The formulation and implementation of these specifications will guarantee the scientific design of demonstration projects in the early stage of the formation of demonstration area, and provide references for design agencies, review agencies and management agencies.

14.5 Progress of Basic Research

In order to scientifically guarantee the implementation of the LID demonstration area, the overall scheme of LID demonstration area in Guangming New District advocated that the demonstration projects must be evaluated through combination with relevant research projects and science and technology of institutions. What is more, international or national technical forums could be aperiodically held to promote the technical staffs participate in LID practices.

After more than 1 year of application and evaluation, the research project named "the research and demonstration of LID techniques in urban stormwater system" was successfully obtained the approval by MHURD in October 2011. This project was ranked as The State Key Special Funds for Water Program. With the systematic analysis of the typical urban area and facilities such as roads, green spaces, buildings, communities, drainage systems, a series of appropriate LID single technologies, integrated technologies, design tools and demonstration projects which were suitable for above sites and different control objectives were developed. Then LID guideline, planning and design standards, standard atlases would be developed as well, and some related standards would be revised. These works will promote the industrialization and standardization of high-tech products and technologies of urban ecological rainwater drainage system, and build urban stormwater comprehensive control strategies and management system. Furthermore, it would provide policy and technology support for building low carbon city, promoting green infrastructure and building [6].

This research involved in more than 20 research institutions, such as Beijing University of Civil Engineering and Architecture, Chongqing University, Urban Planning and Design Institute of Shenzhen, Harbin Institute of Technology Shenzhen Graduate School, etc. This research will be successfully conducted and establish a technical supporting for the demonstration area under the supervision of the MHURD.

14.6 Conclusions

Because LID techniques have a significant effectiveness in reducing runoff pollution, repairing hydrological cycle, controlling peak flow, it becomes an indispensible and important elements of the construction of low carbon and ecological demonstration city and green city in Shenzhen. The establishment of national LID demonstration area is an arduous and innovative work. With the guidance of local government and promotion of the overall scheme of LID demonstration area in Guangming New District, Guangming New District have made substantial progresses in LID practices. As the thorough study on LID approach, the large-scale and integrated application of LID construction pattern will be completed, the techniques and management system relating to planning, design, implementation, operation and maintenance will be formed, which will provide reference and demonstration for national LID application.

Acknowledgement We gratefully acknowledge the financial support from The State Key Special Funds for Water Program (No. 2010ZX07320-003).

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Chapter 15
A Multi-level Grey-Based Approach to Evaluating the Indicators for Sustainable Housing Development

Shichao Ma and Zhengdao Li

Abstract It is urgent to disseminate the concept of sustainability development and put it into practice in housing development. However, because Mainland China has a larger population, building density, and less availability of reusable energy, it is critical to consider the status quo of the housing development and the existing sustainability development levels when we establish evaluation indicators for sustainable housing development. This paper analyzed the requirements, characteristics, standards for sustainable housing development and established the evaluation indicators of sustainable housing development pertaining to economic, environmental, social and project facets. In the case study, we examined the feasibility and practicability of the established indicators by applying Multi-level Grey evaluation method. It is found that the indicators were applicable as evaluation foundations of the housing development. The significance of this research lies in its direction to extend the established indicator system of sustainable housing development to a nation-wide standard.

Keywords Sustainability development • Indicator system • Sustainable housing development • Multi-level grey evaluation

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_15,

15.1 Introduction

Housing is an essential to high quality of life and sustainable development. Housing is important to sustainability in that the location, construction, design, management/maintenance and use, and demolition have significant effects on the environment, economy and society in China [1, 2].

Sustainability is a complex phenomenon with positive economic, environmental and social impacts; it should be incorporated into housing development in China. Important elements in sustainable housing development include green materials, advanced techniques and efficient management. These elements could be reflected in a form of indicators. However, indicators of the housing development project have not been emphasized in China, in spite that they are important in guiding the SD promotion, practice and the trends of the sustainable housing development [3–5]. Reviews on the existing research in sustainable housing development show that the current indicator systems of sustainable housing construction reflect only partial aspects of SD, such as society, economy, environment impact and housing performance, which cannot give complete and profound references for the indicators of sustainable housing development [3–6]. Besides, there is a lack of theory support in the method to evaluate the sustainable housing construction system, making the practicability of evaluation method groundless.

This paper aims to establish an indicator system of sustainable housing development which is highly relative to the practice of housing construction in Mainland China and evaluate the established indicator system by applying Multi-level grey evaluation method. The paper is divided into four parts. The first part is introduction. Section 15.2 introduces the method to choose indicators of sustainable housing development. Section 15.3 introduces the Multi-level Grey Evaluation method to evaluate indicators established in Sect. 15.2. Section 15.4 implements a case study to illustrate how the established indicator system of sustainable housing development can be applied using Multi-level Grey Evaluation method. Section 15.5 summarizes the results and concludes the evaluation system of sustainable housing development in Mainland China.

15.2 Indicators for Sustainable Housing Development

The indicators for sustainable housing development are synthesized by literature review, questionnaire survey and experts interview. Questionnaire is carried out to choose and establish the indicators which represent SD in housing development in Mainland China. The experts in the construction field are interviewed to consult which indicators are feasible and practicable.

In the questionnaire, respondents were required to tick the significance of the index as in Likert methods. All respondents for questionnaire survey were contacted beforehand to make sure that they were familiar with sustainable construction projects and were willing to participate in the survey. Two hundred twelve sets of questionnaires were sent to professionals in the industry. Ninety three feedbacks were received, giving an overall responding rate of 43.90 %. However, 19 feedbacks were identified as invalid due to incomplete or invariable answers, leaving 74 sets of responses valid for further analysis. Nevertheless, this represents a valid response rate of 34.6 %, which is acceptable according to Moser and Kalton's assertion [7].

According to the statistical analysis of the survey, 18 indicators were remarked as less than 3-average, which were deleted consequently. Finally, 78 indicators were established to construct the indicator system of housing sustainability development. The indicators were classified to four categories as in Appendix 1: economical, environmental, social and project techniques and management.

After analyzing the contents of established 78 indicators, sustainable housing development is essential to keep balance among economy, ecology, and society and project management (see Table 15.1). Economy and financial benefits motivates the development of SD whereas environment could limit the SD. Social development is the final objectives of SD and project techniques and management provide support for SD. Therefore, the paper studies and categorizes the indicators of sustainable housing development from four aspects: economy, environment, society, project techniques and management levels.

15.3 Proposed Multi-level Grey Evaluation Approach to Evaluate the Established Indicators

The multi-level grey evaluation method is chosen to comprehensively evaluate the levels of indices coming along with sustainable housing development in Mainland China. The multi-level grey evaluation method is often used to tackle complex project decision making using subjective judgments based on well-established logical reasoning rather than feeling and intuition [8].

15.3.1 Hierarchy Structure of Indicators

The indicators were divided into three levels according to their different attributes. The first level of indices were labeled as Ui (i = 1,2, 3,4), the second level of indices as Uij(i = 1,2,3,4; j = 1,2,3,...ni), and the third level of index as Uijk (i = 1,2,3,4; j = 1,2,...,ni; k = 1,2,3.., nj), referring toApendix1.

Table 15.1 Indicators for sustainable housing development in Mainland China

First level index	Second level index	Third level index	First level index	Second level index	Third level index	First level index	Second level index	Third level index
Economy evaluation	Economic performance	Performance and cost ratio	Society evaluation	Community culture	Culture and education facility	Evaluation on technique progress and management efficiency	Housing condition	Plot ratio
		House price and income ratio		Property management	ISO 140001 environmental standard authenticated			Building density
		Energy consumption and cost			Facility management service level			Building height
		Inflation-proofing and appreciation		Easy of access	Walking distance to public traffic facility			Floor clear height
	Economic contribution and financial evaluation	Economic net present value			Vehicle accessible option			Per capita living space
		Benefit-cost ratio			Mancar shunt		Project life cycle	Decision-making period
		Internal rate of return		Employment effects	Direct employment effect			Design period
		Dynamic payback period			Indirect employment effect			Construction period
Environment evaluation	Water	Non-traditional water		Social harmonious	Culture and custom compatibility		Housing design	Design rationality of plane figure and structure
		Quality of water supply			Policy compatibility			Environment compatibility
	Land	Unit floor areaU020201		Impact on local people	Impact on health care			Esthetics
		Underground exploration			Impact on education		Intellectual technology	Housing intelligence system
	Waster	Waste water exhaust per capita			Impact on land expropriation and migration			Public administration system

		Waste gas exhaust per capita		Impact on local economic development	Impact on local economic			Communication and network system
		Waste residue exhaust per capita			Impact on investment environment		Building energy-conservation system	Water saving system
		Refuse collection and classification ratio			Impact on related industry development			Energy saving system
		Waste recycling ratio	Society evaluation	Project reorganization	Selling ratio			Building material saving system
	Sound	Day-time noise degree			Occupational ratio		Engineering technology	Advancement of technology
		Night-time noise degree		Safety performance	Fire control improvement			Advancement of equipment
	Air	Ambient air quality			Water-proof measure		Project quality	Fitness of quality
		Housing ventilation ratio			Skidproof and safety hook		Project management system	Rationality of structure
	Light	Natural lightning ratio			Burglary-resisting installation			Effectiveness of management
		Light pollution degree			Jeopardous			
		Exterior illumination system		Public installation	Recreation facility			

15.3.2 Determining the Weight of Indicators

The significance of different levels of index (Ui, Uij, Uijk) are different, and thus the weights of indicators should be determined in the same way as in the questionnaire. The questionnaires were issued again for scaling the weights of the indicators. The experts taking the questionnaire gave the opinions on the relative significance of each indicator comparing with other indicators. Analytic Hierarchy Process (AHP) was applied to get the weights of each indicator.

15.3.3 Establishing the Evaluation Matrix of the Indicators

According to the established indicator system for sustainable housing development, there are 78 indicators which can be categorized into 4°, being excellent, good, pass and fail respectively. The indicators could be standardized by following related standards, specifications, and regulation in Mainland China.

After all the above steps are carried out, we can get the mth experts' judgment of evaluation dijkm to Uijk. Totally, the corresponsive evaluation matrix D can be achieved (p = 5).

$$D = \begin{bmatrix} d_{0101011} & d_{0101012} & d_{0101013} & d_{0101014} & d_{0101015} \\ d_{0101021} & d_{0101022} & d_{0101023} & d_{0101024} & d_{0101025} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ d_{0102041} & d_{0102042} & d_{0102043} & d_{0102044} & d_{0102045} \\ d_{0201011} & d_{0201012} & d_{0201013} & d_{0201014} & d_{0201015} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ d_{0408021} & d_{0408022} & d_{0408023} & d_{0408024} & d_{0408025} \end{bmatrix}$$

15.3.4 Defining Grey Cluster

The classification of grey fuzzy can be categorized as excellent, good, ordinary and bad. Ablation functions are understood as rough scales rather than specific numbers. $\otimes$ is the grey number. Assume that f(X) represents the preferences of $\otimes$ (x) to x in the different situations. f(x) is the ablation function of $\otimes$ (x). There are mainly four kinds of functions from 1 to 4 and the grey cluster could be established as the example of cluster 1.

Grey cluster 1 "excellent"(e = 1), grey number $\otimes_1 \in [d_1, \infty)$, ablation functions:

$$f_1\left(d_{ijk}\right) = \begin{cases} \dfrac{d_{ijk}}{d_1} & d_{ijk} \in [0, d_1] \\ 1 & d_{ijk} \in [d_1, \infty) \\ 0 & d_{ijk} \notin [0, \infty) \end{cases}$$

15.3.5 Calculating the Grey Evaluation Coefficients

For the indicators Uijk, the grey evaluation coefficients for the project to eth grey cluster is $x_{ijke} = \sum_{m=1}^{p} f_e(d_{ijkm})$. f_e is the ablation function of grey number e. The comprehensive grey coefficient is xijk and $x_{ijk} = \sum_{e=1}^{g} x_{ijke}$.

15.3.6 Calculating the Grey Fuzzy Weight Vector and Weight Matrix

Grey weight for the indicator Uijk to eth grey cluster, is rijke and $r_{ijke} = \frac{x_{ijke}}{x_{ijk}}$. Considering that there are four grey clusters, the weight vector for the indicator Uijk to each grey cluster is $r_{ijk} = \left(r_{ijk1}, r_{ijk2}, r_{ijk3}, r_{ijk4}\right)$. After synthesizing each weight vectors, the weight matrix Rij for indicator Uijk belong to Uij can be obtained as Ri.

15.3.7 Grey Evaluating the Indicators

The indicators in the lowest level attribute to the second level index evaluation can be evaluated from lower level in the hierarchy to upper level. For example, in the first level evaluation, given that we know the indices' weighting matrix Rij and the judgment matrix A3, the evaluation vector Bij for the indicators Uij can be indexed by calculating matrix with fuzzy operator M. Therefore, it is reasonable to deduce that the comprehensive evaluation for Ui, Bi and B can be obtained in the similar way.

$$
R = \begin{bmatrix} B_1 \\ B_2 \\ \vdots \\ B_m \end{bmatrix} = \begin{bmatrix} b_{11} & b_{12} \cdots & b_{1g} \\ b_{21} & b_{22} \cdots & b_{2g} \\ \vdots & \vdots \ \vdots & \vdots \\ b_{m1} & b_{m2} \cdots b_{mg} & \end{bmatrix} B = A \bullet R = A \times \begin{bmatrix} A_1 \times R_1 \\ A_2 \times R_2 \\ \vdots \\ A_m \times R_m \end{bmatrix}
$$
$$
= \left(b_1, b_2, \cdots, b_g\right)
$$

B is the 5° of membership, under which each of the five values represents the subject being evaluated which belongs to either 'very serious', 'severe', 'average', 'minor', or 'insignificant'. Once we have the judgment indices, the evaluation results corresponding with the largest judgment indicator are taken as the final evaluation achievement using method of largest degree of membership.

15.4 Case Study

The project, VankeVac Evergreen Garden, is positioned as excellent town house developed by Wanke Group, who is the pioneer in developing houses using advanced techniques to support sustainability development. The project was typically chosen to compare its characteristics with the evaluation results of index system and examine the feasibility and rationality of the established index system. The data for the different indicators were collected based on the characteristics of the practical project. The Multi-level Grey evaluation method was chosen to evaluate the established index system of sustainable housing development. The appraisal result-the largest value under the ranking good is 0.406, which implies the final evaluation result of the project is good, consistent with the practical conditions of the project. In other words, the established sustainable housing development system is an appropriate evaluation system, which could apply to the real projects with sustainable evaluation methods.

15.5 Conclusions

The indicator system of sustainable housing development is established to construct an evaluation system to appraise the to-be-built or built housing projects. Seventy eight indicators were synthesized from four pillars of economy, environment, society and project management. The established indicator system of sustainable housing development is the foundations to assess whether housing project satisfy the requirements of SD. To examine the feasibility and practicability of the established indicators, the project VankeVac Evergreen Garden was evaluated by implementing Multi-level Grey evaluation method. The results showed that the indicator system was feasible to support the monitoring of housing development in terms of housing trends and concerns pertaining to ecological, economic and social improvement. However, the indicator system of sustainable housing development should be further adjusted and developed to be more accurate and complete to fit development condition in practice.

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Chapter 16
Impact of Labour Arrangements on Construction Material Waste Generation

Jeyaraja Jayamathan and Raufdeen Rameezdeen

Abstract Construction waste originates from various sources from the inception through completion of a building project. Previous research has shown that there is a link between the quantity of waste generated and the way labour is organized in the construction industry. However, these studies have failed to look into the sources of waste and how it affects the waste generation. To fill this gap in the literature, this study investigated the impact of labour arrangements on construction waste generation, particularly the sources of waste origin and the attitudes of workers. Using a combination of direct observations and source evaluations on the sites of six case studies, the construction waste in direct and subcontracted labour arrangements was quantified. A questionnaire survey was administered among the workers participating in the observation study to elicit their attitudes towards waste. The results show that the subcontracted labour arrangement produced higher waste than the direct labour in all three work processes considered. A lack of organizational commitment and strategy was found to be the main barrier to waste reduction.

16.1 Introduction

Materials and labour comprise the major inputs of construction work. Past research showed that waste generation rates are related to the different labour arrangements practiced in the industry [1]. It identified significant differences in waste generation between the arrangements of direct labour and labour only subcontracting.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_16,

The labour only subcontracting arrangement generated higher levels of waste than did direct labour. Interestingly, labour and material subcontracting generated the lowest waste percentages for all five materials considered, indicating that the level of material wastage is decided by who pays for it. The above study, therefore, poses an important question on the assumption that the attitude of workers is the prime reason for material wastage, as espoused by some other researchers [2, 3]. The results of Tam et al. [1] point to the fundamental issue of whether site supervision is a major factor in deciding construction material waste. To answer this question, one should look at how waste occurs in different labour arrangements; however, Tam et al. [1] did not look at the sources of waste in the three labour arrangements. It did not categorize the waste into different sources, due mainly to limitations posed by the methodology used. It used material reconciliation in quantifying waste, which is essentially an audit that would not provide the different sources.

What are the origins of waste in different labour arrangements? Do these origins significantly differ among the different labour arrangements? Is there a major difference in the attitudes of workers towards waste between the labour arrangements? These are some of the questions to which Tam et al. [1] were unable to provide answers. The present study addresses these questions through a comparative study of direct labour and labour only subcontracting arrangements using a source evaluation methodology. Source evaluation provides an opportunity to separate waste streams based on their origins.

16.2 Construction Material Waste Generation

Causes of construction material waste can be divided into two broad categories: non-site based and site based. Non-site-based waste largely occurs due to design errors [4, 5], design changes [6, 7] and excessive ordering of materials [8]. Site-based waste contains the actual loss of materials during site operations. Careful transportation, reception, handling, storage and coordination can reduce site-based material wastage [9]. Site-based material waste can be further divided into two categories: upstream and downstream. Upstream waste is generated prior to the construction operation. Improper material handling and storage have been found to be the main causes of upstream waste [4, 10]. Downstream waste refers to waste generated at the operation stage. There are two basic underlying reasons for downstream waste [2, 11–13]:

- The attitude among workers that waste is unavoidable, and
- Lack of supervision.

Researchers that support the attitude school of thought argue that little awareness was found among construction workers on the importance of minimizing waste [2, 3, 14–16]. Researchers belonging to the supervision school of thought assert that construction material wastage is not considered as an important variable in the cost equation [5, 11, 17]. Labour is generally more expensive than building materials; therefore, contractors tend to allow a considerable amount of material wastage on site rather than engaging more human resources to manage waste.

16.3 Research Methods

The aim of this study was the investigation of wastage levels and their sources under different labour arrangements employed in construction. The case study method was adopted as the research methodology [18], and six case studies were selected among building construction sites belonging to C1 grade contractor organizations in Sri Lanka (classified by the Institute for Construction Training and Development of Sri Lanka). Direct observation with the source evaluation method were used within the case studies to measure wastage levels in the two frequently used labour arrangements, namely direct labour (DL) and subcontracted labour (SL). The major requirements in selecting the case study sites were that both DL and SL arrangements were being used simultaneously in the trades concerned and that the building was under construction during the observation period. To fulfill the above requirements, only three trades (i.e. brickwork, reinforcement and formwork) could be used in the study. The direct observations focused on delivery, internal site transit, cutting, fixing and residue wastes. Management waste, waste caused by other trades and waste due to wrong use were not separately recorded, due to difficulties in measurement. Observations were carried out only for work done on the ground and first floor levels to maintain consistency and accuracy of the data collected. The selected sites had similar store management systems and similar distances from the initial storage of materials to the activity locations. The selection of the volume of work for observation was carefully carried out to ensure that approximately the same number of workers were employed under the DL and SL arrangements. However, due to differences in the labour gang compositions used by the contractors, the same number of workers were not involved in actual operations. As this study focused on a comparison of wastage between DL and SL arrangements per unit of work carried out, the above limitation would not lead to any methodological deficiencies in the research (see Table 16.1 for the profile of case studies). The measurements of waste during the observation period were carried out using source evaluation methodology. The use of source evaluation for waste quantification is very popular among researchers [4, 9, 19]. Waste was separated for different sources at the time of its generation. Thus, at the end of an observation, the waste from different sources was quantified separately [4, 19].

A structured questionnaire survey was also administered among the workers involved in the observation study, in order to evaluate their attitudes and perceptions regarding construction waste. The main objective was a comparison of the differences in attitudes between the DL and SL workers in the study. Thus, the sample was purely purposive, and the research assistants were directly involved in administering the questionnaire. Respondents were asked to rate their opinion on

Table 16.1 Profile of case studies

Site	Parameter	Brickwork		Formwork		Rebar	
		DL	SL	DL	SL	DL	SL
A	Amount of work observed	2.0 m3	1.9 m3	19.8 m2	18.9 m2	1.6 t	1.3 t
	Skilled workers	1	1	2	2	2	2
	Unskilled workers	3	2	3	4	1	2
B	Amount of work observed	3.2 m3	2.5 m3	24.6 m2	21.0 m2	1.3 t	1.4 t
	Skilled workers	1	1	2	2	1	2
	Unskilled workers	2	2	2	4	2	3
C	Amount of work observed	2.0 m3	2.8 m3	30.2 m2	36.4 m2	2.8 t	3.2 t
	Skilled workers	2	1	2	2	1	2
	Unskilled workers	2	2	1	2	1	1
D	Amount of work observed	3.1 m3	5.1 m3	38.8 m2	32.5 m2	5.3 t	6.2 t
	Skilled workers	1	1	4	2	2	1
	Unskilled workers	2	2	1	1	–	1
E	Amount of work observed	2.1 m3	3.0 m3	17.2 m2	21.3 m2	7.2 t	6.0 t
	Skilled workers	1	1	2	1	3	2
	Unskilled workers	2	2	1	1	1	2
F	Amount of work observed	2.2 m3	3.1 m3	24.5 m2	29.0 m2	1.9 t	2.3 t
	Skilled workers	1	1	4	2	2	1
	Unskilled workers	2	2	–	1	2	2

statements of sustainability and waste (following [3]) based on a five-point Likert scale, using “strongly agree”, “agree”, “neither agree nor disagree”, “disagree” and “strongly disagree”. Out of the 125 workers involved in the observation study, 96 filled out and submitted the questionnaires. Five of these responses could not be used for the analysis and had to be discarded, as the respondents had not understood the rating system correctly. Thus, 91 questionnaires were used in the analysis, making the response rate 72.8 %.

16.4 Results and Discussion

Within the three trades included for observation, four materials were studied for their waste generation rates, as given in following formulae.

$$WGR_b = \frac{\sum_{i=1}^{n} \left(\frac{B_{wi}}{V_{bi}} \times 100 \right)}{n}$$

$$WGR_m = \frac{\sum_{i=1}^{n} \left(\frac{M_{wi}}{V_{bi}} \times 100 \right)}{n}$$

Table 16.2 Waste generation rates

	Direct labour		Subcontracted Labour	
Material	Mean waste generation rate (%)	Standard deviation	Mean waste generation rate (%)	Standard deviation
Bricks	3.05	0.35	4.75	1.32
Mortar	1.47	0.51	2.46	1.08
Formwork timber	6.03	0.67	12.51	0.49
Reinforcement bars	4.79	0.03	6.91	0.94

$$\mathrm{WGR_f} = \frac{\sum_{i=1}^{n}\left(\frac{F_{wi}}{A_{fi}} \times 100\right)}{n}$$

$$\mathrm{WGR_r} = \frac{\sum_{i=1}^{n}\left(\frac{R_{wi}}{T_{ri}} \times 100\right)}{n}$$

where WGRb, WGRm, WGRf and WGRr are the mean waste generation rates of the bricks, mortar, formwork and reinforcement, respectively; Bwi, Mwi, Fwi, and Rwi are the amounts of wastage that occurred on the ith site for bricks (m3), mortar (m3), formwork (m2) and reinforcement (t); Vbi, Afi, and Tri are the volume of brickwork, area of formwork and tonnage of reinforcement work carried out on the ith site during the observation period; and, n is the number of case study sites.

Boxes (1 m3) were kept at the source of the brickwork to collect brick and mortar waste. Summary of the results (i.e. mean waste generation rates of the four materials along with standard deviations) is given in Table 16.2. The results shows that DL workers generated relatively less wastage than did SL workers, while maintaining a smaller standard deviation. The mean wastage rate for formwork timber recorded by SL was more than twice that of DL. These results validate those reported by [1], confirming that DL generates less waste than SL. A t-test was performed on the results obtained for the two groups, in order to verify the significance. The null and alternative hypothesis for the test were given as:

$$\mathrm{H0} : \mu 1 = \mu 2 \,\mathrm{and}\, \mathrm{H1} : \mu 1 < \mu 2,$$

where μ1 is the mean waste generation rate of DL, and μ2 is the mean waste generation rate of SL. With a 0.05 significance level, the t-test results indicated that the two groups had significantly different waste generation rates (Table 16.3).

Apart from cutting and upstream handling damage, no other major causes of brick wastage were observed during the study. The amount of bricks wasted due to these causes for both DL and SL arrangements are given in Fig. 16.1. The main cause in DL was found to be cutting rather than handling, except for one site. However, handling was determined to be the major cause for SL on four out of the

Table 16.3 Summary of t-test for DL and SL samples

Material	t-value	P value
Bricks	−3.049	0.012
Mortar	−2.033	0.069
Formwork	−19.122	0.000
Reinforcement	−5.522	0.000

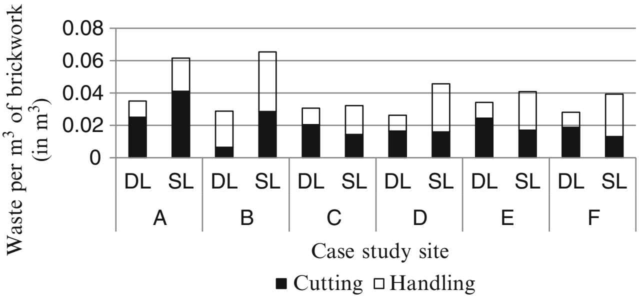

Fig. 16.1 Causes of brick waste (*DL* direct labour, *SL* subcontracted labour)

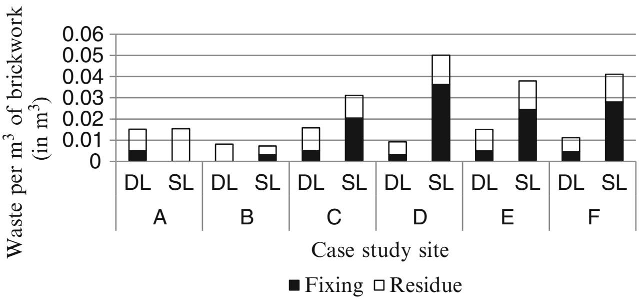

Fig. 16.2 Causes of mortar waste (*DL* direct labour, *SL* subcontracted labour)

six sites. The major causes of mortar waste in brickwork were observed to be fixing and residue. The amount of mortar wasted due to these two causes for both DL and SL arrangements are given in Fig. 16.2. The main cause of DL mortar waste was found to be a result of residue than fixing. Five out of six sites showed a higher residue waste compared that of fixing. On the other hand, fixing waste was higher for SL in four out of the six sites. The comparatively lower fixing rates for DL can be explained by their superior skill levels compared to those of SL. In all but one site, the amount of residue waste of SL was still higher than that of DL. It was observed that formwork and reinforcement waste was caused entirely by cutting operations.

Data collected through the questionnaire survey administered among workers gave a detailed account of their attitudes towards waste. The SL group was comprised of relatively young and less experienced workers compared to the DL

Table 16.4 Existence of a waste management strategy in the organization (%)

Labour arrangement	Strongly disagree	Disagree	Neither	Agree	Strongly agree
Direct	10.2	18.7	19.8	34.8	16.5
Subcontracted	32.1	39.5	14.5	9.2	4.7

Table 16.5 Importance of waste management (%)

Labour arrangement	Strongly disagree	Disagree	Neither	Agree	Strongly agree
Direct	3.1	10.6	15.4	25.5	45.4
Subcontracted	4.3	4.9	22.8	29.8	38.2

Table 16.6 Attention to waste management in practice is not sufficient (%)

Labour arrangement	Strongly disagree	Disagree	Neither	Agree	Strongly agree
Direct	4.3	5.9	10.2	31.4	48.2
Subcontracted	5.2	3.2	10.5	26.2	54.9

Table 16.7 Waste management is worthwhile, irrespective of the financial gain (%)

Labour arrangement	Strongly disagree	Disagree	Neither	Agree	Strongly agree
Direct	20.4	29.8	34.6	10.2	5.0
Subcontracted	26.8	32.4	35.6	3.0	2.2

workers in the sample, and all respondents in both groups were male. A majority of workers belonging to both the DL and SL arrangements agreed that natural resources should be conserved, waste should be managed, and adequate planning is needed to implement such strategies. There were no significant differences in responses to these three questions between the DL and SL workers. However, when they were asked about knowledge regarding the existence of a waste management strategy in their organization, the responses were found to be different between the two groups, as shown in Table 16.4. Workers' knowledge of a waste management strategy in their organization was very low among SL workers compared to that of DL workers.

The importance given to waste management by workers was assessed using three further statements included in the questionnaire:

- Waste management is as important as other activities.
- Attention to waste management in actual practice is not sufficient.
- Waste management is worthwhile, irrespective of the financial gain.

Although the overall attitude on the importance of waste management was high in both groups of workers (refer to Table 16.5), the attention paid to waste management in actual practice was not apparent in both groups, particularly among SL workers (refer to Table 16.6). Workers do not gain any personal benefit by adopting waste management at work. The majority of surveyed workers were of the opinion that waste management is not worthwhile, unless it is tied to personal financial gains (refer Table 16.7).

16.5 Conclusions

This study showed that direct labour workers generated comparatively less wastage than did subcontracted labour workers. The mean waste generation rates recorded by the six case study sites for bricks, mortar, formwork timber and reinforcement bars for direct labour were 3.05, 1.47, 6.03, and 4.79 %, respectively. The comparative mean values for these four materials under subcontracted labour were 4.75, 2.46, 12.51 and 6.91 %, respectively. These findings indicate that the wastage level of subcontracted labour was considerably higher than that of direct labour. For formwork timber, mean wastage rates of subcontracted labour were more than twice those of direct labour. For all four materials, the waste generation rates were shown to be significantly different between these two types of labour arrangements.

The results of this research showed that the causes of waste differed between the two arrangements of workers; however, it was determined that there was no marked difference in workers' attitudes towards construction waste between the two labour groups. It becomes clear, therefore, that the differences in wastage levels between the direct and subcontracted labour arrangements were not due to differences in attitudes, but to other factors related to the implementation of waste management on site. The majority of workers were of the opinion that waste management is not worthwhile, unless it is tied to personal financial gains. Attitudinal change is difficult to implement unless there is personal financial benefit. Therefore, an organizational strategy is needed to manage waste.

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Chapter 17
Disaggregation of Household Energy Consumption Patterns in Australia

Patrick X.W. Zou and Rebecca J. Yang

Abstract Improving energy efficiency is an important target to be achieved in residential building development and household behaviour. The aim of this research is to help building professionals and policy makers understand the current housing situations and householders' behaviour regarding energy consumption. The results of a survey of energy consumption, including house situations and householder behaviour, of 504 households in New South Wales Australia are reported. Twelve features affecting household energy consumption are investigated. These features included cooking appliances, refrigerators, laundry appliances, televisions, computers, gaming consoles, hot water systems, space cooling and heating systems, glazing, insulation, lighting, and other major energy consumption facilities. The differences of these features across different households with different physical characteristics, social-demographic features and geographical areas are analyzed. Based on the disaggregate study, it is found that mandatory policy, geographical and socio-economic factors can significantly affect the selection of fixtures and appliances in the households. It is also found that the positive effect of the government's mandatory policy implementation on household energy consumption behaviour is evidenced. The findings will be of use in sustainable residential building development policy-making, and tailoring the regulations and standards with consideration of the various geographical and socio-economic factors.

Keywords Energy consumption • Residential building • Building features • Householders' behavior • Disaggregation

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_17,

17.1 Introduction and Research Aims

Among all sources of greenhouse gas emissions (GHG), evidence indicates that the building sector is a major contributor to global GHG emissions [1]. For example, the Australian building sector, comprising all commercial and residential buildings, contributes 23 % of emissions to Australia's GHG emission profile, compared to transport (15.4 %), agriculture (16.8 %), and industrial processes (5.6 %) [2]. Inside homes, the largest sources of carbon pollution are household appliances (especially fridges and televisions, and including keeping them in standby power mode), water heating and space heating and cooling (including an increasing use of air conditioning [1]. Research has shown that smart behaviour and small behavioral changes at home can reduce energy consumption and provide significant annual savings. Below are some examples of possible energy saving for a family of four, as identified in the Clean Energy Future Plan [3]:

- Washing clothes in cold rather than hot water could save around $90/year.
- Using a clothesline instead of an electric dryer once per week could save around $55/year.
- Switching off appliances at the wall (power point/source) could save up to $100/year.
- Switching from incandescent light bulbs to compact fluorescent lights could save around $160/year.
- Fitting a low-flow showerhead and taking shorter showers could save up to $550/year.
- Once installed, a solar hot water system replacing an electric system could save over $400/year.

Research by McKinsey and Company [4] also found that a total of 60 megatons of carbon-reduction opportunities can be found in the building sector all at low or negative cost.

Therefore, the most effective way for households to reduce carbon pollution is by carefully understanding and changing their energy consumption patterns in fixtures, heating and cooling systems and appliances and changing their behaviour related to energy consumption. Changing house design and construction and householders' behaviour requires driving force from both internal and external, including mandatory government policies.

The Australian government departments and agencies, at various levels, have developed a number of mandatory policy instruments and voluntary tools for reducing GHG emissions from buildings, and BASIX -Building Sustainability Index is one of such policies aiming at achieving up to 40 % energy and water savings. BASIX was developed by New South Wales (NSW) Department of Planning (now Department of Planning and Infrastructure) as a unique, web-based tool that sets mandatory, measurable emission, energy and water saving targets for every new residential development and major renovations across the NSW State. Seven years since its implementation in July 2004, BASIX has made a significant contribution in shaping residential development toward a lower carbon, water efficient, energy efficient and more sustainable future. According to the Commonwealth of Australia [3], BASIX has effectively helped phase out many unsustainable design and construction elements in residential development across the State without resorting to proscriptive legislation [3].

To continue delivering an effective and efficient policy instrument that addresses current sustainability issues, as well as national directions on climate change, and is efficient in terms of maximising the benefits to the community, taking costs into account [3], it is necessary to understand the existing housing situation and householders' behaviour regarding energy consumption in fixtures, systems and appliances, especially to compare the features in pre and post BASIX buildings, and to draw the lessons learned from the BASIX case, which are also the main aims of this research.

In the following sections, the paper will describe the design and development of the questionnaire, analyse the characteristics of respondents and present the research findings.

17.2 Questionnaire Development, Data Collection and Analysis

The survey questionnaire was developed based on literature review and input from experts who have relevant experience and knowledge. The surveys were presented with a standardised set of questions. This was done to ensure that the dataset obtained was comparable for data analysis. A semantic differential scale from 1 to 5 was used in most questions, with 1 given the most negative value, 3 a neutral value, and 5 the most positive value. In total, the survey questionnaire included 8 sections with 82 questions. Twelve features affecting energy consumption are investigated in the questionnaire, including cooking appliances, refrigerators, laundry appliances, televisions, computers, gaming consoles, hot water systems, space cooling and heating systems, glazing, insulation, lighting, and other major energy consumption facilities.

Before embarking on the full scale data collection, pilot studies were conducted to test the questionnaires. Once tested, the questionnaire was uploaded to an online survey platform allowing respondents access and respond to the survey from a remote end such as home or work office. The online survey setup also allowed automatic data collection. For the effectiveness of data collection, 'hot-spots', identified based on NSW Department of Planning and Infrastructure data about NSW suburbs with high numbers of BASIX-certified homes, were targeted for letterbox drops. There were about 21,000 homes located in these 'hot-spots', and 21,000 hard copy flyers were designed and printed by the researchers, and sent by the Australian Post Office to these residents' letterboxes inviting them to participate in the online survey. Local governments in these areas were asked to help promote the survey by publishing the survey links on their council websites and in e-newsletters, with messages encouraging the readers to take part in the survey.

In addition, the online survey is also open to general public and several professional bodies helped to promote the research by encouraging their members to take part in responding to the survey. Incentives, in forms of entering lucky draws, were provided to encourage and motivate more participation. As a result, 504 responses were collected.

While the questionnaire contains a comprehensive set of 82 questions, this paper analysed data (and present results) related to geographical and socio-economic factors. Wherever suitable, comparison is made with similar studies undertaken in the UK (e.g., [5]) and US [6].

17.3 Characteristics of Respondents

Descriptive analysis of survey responses is used to understand the range and average physical characteristics of participants' houses: types of postcode location and year of house construction. The majority of respondents' houses were detached or separate houses (89.3 %) and 12.5 % was also used as a place of business and so had both residential and commercial pressures on their dwellings' sustainability 68.1 % of the homes were built before July 1, 2004, when mandatory BASIX energy and water targets were introduced and 24.6 % known to be built after July 1 2004 (the rest being stated as "don't know"). This helps identify BASIX-driven improvements in sustainable development.

The participants also provided details of their household profiles, including incomes, household size and the household pattern (i.e., number and age of adults and children), and results are as shown in Table 17.1.

Table 17.1 Descriptive statistics on household patterns

Household characteristics		Frequency	Percentage (%)
Permanent home or not	Yes	502	99.6
	No, not a permanent home (e.g., holiday house or work accommodation)	2	0.4
Household pattern	Children and adults (no seniors)	226	44.9
	Adults only (no seniors)	177	35.2
	Adults and seniors	37	7.4
	Seniors only	52	10.3
	Children, adults and seniors	11	2.2
Household size	1–2 residents	217	43.1
	3–4 residents	227	45.0
	5 or more residents	59	11.7
	Don't know or would rather not say	50	9.9
Income classification (before tax)	Low income	61	12.2
	Medium income	324	64.7
	High income	66	13.1
	Don't know	50	10.0

17.4 Main Research Findings

17.4.1 Finding 1: Fuel Sources Vary Across Different System and Appliance Types

Figure 17.1 shows that householders' choices of fuel sources vary significantly across different fixture, system and appliance types. Natural gas was the dominant source of fuel for hot water systems (45.4 % of systems compared to 35.8 % for electrical and 12.9 % for solar). Stovetops were fairly evenly split between gas and electricity (49.8 % and 46 %, respectively), but most ovens used electricity (80.1 % of households). Household heating and cooling was primarily fuelled with electricity (67.9 % of heating systems were air-conditioning or portable heaters, 18.3 % were gas), and 64.1 % of heated hot tubs, spas and jacuzz is used electricity. Solar as an important energy source for future sustainability is primarily used in heated swimming pools (65.21 % of the heated pools).

17.4.2 Finding 2: Alternative Fuels Are More Common in Post-BASIX Homes

The results shows that homes built after July 1, 2004 more often chose natural gas as the main type of fuel for kitchen stovetop burners. Gas fuel for heating appears to be decreasing in favour of electric air-conditioning – more than half of homes built after July 1, 2004 were using central (ducted) air-conditioning systems for heating, whereas in houses built before July 1, 2004, gas fixed flued heaters featured fairly equally alongside central systems and portable heaters. After July 1, 2004, fewer

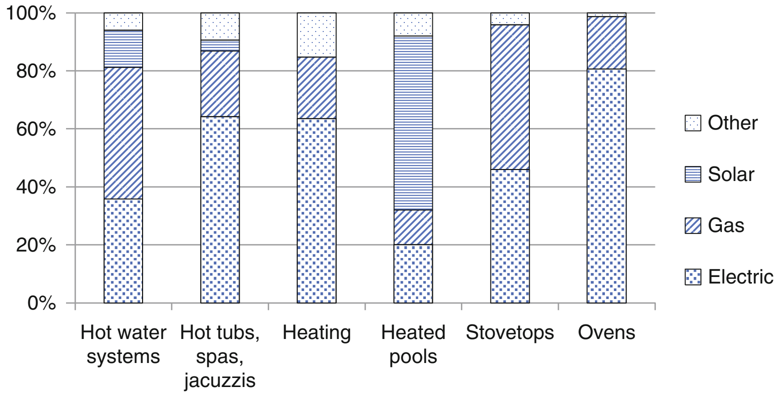

Fig. 17.1 Proportion of electricity and alternative fuel use in householder systems

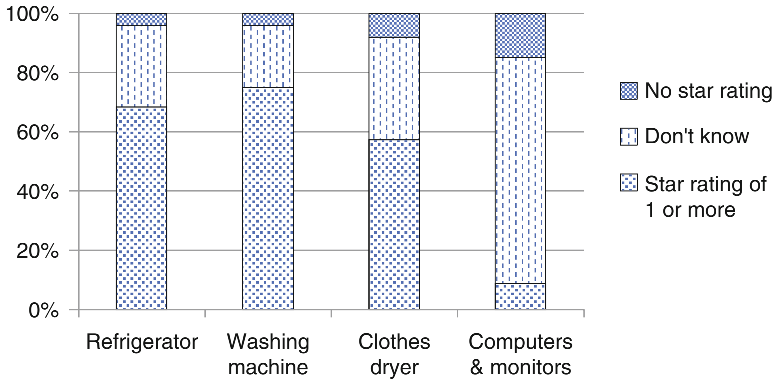

Fig. 17.2 House appliances with energy efficiency star ratings

households used wood or other solid fuel for heating. It should be noted that this change may be due to not only BASIX implementation, but also in combination effect with other relevant policies or technology improvement.

17.4.3 Finding 3: Many Respondents are Unaware of Appliance Energy Efficiency Rating, or Own Unrated Appliances

Figure 17.2 shows a large number of householders were unable to identify the energy efficiency ratings of their refrigerator, clothes washer or dryer, or owned unrated appliances (31.7 %, 24.1 %, and 42.6 %, respectively). Almost all householders did not know the ratings of or had unrated computers (89.3 %).

17.4.4 Finding 4: Energy Usage Behaviour Was Unpredictable and Not Reflecting Dominant Trends

According to the proportion of responses, most of the respondents have different behavioural patterns when they use the appliances. They only tend to use nine of the 19 surveyed items with similar usage frequency: microwave, television, clothes dryer, hot water, non-summer cooling and non-winter heating use. This indicates that there is wide variance in energy use behaviour, and any estimate of average energy consumption or emissions will need to be weighted to account for differences in household use, rather than reflecting any one dominant pattern.

17.4.5 Finding 5: Higher Household Incomes, Higher Energy Consumption

Households with higher incomes are likely to have higher energy consumption from portable appliances, but they also chose higher energy efficiency star-rated appliances. For example, the higher the income of the household, the larger the size of televisions they used and more gaming consoles they had, but they also identified higher energy and water efficiency ratings for their washing machines. The results suggest that increased householder incomes may result in consumption increases. This phenomenon will limit the benefit brought by sustainability improvements.

17.4.6 Finding 6: Energy for Heating and Cooling Decreased in Post-BASIX Homes

The householders in homes built after July 1, 2004 tend to use less air-conditioning in summer and heating systems in winter as compared to those in the houses built before that time. This may be because of better insulation and air-circulation was installed in the post-BASIX houses. The research further found that 82 % of the houses had ceiling insulation, and the indoor thermal insulation quality in these houses was considered good (quite well-insulated), whereas in the houses without ceiling insulation, the indoor thermal insulation quality was considered poor. The indoor thermal insulation quality is also highly influenced by the number of glazing fixtures and the presence of 'performance' glazing.

17.4.7 Finding 7: Energy Efficient Lighting Is Prevalent in Both Pre- and Post-BASIX Homes

Homes built before July 1, 2004 and those built after July 1, 2004 had a similar ratio of energy efficient to incandescent or halogen bulbs (2:1 and 1.9:1, respectively), suggesting that the age of a home has no clear influence on bulb type selections. However, newer homes had a greater mean number of total bulbs than older ones – homes built before July 1 2004 had an average of 16.2 bulbs compared to 21.8 in homes built after July 1, 2004.

17.5 Conclusion

In order to achieve energy efficiency improvement and energy savings it is important to understand the housing situations regarding energy consumption in fixtures, systems and appliances. In this research, the results of a survey on over

500 household energy consumption held in NSW Australia are reported. The analytical comparisons were made according to the household characteristics including incomes, year of building, and household pattern to identify variations in energy consumption across different types of household, and with houses built before and after the implementation of NSW's BASIX policy in 2004.

Based on the disaggregate study, the geographical and socio-economical factors (e.g. house type, year of construction – i.e. pre- or post- BASIX implementation, and household incomes) can significantly affect the selection of fixtures, systems and appliances in the households. The positive effect of the mandatory policy implementation, in the form of BASIX, on household energy consumption behaviour is evidenced. The findings will be useful in sustainable energy consumption policy-making, and tailoring the regulations and standards with consideration of the various geographical and socio-economic factors. Future research will focus on how to improve the households' awareness and understanding of energy consumption of their homes and change their at-home behaviour to be more energy efficient. In such future research, the benefits and barriers, as pointed out by Zimmerman and Martin [7] and Hadjri and Crozier [8], and the new challenges, as stated in Stevenson and Leaman [9] should be considered carefully.

Acknowledgments The authors are very grateful for the cash and in-kind support provided by NSW Department of Planning and Infrastructure, without which this research would not have been possible. The authors are also thankful to Dr Benson Lim of The University of New South Wales for his help in the process of developing the survey questionnaire.

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Part II
Urban Construction and Land Use

Chapter 18
Research on the Method of Urban Transportation Land Use Assessment Based on Low Carbon Transportation Model

W.M. Feng and Y.K. Chen

Abstract In order to mitigate the contradiction between increasing requirements of urban transportation land use and finite urban land resources, this paper studies the method of managing urban transportation land use more reasonably and effectively in low carbon model. By analyzing the conception model of transportation land use based on the consideration of the road network capacity and the traffic flow velocity, this paper discusses some key parameters in the model for the needs of low carbon, and works out the rational scale of urban transportation land and traffic flow velocity by employing the K-T rules. The paper also analyses 4D system of urban transportation land use and compound lands conception, which both play a important role in shortening travel distance and reducing energy consumption. From this research, some key correlative parameters of the assessment model and the plan of compound lands in urban land layout are studied for the green low carbon transportation system. The study for low carbon transportation model will lead a correct positive way of urban transportation land use and promote sustainable society development.

Keywords Urban transportation land use • Low carbon • Assessment model • Parameters • Compound lands

18.1 Introduction

Nowadays, the rapid development of urban economy accelerates the process of urbanization, that result in the expansion of urban scale and the increase of residents' travel distance. Meanwhile, owing to the increase of residents' incomes

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_18, © Springer-Verlag Berlin Heidelberg 2014

for economic development, they are incline to purchase automobiles and travel with them. As a result, traffic congestion and exhaust emissions lead to increasingly serious urban and even global environment problems. On the other hand, The expansion of the urban area and insufficiency of the roads make the urban infrastructure and bus services can't keep up with it, for which the demands of car's travel are enhanced, these factors aggravate obviously traffic congestion and urban environment problems [1]. For example, in Shenzhen, China, the number of car ownership have grown from one million in 2007 to two million in 2012, it takes 27 years to increase car amount from about 0 in the initial stage of building the city to one million in 2007, however, it takes only 4 years to do it from one million to two million. What is worse, the density of cars on the road in Shenzhen not only has been the top one in China with breaking the level of 300 cars/km, but also has exceeded the international limitative standard (270 cars/km).

Therefore, it is necessary for solving above problems to mitigate the contradiction between increasing requirements of urban transportation land use and finite urban land resources.

18.2 The Conception Model of Urban Transportation Land Use

Urban lands are very scarce, The correct value assessment of them can provide a basis for giving priority to choosing the land use property, and also can offer reference to determining the scale of transportation land use a reasonable area of transportation land use not only can promote the unobstructed moving of urban crowds and logistics, but also can enhance the utilization efficiency of the urban lands, actually that is the optimized allocation of urban land resources [2]. While before determining, some viewpoints must be defined as follow:

- It is necessary to use the opportunity cost theory to assess the value of each plot of the urban land.
- The scale of urban transportation land use cannot be too large, or it may occupy other land properties and increase opportunity cost of the land, and reduce the rationality and efficiency of the structure of urban lands.
- Some natural needs must be satisfied, such as environmental capacity, green belt, and so on. All these needs possibly influence the determining of urban transportation land use.
- The great losses of transportation land use should be in control, including the huge construction investment, traffic energy consumption, the pollution to the environment with noise and emissions [3, 4].
- To avoid a Baress paradox effect. According to this paradox, enhancing the traffic capacity likely causes the road blockages and makes the pollution problems more serious.
- Urban land for traffic cannot too be small. Because the density of the road network must meet the basic requirement of the urban traffic [5].

After then, a conception model of urban transportation land use is established below based on the capacity of the road network and traffic flow velocity [2].

$$\max Z(A,\ V) = \Delta N(V) \cdot \omega \cdot t + \Delta T(v) \cdot \xi \cdot t + \Delta \mu(V) \cdot \Psi - Q(A) - I$$
$$s.t. \begin{cases} C(A, V) - D \geq 0 \\ V - V_0 \geq 0 \end{cases} \tag{18.1}$$

ΔN(**V**)- new freight times; ω- the value of each freight; **ΔT**(**v**)- the decrease of commute time; ξ- the average labor productivity; Δμ(**V**)- emissions variation by the motor vehicle; Ψ-a unit of cost for pollution control; **Q**(**A**)- opportunity cost of the new land; **I**- the total economic investment; **C**(**A**,**V**)- the new road network capacity; **D**- average travel rate of the motor vehicle; **V**- the average velocity of traffic flow; $\mathbf{V_0}$- the setting velocity before; **A**- total area of the road network; **t**- the years designed for the road network.

Condition (18.1) means the determining of the transportation land should guarantee that the benefits are more than the losses from increasing new transportation land under the constraints of capacity and velocity.

18.3 The Application of the Conception Model in Low Carbon Transportation

18.3.1 The Influence on Some Parameters of the Model by Low Carbon

The conception model above merely describes the relationship between the benefits and the losses, but the complicate relation among these parameters and the influence on determining them by low carbon transportation model both need to be further discussed.

18.3.1.1 The Shortage of Land Resources

With the population expansion, particularly in the city, the land resources become more and more shortage and precious. Chinese land area is ranked the third in the world, but Chinese per capita land area is only one-third of the average level of the world result from the high population density. So in order to save the urban land to avoid occupying the living land or other properties of lands, the land area for traffic need to be controlled in a limited range. In an inequality, $\mathbf{A} < \mathbf{Ac}$ (**Ac**-the allowable area of transportation land use).

18.3.1.2 Transportation Energy Consumption

As we know, transportation energy consumption accounts for the most proportion of the total energy consumption in the city. According to the statistics, in some major developed countries, the transportation energy consumption has accounted for about 30 % of the national total consumption, nearly 80 % of the gasoline in the world have been used in transportation. These consumption greatly reduce the non-renewable resources on earth and bring much Greenhouse Gas to pollute the environment.

From the survey, it is found that slowing the motorized process and reducing the rate of automobiles travel can efficiently save energy and lessen carbon emissions, and these measures will affect some parameters about the motor vehicle, including **V**, **D** & **C**(**A**,**V**).

18.3.1.3 Environmental Capacity

The limits of environmental tolerance for pollution is called environmental capacity. According to the statistics, in the city more than 60 % of the atmospheric pollutants are from the exhaust emissions by motor vehicles, the control of traffic pollution is the most important content of it for atmospheric pollution. Therefore, the emissions of the motor vehicles, the cost of the pollution control and the road network capacity need to be restricted under the constraints of environmental capacity. In an inequality, $\Delta\mu(\mathbf{V}) < \Delta\mu_{\mathbf{c}}$, $\Psi < \Psi_{\mathbf{c}}$ ($\Delta\mu_{\mathbf{c}}$- the allowable emissions variation; $\Psi_{\mathbf{c}}$- the allowable cost of pollution control).

18.3.1.4 The Capacity of the Road Network

The capacity of the road network represent the maximum number of the vehicles accommodated in unit time on the road network. When the traffic flow is divided into three parts, including taxi, bus and other vehicles [2] the capacity of road network can be estimated from the following equation:

$$\begin{aligned} C(A,V) &= \frac{TR_e - TR_t - TR_b}{TR_{do}} + q_t + q_b \\ &= \sum_{i=1}^{4} A \cdot \eta_{1i} \cdot \eta_{2i} \cdot \eta_{3i} \cdot \frac{c}{l_p} - \left| \frac{v_t}{l_p} - 1 \right| \cdot q_t \cdot - \left| \frac{k_b \cdot v_b \cdot \eta_4}{l_p} - 1 \right| \cdot q_b \ldots \end{aligned}$$

Where $\mathbf{TR_e}$ is the total resources of the road network; $\mathbf{TR_t}$, $\mathbf{TR_b}$, $\mathbf{TR_{do}}$ are the resources held by taxi, bus, or other vehicles; $\mathbf{q_t}$, $\mathbf{q_b}$ are the number of taxi, bus; $\eta_{\mathbf{1i}}$, $\eta_{\mathbf{2i}}$ are the utilization coefficient of roads; $\eta_{\mathbf{3i}}$ is the effective length coefficient of roads; $\eta_{\mathbf{4}}$ is the travel rate of bus in every hour; **c** is the traffic capacity of a single road; $\mathbf{l_p}$ is the average travel distance of vehicles; $\mathbf{v_t}$,$\mathbf{v_b}$ are the average velocity of taxi, bus; $\mathbf{k_b}$ is the equivalent value.

As the constraints of energy consumption and environmental capacity, the capacity of the road network must be in control, In an inequality, **C**(**A**,**V**) < **Cc**(**A**,**V**) (**Cc**(**A**,**V**)-the allowable capacity of the road network).

18.3.1.5 Transportation Investment

The urban transportation investment mostly derived from the government's financial revenue. Statistics shows that the capital investment of about 4.7 trillion yuan has been used for the national road network (3.98 million km) during Chinese 11th Five Years Plan, and more 6.2 trillion yuan will be invested in the transport infrastructure in 12th Five Years Plan. Low carbon economy is the foundation of low carbon transportation, and the sustainable development of society need reasonable allocation and use for national revenue. Consequently, the investment for urban transportation land use should have a economical utilization, detailed budget and strict supervision. In an inequality, **I** < **Ic** (**Ic**-the allowable total investment for traffic).

18.3.2 The Solving of the Conception Model

18.3.2.1 Simplification and Calculation

Firstly, some parameters instead of the ones in the conception model are defined as:

$$a = \sum_{i=1}^{m} \frac{\omega^i}{\omega^i{}_{\max}} N_i{}' \cdot \omega \cdot t \qquad c = \sum_{i=1}^{m} N_0{}^i \cdot \omega \cdot t + I - P_0 A \qquad d = \eta_{1i} \cdot \eta_{2i} \cdot \eta_{3i} \cdot \frac{c}{l_p}$$

$$e = \frac{q_t}{l_p} + \frac{k_b \cdot \omega_b \cdot \eta_4 \cdot q_b}{l_p} \qquad e = q_t + q_b - \frac{q_0 \cdot \eta_5 + \eta_4 \cdot q_b + q_t}{1 - \eta_6}$$

$$b = \sum_{j=1}^{n} \left| \frac{1}{\omega_0{}^b \omega_0} - \frac{1}{\omega^b} \right| \cdot L_j \cdot q_j \cdot \xi \cdot t + \sum_{k=1}^{3} \sum_{i=1}^{m} \frac{M_i \cdot R_i \cdot \beta_{ik} \cdot \alpha_{ik} \left| \frac{1}{\omega_0{}^i \omega_0} - \frac{\tau \cdot \sigma_i}{\omega^i} \right|}{10^{10}} \psi \cdot t$$

$\mathbf{N_i}'$-the freight times of the **i** vehicle; -the conversion coefficient of velocity; $\mathbf{P_0}$-the price of the new transportation land; **n**-the number of groups for dividing travel distance; $\mathbf{L_j}$-the length of the i group; $\mathbf{M_i}$-the number of the i vehicle; $\mathbf{R_i}$-the fuel oil consumption of i vehicle each year; β**ik**-the concentration of the k pollutants from the i vehicle(g/m^3); $\alpha_{\mathbf{ik}}$-the k pollutants discharged by the i vehicle with consuming a liter of fuel oil(m^3/L); τ-the decrease of emissions.

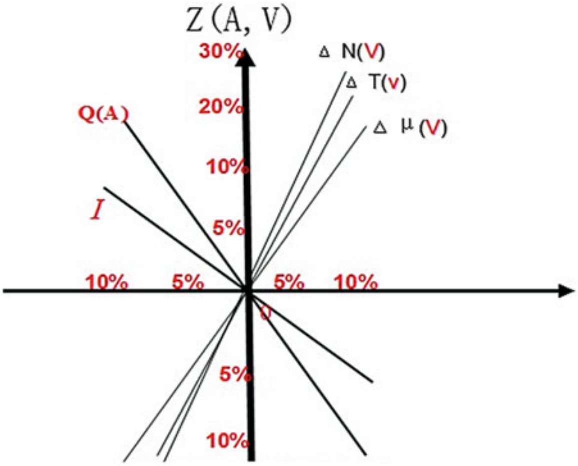

Fig. 18.1 Sensitivity analysis of the parameters (by case study)

After taking these substitute parameters into the conception model, the area of urban transportation land use and corresponding traffic flow velocity can get a optimal solution through using K-T condition [2]:

$$A^* = e\sqrt{\frac{b}{ad^2 - Ped}} - \frac{f}{d} \quad V^* = \sqrt{\frac{bd}{ad - Pe}}$$

18.3.2.2 Sensitivity Analysis of the Parameters

Combining with a case to do a sensitivity analysis for the parameters. The result shows in Fig. 18.1, all parameters are very sensitive to determining the area of transportation land use, especially, the variations of ΔN(V), ΔT(v) & Q(A) will greatly influence the calculation result of the conception model. It indicates that the velocity of the traffic flow need to be enhanced to a certain extent with improving the corresponding equipments and making some new regulations about traffic control, that accord with the second constraint condition of in the model.

18.4 Urban Land Use Under the Low Carbon Transport Model

18.4.1 The 4D System of Urban Land Use

The traditional viewpoint is that the rapid economic development inevitably bring the automobiles' growth. In early city planning, the city area and land use for

Table 18.1 Energy consumption of the urban transport model (Mi/person km)

Model	Production process	Energy consumption	Total
Bicycle	0.5	0.3	0.8
Light rail	0.7	1.4	2.1
Bus	0.7	2.1	2.8
Metro	0.9	1.9	2.8
Car	1.4	3	4.4

From: Energy conservation and emission reduction strategies. TDM Encyclopaedia

car-oriented transport (COD) both have been expanded, that would cause the vicious circle introduced in the beginning of this paper. But in low carbon times, it is necessary to establish a green transport system that will attach importance to developing pedestrian-oriented (POD), bicycle-oriented (BOD) and transit-oriented (TOD) traffic ways.

From the perspective of energy consumption, the transportation energy consumption closely relate to the transport model in the city [6]. Table 18.1 shows the per capita energy consumption by various traffic ways, obviously cars have consumed the largest energy. According to the survey, the per capita energy consumption of the public transport is only a quarter of the private cars'. A study in Dutch has told that about 30~40 % of the cars travel were not necessary and could be replaced by travel means of public transport or even walking. Therefore, curbing the rapid motorized process and converting the transport model is the main way to saving energy. The government need to concentrate on switching to 4D transport model with evenly developing POD, BOD, TOD and COD, instead of 1D model that has mainly attention to COD (Figs. 18.2 and 18.3 4D = POD + BOD + TOD + COD).

Besides, only infusing the concept of POD > BOD > TOD > COD, the carbon emissions will be reduced by a big margin. It means that the pedestrian and the bicycle use should be gave priority to being developed through improving the urban sidewalks and cycleways [7]. And then government need to strive to develop the public transport and control the car transport, Seamless transition among POD, BOD and TOD also need be attached importance to. As we know, Danish capital Copenhagen is a famous bike city in the world. Figure 18.2 clearly shows that the urban central area has been covered with the cycleway network, by the end of 2001, the total length of the cycleways had been more than 316 km. The city also has planned to become the first metropolis with carbon zero-emission in the world by 2025.

18.4.2 Compound Lands

Compound lands idea in urban land use, which can reduce the proportion of car travel and make the residents' travel in short routes, just caters to the goals of low carbon transport. This idea tends to emphasize the mixed use among lands, space

Fig. 18.2 Cycleway network. Copenhagen, Denmark (*Black lines*: cycleways that had existed in 2001. *Red lines*: cycleways that had been planned to build from 2001 to 2016)

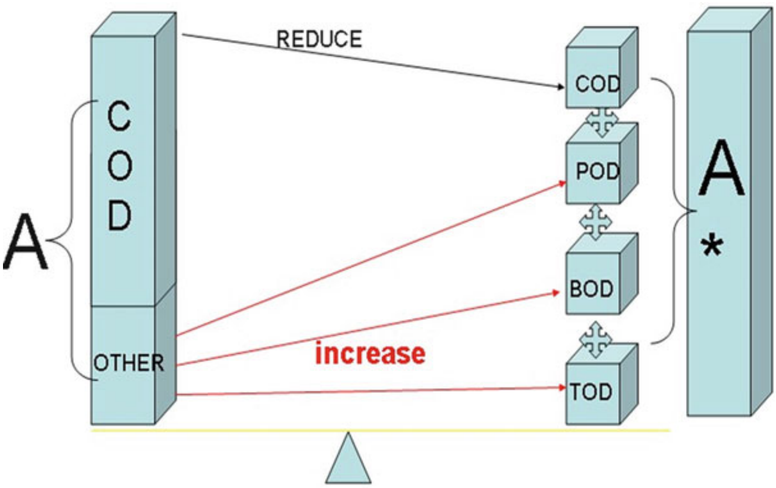

Fig. 18.3 4D Model transition of urban transportation

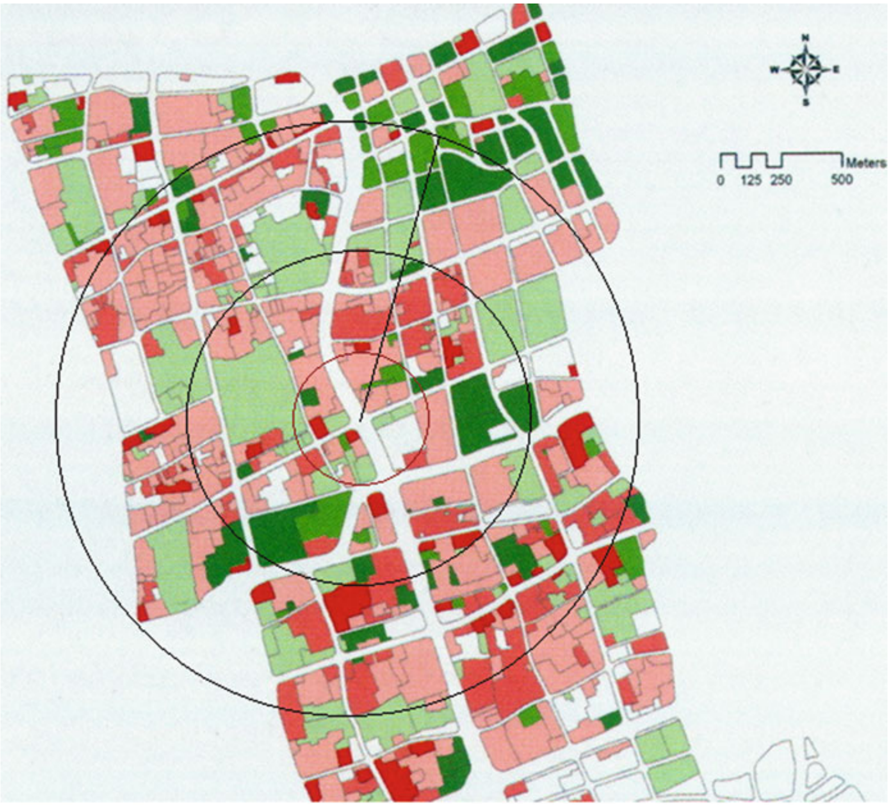

Fig. 18.4 The land use plan in Luwan district, Shanghai, China

and buildings in the planning of urban land use [1, 8], and it can avoid forming a huge and singular urban district in the city expansion. Through analyzing by the value engineering theory, compound lands make the value of lands get improved for its compound functions (F↑), and the traffic planning for short routes travel can reduce the cost of the transportation land use (C↓), consequently, compound lands idea can increase the value of urban lands to a great degree (V↑↑ = F↑/C↓).

In Luwan district of Shanghai, China, the land use in the 2 km range of the center area have adopted the compound lands idea obviously (Fig. 18.4). Although most lands have been used for living and public facilities (the living lands account for about 54.2 %), the land use for office, shop, hospital, school, and so on also hold a large proportion, besides, some factories have got a sporadic distribution over there. Through comparing with other several blocks in Shanghai, it is visible that the residents in Luwan block (L.W) prefer to travel in low carbon traffic ways (Table 18.2).

Table 18.2 Transport ways residents choose among four blocks in Shanghai

	K. J block (%)	L. W block (%)	Z. Y block (%)	B. block (%)
Walking	15.80	38.60	21	20.10
Bicycle	15.70	28.90	19.20	17
Electric cycle	0.90	3.40	2.60	3.10
Motor	1.90	1.50	0.80	5
Car	4	1.70	2	5
Taxi	4.20	3.90	2	5
Bus	37.30	20.70	50.40	39
Metro	20.10	1.20	1.80	6.30

From [1]

18.5 Conclusions

1. By analyzing the conception model of transportation land use based on consideration of the road network capacity and traffic flow velocity, the influences on determining some parameters by low carbon transport are explicit, In the practical application of the conception model, it is necessary to consider these influences and requirements for determining a reasonable area for transportation land use and an average velocity of traffic flow;
2. It is inevitable for developing low carbon transport model to establish a green traffic system which is made up of POD, BOD,TOD and COD, and while planning the urban transportation, the order of considering them should be POD $>$ BOD $>$ TOD $>$ COD. This 4D system not only can efficiently transfer the urban crowds and logistics, but also can dramatically reduce energy consumption and greenhouse gas emissions, all these would ensure that the requirements of environmental capacity are met;
3. The urban planning with compound lands idea can create the preconditions for establishing the 4D transport system. It also greatly enhances the value and the structure efficiency of the urban land use;
4. Developing low carbon transportation model is the only way to solve ecological environment problems and the vicious circle brought by the rapid urban motorization. Low carbon transportation and compound lands idea not only influence on some relevant parameters in the conception model, but also provide the basis for urban land planning, and powerfully promote the sustainable development of society.

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Chapter 19
What's the Effect of Urban Villages on Commercial Housing Price? An Analysis Based on Second-Hand Housing Transactions in Beijing

Yingjie Zhang, Siqi Zheng, and Cong Sun

Abstract China's rapid urbanization, characterized by large-scale rural–urban migration and radial expansion of urban built-up areas, has produced a new type of urban neighborhood, namely the *chengzhongcun*. With access to an unique micro second-hand housing transactions database which the number of samples is more than 20 thousands during the period from 2006 to 2011 in Beijing, and the list of the 50 key villages which was announced by the government in 2010, we first develop a hedonic housing price model to investigate whether the proximity to urban villages affects the selling price of urban housing units, and then use a DID-Hedonic model specification to examine the effect of the redevelopment project on the surrounding housing price. Controlling for the structure, other characteristics of urban housing units, the time trend and the spatial fixed effect, we find that housing prices are lower the closer the buildings are from urban villages. Further, the housing units near the villages do enjoy a higher increase in price after the announcement of the redevelopment projects. Both of the results are significant at 1 % level. This may indicate a significant negative externality of urban village to its neighbors.

19.1 Introduction

Behind the amazing prosperity and vitality of Chinese cities, and maybe just beside the towering landmark buildings, there are the urban villages inhabited by large numbers of migrant workers. On one hand, the urban villages have provided low-cost housing for large amount of immigrant in the city, and support the city's industrial development by maintaining low-cost labor. So someone regards the urban villages as "the patches of the city". But one the other hand, because of the lack of urban management and

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_19,

supporting public service, most urban villages are suffering from the "dirty, noisy and disorder" living condition. Hence people also call these villages "the scar of the city".

The urban village can be regarded as a product of both rapid urbanization and the binary of the urban-rural land market in China [1]. And the topics about urban village cover many aspects of urban development, such as the population, land, housing, social integration and urban planning. Many scholars have focused on deciphering the urban villages, exploring the reason why migrants live there and investigating their living conditions and behaviors [2–4], or criticizing the redevelopment polices for villages [5].

However, in the circumstance that urban villages are just embed in the modern urban landscapes and surrounded by residential or commercial developments, a very interesting question is what are the effects of these villages on urban housing markets? Specifically, if a standard house is moving near the urban village, will the transaction price change? Further, if a village is going to be redeveloped, what will the price trend of its surrounding houses be like? To our knowledge, these two questions have received little formal analysis by scholars. We attempt to answer these two questions in this study.

In this paper, with access to an unique micro second-hand housing transactions database during the period from 2006 to 2011 in Beijing, which is provided by the China Data Center at Tsinghua University, and the list of the 50 key villages which was announced by the government in 2010, we first develop a hedonic housing price model to investigate whether the proximity to urban villages affects the selling price of urban housing units. And then examine the effect of the redevelopment projects of urban villages on surrounding housing units' selling price, with a DID-hedonic model specification.

19.2 Externality of Urban Villages

Through background analysis and on-site survey, previous researches look deep into the externality of urban village from many different aspects. The village's negative externalities are presented in three aspects: urban spatial form, social security and rent income [6, 7]. The high criminal rate, which results from poor living conditions and high density of floating population with low income, destroy the city's image and cause severe social problems. The land value suffers much from such effects in two ways: on one hand, many workers would choose to live in the urban villages to cut their spending, though many of them can afford sharing commodity housing, thus undervaluing the neighboring commodity housing price through market competition;; on the other hand, urban economics studies show that high criminal rates and poor hygiene conditions would affect land value negatively since people, if possible, would choose to live away from such factors.

Previous studies also prove that urban villages can also have some positive effect on a city's development. The villages can provide much cheaper labor to support the urban development and help villagers to accumulate wealth. Zheng et al. [8] document that in the early period of the urban development which labor-intense industries is dominate, urban villages provide large amount of low cost labors through the affordable houses to rural migrants so that help to sustain the rapid GDP growth. To some extent, the urban villages create public benefits: the villagers earn a lot from the house rent and improve their utilities without the subsidization from the city government, thus promoting the social stability and accelerating the city's development. Besides, in some southern areas, the urban villages, usually with local distinguishing features, act as cultural carriers [9]. China's urban villages are far different from slums in the western countries in the way that they provide neighboring households with much convenience despite the dirty and chaotic living environment.[1]

19.2.1 The Effect of Urban Village on Housing Market

The externality of urban villages will affect people's residential location choice behavior (both from the positive side and negative side) and further influence the commodity housing price.

However, the existing studies mainly focus on qualitative analysis and discussion of the externality to propose policy suggestions rather than analyzing the impact of it from the quantitative aspect. Recently, Song et al. [1] apply Hedonic housing price model to empirically analysis the effect of urban villages in Nanshan District, Shenzhen. Their study reveals that the price of residential housing unit which locate closer to the urban villages is significantly lower than others. In this paper, we will study the effect of both the existence and redevelopment of urban villages on neighboring houses transaction price using quantitative methods with the data of 50 key urban villages in Beijing and a large amount of micro second-hand housing transaction units from 2006 to 2011.

19.3 Data

19.3.1 Definition of Urban Villages in Beijing and Study Area

What we studied in this paper are the villages locate in the urban fringe, which means the village samples are those urban villages[2] located far away from the city

[1] Apart from the negative effects mentioned above, the citizens also approve of the positive functions of urban villages such as cheap daily commodities and services, such as cleaning staff and security guards.

[2] The urban villages in Beijing can be classified into two types: the first type refers to the nooks of the city which are in the built-up area with poor hygiene condition and social security; the second refers to the administrative villages in urban planning areas, most of which are located in rural-urban fringe zones. The differences of the two lie in the land ownership, size and location. The land of the first type is state owned while the second is rural collective owned. As for the size and location, the first villages are mainly small ones close to the center of the city (within 4th Ring Road or even 3rd Ring Road) while the latter are large ones where many immigrants are settled and are further form the city center (most are out of the 4th ring road of Beijing).

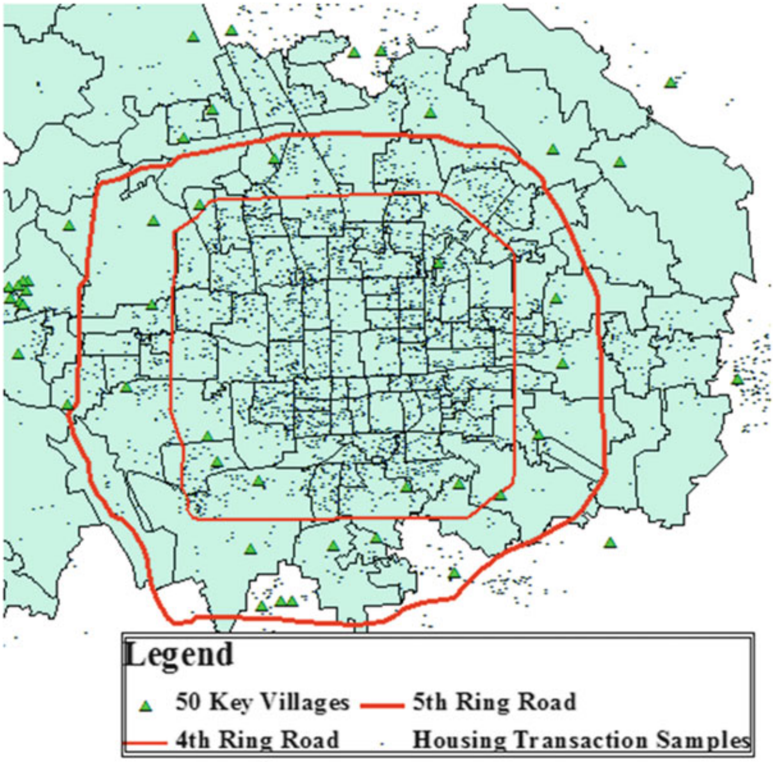

Fig. 19.1 Spatial distribution of urban villages and housing samples, and the range of the 5th ring road in Beijing

center and have gathered many immigrant settlements. To be consistent, we choose the areas within the 5th Ring Road to study.

After the 2008 Olympics, Beijing started the renovation of urban villages in rural–urban fringe zone and takes more efforts to ensure the stability of villages with more immigrants and social security problems after the Xinjiang "7-5" event in 2009. The working list of 50 villages to be renovated was issued and the renovation began in the beginning of 2010.[3] The list contains detailed information of the names and locations of these villages and thus can be used as the potential samples in this empirical study after space processing. Since we have limited the study area within the 5th Ring Road, 28 remote ones were ruled out and 22 were selected (The detailed locations are shown in Fig. 19.1). We can at least make sure that these

[3] Due to the lack of information, we cannot get detailed information about the location of all the urban villages in Beijing. According to the survey by Beijing Liquidity Management Committee in 2009, the number of villages with more than 10,000 immigrants has reached 81 [10]. Thanks to the vigorous promotion of renovation programs and news reports, we are able to collect some key facts of the villages.

urban villages have always existed by 2010, and the information that these villages will be redevelop is announced at the first quarter of 2010, it is feasible to base our empirical study on them.

19.3.2 Micro Data of Beijing Second-Hand Housing Transactions

Another important source of data of our paper is the micro-sample data of Beijing stock housing transactions which is from "Wo Ai Wo Jia" (a housing agency in Beijing), the samples record in detail the micro-information[4] of each second-hand housing transaction from 2006 to 2011 in Beijing. The spatial distribution situation is shown in Fig. 19.1.

19.4 Methodology

In the first stage, we aim to capture the effect of the existence of urban villages on the nearby housing units price, which we expect to be significantly negative. The method of empirical study is based on Hedonic model and is shown in expression (8.1). By controlling other influential factors we can find out the influences of urban villages on the commodity housing price. The decisive factors of the urban housing price are as follow:

$$\begin{aligned}&\mathrm{Log}(\mathrm{Housing\,Price})\left(\mathrm{Average\,Price\,Per\,m^2}\right)\\&=f(\mathrm{Influence\,of\,Urban\,Village,Housing\,Structural\,Feature,\,Housing\,Spatial\,Feature;}\\&\quad\mathrm{Spatial\,Difference,Temporal\,Trend})\end{aligned} \tag{19.1}$$

Among the influential factors, the first is the housing spatial feature, like the distance between the house and working center/sub-center, the distance between the house and subway station, primary school, shopping mall, etc., which measures the house's spatial convenience. The second is the house's structural feature, like the house type, floor, area, orientation, house age, decoration, etc. The third includes some spatial differences that are hard to observe and quantify, like the influence of factors impossible to observe, for example the better administration or neighborhood environment. In the empirical study we control space-fixed effects through applying dummy variables to each jiedao. The fourth factor is the transaction time, and we add

[4] The information includes features like the transaction price, project name of the house, location, etc. and housing structural features like the area, house age, house type, floor, orientation, decoration, etc.

quarter dummy variables to capture the time trend of housing price. Controlling all the influential factors above, we can find the clear effect of urban villages on the commodity housing price, what effect will spatial proximity to urban village have on transaction price when other factors are fixed?

In the second stage, we set up a DID-Hedonic model specification to analysis what the price of the housing units near the urban villages will be like after the announcement that the villages will be redeveloped. And we expect the result to be significantly positive. The model specification is shown in expression (19.2). The dummy variable *D_In* indicates that whether the housing sample is near a urban village, which distinguish the experimental group (housing samples near the villages, within 1.5 km around the urban village) and control group (housing samples out of the villages). And the variable *D_Govern* takes the value of 0 before 2010 and takes the value of 1 since 2010Q1, which indicates that whether the announcement of the redevelopment project is published to the society and help to distinguish whether the treatment takes places. After controlling for the two dummy variables and others the same as Eq. (19.1), we focus on the interact term of these two dummy variables "*D_In*D_Govern*", this variable capture the difference of the housing transaction samples' price between both in/outside the urban villages and before/after the information of redevelopment is announcement. We expect the variable to be significantly positive, which means that the redevelopment of urban villages will help to increase the transaction price of the nearby housing units.

$$\begin{aligned}&\mathrm{Log}(\text{Housing Price})\left(\text{Average Price Per m}^2\right)\\&=f(\text{Dummy\_In},\ \text{Dummy\_Govern},\ \text{D\_In} * \text{D\_Govern}; \text{Other Controlled Variables})\end{aligned} \tag{19.2}$$

The main independent variables used in empirical study are shown in Table 19.1.

19.5 Empirical Results and Analysis

19.5.1 Basic Model Results

The results of existence of urban villages on nearby housing price are shown in Table 19.3. In this stage, we using the micro housing samples which the transaction time is between 2006 and 2009, just before the start of the redevelopment in 2010Q1.

Column (1) indicates that the price gradient near urban villages is significantly positive under the control of urban spatial characteristics, housing structural characteristics, jiedao-fixed effect and quarter fixed effect. This result indicates that the closer housing units are to the urban villages, the lower are the housing prices. When the residential houses are 10 % closer to the urban villages, the housing price will decrease 2.7 %. Since many of the samples are located within

Table 19.1 The independent variables used in the empirical study

Category	Main variables (Properties of housing samples)	Symbol used in the model
1. Urban village	Distance to nearest urban village	Lnd_village
2. Spatial feature	Distance to CBD	D_cbd
	Distance to the working sub-center (Beijing financial center)	Lnd_jrj
	Distance to the working sub-center (Beijing Yayuncun)	Lnd_yyc
	Distance to the working sub-center (Beijing Zhongguancun)	Lnd_zgc
	Distance to subway station	Lnd_sub
	Distance to primary school	Lnd_school
	Distance to the hospital	Lnd_hospital
	Distance to shopping mall	Lnd_shop
3. Housing feature	Number of parlour	Parlour
	Number of bedroom	Room
	House age	Age
	Area	Area
	Floor	Floor
	Total floor of the program	Total_floor
	Orientation	Towards
	Decoration	Decoration
4. Space-fixed Effect	*Jiedao* dummy variable	*Jiedao_id*
5. Time-fixed Effect	Quarter dummy variable	Quarter

Note:
(1) All the distances are calculated with the help of GIS
(2) The Symbol Ln means calculate the logarithm of distance
(3) Considering the construction process of Beijing subway, distance to subway station represents the distance between the housing sample and the nearest subway station that has opened at the time of transaction

the third ring of Beijing while the urban villages are usually out of the third ring, we redo the regulation just using the housing transaction samples within 3 km of the urban villages in column (2). The results also indicate significantly negative effect of urban villages to the prices of residential houses that nearby. When the distance between the sample and the urban villages decreases by 10 %, the housing price will decrease 2.1 %.

Besides the analysis of housing gradient, we set the distance (1 km, 1.5 km, 2 km) between the urban villages and the residential houses as dummy variables in columns (3)–(5). Take equation (3) for instance, the housing price will decrease by 2.6 % when the house is located within 1 km of the urban villages. This result shows more significantly negative effect of urban villages in Beijing to housing prices than the empirical result done by Song (2012) in studying the urban villages and housing value in Shenzhen Table 19.2.

The results table is simplified by merging some controlled variables of the same type, and the list of all the independent variables are shown in Table 19.1.

Table 19.2 The existence of urban villages and surrounding housing units' price

	(1)	(2)	(3)	(4)	(5)
Equation	Total samples 2006–2009	Subsamples within 3 km of the villages	Total samples 2006–2009		
Variables	Log(HP)	Log(HP)	Log(HP)	Log(HP)	Log(HP)
Lnd_village	0.027***	0.021***			
	(5.434)	(3.736)			
Dv1000			−0.026***		
			(−3.419)		
Dv1500				−0.028***	
				(−4.325)	
Dv2000					−0.016***
					(−2.919)
D_cbd	−0.013***	−0.037***	−0.012***	−0.013***	−0.011***
	(−4.794)	(−8.417)	(−4.626)	(−4.883)	(−4.281)
Lnd_sub	−0.017***	−0.022***	−0.015***	−0.015***	−0.016***
	(−5.719)	(−5.377)	(−5.211)	(−5.214)	(−5.337)
Urban spatial characteristics	YES	YES	YES	YES	YES
Housing structural characteristics	YES	YES	YES	YES	YES
Quarter dummies	YES	YES	YES	YES	YES
Jiedao-fixed effect	YES	YES	YES	YES	YES
Observations	15968	7391	15968	15968	15968
R-squared	0.689	0.719	0.689	0.689	0.689

T-statistics in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

19.5.2 DID-Hedonic Model Results

Further, we examine whether the announcement of the urban village redevelopment project will affect the nearby housing units' value using the DID-Hedonic model specification shown in Expression (19.2), and the micro housing samples from 2006 to 2011.

The results are shown in Table 19.3. In column (6), the dummy variable D_In is significantly negative at 1 % level, which also indicates that within the 1.5 km of the nearest urban villages will significantly decrease the transaction price, and the dummy variable D_Govern is significantly positive at 1 % level, after controlling for the quarter dummies, this shows that the housing price is significantly higher after 2010Q1 than before. What we most concern is the interact term of the two dummies, and the results prove to be significantly positive at 1 % level. This means that the housing samples near the urban villages experience a significantly higher price increase after the announcement was published than the housing units further from the villages.

In the full regression results of Eq. (6), some of the variables of urban spatial characteristics are not significant and the signs are opposite to expect. We delete other urban spatial variables except the distance to the CBD and subway station, the results is shown in column (7) which is nearly the same as in column (6).

Table 19.3 The announcement of redevelopment and surrounding housing units' price

	(6)	(7)
Equation	Total samples 2006–2011	
Variables	Lnhp	Lnhp
D_In	−0.022***	−0.022***
	(−2.638)	(−2.660)
D_Govern	1.120***	1.115***
	(65.566)	(64.986)
D_In*D_Govern	0.031***	0.032***
	(2.682)	(2.742)
D_cbd	−0.010***	−0.020***
	(−3.740)	(−11.192)
Lnd_sub	−0.007**	−0.019***
	(−2.404)	(−6.807)
Other urban spatial characteristics	YES	NO
Housing structural characteristics	YES	YES
Quarter dummies	YES	YES
Jiedao-fixed effect	YES	YES
Constant	12.183***	9.744***
	(56.903)	(205.399)
Observations	24521	24521
R-squared	0.721	0.718

Note: T-statistics in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

19.5.3 Questions to be Further Discussed

We must admit that there are still some problems and shortcomings of this paper.

First of all, the samples chosen for studying urban villages do not cover all the villages in Beijing and may even miss a lot. The empirical study in this paper choose 50 key villages published in 2010 that located within the fifth ring in Beijing as its samples and indicates the significantly negative effect of urban villages to housing price. All of these 50 key villages share some typical characteristics, for example, there are many migrant populations in the village and the public security may sometimes be not guaranteed. These characteristics could also strengthen the negative effect in housing price. In this way, the housing price that negatively affected and decreased by other urban villages are taken as the basic price that are not affected by any villages in comparing with the samples in the empirical study. As a result, the study underestimated the real effect of urban villages – they should have more negative effects when the influence of other villages is controlled. Also, if there exists significantly difference between the key villages and other villages, there will be more uncertainty in the result.

Secondly, the influences of each typical village's characteristics to external effects are not considered in the study, for instance, the influence of area and migrant population are not taken into consideration subject to the availability of data. In this study, the village within the city is considered as a point when calculating the distance between the residential houses and the village.

19.6 Conclusions

The externality of urban villages has been the hot spot in academic study and both the negative and positive external effects have been pointed out, but quantitatively empirical analysis is not much. This paper empirically studies the effect of the urban villages on the nearby housing units from the perspective of both the existence and the redevelopment of urban villages, based on the micro housing transaction data and 50 key villages in Beijing. The empirical results in this paper indicate the significant negative effect of urban villages to the surrounding housing prices. What's more, the price of surrounding housing units show a significantly increase after the announcement that the nearby village will be redeveloped.

First, this paper proves that the existence of urban villages have significantly negative effect on the nearby housing price, and the residential housing units' price that locates within 1 km of the village are 2.6 % lower than those outside the village. This reflects the negative effect of urban villages decrease residents' willingness of buying the houses. Second, we also find the significant positive effect of the redevelopment of the urban village on the housing samples' price. After the information of the redevelopment is published, the housing units near the urban villages do enjoy a higher price increase than the further ones.

This empirical result could be used as reference in creating new method of gathering resources in the process of the redevelopment of urban villages. Developers have involved in redeveloping urban villages in some cities where market competitive mechanism has been introduced, while developers in Beijing are not that interested in that due to the strict planning constrain. The reconstruction of urban villages could help eliminate or alleviate the negative external effects so as to increase the value of surrounding properties, which will be popular among owners. Under this circumstance, the owners of surrounding properties could be involved in developing the village jointly or they could help financing the project, for instance, use a portion of the property tax of surrounding properties as the construction capital resource. Furthermore, attentions should be paid to positive external effects that could not be capitalized in housing market. In the reconstruction of urban villages, the government should not focus on eliminating the villages but on protecting the rights of disadvantaged groups like local villagers and the migrant working populations. It is hoped that, the financing mode proposed in this paper could help in raising fund and increase the subsidy to disadvantaged groups in reconstructing the urban villages.

Acknowledgments This research is supported in part by the National Natural Science Foundation of China (No. 70973065), Major project of National Social Science Foundation of China (No. 09&ZD042) and Tsinghua University Initiative Scientific Research Program.

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Chapter 20
The Skyline Design Under Constraint of Natural Environment: A Case Study of Nanan City

De-yi Dai and Ying-xue Rao

Abstract A skyline is the overall or partial view of a city's structures and its natural environment against the sky. It serves as an important kind of landscapes of the city. The organization and design of urban skylines would be beneficial to enrich the resource of urban landscape, to coordinate the interaction between the urban and its natural environment, and to strengthen the guiding and control effects of urban design. The organization and design of urban skyline should be based on full understanding its natural environment, and it should also follow the hierarchy principle, harmony principle, principle of combination of dynamic and static, and individuality principle. Nanan City was the study objective in this paper. To study the elements of its skylines, we should consider the important roles of its water body and mountain body in the skyline organizational design. In visual depth direction, a skyline can be divided into foreground, middle ground, and background. The targets and ways for organization and design of the skylines were proposed, fully considering each layer's function and characteristics, and requirement of coordinated development between skylines and natural environment.

Keywords Skyline • Hierarchy analysis • Design • Nanan City

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_20,

20.1 Introduction

Skyline is an important expression of the city's outline, also be an important resource of urban landscape. A city is a production of social productivity development, also be a settlement pattern of human formed by adaption and transformation to the natural environment [1]. Social environment, in addition of the human action is an essence power of city's development. Natural environment provides the material basis for the city's development. It effects the formation and development of city, and controls the outline changing of city. Therefore, it should fully consider to the influence of natural environment while designing the urban skyline.

Urban skyline is accepted in the situation of the continuous development of the theory and practice in modern urban planning and design. Howard's theory of "garden city" and Wright's theory of "wide acres city" emphasizes the coordinate relation between the development of social function and natural environment, which provide a plain and coordinate concept for skyline design and other design of urban spatial morphology. Geddes brought ecological concept into urban planning [2]. Sitte's research of city morphology emphasize artistry as an importance characteristic of the city's space forms, which pursuit of the coordinate relation between human and environment [3], brought an important theory of urban skyline design and other spatial design. In the book of "Design with nature", Mcharg considered natural environmental factors as the most important resource in structure of social value [4]. Lynch established the theory of urban image, which provide unique humane view for considering the skyline as a kind of city's image [5]. Chicago's "city beautiful movement" opened a curtain of the changing in modern urban skyline [6]. Corbusier established a developmental form of skyscraper buildings based on urban function theory, which brought further influence to the changing of city's spatial morphology [7]. Skyline has changing thoroughly with the development of high-rise and high-density structure in modern city.

China has created Luoyang, Chang'an, Kaifeng, Beijing and other Metropolis in its long historical period, also produce a traditional natural view of "law in nature" and "unify of human and nature". The inheritance and development of Traditional natural view should be the advantage of urban planning and design in china. However, due to the Institutional constraints in past historical period, China has loss of the advance opportunity of modern city's development. Then it brought out a rash advance stage of urban construction. In the design practice of urban skyline, although it has carry out Hong Kong, Suzhou, Qingdao and other successful cases, most city just pursuit of mechanical function, high density development. They did not pay full attention to the natural environment in urban design. It caused to produce a batch of skyline views of imbalance and conflict apparent under the natural environment. There's few current research of design theory of urban skyline. Mainly current research concentrated in the relationship between city and its skyline, or between height and shape control of building skyline. Otherwise, a few research concentrated in image function of urban skyline [8–15]. Most current research of urban design is lacking of perspective in the relationship of skyline and natural environment. Therefore, the skyline design theory and its practice research under the constraint of natural environment will help to promote the theory of the city's special planning and design. The research also provides a specific draw for the control guidance of urban skyline.

20.2 Significance and Principle of Urban Skyline Design

20.2.1 Significance of Urban Skyline Design

20.2.1.1 Enrich Resources of the Urban Landscape

Skyline provides a direct view of the city's outline. As a kind of landscape resources, it included of human characteristics, aesthetic characteristics and identification characteristic connotation. It also be the intentional reflects of the city which has concentrated Generalized the overall features and cultural connotation of the city [13]. As a "line" element of the urban landscape, Skyline's outlines and their combination create the diversity and hierarchy of the special landscape. Stereo, diverse and personalized skyline will be high quality landscape resource of the city, which providing the characteristic carrier of urban landscape.

20.2.1.2 Coordinate Interaction Relation Between the Urban and Its Natural Environment

A skyline is the overall or partial view of a city's structures and its natural environment against the sky. It's outline and vehicle high show the relationship between urban and natural environment. The natural environment offers mountain and water scenery with important composed elements of landscape, constraints of the growth direction of skyline. Humans in city adapt and transform the natural environment with its initiative, formed the relationship between city and nature environment. A reasonable urban design will be beneficial to coordination the interaction between city and its natural environment.

20.2.1.3 Enhance Guiding and Control Effects of the Urban Design

Skyline design needs to use the guidance and controller of building's height, density, appearance and open space of the city to achieve the aims. Urban design has focus on the city's morphology control and image organization [16]. As an important object of urban design, skyline design should be the guidance and controller of the city's space order. It also be an important measure strengthen the power of the guidance and controller in urban design.

20.2.2 Principles of the Urban Design

20.2.2.1 Principle of Hierarchy

The spatial structure of urban makes the space hierarchy to be intrinsic characteristic of urban skyline. Multi-level skyline can enrich resources of the urban landscape, can fully demonstrate the effective landscape which formed by the outline style of city. It also benefit to the expression of city's characteristic and the enhancement of the city's identification.

20.2.2.2 Principle of Combination of Dynamic and Static

The experience of the urban landscape isn't in a last state of static, but stays with a combination state of dynamic and static. The perception of skyline landscape has two styles, one is static style, another is dynamic style. So urban skyline design should follow the principle of combining of static and dynamic, to achieve the target of the variability and rhythmicity.

20.2.2.3 Principle of Coordination

City's environment consists of natural environmental elements (mountain, water, vegetation and so on) and artificial environment element (buildings, structures and other artificial facilities), provides a variable elements of the skyline landscape. A skyline landscape of coordination feature meets human's need of cognitive psychology. It also the protective requirements of the urban skyline design. Coordination principle is not immutable or frozen uniform, but pursuits for contrast and complementary between the landscape elements basis on the overall of skyline, to construct a coordinate landscape of skyline. In addition, the coordination principle also performance in the skyline design which considering for the adaption to natural environment and social environment [9].

20.2.2.4 Principle of Individuality

City's environmental resources provide characteristic material of landscape for the characteristic of skyline design. Characteristic of the skyline create a special landscape of urban. Skyline design should highlight its identification to make the urban skyline become a characteristic landscape. Expression of personality is an important purpose of the urban skyline design. A reasonable, beautiful and full of individuality skyline create an excellent visual sense for city's residents while enhancing the sense of belonging to the city.

20.3 Skyline Design Under the Constraint of Natural Environment in Nanan City

20.3.1 Composition and Characteristics of Skyline Landscape

20.3.1.1 Natural Component of Skyline

Landscape elements of urban skyline both including of the humane landscape and natural landscape. Water body and mountain body are the most important natural elements effecting on skyline. Nanan City is located in a hilly region of the southeast of China. The urban district grows along the Xixi river valley. Around the city were a lot of mountains that have smooth lines of the vertical direction and good vegetation cover. The Xixi River running across the city has a wide water body with small water drop. Good conditions of mountains and water create a diverse and three-dimensional skyline landscape. If take a view of the mountain skyline from the south or north bank of the Xixi River, it will bring comfortably enjoy on the skyline with a maximum elevation angle less than 15° (Fig. 20.1).

20.3.1.2 Present Constructions

Nanan City lies in the coastal area of China's Southeast. In recent years, the city's development has run across the Xixi River from south to north, facilities of the city have been constantly improved. Most buildings of the city are multi-story buildings and high-rise building below 100 m. High-rise buildings are concentrated in the area along the Xixi River and the foothills of mountain, which have a closely contact of visual with the Xixi River and the city's main mountains. But the spatial order formed by the building is not clear. By influence of the building height, cause insufficient volume and poor rhythm to building skyline. As a result of the lack in development intensity, view of mountain skyline has been objectively preserved, and urban skyline has better plasticity.

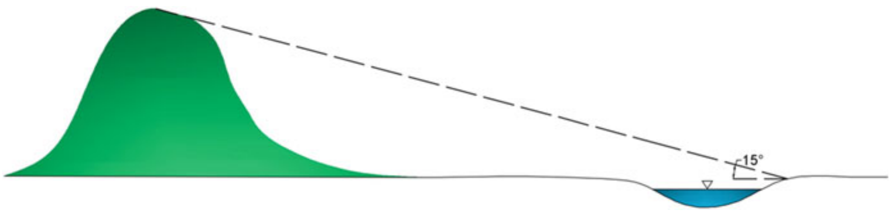

Fig. 20.1 The elevation sketch of the mountain skyline in the area belongs river

20.3.2 Layers' Analysis of the Urban Skyline Landscape

As a landscape, urban skyline is inseparable from the subject and object elements and their visual contact [15, 16]. Analysis of visual hierarchy of Nanan City's skyline under constraint of natural environment and development situation in the area along the Xixi River, the urban skyline landscape could be divided into foreground, middle ground and background in the depth direction.

20.3.2.1 Foreground of the Urban Skyline

Foreground of skyline shows the interactive relation between Nanan City and its natural environment. It plays the roles both as visual open space of the skyline landscape and detail display of the skyline from close distance. Landscape composition of Skyline's foreground including the Xixi River, wetland Park along the Xixi River and buildings set on the belt district along the Xixi River. The actual forms of the skyline's foreground including water body, vegetation, Roads along the river, buildings and other landscape structures. Color and form styles are rich in the foreground of skyline. The most important guidance and control of Skyline's foreground is the security of skyline's visibility and skyline's detail view. District along the river should be reserved an open space for skyline's view, it also need to reduce the visual disturbance which bring by uncoordinated landscape in the foreground of skyline (such as building and structures with exaggerated outline and color).

20.3.2.2 Middle Ground of the Urban Skyline

Middle ground of the skyline composed by buildings lie on the district between mountains' foothills and outside border of the foreground of the skyline. It determines the volume of skyline mainly. In this layer of skyline, the existing building heights were insufficient, the amount of high-rise building wasn't enough, the variability and rhythmicity also be lack. Because of the lack in middle ground of the skyline, buildings did not effect on the lift of skyline, the overall visual effect of skyline was limited. To take the effect as visual center, the guidance and control of Skyline's middle ground should including follows: appropriately increase the high-rise buildings, improve the height of buildings, properly improve the volume of buildings or their combination groups, coordination of the relation between building's height rhythm and the background mountain.

20.3.2.3 Background of the Urban Skyline

Conditions of natural environmental decide the background mountain as important characteristic of urban skyline in Nanan City. The outline of skyline formed by the overall combination of buildings and mountains background. Nanan City's

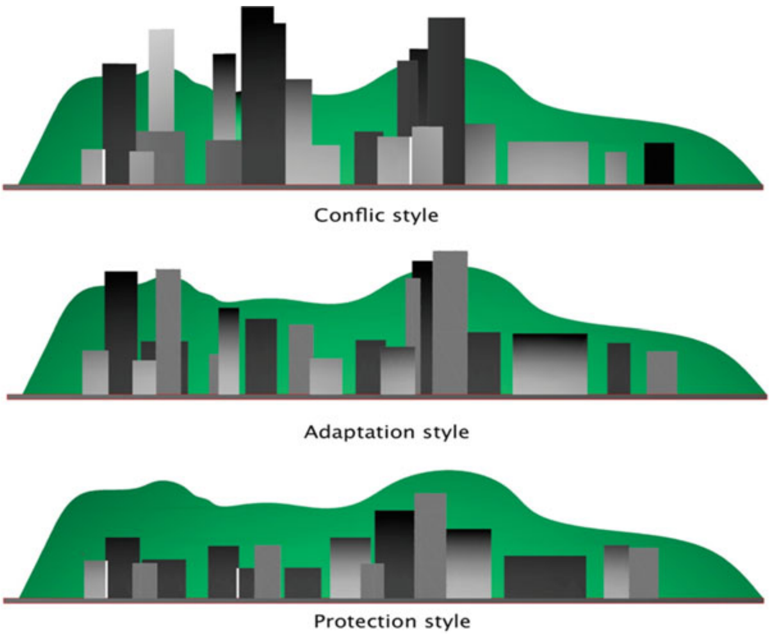

Fig. 20.2 Sketch of the relationship between building skyline and natural mountain skyline

mountain peak has an elevation about 354 m. All mountains have smooth vertical drop and moderate volume, it provide favorable conditions for the variability and rhythmicity of skyline. Guidance and control of Skyline's background should focuses on the showing of smooth mountain skyline, it also need to coordinate the combination relation between building's height, volume and mountain's height and volume.

20.3.3 Organization and Design of the Urban Skyline Landscape

20.3.3.1 With the Target to Achieve Diversity and Identification of the Skyline, the Layer of the Buildings and Mountains in the Skyline Should be Adjusted

Relations between Buildings and mountain background of skyline expose the different ecological concepts [17], the concepts have three general types: conflict type with the building heights and volumes obviously breakout the mountain background, adaptation type with building heights and volumes coordinate the mountain background, protection type with building heights and volumes under strictly constraint of the mountain background (Fig. 20.2).

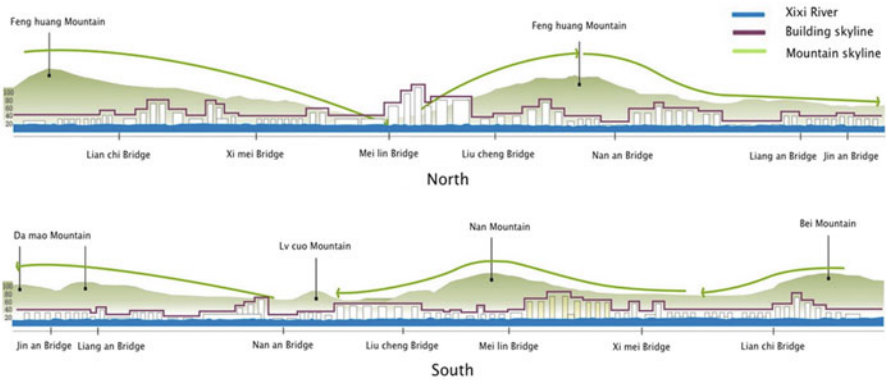

Fig. 20.3 Sketch of the control relation between valley and peak of buildings along the Xixi River and main mountains

In addition to expression the diversity with elements of skyline landscape, line shapes of the skyline should be various. The display of skyline can enrich skyline landscape of Nanan City, it also can improve the identification of the skyline landscape. By the influence of Nanan City's development level and the natural conditions, to deal with the relation between buildings and mountain background, it should take the protection way to coordinate the relation between buildings and main mountains, and focus on the protection of mountain skyline especially of the preserve continuous ridge, to achieve the target of general identification of the skyline.

20.3.3.2 With the Target to Achieve Variability and Rhythmicity of the Skyline, the Correlation Between Peaks and Valleys of the Mountains and Buildings Should be Adjusted

The alternating with the valley and peak of the building skyline and Mountain skyline increased variability and rhythmicity of the urban skyline. If the alternated trend of the valley and peak of building skyline and mountain skyline were exactly the same, skyline landscape would be monotonous. Therefore, in addition of the strict protection of main mountain's ridge, it should appropriate enhance the contrast of the peak and valley of mountain skyline and building skyline, which to improve the static effect and dynamic effect of the urban skyline, to achieve the target of variability and rhythmicity of the skyline.

For skyline design, it should focus on the limiting of building heights not breakthrough the main mountain's ridge, and partly reverse the synchronization relationship between valley and peak of building skyline and mountain skyline, forming the combinations of skyline with unique and overall characteristic (Fig. 20.3).

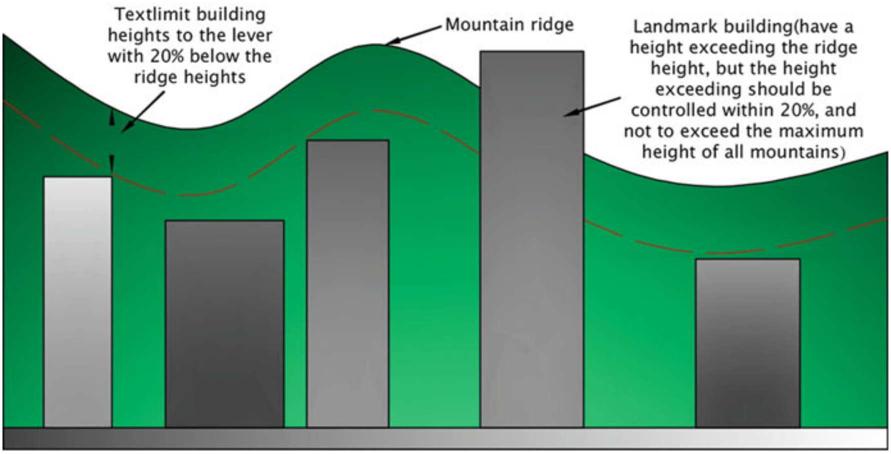

Fig. 20.4 Sketch of the control relation between building heights and mountain heights

20.3.3.3 With the Target to Achieve Overall Coordination of the Skyline, the Relationship Between the Building Height, Density, Volume and Their Background Should be Adjusted

Building heights, density and volumes are important factors effect on the skyline [13]. For reasonable show of the skyline mountain's background, it should strictly control building heights in foreground and middle ground of the skyline, to preserve 20 % space of the mountain not being cover. In practice, it should limit building heights to the lever with 20 % below the ridge heights. On this basis, for enhance the spatial recognition of city by improving the identification of skyline, allowing the individual landmark building to have a height exceeding the ridge height, but the height exceeding should be controlled within 20 %, and not to exceed the maximum height of all mountains (Fig. 20.4).

To regulate the density and volume of building, on one hand, it should improve the prospects permeability of the skyline by controlling the building height, density and volume in foreground of skyline: controlling the height, density of building along the Xixi River, controlling the building along the Xixi River as dot mode, reducing the volume of the single or combination building, avoid constructing slab-type building with big volume, controlling setback of the building along river, and reducing oppression on the open space of the Xixi River's ecological environment by the building. On the other hand, it should make the buildings in middle ground of the skyline to play a role as landmark building, it should followed the principle of overstating the building height, to achieve the target of enhancing the view of the skyline by improving the height and monomer volume of middle ground.

20.3.3.4 With the Target to Improve the Visibility of the Skyline, Sighting Network of the Skyline Should be Controlled

A clear sight is necessary for appreciate the city's landscape. It should be based on the analysis and adjusting of skyline sighting network, for keeping a good sighting through the three layer of urban skyline in Nanan City, it should avoid shielding the important landscape of city. The regulation and controlling of the sighting network in Nanan City's skyline should include follows: the first is protecting the Xixi River and its open space, showing the general image of urban skyline. Secondly, it should improve the prospects permeability of the skyline's middle ground, to show the volume of building skyline except for a large cover to the main mountain. Besides, still need to protect the sighting channel between the main mountains, and strictly control the building in the sighting channel to preserve the visual space between the main mountains through the Xixi River.

20.4 Conclusion

Carry a reasonable skyline design basis on the fully recognize of the city and its natural environment has become an important work to control urban planning and its construction management, and to fix the construction index and shaping the outline of the city.

Complete system of skyline design including design concept, design principles, analysis of landscape structure and control strategy of the skyline. In practice, it need to take a comprehensive analysis on the property, composition, structure and characteristics of the urban skyline, focus on the coordinate relation between buildings and city's natural environment, and optimization of the combination design of the building skyline with natural skyline. With complying of the requirements above, it will create skyline landscape with characteristics of diversity, identity, variability and rhythmicity.

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Chapter 21
Research on Land Use Classification of Land Change Survey for the Integration of Urban Planning and Land Resource Administration

Qi Liao, Mo Su, Ganghui Luo, and Xiaowu Wei

Abstract The integration of urban planning and land resource administration in Shenzhen city make an urgent requirement for data integration. Therefore the integration of urban land classification standard and land use classification standard is discussed in this paper. After analyzing the differences and similarities between these two standards, a series of key points are discussed, such as the principles of integration, the relationship between two or more land types, subdivision, combination and coding of land types. Finally, a new land use classification of land change survey is made, and a one to one relation between two standards can be established through this classification. The application of this new classification in land change and urban construction land survey in 2011 indicated that not only two kinds of data can be acquired from one survey, but also made a solid foundation for the seamless integration of urban planning and land resource administration at data acquisition level. Meanwhile, the survey data can be widely used in management, such as urban planning, land use planning, land approval and land supervision.

Keywords Urban planning • Land resource • Land change survey • Land classification • Integration

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_21,

21.1 Introduction

After the big department system reform of Shenzhen government in 2009, some departments which have similar duty were integrated, including Shenzhen planning bureau and Shenzhen land resources and housing administrative bureau. These two departments were integrated into Shenzhen urban planning, land and resources commission. At present, the unified administrative framework of urban planning and land resource is established in Shenzhen city, and the relationship between urban planning and land resource become more and more close. In order to promote the integration of urban planning data and land resource data, the requirements of urban planning and land resource were taking into consideration in the annual land change survey in 2011, and the regular land change survey was expanded into land change and urban construction land survey. Land classification is the basis of these two surveys, therefore in order to implement this unified survey, two different land classifications must be integrated.

In addition, Shenzhen city is a highly urbanized region, the land classification based on average level of China cannot meet the demand of rapid economic and social development and fine management. Therefore, in the new land classification, some land types are subdivided into several new land types which are highly related to economy and society, such as strategic new industry and indemnificatory housing. Thus, the unified survey with integrated and subdivided classification can provide basic data for fine urban planning and land resource administration.

Therefore, in order to promote the integration of urban planning data and land resource data and meet the requirement of fine management, the integration and subdivision of urban land classification standard and land use classification standard are discussed in this paper, so as to make a new land classification for land change and urban construction land survey, and a look-up table between two classification standards for data conversion.

21.2 The Current Classification Standards

21.2.1 Classification Standard of Land Change Survey

The land classification of land change survey is the Current Land Use Classification (CLUC). It is a national standard issued by the State in 2007 and adopted by the second national land survey. CLUC is made for land and resources administration, and based on the type of land use, management characteristics, land cover characteristics and other factors [1]. CLUC has a two-level classification framework. There are 12 land types at first level and 57 land types at second level. The publication of CLUC meant it was promoted from a standard just for land administration to a national standard, and symbolized the land department basically reached a consensus on land classification standards. However, in the background of administrative integration of urban planning and land resource in Shenzhen city, unify land use classifications is not enough, it is also necessary to integrate urban land classification and land use classification.

21.2.2 Classification Standard of Urban Construction Land Survey

The land classification of urban construction land survey is Shenzhen urban land classification(ULC). ULC is a part of "Shenzhen Urban Planning Standards and Guidelines" which was issued in 2004 [2]. Considered the publication of "Code for Classification of Urban Land Use and Planning Standards of Development Land" in 2012 [3] and the actual situation of Shenzhen city, ULC was simplified and optimized [4]. Therefore, in this paper the new ULC (NULC) is used for the integration. NULC is a standard for compilation and management of urban planning and statutory plan. NULC is made based on the function of urban land and other relevant factors, and focus on the construction status and functional characteristics of construction land. NULC also has a two-level classification framework. There are 9 land types at first level and 42 land types at second level.

21.2.3 Limitations of the Current Classification Standards

First, different classification standards cannot meet the requirement of administrative integration of urban planning and land resource. CLUC and NULC are similar, but also have some differences for the reason that urban planning and land administration have different emphases. CLUC is more explicit in agricultural land and focus on land use control. It can be used for land survey, planning, evaluation, statistics, registration and information management [5]. NULC is more explicit in construction land (Table 21.1) and focus on urban land function and planning purposes. It can be used for urban planning and construction [6]. At present, CLUC can basically meet the requirement of land management, but it is not explicit enough in construction land, and cannot fully meet the requirement of fine management of urban planning and land resource. Therefore, it is urgent to establish a new land classification and find the relationship between CLUC and NULC through integration research. With this new land classification, urban planning data and land resource data can be converted to each other with no impact on the current management.

Second, implement the integration at data application level cannot achieve the seamless integration of urban planning data and land resource data. At present, Beijing, Tianjin and Shanghai have also made some research on the integration of urban land classification and land use classification, and issued look-up table between these two classifications respectively. Look-up table can be used for data

Table 21.1 The differences between CLUC and NULC

Current land use classification				Shenzhen urban land classification		
First Level		Second Level		Code		Name
Code	Name	Code	Name	First Level	Second Level	
06	Industrial and Warehouse Land	061	Industrial Land	M		Industrial Land
					M0	New Industrial Land
					M1	Ordinary Industrial Land
					M2	Special Industrial Land

conversion [7, 8]. But they implement the integration at data application level, it cannot completely solve the problem of seamless integration of urban planning data and land resource data. The reason is the definition of land types, emphasis points and subdivision of these two classifications are different. The data acquired from two surveys by urban planning and land administration departments are inherently different. After data acquisition, no matter what kind of look-up tables are used in data conversion, there must be some error. However, if the integration is implemented at data acquisition level with a new land classification which can convert to urban land classification and land use classification, the standard of identifying land types of CLUC is the same as NULC in field survey. Thus, the survey results can convert to urban planning data and land resource data, so as to achieve the seamless integration of urban planning date and land resource data.

21.3 Integration and Subdivision

21.3.1 The Principles of Integration and Subdivision

To ensure the new classification called land change survey classification (LCSC) is scientific and practical, the integration and subdivision should follow the following principles: (1) The principle of inheritance. In order to avoid impact of integration on current land change survey, LCSC is based on CLUC and maintains the basic framework of CLUC. (2) The principle of necessity. The subdivision of land types should be appropriate and based on the requirement of urban planning and land administration. On the one hand, if LCSC is too coarse, it will not be able to support management, on the other hand, if LCSC is over subdivided, it will increase workload and it is difficult to identify land types. (3) The principles of maneuverability. First, the definition of land types should be explicit and unambiguous so as to facilitate identifying land types in field survey. Second, the code of land types in LCSC should be compatible with CLUC and NULC so as to facilitate automatic processing and conversion by computer.

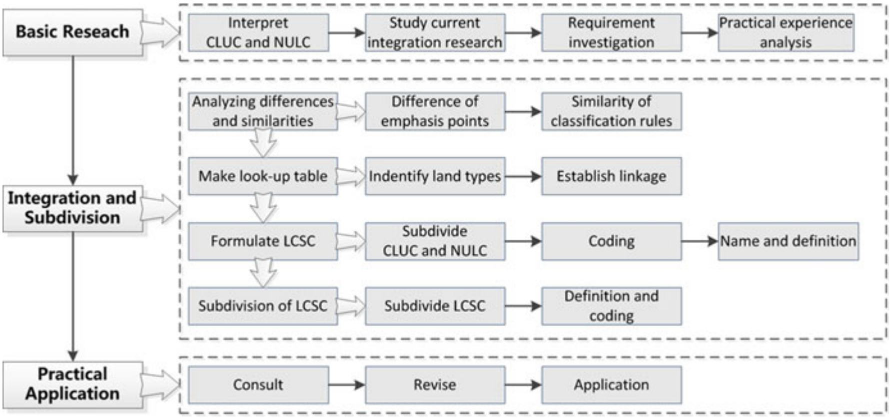

Fig. 21.1 Research technique routine

21.3.2 The Ideas and Methods of Integration and Subdivision

After analyzing the differences and similarities between CLUC and NULC [9], combined with the actual management demand and practical experience of surveyors, a series of key methods are used to implement the integration, such as establishing relationship between two or more land use types, subdivision, combination and coding of land types. Finally, LCSC can be made and a one to one relation between two classifications can be established through LCSC. In this research, theoretical analysis and practical verification methods are used to accomplish the integration, such as data collection and analysis, standards interpretation, requirement investigation, practical experience analysis, consulting, pilot applications Fig. 21.1.

21.3.3 The Process of Integration and Subdivision

21.3.3.1 Analysis of Differences and Similarities

CLUC focuses on the type of land use and is more explicit in agricultural land, while NULC focuses on the function of urban land and is more explicit in construction land. Their emphasis points and subdivision are both different. But at the same time, classifying land types according to the function of land is the internal common point between CLUC and NULC, and it is also the premise and basis of the integration. Therefore, the difference of emphasis points and the similarity of classification rules are the breakthrough point for the integration. For land types with the same function, they can be directly linked. For land types with a part of different function, they can be also linked through subdivision.

21.3.3.2 Make Look-Up Table of Classification

Step 1: identify land types. Identify the definition and meaning of land types through interpretation of CLUC and NULC and the experience of field survey.

Step 2: establish linkage. Establish the linkage between land types at second level of CLUC and NULC according to the definition of land types. There are three kinds of linkages between land types: one-to-one relation (e.g., "mining field" in CLUC corresponds to "open pit" in NULC), one-to-many relation (e.g., "industrial land" in CLUC corresponds to three kinds of industrial land in NULC), many-to-one relation (e.g., three kinds of cultivated land in CLUC correspond to "cultivated land" in NULC). After establishing linkage, a look-up table between CLUC and NULC is accomplished.

21.3.3.3 Formulate LCSC

Step 1: subdivision. Subdivide land types with one-to-many and many-to-one relation. First, set a column between CLUC and NULC of look-up table for LCSC. Second, put the land types with one-to-one relation into LCSC directly. Third, analyze land types with one-to-many and many-to-one relation, and then subdivide the coarse land types according to the fine land types. For example, "industrial land" in CLUC is subdivided into "new industrial land", "ordinary industrial land" and "special industrial land" according to NULC, and then put these three subdivided land types into LCSC. In fact, LCSC is equivalent to land types at third level of CLUC and NULC. Thus, a one to one relation between CLUC and NULC can be established through LCSC.

Step 2: coding. The code of LCSC is a combination of CLUC and NULC. The first half is the code of CLUC and the second half is the code of NULC. For example, "first-class residential land" in LCSC corresponds to "urban and town residential land (071)" in CLUC and "first class residential land" in NULC (R1)", according to above coding rules, the new code is "071R1". This coding system will not exert impact on current management, and it is convenient for the staffs of urban planning and land management to identify land change survey data, and it is also available for computer automatically extracting urban land data and land use data.

Step 3: name and definition. According to the principle of inheritance, if the land types in CLUC have one-to-one and many-to-one relation with land types in NULC, the name and definition of land types in CLUC is adopted. On the contrary, if the land types in CLUC have one-to-many relation with land types in NULC, the name and definition of land types in NULC is adopted. In addition, some practical descriptions which can improve the maneuverability of field survey are added to the definition. For example, "urban and town residential land" in CLUC have one-to-many relation with land types in NULC, it must be subdivided into two land types so as to establish one-to-one relation with "first-class residential land" and "second-class residential land" in NULC. Therefore, the name and definition of

Table 21.2 Subdivision of LCSC

First Level		Second Level		
Code	Name	Code	Name	Definition
061 M0	New Industrial Land			Scientific and technological research, creative designation, management training, trade fairs, pilot scale experiment, production and other comprehensive industrial land.
		061 M01	Strategic New Industry	Industry defined by 12th Five-Year national strategic new industry development plan, such as energy conservation and environmental protection, new generation of information technology, biotechnology, high-level equipment manufacturing, new energy, new materials, new energy vehicles.
		061 M02	Other New Industrial Land	New industrial land except for strategic new industry
071R2	Second-Class Residential Land			Residential land with good facilities and distribution, such as low buildings(4–6 floors), medium building s(7–10 floors) and high buildings (more than 10 floors)
		071R21	Indemnificatory Housing	Houses with special price provided by government for low income families, including low-rent housing, affordable housing, special commercial housing for low income person and policy-oriented rental housing
		071R22	Other Second - Class Residential Land	Second-class residential land except for indemnificatory housing

NULC is adopted in LCSC, and some quantitative descriptions of the floors are used to interpret “low building” and “high building”.

21.3.3.4 Subdivision of LCSC

Shenzhen city is a highly urbanized region, in order to meet the requirement of rapid economic and social development and fine management, on the basis of LCSC’s single level framework, some land types are subdivided into several new land types. These new land types are at second level of LCSC (Table 21.2). For example, in order to adapt to the new situation of Shenzhen city which is in urban development transition, and comply with 12th Five-Year national strategic new industry development plan, the “new industrial land(061 M0)” is subdivided into “strategic new industrial land” and “other new industrial land”. The code of land types at second level inherit the land types at first level, and with one extra number behind it, that is “061 M01”. In order o survey the construction conditions

Table 21.3 Shenzhen LCSC and look-up table between CLUC and ULC (excerpt)

Current Land Use Classification				Land Use Classification of land change survey		Shenzhen Urban Land Classification	
First Level		Second Level					
Code	Name	Code	Name	Code	Name	Code	Name
01	Cultivated Land	011	Paddy	011E2	Paddy		
		012	Irrigated Land	012E2	Irrigated Land	E2	Cultivated Land
		013	Dry Land	013E2	Dry Land		
07	Residen-tial Land	071	Urban And Town Residential Land	071R1	First-Class Residential Land	R1	First-Class residential land
				071R2	Second-Class Residential Land	R2	Second-Class residential land

of indemnificatory housing and provide reference for making housing policies, the "second-class residential land (071R2)" is subdivided into "indemnificatory housing" and "other second-Class residential land", and the code of "indemnificatory housing" is "071R21".

21.3.4 Results

Shenzhen LCSC and a look-up table between CLUC and NULC can be formulated through the above integration process (Table 21.3). With the help of LCSC, a one-to-one relation between CLUC and NULC is established. For LCSC can convert to CLUC and ULC with no error, it can applied in land change and urban construction land survey, and two kinds of data can be acquired from one survey.

21.4 Practical Application

To ensure LCSC was scientific and practical, it was revised and improved according to opinions of related management department, technology department and field survey companies, and it was applied in Shenzhen land change and urban construction land survey in 2011. The application results indicated that not only two kinds of data can be acquired from one survey, but also made a solid foundation for the seamless integration of urban planning and land resource administration at data acquisition level.

21.5 Conclusions

Shenzhen city is a highly urbanized region, and urban planning and land resource administration are integrated. In order to accomplish the integration of urban planning data and land resource data and meet the requirement of fine management, integration and subdivision of CLUC and NULC are discussed in this paper. Finally, a new land classification named LCSC and a look-up table between CLUC and ULC are made. This study has the following innovations: First and theoretically, the integration was implemented at data acquisition level and solved the integration problem of urban planning data and land resource data. Second and technically, a new land classification was formulated to link CLUC and ULC, and a one-to-one relation was established through this classification. Third and at application level, some land types were subdivided into several new land types which are highly related to economy and society so as to support fine urban planning and land resource management. In the long run, with more deep theoretical research and wide practical application, LCSC will be improved and become a new standard of urban planning and land resource administration in Shenzhen city.

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Chapter 22
Explorations and Practices of Land Change Survey in the Background of Unifying Planning Departments and Land Departments

Mo Su, Qi Liao, Ganghui Luo, and Xiaowu Wei

Abstract Administrative departments for urban planning (abbr. planning departments) and administrative departments for land resources (abbr. land departments) in China set up different surveying systems for land use with different standards for statistics, which renders the fundamental databases generated by the different surveying systems inconsistent. In order to unify the planning departments and land departments, Shenzhen, as a highly urbanized city, has designed a new annual fundamental survey system which could serve both the urban planning and land resources management. The survey system has the following three innovations. First, survey-specific land types are defined based on both the survey system for urban planning and that for land resources management, hence easily converted to the two survey systems; second, spatial units used for surveying are unified. The smallest survey unit is a land mass with only a single land use type or status and segmented out by ownership boundaries, administrative boundaries or linear features. Third, additional fields could be added into the fundamental databases, depending on the actual needs of urban planning and land resources management.

Keywords Land survey • Land classification • High urbanization • Shenzhen City

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_22, © Springer-Verlag Berlin Heidelberg 2014

22.1 Introduction

Land survey is a conventional and fundamental work for land resources management. For clarity, in this paper, Ministry of Land and Resources of the People's Republic of China and low level land administrative departments are generally called 'land departments'. Ministry of Housing and Urban-Rural Development of the People's Republic of China and low level administrative departments of planning are generally called 'planning departments'. According to the Law of Land Administration, land departments should be in charge of land change survey. However actually, planning departments establish different urban land use survey systems, take independent annual urban land survey, and set up a separate annual report system [1]. Due to the differences between the survey systems adopted by land departments and planning departments, the generated survey databases become inconsistent, which seriously hinders the linkage between relevant work in planning departments and land departments, especially in the area with relatively high degree of urbanization. In Shenzhen, a highly urbanized city, the problems resulted from the above inconsistency are especially serious and hence the unification of land departments and planning departments becomes especially emergent.

22.2 Problems

Current Land Use Classification Standard (GB/T21010-2007) [2] published by the nation in 2007 is adopted by land departments and used when carrying out the second national land survey and successive land change surveys, which unifies the national land survey data; However, planning departments make use of another newly published national standard: Code for Classification of Urban Land Use and Planning Standards of Development Land (GB50137-2011) [3]. Low level administrative departments of planning even establish their own standards according to the national standard. For example, Shenzhen City has formulated Shenzhen Urban Land Use Classification [4] which has been published in the Shenzhen Urban Planning Standards and Guidelines in 2004 [5]. For another instance, Beijing City has worked out Beijing Urban-Rural Land Use Classification and Mapping Standards (Proposed) [6] in 2005.

Here, taking Shenzhen as an example, the inconsistency between land change survey and urban development land change survey could be summarized in the following:

22.2.1 Different Land Use Classifications

Current Land Use Classification ('CLUC' for short in the following), defining a two-level classification system with 12 first-level types and 57 second-level types,

Table 22.1 Shenzhen urban land use classification (Excerpt)

Code	Name	Definition	Correspondent current land use type
	Residential land	Residential area, residential cluster or streets with living buildings and related facilities	Residential land
R1	First-class residential land	Land mainly for detached houses with complete facilities, complete layout, and good environment	Urban residential land
R2	Second-class residential land	Land mainly for mid-rise, mid-high-rise and high-rise apartments with complete facilities and complete layout	Urban residential land
R3	Third-class reside-ntial land	Land for dormitories for unmarried workers or dormitories for students, with some facility	Industrial land
R4	Fourth-class reside-ntial land	Land where rural residents gathered with some public facility and municipal public facility	Rural residential land

is used in Shenzhen land change survey. While Shenzhen Urban Land Use Classification ('SULUC' for short in the following), designing a three-level classification system with 11 first-level types, 53 second-level types and 80 third-level types, is employed in Shenzhen urban development land change survey. The above two classification systems are different in the class definitions, classification levels and emphasis. For example, the land used for auxiliary facility directly serving industrial production is classified as industrial land in CLUC; yet it is included in the definition of the third-class residential land in SULUC (detailed in Table 22.1).

22.2.2 Different Survey Contents

Besides land use classifications, land change survey will further divides newly added development land into three types: 'approved this year and developed this year', 'unapproved this year yet developed this year', and' approved this year yet undeveloped this year' [7], which are used to analyze whether development is legal; while urban development land change survey will describe newly added development land in three statuses: 'developed', 'developing', and 'undeveloped' (Fig. 1), which are used to analyze the actual use amount of the newly added development land. Although both aimed at the newly added development land, the survey contents of land change survey and urban development land change survey are different.

22.2.3 Different Survey Units

Urban development land change survey emphasizes the use of land, not the ownership of land; hence its smallest survey unit is the land mass with only a single land use type. On the contrary, land change survey takes land ownership into consideration and its smallest unit could be parts of a land mass with only a single land use type, usually segmented out by ownership boundaries, administrative boundaries or linear features. For non-development land, the two surveys are almost the same; while for development land, due to the existence of land ownership and corresponding land parcels, the two surveys are spectacularly different. Generally speaking, land change survey decides survey units in terms of land parcels, rendering survey units more regular; while urban development land change survey defines survey units according to land use types, making survey units more broken.

To sum up, all the above-mentioned discrepancies make the two surveys inconsistent, hence hindering the linkage between relevant works in urban planning and land resources management, such as data statistics, planning compilation, site selection, and land use regulation etc., especially in highly urbanized cities such as Beijing, Tianjin, Shanghai, and Shenzhen. The more sophisticated the land use, the more intensified the management of the urban development land, the fiercer the contradiction between urban planning and land use management.

22.3 Current Researches

In order to solve the above contradiction, Beijing and Tianjin have taken several researches. They made use of classification look-up tables which could convert the two classification systems to each other. In 2008, Beijing Municipal Commission of Urban Planning together with Beijing Municipal Bureau of Land and Resources formulated Beijing Look-Up Table from Urban-Rural Development Land Classification to Current Land Use Classification (Proposed) and Beijing Look-Up Table from Current Land Use Classification to Urban-Rural Development Land Classification (Proposed) [8]; In 2010, Tianjin Municipal Commission of Urban Planning published Tianjin Look-Up Table between Urban Land Use Classification and Current Land Use Classification [9]. However, classification look-up tables could only partly solve the conversion problem between the two surveys, since the relations between the two classification systems are very complicated, including one-to-many and many-to-many relations (details in Table 22.2), resulting in land mass split and hence precision loss during conversion. The key reason here is that only one-to-one relation type could never fully characterize the relations between the two surveys and that large types are very difficult to convert to small types.

22.4 Explorations and Practices

Classification look-up table is just a matter of expediency, and could not radically solve the contradiction between the two surveys. Under the guide of unification, Shenzhen has set up an annual fundamental survey system which serves both land resources management and urban planning at the same time and unified the survey units, contents and databases.

Table 22.2 Tianjin look-up table between urban land use classification and current land use classification (Excerpt)

Urban land use classification			Current land use classification		
Code	Name	Definition	Definition	Name	Code
M1	First-class industrial land	Land which basically has no interference with and contamination to the environment of living and public facility	Land for industrial production and facilities which directly serve industrial production	Industrial land	61
M2	Second-class industrial land	Land which basically has no interference with and contamination to the environment of living and public facility			
M3	Third-class industrial land	Land which has serious interference with and contamination to the environment of living and public facility			
M4	Land for industrial research and development	Land for high-tech research and development, standard laboratories, pilot test laboratories, special factory buildings, warehouses, and facilities	Land for industrial production and facilities which directly serve industrial production	Industrial land	61
			Land for education, scientific research, survey, design, technology promotion, science popularization and so on	Land for science and education	83

22.4.1 *Unification of Land use Classification*

Shenzhen land change survey has adopted a new specially designed survey system: 'Shenzhen Special Land Use Classification for land change survey' (SSLUC). This classification system is more detailed than CLUC and SULUC, and could convert to CLUC and SULUC directly without any land mass split and precision loss because one-to-one relation type could fully characterize the relations between SSLUC and CLUC, and those between SSLUC and SULUC. Additionally, the definition of land use type in SSLUC is very clear and convenient for field investigation. The code of land use type in SSLUC consists of two parts, combining the code in CLUC as the first part and the code in SULUC as the second part. Through this coding way, it is easy to get the correspondent code in CLUC by extracting the first part of the code in SSLUC and the correspondent code in SULUC in terms of the second. Therefore, through SSLUC, Shenzhen realized 'one survey and two databases' Table 22.3.

Table 22.3 The relations among SSLUC, CLUC, and SULUC (Excerpt)

CLUC			SSLUC			SULUC		
Code	Name	Definition	Code	Name	Definition	Code	Name	Definition
071	Urban residential land	land for the living houses and auxiliary facilities in the city	071R1	First-class residential land	Land mainly for low-rise buildings (i.e. villa) with complete facilities, complete layout, and good environment.	R1	first-class residential land	Land mainly for detached houses with complete facilities, complete layout, and good environment
			071R2	Second-class residential land	Land mainly for mid-rise (4–6 floors), mid-high-rise (7–10 floors) and high-rise buildings (more than 10 floors) with complete facilities and complete layout.	R2	Second-class residential land	Land mainly for mid-rise, mid-high-rise and high-rise apartments with complete facilities and complete layout

Table 22.4 Development land use status

Field name	Status	Code	Definition	Investigation
JSZT	Developed	J-1	Developed and used land	Field
		J-2	Developed yet unused land	
	Developing	Z-1	Land with the construction going on and the main building structure still under the ground surface	
		Z-2	Land with the main building structure on the ground surface and the construction still going on	Field
		Z-3	Land with the main building structure unfinished but the construction already stopped	
	Undeveloped	K-1	Saved for the long-term urban development	Field and indoor
		K-2	Land of which the use is stopped due to shut down, relocation or bankruptcy of its user	
		K-3	Approved but without land supplied	
		K-4	With land supplied and the contract valid	
		K-5	With land supplied but the contract expired	

22.4.2 Unification of Survey Content

Shenzhen land change survey has unified the survey of development land use statuses and the survey of development land use types. The development land use statuses are examined through field investigation (detailed in Table 22.4). The development land use types are confirmed through indoor investigation by overlapping the development land use statuses with the approved information. The developed land overlapped with approved information is classified as 'approved this year and developed this year'; the developed land without approved information is classified as 'unapproved this year yet developed this year', and the undeveloped land overlapped with approved information is classified as 'approved this year yet undeveloped this y**ear**'.

22.4.3 Unification of Survey Unit

The scale of Shenzhen land change survey is 1:2,000 [10], which is larger than that of conventional land change survey. Its survey unit is smaller. The smallest survey unit is a land mass with only a single land use type or status and segmented out by ownership boundaries, administrative boundaries or linear features. Refer to SSLUC for the definition of land use type here.

22.4.4 Unification of Survey Database

National land change survey consists of four-level survey databases: national, provincial, municipal and county-level. Lower level databases are summed up to form the higher level database. Shenzhen land change survey takes advantages of 'supplementary fields', adding 'special land use type' field and 'development land status' field, etc. These supplementary fields are hidden when summing up to the higher level databases and kept when serving the local administrative departments, such as planning departments and land departments.

22.5 Conclusions

The unification of survey systems in planning and land could radically eliminate the discrepancies between their databases, assure survey achievements applicable to many relevant management work including data statistics, planning compilation, site selection, land use regulation, etc., and effectively solve the contradiction between planning departments and land departments. This has great significance for reference for those highly urbanized cities such as Beijing, Tianjin and Shanghai.

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Chapter 23
Research on Allocation of Urban Land Based on the Fiscal Revenue of Local Governments

Xiaomeng Wang and Fenjie Long

Abstract Researches of urban land-use allocation continue to generate increasing attention on how to allocate the available space to several types of land use. Since the creation of tax assignment system in 1994, local governments have been facing both fiscal and political pressure simultaneously. In the Chinese particular system of land supply, income from land sales and relative taxation have become an important source of local revenue and funds for urbanization, which eventually results in the land finance. Against this background, the paper focuses on a method to address land-use allocation issues where the fiscal revenue of local governments is taken into account, which provides an innovation to solve the land-use allocation problems. A model has been designed for the allocation of land-use areas dealing with linear programming as a tool, where the objective is to maximize land financing for local governments. Moreover, the indicators for urban development and sustainability are considered as well: the available amount of land resource, the increasing needs and relative regulations. These are built into the model via constraint equations, marking upper and lower limits to the use of land resources. Finally, feasibility and rationality of the model is discussed combined with the successful application to a case study located in the central region of China.

Keywords Land use allocation • Quantitative structure • Demand forecast • Linear programming

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_23,

23.1 Introduction

Land-use Allocation is the process of the assignment of land resources to various usage purposes.[1] Since multiple stakeholders with conflicting goals and objectives are involved in it, land-use allocation is a complex planning problem.

In Chinese particular system of land supply, it generates growing recognition that land lease revenue is a major source of budgetary and extra-budgetary revenue to facilitate urbanization and local economic development. While cities capture substantial revenues, they are trapped into the predicament where increasingly rarer land resources hardly satisfy the demands for urban growth. Therefore, the debate on how to divide the available space among several types of land use is always attracting attentions from researchers.

The present work mainly focuses on integrating the problem with advances in computer hardware and software, which affords an opportunity to a new generation of integrated land-use models including agent-based modeling [1], cellular automata [2]) and geographic information systems (GIS) [3–5]. Besides, quite a few authors tend to concentrate on protection and reservation of ecologic land rather than urban land [6, 7, 8]. However to date, there is limited published research on land assignment based on municipal fiscal revenue in China.

In this paper we address the use of linear programming for solving the optimal allocation of urban land. A land-use allocation model that maximizes proceeds of land lease and ensures the simultaneous requirements of urban growth is proposed and then successfully applied to a case in China, which demonstrates the practical use of the method for planning decision support issues.

The following section describes the land-use allocation model that determines the area of all types of land-use which subjects to all constraints under consideration of land availability. The third section of the paper introduces the application of an Economic and Technological Development Area as case study. Finally, the paper ends with conclusions and discussions on the wider applicability of the method and some suggestions for further research.

23.2 Land Use Allocation Model

The nature of resource allocation is to assign the available resources in an economic way. It generally means maximizing economic return that can enable the municipality to at least sustain itself economically from the perspective of local government who is actually the monopoly in urban land markets. The land-use allocation model presented here is thus based on the guiding principle above.

[1] http://www.objectvision.nl/geodms/operators-a-functions/allocation

Motivated by the conflict-laden nature of land finance and the demand of development, we have designed a sustainable land use allocation model using linear programming to balance conflicts of total amounts for different kinds of land, and to analyze tradeoff between the financing and demand.

Given the form of linear programming, our model has an objective to maximize land lease revenue under the constraint of supply and demand. More specifically, the revenue generated by local governments is composed of two terms: land transfer fees and annual tax revenues. And the two constraints of the maximization process are land availability and the demand for each type of land-use.

How the land use allocation model is built will be expounded step by step as the follow.

23.2.1 Land Use Allocation Model

23.2.1.1 Variables

Above all, the object of study should be specified well. We select the area of the different types of land use as variables, denoted as $\mathrm{UL_i}$, which is the sum of the type $\boldsymbol{i}$ of land-use (in hectare).

23.2.1.2 Objective Function

As illustrated earlier, the objective function is to maximize the total economic proceeds of land lease based on the local governments.

23.2.1.3 Constraints

The constraints are composed of two parts: (1) the forecast demand for each type of land use; (2) other constraint equations concerning resources availability and other restrictions besides those already defined by the various concerns described above.

Hence, the land-allocation problem is expressed as

$$\max \mathrm{GI} = \sum\nolimits_{\mathrm{i}} \mathrm{p_i UL_i}, \mathrm{i} = 1, 2, \ldots \tag{23.1}$$

$$\text{s.t.} \sum\nolimits_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{a_{ij} UL_i} \le \mathrm{b_j}, \mathrm{j} = 1, 2, \ldots \tag{23.2}$$

$$\mathrm{UL_i} \ge 0, \mathrm{i} = 1, 2, \ldots \tag{23.3}$$

where GI is the total amount of revenue from land lease, $\boldsymbol{p_i}$ is per hectare economic value of land-use $\boldsymbol{i}$, $\boldsymbol{UL_i}$ is the amount of hectare of land devoted to land use activity

i, $\boldsymbol{a_{ij}}$ and $\boldsymbol{b_j}$ are the coefficients expressing the constraints for each type of land-use in equation ***j***.

The Eq. (23.3) means that the algorithm must not allocate negative amounts of land use of one type in order to maximize financial benefit.

Since residential land (LR), commercial land (LC), industrial land (LI) and official land (LO) are the primary resources of the lease payment stream considering Chinese ground lease regime and tax system, we specify those four types of land-use for our analysis. Additionally, we decompose commercial land into two subtypes, land for retailing (LS) and land for hoteling (LH) due to their differences in rate paying.

Rather, we can specify the equations as

$$\max \mathrm{GI} = \mathrm{p_r} \times \mathrm{LR} + \mathrm{p_I} \times \mathrm{LI} + \mathrm{p_s} \times \mathrm{LS} + \mathrm{p_h} \times \mathrm{LH} + \mathrm{p_o} \times \mathrm{LO} \tag{23.4}$$

$$\text{s.t.} \quad \mathrm{a_{1r}} \times \mathrm{LR} + \mathrm{a_{1i}} \times \mathrm{LI} + \mathrm{a_{1s}} \times \mathrm{LS} + \mathrm{a_{1h}} \times \mathrm{LH} + \mathrm{a_{1o}} \times \mathrm{LO} \le \mathrm{b_1} \tag{23.5}$$

$$\mathrm{a_{mr}} \times \mathrm{LR} + \mathrm{a_{mi}} \times \mathrm{LI} + \mathrm{a_{ms}} \times \mathrm{LS} + \mathrm{a_{mh}} \times \mathrm{LH} + \mathrm{a_{mo}} \times \mathrm{LO} \le \mathrm{b_m} \tag{23.6}$$

$$\mathrm{LR} \ge 0, \mathrm{LI} \ge 0, \mathrm{LS} \ge 0, \mathrm{LH} \ge 0, \mathrm{LO} \ge 0 \tag{23.7}$$

where ***m*** is the number of constraints.

This method will be illustrated in detail through the following case.

23.3 Case Study

In this section, an Economic and Technological Development Area in Shanxi Province (Hereinafter referred to as SDA) is selected to test and assess the method above. The task is to allocate the urban land sustainably during 2009–2020 in SDA.

23.3.1 Brief Introduction of SDA

SDA is a provincial-level economic development zone established in 1998. It covers an area of 9.87 km^2, with a population of 50,000. The total area of the land parcels available is 443.85 ha.

The area is facing the dilemma where it has sustained difficulties to make it autarkic and been far away from the intention to fuel the local economic development due to the lack of a sound footing of industry.

Therefore, the municipal government attempts to facilitate its growth by settling city hall in the zone therewith develop it into a sub-center. Unlike an Economic and

Technological Development Area, a sub-center is a complex satisfying almost everything citizens need, which calls for the balance of land-use.

Consequently, the question is how to allocate the land to different uses in SDA to maximize the proceeds generated from land leasing and meet fundamental demands simultaneously.

23.3.2 Allocation of the Urban Land Use in SDA

Clearly, in order to solve the question, we will have to adopt the method discussed in section 2 to construct the model suitable for this case and then determine the numerical value of each variable in the model. Next the application will be interpreted on the basis of formula (23.1), (23.2), and (23.3).

23.3.2.1 Variables

The variables we use as objects in this case are accord with the land-use planning of SDA, including residential land (LR), official land (LO), land for retailing (LS) and land for hoteling (LH).

Note that the industry will be beyond the main concern according to the 2020 Plan of SDA; we exclude industrial land (LI) from the variables.

Furthermore, define the Floor area ratio (FAR) respectively as $\boldsymbol{r_r}$, $\boldsymbol{r_s}$, $\boldsymbol{r_h}$, $\boldsymbol{r_o}$.

The Gross floor area for various uses can be written as

$$\begin{cases} \mathrm{LRGFA} = \mathrm{LR} \times \mathrm{r_r} \\ \mathrm{LSGFA} = \mathrm{LS} \times \mathrm{r_s} \\ \mathrm{LHGFA} = \mathrm{LH} \times \mathrm{r_h} \\ \mathrm{LOGFA} = \mathrm{LO} \times \mathrm{r_o} \end{cases} \qquad (\text{in hectare})$$

23.3.2.2 Objective Function

As precisely described, with a ground lease the government benefits from the land transfer fees and generates a steam of taxation overtime derived from the erection of a building by the developer. That means there are two main sources contributing to $\boldsymbol{p_i}$.

On the aspect of land transfer fees, we obtain the outcome of land lease from 2004 to 2008 in the city where SDA is located from the website of China land market (http://www.landchina.com/).

We employ Market Comparative Method to price the transfer fees of each type of land-use in SDA.

Table 23.1 Taxation variation for different types of land-use

Tax	LR	LC: LS	LH	LO
Value added tax(VAT)		√		
Business tax(BT)			√	√
Company income tax		√	√	√
House property tax	√	√	√	√
Land value increment tax	√			
Urban maintenance and development tax		√	√	√
Education surtax		√	√	√

Table 23.2 The results of coefficients of objective function

(per hectare)	LR	LC: LC	LH	LO
pi	34132	496762	716835	84706

Then the forecast of leases price from 2009 to 2020 can be estimated by dint of an annual rate of increase calculated from Land Transaction Price Index.

As for the taxation, which all types of land-use are subject to, there is a tremendous variation among those four land-uses. Table 23.1 presents different taxes governments levy on from each type of land-use.

Unlike the land transfer fees, the taxes above are collected annually. Suppose that the four types of land are in uniform supply during 12 years(2009–2020)[2] and there is a lag of 2 years between completion and ground lease.

Based on this assumption, we calculate the annual payment of each type of land-use by multiplying unit area of the taxes payable correspondingly by the total amount of land leased. For each land use, the sum of those payments cumulated year by year equals to its coefficient of the objective that represents for the aggregate income per unit of this type land-use till 2020. In addition, regarding of the way taxes assigned to different levels of government in China,[3] we take the corresponding share of the each type of taxation accordance with the provisions.

Table 23.2 displays the coefficients of four types of land-use regardless of discount.

[2] That is annual area of ground lease for each land use equals to a twelfth of the sum, like LR/12.

[3] Since the 1994 tax sharing reform, the central government has captured a larger share of local tax revenue than previously. In the case of the VAT in particular, the four levels of sub-national government (province, prefecture or city, county, and township) are now said to share 25 % of the revenue collected. They also share 40 % of the enterprise income taxes and personal income taxes, transferred from the central government. The business tax (BT) remains almost entirely a local tax with 97 % of the tax allocated to the province and 3 % allocated to the central government.

23.3.2.3 Constraints

The steps to acquiring the constraints can be described as follows:

Step 1: Generate the restrictions of land availability and relative regulations and standards, such as GBJ 137-90[4]
Step 2: Calculate the demands of the specific type of land-use
Step 3: Get intersection of the conditions specified from step1 and 2

Given the total amount of land available, we obtain one of the constraints as

$$\mathrm{LR} + \mathrm{LS} + \mathrm{LH} + \mathrm{LO} \leq 443.85 \tag{23.8}$$

As we move to demand forecast we must be aware of that the accuracy of the forecasting is crucial to the outcome. Owing to a dearth of statistics in SDA, we convert the demands of the whole city into the scope of SDA. The conversion factors are associated with the role of sub-center that implies

SDA shall cater to the need of the zone itself and partly that of the city as well. Besides, we elide the difference between stock and increment considering SDA's comparative brief history,

To develop the forecasting technique, we emphasize the analysis of the factors ascribed to increment in four types land-use respectively. Table 23.3 reports an overview of the method and conversion factors.

Ulteriorly, three scenarios are postulated to construct the upper and lower limits: (1) A + S; (2) A; (3) A-S. Thereinto, A and S represent for the mean and the standard deviation of the three outcome of the total population in SDA.

Taken together, Table 23.4 provides the summary of the forecasting demand for each land-use till 2020.

In general, the model applied to this case is:

$$\max \mathrm{GI} = 34132 \times \mathrm{LR} + 496762 \times \mathrm{LC} + 716835 \times \mathrm{LH} + 84706 \times \mathrm{LO} \tag{23.9}$$

$$\begin{cases} \mathrm{LR} + \mathrm{LC} + \mathrm{LH} + \mathrm{LO} \leq 443.85 \\ \dfrac{562.75}{r_r} \leq \mathrm{LR} \leq \dfrac{582.07}{r_r} \\ \dfrac{15.68}{r_s} \leq \mathrm{LS} \leq \dfrac{31.33}{r_s} \\ \dfrac{11.79}{r_h} \leq \mathrm{LH} \leq \dfrac{16.51}{r_h} \\ \dfrac{41.58}{r_o} \leq \mathrm{LO} \leq \dfrac{66.52}{r_o} \end{cases} \tag{23.10}$$

[4] According to GBJ 137-90, there are specifications for each land use. For instance, residential land is subject to 18.0≤LR per capita≤28.0 and 20 %≤LR as a share of total area≤32 %. However, we neglect the industrial land as a share so that those conditions are not under consideration.

Table 23.3 The summary of forecasting method

Land-use			Forecasting technique	Conversion factor
LR			Population × residential area per capita	Proportion of population, clustering coefficient
LC	LS	Total	Total volume of retail sales[a] ÷ gross sales per unit area[b]	Market share:10–20 %
		Shopping center	"Radiometric Radius Method"[c]	–
		Ground floor store	"Employment Inverse Method"[d]	–
	LH	Population × "residents owned room rate"[e]		Proportion of population, clustering coefficient
LO		The amount of user × "office elasticity coefficient"[f]		Market share:50–80 %

[a]Sources: "China Regional Economy Yearbook(2006–2009)"
[b]Sources: "China Chain Operation Yearbook(2006–2009)"
[c]Considering the land-use planning for shopping center, the area of it needs to be figured out. Based on the category of shopping center (proposed by ULI and ICSC), which is mainly in the light of radiometric radius, the paper ascertains the scope of the area of the corresponding type selected
[d]What's more, the municipal government bears the burden solving the employment of the peasants whose houses are under demolition. The solution is to assign ground floor store to every family expecting that they live on the rents of the stores. Specifically, let each household disposable income equal to the total rents generated from the ground floor store. Given the rent of per unit area, we can obtain the average area of store
[e]We construct an index "residents owned room rate" to estimate how many rooms shall be built in SDA, which is defined as: the number of resident occupying a room. According to some previous case studies and discussion with relative planners, we adjust to it to 50–70 per room
[f]"Office elasticity coefficient": the change of official area to a change in the number of user

Table 23.4 The results of the forecasting demands

		LC				
		LS			LH	
Land use	LR	Total	Shopping center	Ground floor store		LO
Floor area	562.75–582.07	15.68–31.33	1.39	7.11	11.59–16.78	41.58–66.52
FAR	2.0	2.5	2.5	1.0	4.0	5.5
Land area	281.38–291.03	6.27–12.53	0.56	7.11	2.90–4.20	7.56–12.09

We use Excel 2007 to employ this liner modeling methods. Ultimately, Table 23.5 shows a summary of the result.

The solution given above allows government to generate roughly 16.8 million Yuan as fiscal revenue by the end of 2020. Despite of the abundant economic benefits, it should be noted that the total demand is less than available land (the difference between them is 124 ha). Apparently, the constraint of the total amount of land for assignment is ineffectual leading to the result that some available land

Table 23.5 Result of the land-use allocation

		LC			
	LR	LS	LH	LO	GI (thousand Yuan)
Coefficient	34132	496762	716835	84706	16,825,585.4
Land area (in hectare)	291.03	12.53	4.20	12.09	
FAR	2.0	2.5	4.0	5.5	

remains. Rethinking the process of forecasting, there might be two reasons: (1) conservative estimation of demand; and (2) the omitting of other land-use, like land for education (included in land for public facilities).

Generally, the resulting land-use allocations meet both fiscal requirement and regulation criteria in SDA successfully, which proves the feasibility and efficiency of our method.

23.4 Conclusion and Discussion

In this brief paper, we have developed a land-use allocation method based on fiscal revenues generated by municipal governments. The aim is to develop a scientific, functional and computationally easy tool for land-use planners to facilitate the decision-making process.

The model first estimates the demands for allowing each land-use during planning period, then optimizes the area of them with a linear programming approach for the sake of municipality.

The model is demonstrated through a case study of an Economic and Technological Development Area in Shanxi Province. The solution has been turned out to be a settlement to make ends meet and satisfy demands of the zone.

As illustrated, the method is not perfectly general. It applies to mutually exclusive land uses merely in favor of economic benefits for local authorities constrained by data availability. Thus this approach will be helpful in providing guidance for urban planning and achieving sustainable development.

Combined with advanced techniques like GIS, further research might focus on the extension of our approach to take environmental and social equity into account that help deal with the more realistic situations.

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Chapter 24
Dilemmas Between the Protection of Lung and Stomach: Land Use Conflicts in Rapid Urbanization Process of Pearl River Delta

Xueguang Ma

Abstract Land use conflicts (short for LUC) are complicated social phenomenon. Firstly, they usually involved various stakeholders, such as administrative institutions, industrial or commercial corporations, urban residents and indigenous villagers. Secondly, they usually involved various origins, such as disputes of interest, difference in value or ideology and deficiencies in procedure designing. Thirdly, performance and types of LUC are changed in various ways in different periods with difference frequency, intensity and resolutions. Fourthly, LUC verified in different locations of space. For example, key affairs in city center are households' settlement and economic compensation, while primary affairs in urban-rural fringe are more complicated in employment of indigenous villagers, social security and distribution of remaining sites. Under the guidance of urban political economic theory, the paper tried to deeply analysis and interprets these social phenomenons. Taking the case of Haizhu district of Guangzhou city, the paper studied on main aspects of LUC, such as division of types, mechanism analysis, origins and roots, governance mechanism.

Keywords Land use conflicts • Rapid urbanization process • Pearl River Delta

24.1 Introduction

Land is the mother of fortune, which means ownership of land indirectly implied ownership of fortune, and distribution of land resources turned to be focal spot of social conflicts. Tools of land resources distribution are different in various social production systems, for example, plan is the primary tool of land resources

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_24, © Springer-Verlag Berlin Heidelberg 2014

distribution under planned economic system, while market turned to be main tools in land resources distribution under market-oriented economy. Under the transformation stage from planned economy to market-oriented economy, progressive reform in China determined dual resources distribution pattern of co-existence of plan and market resulted in aggravation of social conflicts. Besides system transformation factors, China stands in speeding-up period of urbanization, sharpening political-economy system transformation dragged social members and organizations immersed in old system which inevitable exacerbated frequency and intensity of social conflicts, especially on land use issues.

There existed widespread social conflicts on land use issues which contained spatial regular pattern resulted from cost and benefit distribution of land use change. Ley [1] regarded urban space as place of social factors mutual conflicting. LUC is an evitable spatial phenomenon with the expansion and redevelopment of urban space [2–4]. Lampe and Kaplan [5] divided LUC into four types, such as facility location conflicts, infrastructure conflicts, growth and development conflicts, environment protection and fostering conflicts. Chu [6]though that LUC extensively existed in management of natural protection zones of china especially on competition and contention in land resource and water resources where natural resources played crucial role in satisfying basic need of community residents. Brogden and Greenberg [7] pointed out that it should take new political approaches to practice cooperation and knowledge sharing on environment conflicts of pasturing and economic development. McGee [8] rose up Decisional Congestion Model in urban-rural fringe which indicated that LUC are the outcome of reformation forces derived from states, enterprises and multi-corporations as well as revolution forces derived from local grassroots (local government, media scale corporations, household and so on). Resolutions on LUC in European and American countries are participation, communication and cooperation mechanism. Hutchison [9] considered that special combinations among power, interest and right would motivate or defuse conflicts in decision-making and LUC management. Mitchell [10] thought that there were four approaches in solving conflicts of resources distribution and environment interest disputes, such as political approaches, management approaches, judicial approaches and alternative dispute resolution (ADR). In conclusion, Land use conflict are generally existed in western urban development and concentrated on urban-rural fringe especially on urban invasion of agricultural space and natural resources protection zones.

24.2 Outline of the Research Region

Haizhu Fruit Tree Protection Zone (HFPZ) located in southern east of Haizhu district (Fig. 24.1) with an area of 28.37 km^2. HFPZ has important value in landscape, research, economy and culture.

Firstly, Haizhu district turned into central district of Guangzhou city with "southern lung" turned into "central park" which highlighting its eco-function.

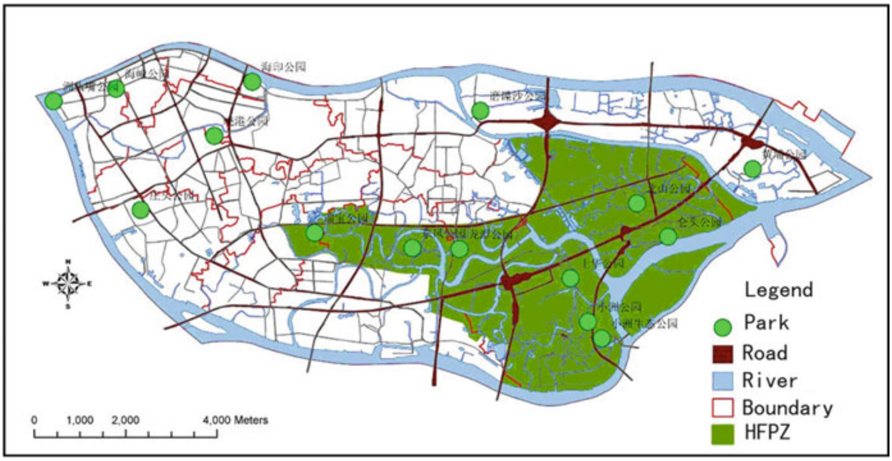

Fig. 24.1 Location of HFPZ in Haizhu Distinct of Guangzhou city

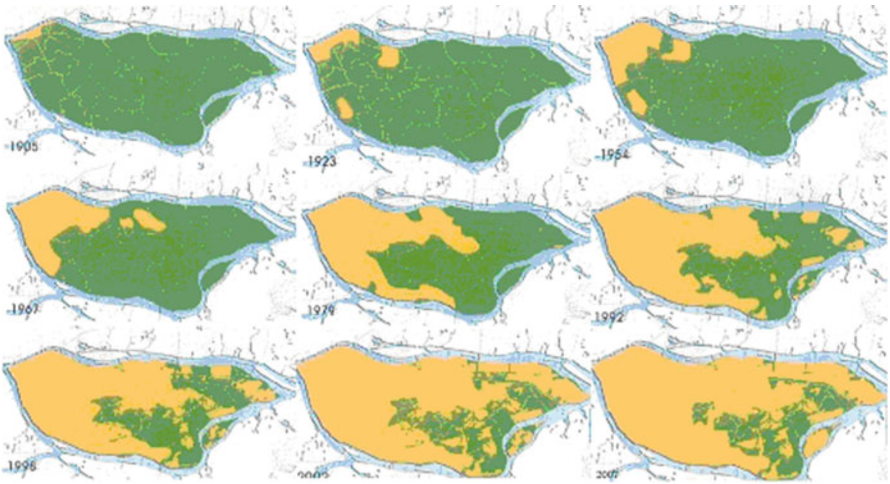

Fig. 24.2 Spatial evolution of green space in Haizhu district of Guangzhou city

Secondly, HFPZ is not only a fruit tree park but also natural and artificial wetland ecosystem which is the classic representative of subtropical delta plain produced by sea tide. Thirdly, HFPZ has famous fruit cultivars with long history and higher brand effect, which is now an important production base of fruit. Fourthly, villages in HFPZ preserved comparative full historical cultural resources.

Master plan of Guangzhou entrusted HFPZ the function of dominated with fruit tree protection and moderately develop tourism vocation and agriculture sightseeing. Urban space of Haizhu district continued to expand outward to countryside while rural construction expand inward to city center, which resulted in city outward expansion with green space inward expansion (Fig. 24.2).

Areas of HFPZ continued to shrink with the decline of ecological security function, economic benefit of fruit tree downgraded, production and survival crisis turned up in HFPZ which proved to be the battle of interest contention among government, community and real estate developers.

24.3 Evolution Process of Land Use Conflicts

HFPZ was a picturesque place in history but replaced by buildings and fallen trees with the boost of urbanization and industrialization. LUC happened among urban and rural construction, economic development and environment protection, collective interest and public interest, which involved in central and local government and government with community, manifested in discordant of destination, institution, interest distribution, value and ideology, and role playing. According to intensity and visible or invisible levels, LUC in HFPZ can be divided into four stages: induction stage, manifest stage, expansion and transformation stage, and stalemated stage. In each stage, there were different participants with different attitude and standpoint, different coping strategies which would all affect the further involution of LUC.

(a) **Induction Stage of Land Use Conflicts (from the Year of 1978–1990)**

Accompanied with the implementation of opening-up policy, stakeholders no matter local government and grassroots community sped up economic expansion. LUC didn't remarkable in this stage because of abundant land resource. The development of urban and rural economy created administrative decentralization and propelled urban construction, urban built environment advanced from urban-rural fringe to urban periphery. In addition, house sits expanded outward villages and occupied a certain amount of cultivated land and orchard. With the implementation of rural contract responsibility system in 1983, Haizhu government supported community development in fund and policy which formulated a pro-growth development coalition in government and community, government loosed land development permission and promoted the occupation of rural collective land. Rural enterprises flourished in HFPZ, more and more building were constructed while the frequency and intensity of LUC was still low.

(b) **Manifest Stage of Land Use Conflicts (from the Year of 1990–1997)**

Under urban-rural dual land management institution, local government loosed constraint on development of collective land which resulted in the shrink of fruit tree areas. In the middle of 1990s, urban-rural land development accelerated during the transformation from planned economy to market-oriented economy while city turned to be economic development machine and sped up urban outward expansion. Meanwhile, rural construction developed in high speed when government loosed regulation on land development permission, which resulted in the manifest of conflicts between ecological and economic benefit, current and long-term benefit and part and whole benefit. In the middle of 1990s, urban and rural land development flourishing with the development of real estates and industrial parks, and fruit trees areas shrunk. Agricultural land narrowed from 33.63 km^2 of 1980 to 27.72 km^2 of 1989, while agricultural land narrowed from 27.57 km^2 of 1990 to 23.08 km^2 of 1996.

(c) **Expansion and Transformation Stage (from the Year of 1998–2005)**

Although government issued relevant management policy and planning regulations, the management framework of HFPZ was set up at the cost of economic development without realizing the importance of taking compensatory policy. Therefore, the development of collective economy was greatly restrained under the implementation of controlling protection policy which resulted in the situation of indigenous villagers begging with golden bowl. At the same time, general media revealed the awkward situation of development and protection conflicts which initiated the participation of media, scholars, planners, real estate developers and representatives of opinions. Then, LUC spread to the whole society and was paid attention by all city residents.

(d) **Stalemated Stage of Land Use Conflicts (since the Year of 2006)**

In this stage, LUC evolved into stalemated stage, community wanted to break away from the situation of under controlled, government took propitiatory measures by deregulations in land development. In dealing with consensus pressure, government put forward Land Lease and Park Establishment (LLPE) plan with economic compensation after interest balance. Based on reduplicative investigation, government learned about the actual intention of community (to take over all collective land from villagers) and chose the low economic cost and minor implementation resistance between land lease and land acquisition limited to related institutional barriers and financial power. Nevertheless, in villagers' view, LLPE plan could not resolve the long-term development affairs, the fundamental difference between government and community still unsolved, the development tendency of LUC still indistinct, and LUC were likely to intensify at any time because of the existence of material difference between government and community.

24.4 Typologies of Land Use Conflicts

HFPZ is an institutional space created by administrative power with LUC of inherent deficiencies. LUC can be divided into procedure conflicts, valuation conflicts, interest conflicts and structural conflicts, manifested in illegal land use, intense relation between government and community, ecological space shrink and degeneration of environmental condition of HFPZ.

(a) **Conflicts Rooted in the Disproportion of Interest Distribution and Bearing**

Interest conflicts in HFPZ mainly displayed in sacrifice for public interest of community without relevant compensation which resulted in interest damage;

rigorous control and close inspection of government restricted the development of community non-agricultural economy; development in surrounding regions led to serous pollution of HFPZ and degeneration in fruit quality, and affected the development of collective economy and increase of villagers' income.

(b) **Conflicts Rooted in the Incompatibility of Ideology and Values**

In the need of urban sustainable development, government stressed the protection of HFPZ as one of the most important strategy in construction of ecology city with "mountain, city, farmland and sea". But the designation of HFPZ restrained non-agricultural land development which prejudiced to the development of collective economy and increase of villagers' income, while community villagers considered these protection measures as deprivation of development right which was negatively resisted by community villagers.

(c) **Conflicts Rooted in Drawbacks of Institutional Structure**

Structural conflicts derived from scattered management of collective land contracting institution, deficiency in fruit tree protection policy, regulations and implementation institutions, urban and rural dual management institution, problems in planning. It's the existence of structural conflicts that led to conflicts in interest distribution and valuation conflicts.

(d) **Conflicts Rooted in the Improper Design of Communication and Participation Procedures**

Procedure conflicts lied in deficiency of government measures, action capacities, management mechanism, and communication with community which restrained the implementation of policy in adverse.

24.5 Governance Mechanism of Land Use Conflicts

(a) **The Governance Structure of Land Use Externalities**

LUC involved the following levels of conflicts: firstly, conflicts between public interest and collective interest, partial interest and general interest, current interest and long-term interest in land use. Secondly, conflicts between land development and environment protection which derived from special location, scarcity of resources and unique value. Thirdly, spatial distribution conflicts about land use externalities which resulted from spillover effect of land use.

(b) **Establish Land Use Management Mechanism Combined with Zoning and Land Development Right Transfer**

Land Development Right Transfer (LDRT) institution played an important role in clear land development right, protect agriculture land, conserve ancient architectures, eliminate user equalities unfair resulted from planning. During land acquisition press, rural collective land attribute changed with land price increased which produced land upvaluation profit. LDRT provided a tool to make up for land user's benefit deprived by land use control policy and relieved social unequal derived from land control regulations.

(c) **Establish the Co-management Mechanism Based on the Participation of Community**

After 10 years, HFPZ didn't change the possibility of being swallowed. The reason lied in two aspects: for one thing, the establishment of HFPZ is based on deficient interest distribution pattern which at the cost of collective economy development and villagers' income growth. For another, the management of HFPZ ignored the importance of villagers' participation which resulted in the passive attitude of community. The development of HFPZ should propel community participation and implement co-management strategy.

(d) **Establish Economy Management Mechanism Based on Interest Balance**

LUC in HFPZ may be solved in four ways: conservative plan, improvement plan, progressive plan, and radical plan. Firstly, the conservative way continue to implement the protection and development model of land rental and establish parks to all communities on the same standard (1,500 RMB per mu annually). Secondly, distribute compensations according to land types and land occupancy of each communities. Thirdly, progressive plan indicated that government carried out one-time requisition on collective land but paid land acquisition compensation in terms. In this way, collective land would be managed by municipal corporations or maintained by contractor under the requirement of employing villagers and provide jobs to indigenous villagers. Fourthly, radical plan advised local government to take over collective land, change land attribute and move indigenous villagers out of HFPZ and settle them in surrounding communities.

(e) **Establish Land Use Conflicts Management Mechanism Centered on Presentment and Meditation**

Formal LUC resolution mechanism with administrative management assisted by actions at law achieved the goal of reduce LUC while inevitable harm the relationship between government and communities after the implement of administrative power and legal procedure. So, it necessary to set up LUC management mechanism centered on prevention and mediation. Firstly, set up integrity institution system especially the continuity of regulations. Secondly, enhance the potency dimension of propaganda and education. Thirdly, strengthen public participation during the process of institution establishment, brought opinions and viewpoints into it.

(f) **Establish Social Interaction Mechanism Based on Participation and Communication**

Firstly, set up social action mechanism based on participation and communication. Although stakeholders have deep interest conflicts, the appropriate communication patterns or lack of channels in communication deepen the misunderstanding among stakeholders which only by participation and communication can defuse conflicts. Secondly, the duty of public mediation bridged information among stakeholders. As a public domain, general mediation provided soils of civil society and orientation of public supervision which created legal basis for government and led to a diversified social society. In this way, general mediation connected national development and social society evolution which coordinated uttermost interest relations among governments and general publics.

24.6 Conclusions

Land use conflicts are widespread social phenomenon in transformation process of China, which also exist in other developed or developing countries. The paper studied on main aspects of LUC, such as division of types, mechanism analysis, origins and roots, governance mechanism with the example of HFPZ of Guangzhou city under the guidance of urban political economic theory. The paper set up an example for the theorization on social conflicts issues derived from land use.

Acknowledgements This research supported by National Natural Science Foundation of China Youth Scientists Fund Project [Grant No.41001091].

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Chapter 25
A Review of Planning Support Systems for Urban Land Use Planning

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Abstract This paper reviews the research work on a relatively particular area – planning support systems (PSS) for urban land use planning (ULUP) from their emergence to the present. To aid readers' clear understanding of PSS, its definition is discussed in the beginning. The review summarizes the development of PSS from two perspectives: system components and system application. In terms of system components, namely, the major theories and technologies serving for building the PSS such as related planning theories, GIS and decision support systems (DSS) technologies are reviewed respectively. With respect to system application, the paper discusses in detail their application to urban (land use) planning and other specialized planning separately. Based on this systematic overview, the characteristics in different times, especially current advantages and shortcomings of the PSS are indicated. Moreover, several new research trends in the PSS area are also highlighted for guiding researchers in future studies.

Keywords Planning support systems • Land use planning • Urban planning • Spatial decision support systems • GIS

25.1 Introduction

Land is the foundation of human activities. Without enough land, cities cannot be formed, let alone developed further. With the development of human civilization, natural land has been occupied by human beings increasingly. Because of the rapid growth of the world population, more and more developed land is needed to satisfy the demands of humans. However, only 29 % of the earth's surface is land, and

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_25,

much of the land is not suitable for human living. To a large extent, one of the biggest competitions among cities and even countries is for land resource. Therefore, how to efficiently utilize and manage the land resource is a great concern for every city nowadays.

Land use has become an issue since the eighteenth century when the world's population began to rise significantly. At present, every country has paid much attention to the research on land use and tried to seek a sustainable mode of land use in order to solve their problems. In terms of land use studies, there are many differences between urban areas and rural areas. Simply speaking, the land use condition in urban areas are generally more complex because of such characters as the higher population density, more land use categories, more occupational classifications, and greater complexity of residents' activities. So the land use studies in urban areas are usually more difficult and complicated than the ones in rural areas. According to a research report published by the Department of Economic and Social Affairs of UN in 2005, over 50 % of world population lives in urban area, and the urban population will increase to 60 % of the total in 2030 [62]. Owing to rapid urbanization, many problems related to urban land use have emerged during recent years, such as land degradation, environmental deterioration, and inefficient or incompatible land use. As a result, the research on land use in urban areas has become a focus of interest in this research field. In other words, more researchers have focused their studies on the issue of urban land use rather than the rural area.

In the research field of urban land use, several specific research directions can be divided by different disciplines, for example, land use planning, land use/cover change (LUCC), land use management, and land use information system. In each specific direction, much research work has been done. For instance, Bruff and Wood [1] conducted their research on the contribution of land use planning to the local government. Weng [2] analyzed the land use change using the techniques of Geographic Information Systems (GIS) and Remote Sensing (RS). Yang et al. [3] built a GIS-based spatial analyzing system for urban land-use management. Specifically, in terms of ULUP, thanks to the rapid development of computer and information technology and geospatial techniques, a computer-aided approach with GIS spatial visualization and analysis, or an integrated planning support system has been applied to urban planning in practice. Correspondingly, research related to PSS for ULUP has also been done by some scholars, such as Klosterman [4], Kwartler and Bernard [5] and Waddell [6]. These successful GIS-based systems or models were developed and practically used in assisting ULUP and decision-making. Due to some advantages in the aspects of spatial visualization, data storage and analysis, scenarios prediction, the PSS for ULUP has been regarded as a useful and promising tool for assisting decision-makings in this field.

This paper reviews the literature on the PSS for ULUP. It first explores the definitions of PSS and indicates the recognized ingredients of them. It then summarizes the theoretical basis of PSS and then how these have been applied in practice. It will be seen that applications have evolved to the extent that a classification of approaches can be attempted. The variety of applications extends not only to urban planning issues, but also to at least five other planning specializations. The discussion section summarizes the key concepts and technologies considered essential to PSS, as well as provides an overview of the latest developments in PSS with suggestions for future research directions. Finally, the conclusions are drawn based on the above analysis. Using a systematic classification such as from theory and technology to application, this review paper summarizes the existing research work in this research area to fill the gap of lacking such a special review on PSS for ULUP, and it also can serve as a road map for the researchers to conduct their future research in this specific area.

25.2 Definition of PSS for Urban Land Use Planning

PSS are such a kind of innovative tools which can assist the urban planners to foresee the potential scenarios of land utilization in the future and make a better land use planning. So far, there have been several main definitions given by different distinguished scholars in this research area. According to Batty [7] and Klosterman [8], PSS were regarded as relatively new phenomena, which were emerging in the planning field in the mid-1990s as geo-information technologies were gradually fully utilized to support and improve the performance of specific planning tasks. In a sense, they had something to do with GIS, but the latter were general tools for capturing, storing, manipulating, analyzing and displaying geospatial data, which are applicable to various spatially-related problems, whereas the PSS distinguished themselves by being focused on supporting specific planning tasks. In many cases, a PSS included a GIS, especially when geospatial data were required in the task. They were also related to spatial decision support systems (SDSS), although the former generally laid emphasis on long-range problems and strategic issues, while SDSS were commonly designed to support short-term policy making which involved individuals or business organizations [9]. 'PSS are usually comprised of planning-related theory, data, information, knowledge, methods and instruments that take the form of an integrated framework with a shared graphic user interface' [10].

Harris and Batty [11] were recognized as the initiators to associate the concept of PSS with the combination of a series of computer-based methods and models into an integrated system, used to support a particular planning function. Furthermore, in their opinion, a single PSS formed the framework in which three components were integrated: 'the specification of planning tasks and problems at hand, including the data assembly; the systematic models and methods that optimize the planning process through analysis, prediction and prescription; and the transformation of raw data into useful information which, in turn, provides the driving force for modeling and design'. Similarly, Klosterman [8, 12] and Brail and Klosterman [13] described PSS as a kind of information technologies that were used specifically by planners to undertake their unique professional missions. They indicated that PSS had developed into frameworks of integrated systems of information and software that synthesize the three components of traditional DSS: information, models, and visualization, and deliver them into the public. At the earlier time, Batty [7] suggested PSS to be a subset of geo-information technologies, dedicated to supporting those involved in practical planning to explore, represent, analyze, visualize, predict, prescribe, design, implement, monitor and discuss the issues associated with the need to plan. Geertman and Stillwell [10] considered PSS to be geo-information technology-based instruments that incorporate a set of components (theories, data, information, knowledge, methods, tools, meta-information) which collectively support some specific parts of a unique professional planning task. Brail (cited in [7]), on the other hand, paid attention to the fact that many PSS are developed and applied to provide predictions of some probable scenarios in the future or may involve some estimation of the impacts that result from some different patterns of development.

To sum up, these kaleidoscopic reviews from different researchers indicate that so far there is no uniform definition of PSS for ULUP. However, a further conclusion made by Klosterman and Pettit [14] in one of their guest editorials for a journal – 'all definitions coincidentally tend to include or mention the same kind of required functionalities which are implemented in the supporting instruments'. Many observers also regard PSS as being capable of improving the handling of knowledge and information in the process of land use planning, and a function that provides great assistance to those involved in dealing with the increasingly complex planning tasks in practice.

25.3 Major Theories and Technologies of the PSS

25.3.1 Land Use Planning

Land use planning is a term used for an administrative and statutory activity which seeks to regulate and order the land utilization in an efficient and appropriate way, thus avoiding land use conflicts. The 'Canadian Institute of Planners' offered a definition of land use planning: it is 'the scientific, aesthetic, and orderly disposition of land, resources, facilities and services with a view to securing the physical, economic and social efficiency, health and well-being of urban and rural communities' [15]. According to another similar definition given by Wang [16], ULUP is a temporal-spatial plan or arrangement for the reasonable configuration and utilization of land resource in accordance with the social, economic and natural conditions within the urban area. Undoubtedly, the two definitions have the same principles and objectives of land use, and it is also indicated that land use planning could control and determine the future land-use development to a large extent in the planned areas.

Usually, local land use planning can be seen as a high-stake game of competition over a city's or region's future land-use pattern. In this game, land-use planners are central players and game managers in their role as stewards of the public interest [17].

Meanwhile, cities are highly complex systems due to all kinds of stakeholders and energy flows involved in, such as all levels of governments, land developers, common residents, and also intensive money, material resources, manpower. These lead to the increasing complexity of urban planning and land use planning, and set a higher requirement for urban planners. Under such circumstances, an effective planner acts as a mediator to resolve all kinds of conflicts, a coalition builder to achieve multi-group benefits, and an advocate to advance the interests of underrepresented groups. They must be visionary thinkers who look beyond immediate concerns to the needs of future generations, and effective communicators of these visions of the future who inspire confidence in the reality of sustainable land use patterns [17]. Therefore, land use planning must be done by carefully watching, considering and responding to the interests, actions and alliances of other players.

In practice, the tasks of land use planning are confusing and frustrating even to experienced planners. It can be regarded as an arena or even 'battlefield' for different political groups such as central government, local governments, land developers and common residents to compete for their own interests. Rather than being an orderly and regular procedure of adopting land use plans derived from systematic studies aiming at certain major objectives and requirements, planning has become a special and complex process involving various requests and views from different interest groups and also some uncertainties in reality. Therefore, theories of ideal urban form, urban economics, policy-intervention strategy and statistical modeling techniques taught in planning classes often carry less weight, in other words, they receive less attention than the actual demands or expectation of the government in the practical process of land use planning. The land use planning and decision-making process can be treated as a high-stake contest with a series of requests required to be taken into consideration over the future land use pattern in an area. However, the competitive process could be tempered by the presence of cooperation and collaboration amongst the different players. In view of this reality, land use planning is a key and useful tool to coordinate community land utilization and development activities. Planning is not simply a process, but is a process guided by a plan [17]. The plan fulfills many needs, from both the traditional functions of guiding urban infrastructure and setting parameters for zoning and other land use regulations on private and public property, as well as the newer purposes with more collaboration and agreement amongst the different stakeholders.

Both the complexity and turbulence of land use planning pose a challenging decision-making environment to planners. At the same time, these characteristics offer an opportunity and incentive to build innovative and adaptive land use planning programs or systems, e.g. PSS for land use planning. A conceptual framework of land use planning was formed in Berke et al. [17]'s book – 'Urban Land Use Planning' (Fig. 25.1). This framework depicted relationships among land use values of different respective stakeholders, such that their planning schemes and outcomes constitute the game of land use planning. The emergence of the goal of sustainable community is also mentioned for the new trend of considering the requirement of sustainable development. That goal aims to seek a sustainable land use pattern which can keep an appropriate balance among economic, social, environmental and livability values.

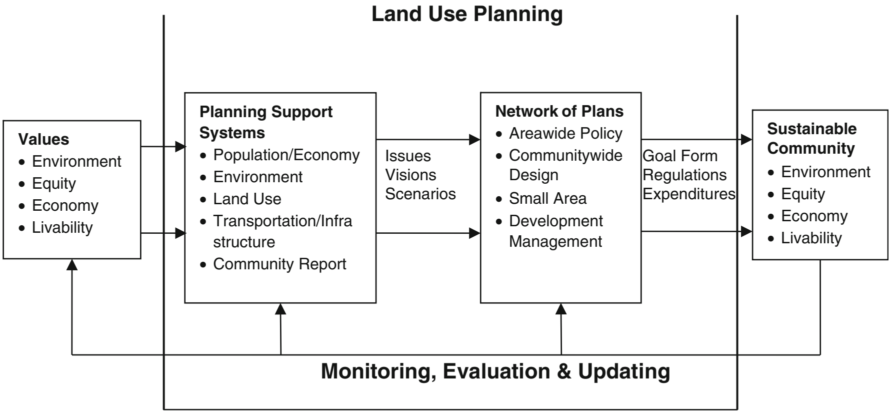

Fig. 25.1 Conceptual framework of land use planning (Source: [17])

25.3.2 Geographic Information Systems (GIS)

GIS are a set of tools or techniques which capture, store, analyze, manage and display spatial data that are related to location(s). Simply speaking, a GIS is a 'compound' which is the merging of cartography, statistical analysis, computation and database technology [18]. Definitions of GIS were also given by some academics: 'GIS are one kind of computer systems which are capable of capturing, storing, analyzing and displaying geographically referenced information – information attached to a location, such as latitude and longitude, or street location. The geographically referenced information is also known as geospatial information' [19]. The geospatial information includes all kinds of geographic features such as road intersections, office buildings, rivers, railways, contour lines, or district boundaries. GIS is a kind of software that uses geographic (spatial) location as the organizing principle for collection, storage, analysis, and presentation of information in digital form. It began as a tool for planning, moved forward into engineering through computer aided drafting, and has rapidly developed into the best enterprise software available for management and decision support [20].

From the emergence of GIS theory to the present time, GIS have gradually been used in cartography, remote sensing, land surveying, public utility management, natural resource management, photogrammetry, geography, urban planning, emergency management, navigation, and localized search engines [18]. Undoubtedly, in the past 30 years, GIS has developed rapidly, increasing its potential for effective use in both public and private organizations. In some developed countries, especially the U.S., GIS have been adopted as planning tools by the governments for many years. However, GIS applications to urban simulation and practical urban planning and also the construction of geo-information infrastructure supporting urban and regional management are still at a relatively low level in most countries. In other words, although GIS was developed over three decades ago and has been recognized as an effective tool in geographic research area, these techniques had been developed in parallel with urban modeling and simulation without sufficient interactions for over two decades [21].

The power of GIS is the capability to combine geospatial information in unique and efficient ways – by symbols or layers, and extract something new. For example, a GIS analysis may include the location of a highway intersection and the average number of vehicles that pass through the intersection throughout a day, and extract useful information for locating a business [19]. The GIS technology has made it easier to create and implement models for solving actual problems in geographic space. 'GIS tools help not only to process, analyze and combine spatial data, but also to organize and integrate spatial processes into huge systems that model the real world' [22]. Some GIS products such as ArcGIS, MapInfo, SuperMap, use graphical manifestation of models (diagram toolbars), making it easy to create, edit and implement geoprocessing workflows. Besides, with the combination of global positioning system (GPS) and remote sensing (RS) technologies (GIS, GPS and RS are called '3S' as a rule), and also the internet, GIS technology – collection, processing, analysis and visualization of spatial data, will be better applied into the practical land use planning, especially with the form of integrating into planning support instruments.

25.3.3 Spatial Decision Support Systems (SDSS)

SDSS are a kind of DSS and they have been developing in accordance with the development of DSS. 'A DSS is a computer-based information system which supports business or organizational decision-making activities' [23]. DSS serve the process of management, operation and planning, and help to improve the planning level and make decisions, which may be rapidly changing without any rules and not easily specified in advance. Usually, DSS include knowledge-based systems. A well designed DSS is an interactive software-like system intending to help decision-makers compile useful information from a pool of raw data, relevant documents, personal knowledge, or business models to identify and resolve problems and finally make decisions [23]. Similarly, a SDSS is an interactive, computer-based system designed to support specified users in achieving a better and more effective decision-making while solving some problems at the spatial level [24]. Sometimes, people consider the 'abbreviation' as the combination of the two typical components – GIS and DSS (i.e. GIS + DSS = SDSS).

In terms of SDSS for land use planning, it is designed to assist the planner with guidance and reference in making land use decisions [25]. For instance, when deciding where to build a new high-speed railway station, many criteria related to the location choice, such as noise and employment distributions, service radius, and surrounding impacts along the railways, make the decision-making difficult and complicated. A SDSS tool which simulates varied scenarios based on different potential decisions could be used to help the practitioner make a better decision.

In some cases, especially in Europe, a SDSS can be treated as be equal to a PSS due to their similar functions in supporting the decision-making with the powerful capability of spatial data processing and analysis. However, the two tools have a few differences in three aspects [26]. Generally speaking, PSS are a kind of computer-based systems which are specially used for supporting the tasks related to planning, while a SDSS can be regarded as the technical framework of a PSS. In short, by solving the spatial problems based on the integrated expert knowledge and the ability for supporting spatial data, SDSS serves as the core processor in the decision-making process of these planning support instruments.

25.4 Major Applications of the PSS

25.4.1 For Land Use Planning (or Urban Planning)

PSS have increasingly drawn people's attention since they were brought about nearly two decades ago. These systems are developed to support, in an integrated form, the various planning-related tasks in the different stages of practical planning process. Due to their planning-oriented nature, PSS have mostly been used in the field of urban planning or land use planning. Commonly, they provide a computer-based platform to apply land use or urban growth models to generate the scenarios of land use plans on the basis of a set of assumptions on future land-use or urban development and policy choices in an area to be planned. Rather than generating exact solutions to some existing problems or predictions of how a planned area should or will be, the systems are intended to support an interactive use of the models where users can change settings and the likely future visions in the area can be shown correspondingly. It has been argued, and widely supported in practice, that this so-called what-if analysis offers added value in particular in the systems where plan development is an outcome of a group planning process involving planners, the local community, and other possible stakeholders [27].

During the period of PSS development, a large number of models for planning support purpose have been built and employed by planning academics and professionals. Meanwhile, a smaller number of commercial software or toolkits, serving as PSS, have been developed and experimentally used in the planning world, such as CommunityViz suite (http://www.communityviz.com), What if?™ (http://what-if-pss.com), SLEUTH (http://www.ncgia.ucsb.edu/projects/gig), UrbanSim (http://www.urbansim.org) and INDEX® (http://www.crit.com) [14]. Among them, What if? and CommunityViz are two well-known examples of PSS and can be regarded as the most successful computer-aided packages with great practicality and effectiveness so far [27]. As a result, some researchers who are focusing their work on urban (land use) planning have applied a toolkit – What if? into the studies on land use planning and assessment, land-use forecasting, evaluation of growth management strategies and scenario of sustainable urban development [28–32].

Table 25.1 Categorization of typical planning support systems (Source: [14])

	Task			
Technique	Land-use/land-cover change	Comprehensive projection	3D visualization	Impact assessment
Large-scale urban models	METROPILUS SPARTACUS TRANUS URBANSIM	METROPILUS SPARTACUS TRANUS URBANSIM		
Rule-based models	CUF WHAT IF? 1.1	WHAT IF? 2.0	COMMUNITYVIZ	COMMUNITYVIZ INDEX® PLACE^{3}S
State-change models	CUF II CURBA			
Cellular automata models	SLEUTH DUEM			

Besides, many similar research have also been conducted by using other systems or models. For instance, Silva and Clarke [33] were interested in the SLEUTH model (slope, land use, exclusion, urban extent, transportation and hill-shade), and calibrated the SLEUTH model by analyzing the simulation results of the urban growth model for two European cities. In order to solve the problems of land-use conflicts and environmental issues in the Valencian Mediterranean Region, Recatalá et al. [34] applied the LUPIS system [35, 36] to generate alternative land-use plans by adjusting the relative importance given by multiple stakeholders to the preference and avoidance guidelines. They also found that, by using the LUPIS system, in a transparent and explicit way, the agreement between contending stakeholders as to how to develop areas of land suitable for competing land uses can be facilitated. Reginster and Rounsevell [37] used a cellular automata (CA) based model (similar to [38]) to present the development of quantitative, spatially explicit, and alternative scenarios of future urban land use in Europe. In this paper, they identified and described the principal driving forces of the spatial pattern change that are specific to the European region and urban sectors on the basis of the theoretical principles of urban economy, and also suggested that 'scenario analysis is a useful tool for testing incentives, measures, or planning regulations according to different policy objectives'.

In addition to the practical use of various PSS or models, the categorization of the typical PSS which have been widely adopted in urban planning should also be mentioned. According to the statement given by Klosterman and Pettit [14], the systems or models can be categorized by two dimensions: (1) technique, the modeling approach that was used to develop the support systems; (2) task, the analytical task which the support systems help address. The details of the categorization can be found in Table 25.1. The four modeling techniques are listed in the table by the order in which they were first applied to planning field. Besides these classifications, another function-dedicated classification was produced which was

Table 25.2 Function-based classification of PSS (Adapted from [39])

No.	Function	Example
1	Information gathering	Traffic-monitoring systems
2	Information storage and retrieval	Geo-databases
3	Information visualization	3D visualization kits
4	Information communication (Collaboration between stakeholders)	Cognitive mapping systems, electronic brainstorming systems, electronic collaborative sketching systems
5	Information analysis (To generate new information from existing information)	Multi-criterion analysis systems, statistical trend analysis systems
6	System modeling (To simulate processes based on current information)	Land-use models, physical process forecasting models

based on the function of a system with regard to handling information in the planning process. The six information-handling functions with their respective examples are listed in Table 25.2 [39]. Taking the first modeling technique – Large-scale urban models for example, some research have been conducted by using the large-scale urban modeling and simulation methods integrated into those tools to assess the future outcomes of policy alternatives and guide future urban (land use) development [40–42], and the Land-use/land-cover change has also been investigated and evaluated by adopting these planning support toolkits [43]. As the basis of spatial analysis models, geo-information databases are essential part of PSS and their integration with analysis models is a research hot spot in urban planning and management [44, 45]. In terms of 3D visualization, although a great deal of innovative work has been done in the realization of visualization over the last decade [46–48], the technique of 3D visualization is seldom incorporated into those PSS in practice. Besides, in recent years, public participation has become one key requirement of urban planning. In other words, a people-oriented development plan should reflect the sufficient concern and views from the public sector. As a result, some researchers have tried to include a collaborative way and integrate participatory techniques into the planning support tools to enhance the public engagement in urban (land use) planning and also develop more effective participation methods for this profession [49–52].

Undoubtedly, PSS provide an environment in which land use models can be utilized to support the planning. In the use of such models, an explicit representation of planning controls (for defining what-if scenarios), short computation time (for rapid feedback), and accuracy of predictions and solutions (for quality of information) are essential for the effectiveness of these tools.

25.4.2 For Other Specialized Planning

PSS can also be used in other specialized planning such as solid waste planning, landscape planning, environmental planning, green space planning and tourism planning [53–56], rather than being limited in conventional urban or regional planning. Similar with the application of PSS in urban (land use) planning, in the special areas, some new methods and technologies are also adopted in the specialized planning with the aid of PSS. For example, Simonovic and Bender [57] introduced the concept of collaborative planning to water-resources planning, and indicated that a collaborative planning support system could integrate available computer technologies, together with modeling and analysis tools in a user-friendly environment. This could be a useful tool to enhance communication between the proponents for resource development and other affected or interested parties in this kind of planning. Shen and Kawakami [58] paid their attention to the usable building space, which is the usable space of a building generated according to the zone restrictions implemented in a district plan. They incorporated the WebGIS technology into their system to generate the virtual world according to the data set of GIS including planning control items, and made the on-line system able to work for network participation. Their work would push forward public participation in the planning process. Gibin et al. [59] described a successful geographic visualization tool which was implemented based on the framework of Google Maps application programming interface (API) for supporting public health service planning. Elsewhere, Schaller et al. [60] focused their research on the development of GIS environmental modeling technology to provide new applications in the field of regional environmental planning and assessment. They have developed a series of new GIS software embedding effective tools and models for environmental planning and management over the past several years.

25.5 Discussions

According to the discussion in above paragraphs, usually, a PSS is a combination of planning theories, GIS technology and computer-based SDSS. As a result, the improvement of PSS will be prompted by the respective development in these three aspects. In detail, (1) the relevant theories and principles on urban planning or land use planning are the theoretical basis of building the planning support tools; (2) GIS technology facilitates the functions of geospatial analysis and visualization in the tools; and (3) computer-based SDSS provide the main skeleton of the PSS for supporting the decision-making process of urban (land use) planning. In addition, the development of PSS has different characteristics in different periods. In the middle of the twentieth century, due to the increasing complexity of urban planning, people tended to seek a computer-aided way to make the decision-making process more efficient and accurate via the application of computer technology. At that time, a PSS mainly looked like a DSS without the module of geospatial visualization. Afterwards, from about the 1980s, geographic information technology began to be largely applied to the support systems when the rapidly developing Geographic Information Science had been established. With the help of the geo-information processing ability of GIS, PSS can visually and effectively support specific tasks of planning through geospatial data collection, analysis and display. It realizes a transformation from non-spatial support, such as ordinary Expert Systems to spatial support with geographic visualization. Undoubtedly, this great progress opens a new page in the history of planning support tools.

During these years, computer and GIS technologies have been both widely used in developing planning support tools, and several tight-coupled PSS software such as What if?, CommunityViz has been produced for planning support in practice. It indicates that the advancement of planning support instruments is no longer represented by the computerizing techniques in terms of these tools development itself, but by some innovative technologies such as GIS spatial analysis and simulation models employed to tackle the practical planning problems and achieve goals in current planning process. Examples include dynamic simulation for land use change, real-life planning scenarios display, and web-based public participation. On one hand, today's research on PSS focuses more on building a series of specialized planning support tools to resolve the specific problems in practical urban or regional planning, for example, population and employment projection, land-use demand prediction, or alternative plans comparison. On the other hand, current PSS are prone to be used to assist all kinds of planning tasks, not only urban (land use) planning, but also some specialized planning such as environmental planning, landscape planning, redevelopment planning.

Many people regard PSS as valuable supporting tools which enable planners to better handle the complexity of planning processes, leading to a satisfactory situation in which plans are completed with better quality and saving a lot of time and resources. In this respect, it seems that a fresh, more positive view concerning PSS has emerged since the beginning of this century. Currently, much more attention is focused on planning support and its technological instruments than the case has been in the past [61]. However, some drawbacks of current PSS such as lack of design standards, weak proliferation capacity, and little usage in practice, indicate that their application is still in an early and exploratory stage [39]. In other words, PSS are far from being standardized software toolkits, which have been widely used in planning practice. In order to improve this embarrassing situation, many researchers are dedicated to the improvement of PSS development technologies, such as dynamic modeling technology, comprehensive geo-databases integration, 3D dynamic visualization, and collaborative channel for public participation, so that several new research trends in this area can be drawn. These are shown in Table 25.3.

25.6 Conclusions

This article provides a detailed and up-to-date review on a specialized area – PSS for ULUP. It aims to serve as a useful reference to future research and applications in facilitating the decision-making of urban (land use) planning. In terms of the definitions of PSS, in this paper, it is indicated that there has been no uniform definition so far but the same elements or functionalities of a PSS are coincidentally

Table 25.3 New research trends of PSS

No.	New trend	Example and description
1	Dynamic scenario-generated PSS	CA, Agent-based modeling with GIS
2	Real-life visualization PSS	3D, Google Earth-combined display
3	Real-time user interactive PSS	Virtual city model with real-time data and mobile avatars
4	Collaborative PSS	Collaboration among stakeholders in planning processes
5	Public engagement PSS	Using Web-based technology for enhancing public participation
6	ArcGIS processing models for multiple spatial analysis	Modeling based on 'Modelbuilder' module in ArcGIS
7	Environmental and landscape planning support tools	Developing PSS for specialized planning, emphasis on environmental sustainability
8	Integrated framework for supporting whole process of planning	Spatial and non-spatial databases integration, multi-level suitability analysis of land use (e.g. street-level)

included in all definitions given. This paper also suggests that the theories relating to land use planning, technologies of GIS and SDSS mainly frame up the PSS, and considers that PSS are not only mostly used in land use planning or urban planning, but also gradually employed in some specialized planning such as landscape planning, environmental planning, and tourism or recreation planning.

In summary, the future of PSS as useful tools both in research and practice is bright. With the rapid development of technologies of computers, network, and spatial data acquisition and processing, a new generation of computer-based tools for planning support may be developed in the near future. It can be considered optimistically that the further development of truly collaborative planning support tools with dynamic visualization and multiple geo-databases integration which could be adapted to a wide range of planning tasks will lead to their widespread adoption by planners, community groups, and policy makers. In the case of planning practice, the major concern or desire of PSS is still their capability to tackle the ever-increasing complexity of planning tasks.

Acknowledgements The authors wish to express their sincere gratitude to the Hong Kong Polytechnic University for the funding support to the research project on which this paper is based, and to Dr. Paul Fox for his kind help in manuscript proofreading. In addition, appreciation should also be given to the group members in our research team for their continuously constructive comments and suggestions on this research project.

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Chapter 26
Analysis of Land Use Difference Among Enterprises in the Development Zones at Different Levels: A Case Study on the City of Wuhan

Jing Han, Qingling Yu, and Xinhai Lu

Abstract The purpose of this paper is to analyze land use difference between enterprises in the development zones at state level and those at provincial level. Methods employed include literature analysis method, sampling survey method and statistical analysis method. The result shows that there is significant difference in the land use situation between the representative enterprises at the two levels when measured by the following four indexes as a whole: unit investment intensity, unit output efficiency, plot ratio, and building coefficient; however, when measured by each index individually, the difference in unit output efficiency is not clear while difference in the other three is remarkable. It is concluded that the difference in unit output efficiency is not significant among enterprises in development zones at different levels, which indicates that the advantage of development zones at state level is not great over those at provincial level. Therefore, it is suggested that unit output efficiency could be used as an important index for measuring land use efficiency in development zones.

Keywords Land use efficiency • Development zone • Enterprise • Difference

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_26,

26.1 Introduction

As the gathering place of modern industry and the growth pole of regional economy, the agglomeration effect, the demonstration effect and the diffusion effect of development zones have played an important role in accelerating China's economic growth [1]. Since land is the significant carrier of development zones, enforcing the supervision of land use efficiency and maximizing the optimal allocation of land resource in development zones are always the critical work targets of land resource management departments at all levels. To regulate the management of land use in development zones, the State Council issued Notice on Clean-up and Rectification of Development Zones and Strengthening of Construction Land Management by General Office of the State Council in 2003 to initiate the complete clean-up and rectification of various development zones in nationwide scope; in 2006, National Development and Reform Committee, Ministry of Land and Resources and Ministry of Construction released jointly Announcement Catalogue on Examining and Verifying Development Zones in China to not only confirm ultimately the legal positions of development zones at all levels, but also lay the foundation of hierarchical management of development zones; Ministry of Land and Resources issued Appraisement Standards on Intensive Land Use in Development Zones (For Trial Implementation)in 2008 and in 2010 individually to guide the land resource management departments to appraise the degree of intensive land use in development zones, and simultaneously make the appraisement results as significant references to expansion or upgrading of development zones.

In addition, Ministry of Land and Resources issued and implemented especially in 2004 Control Indexes of Industrial Project Construction Land (For Trial Implementation) to enforce the construction land management of industrial projects, which was revised and finalized as Control Indexes of Industrial Project Construction Land and the land resource management departments at all levels are required to implement it. Therefore, due to the specialties that most of the land in development zones are devoted to industrial use, exploring of the initial rules of land use in development zones and guiding the rational allocation of land resource by using the rules to achieve the economical and intensive land use have been the focused issues of both the land management departments and the academic field.

26.2 Literature Review and Analysis

The developing mode of development zones that enhancing the economic increasing speed by taking advantage of the low-cost land attributes the construction of development zones to a land resource allocation category [2]. By analyzing the relationship between land expansion and economic increasing of development zones at state level, some scholars confirm that the element of land is surely one of the economic increasing resources of development zones [3]. Assessing scientifically the land use efficiency of development zones by constructing assessment models has already been a critical research scope at the technical level in the researching field and great accomplishments have been achieved [4–9]. Focusing on the land use rules of development zones, some scholars present that the growing phase of land market plays a crucial role in land use efficiency of development zones; some scholars point out that unit investment cost of fixed assets, unit gross industrial production, unit profits and unit revenue from tax are important elements that influence the land use efficiency of development zones; some other scholars think it is essential to make an "admission threshold" for enterprises to provide limited land to them selectively [10–13].

What mentioned above reveals that researches on the land use rules in development zones has been enriched in a large scale. In terms of the rules of land influencing development zones, either an individual development zone has been explored or all the development zones in a specific region have been compared; with regard to intensive land use in development zones, either new methods and techniques are examined or new planning and management ways are discussed. However, there are still two defects existing: Firstly, in terms of researching scale, previous studies focus on the same level with the development zone as the minimum analysis unit. Nevertheless, the real land use subject is the enterprise in the development zone. Focusing on the whole development zone when analyzing the land use rules instead of the individual enterprise in it makes the research lack of precision so as to make the regulating and controlling policies hard to be implemented. Secondly, development zones at the same level are studied mostly with rare exploration on land use rules in development zones at different levels. Levels of development zones are the significant decision-making bases for Chinese government to manage development zones precisely and for one thing, development zones at different levels get different preferential policies; for another, development zones at different levels plays different part in making demonstration effect and serving as models in regional economic development. In consideration of what mentioned above, this article focuses on development zones in Wuhan, making enterprises in the development zones as the minimum analysis units and levels of development zones as major classified variables to construct multivariate analysis of variance model and to analyze the difference in land use efficiency of development zones at different levels by using exploratory methods, so as to provide academic reference for management departments to make land use policies of development zones.

26.3 Hypotheses and Modeling

26.3.1 Hypotheses

As an exploratory research, the research question is: whether difference in levels of development zones causes difference in land use efficiency of the enterprises there?

This study includes two variables: levels of development zones and land use efficiency by enterprises. Therefore, this study presents the following hypotheses:

H1: Land use efficiency of development zones is related to that by enterprises there.
H2: Difference among levels of development zones leads to difference of land use efficiency by enterprises there.
H3: The higher the level of development zone, the higher land use efficiency by enterprises there.

26.3.2 Model Set

This study employs multivariate analysis of variance model to analyze the research questions. Variance analysis is introduced firstly by the British statistician Fisher when he explains his experiment data and it essentially explores the relationship among variables with the principle that judging whether set variables influence significantly ratio variables through testing whether the overall means are equal. The model has the following basic assumption: (1) The response variables are subordinated to multivariate normal distribution. Since multivariate analysis of variance requests no strict IS multivariate normal distribution, in practice this condition is usually reduced to that every response variable obeys normal distribution; (2) The observed object is independent of each other; (3) Variance and covariance matrixes of response variables are equal. As multivariate analysis of variance has higher requirements for variance equality, the condition is relatively strict condition, but also the hypothesis on which this research focuses.

The basic concept of multivariate analysis of variance is dividing the response variable variations (SST) into two parts: one part is within group variations (SSE); another part is variations between groups (SSA). Then the two parts are compared to test whether SSA is greater than SSE. The main analysis steps are as follows:

(1) Hypothesis
The original hypothesis of this model is that in the classification proposed according to set variables, the means of the dependent variables are equal. The forms are as follows:

$$H_{m0} : \mu_1 = \mu_2 = \ldots = \mu_i = \ldots = \mu_k$$

$H_{m1} : \mu_i (i = 1, 2, \ldots, k)$ are not equal
The m is the m th dependent variable, and m is a constant in a range from 1 to n; μ_i is the value of every total mean.

(2) Test statistics
Analysis of variance uses SSA square (named as MSA) and SSE square (named as MSE) to construct F statistics for decision making. The calculation formulae are as follows:

$$MSA = \frac{SSA}{k - 1} \tag{26.1}$$

$$MSE = \frac{SSE}{n-k} \tag{26.2}$$

$$F = \frac{MSA}{MSE} \sim F(k-1, n-k) \tag{26.3}$$

In the above three formulae, n is the number of observations, and K is the total number of levels of factors.

(3) Statistical decision
If $F > F\alpha$, the hypothesis fails because the testing factors have a significant effect on the observed value; if $F < F\alpha$, the hypothesis is confirmed because the testing factors have no significant effect on the observed value. Here, α means degree of significance.

26.3.3 Data

As land use level of industrial projects are substantially variant in accordance with the difference of scales of investment, industry categories, production technologies and other factors, Ministry of Land and Resources controls the land provided to the preliminary design projects mainly through setting standards for the five indexes, that is, investment intensity, volume rate, building coefficient, the land proportion of administrative offices and living facilities, green rate, in the development of Control Indexes of Industrial Project Construction Land . Since the research objects in this paper are enterprises in production in the development zones, the authors take the output intensity into analysis model in reference to the above criteria. This study adopts division plate target sampling method to investigate the basic land use data of enterprises in the development zones and the indexes are calculated. The software SPSS16.0 is employed for data processing, and the deadline of all data is December 31, 2009.

26.4 Empirical Analyses

26.4.1 Survey of Research Objects

The study area is the 16 development zones at or above provincial level in Wuhan city including 3 development zones at state level with a total area of 3,760 ha and 13 at provincial level with a total area of 9,075 ha and the development goal of them is establishing industrial gathering area. Enterprises in the development zones are the analysis unit. Due to the post stimulation problems in the development zone management mechanism, development zones in Wuhan City have always strived for the similar projects, which leads to industrial project homogeneity in development

Table 26.1 Number of surveyed enterprise in the development zones

Industry category	State level	Provincial level	Industry category	State level	Provincial level
Materials	3	2	Foods	1	2
Electrics	6	5	Pharmacies	4	1
Spinning	2	3	Beverages	3	0
Mechanics	1	4	Building materials	0	4
Automobiles	6	2	Logistics	0	2
Light industries	2	3	–	–	–

Table 26.2 Box's test of equality of covariance matrixes

Statistic	Value	Statistic	Value
M of Box	15.7513	df2	13,941.0359
F	1.4486	Sig	0.1521
df1	10	–	–

Null hypothesis: The response variable covariance matrixes in all groups are equal

zones. The following table also reflects this phenomenon. The research obtains 56 valid data from enterprises undertook survey, in which enterprises in development zones at state level and those at provincial level go halves on the data. The specific circumstances are demonstrated in the following tables (Table 26.1).

26.4.2 Data and Description

This study brings the following variables into the research model: (1) categorical variable – level of development zone (rank); (2) fixed ratio variable – unit investment intensity (Y1, unit: 10,000 Yuan// Ha); (3) fixed ratio variable – unit output intensity (Y2, unit: 10,000 Yuan / HA); (4) fixed ratio variable – plot rate (Y3, unit: %); (5) fixed ratio variable – building coefficient (Y4, unit:%).

26.4.3 Model Test

As multivariate analysis of variance has a robust normal impact on the data and is more sensitive for the equality of each group of covariance matrix, the data has to be tested before the analysis to reduce the false-positive errors. This study takes the equality of each group of covariance matrix for Box test by using equality of variance test module provided by SPSS and the results are as follows (Table 26.2).

It can be seen from the above test results that Box test statistics is 15.751, and after the transform calculation statistic value of F is 1.449 and P value is 0.152. Therefore, the null hypothesis could not be rejected, that is, the general covariance matrixes of land use data from enterprises in the development and zones at state and at provincial levels are equal.

Table 26.3 Levene's test of equality of error variances

Name of variable	F	df1	df2	Sig
Unit investment intensity	0.8133	1	54	0.3712
Unit output efficiency	2.7221	1	54	0.1048
Plot ratio	0.1428	1	54	0.7070
Building coefficient	0.2134	1	54	0.6460

Null hypothesis: The response variable error variances in all groups are equal

The equality of variance of each reaction variable in the groups is taken for the Levene's test and the test results are as follows (Table 26.3).

It can be seen from the above results that in Levene's test, P value of unit investment intensity is 0.371, P value of unit output efficiency is 0.105, P value of plot ratio is 0.707, P value of building coefficient is 0.646. Therefore, the null hypothesis could not be rejected, that is, error variances of the above four variables are all equal.

The two test results show that, collected data of this study meet the assumption requirements of multivariate analysis of variance and the analysis is feasible.

26.5 Results

By application of multivariate analysis of variance module in SPSS16.0 software, the variables in the model are analyzed at the 0.5 confidence level and the results of response variables are as follows (Table 26.4).

It can be seen from the above table that the test results of four statistics provided by SPSS are all the same. P value of the model intercept hypothesis test results is less than 0.001 and it means that when the value of independent variable is 0, the value of response variable is not 0, that is, the overall mean vectors of four response variables of development zones at state level are not zero vectors and then the four response variables could not be 0. Statistical test results of levels of development zones show that P value is 0.0191 and the value is significant at the 5 % confidence level, indicating that difference in levels of development zones really makes land use efficiency of enterprises there different.

However, which response variables are affected by the element of level? This question is tested by the between-subjects effect test module of SPSS and the results are as follows (Table 26.5).

It can be seen from the table that P value of the intercept hypothesis test results of the four response variables is less than 0.001 indicating validity of the model. P values of unit investment intensity, plot ratio and building coefficient are 0.0169, 0.0200 and 0.1117 individually, all being significant below the significant level of 5 %, which means statistically the three indexes are different remarkably in different levels of development zones. Since P value of unit output efficiency is 0.136 and it is not significant at the significant level of 5 %, the null hypothesis

Table 26.4 Multibarirate testes

Effect	Statistic	Value	F	Sig
Intercept	Track of Pillai	0.9284	165.3370	0.0000
	Lambda of Wilks	0.0716	165.3370	0.0000
	Tracking of Hotelling	12.9676	165.3370	0.0000
	Largest root of Roy	12.9676	165.3370	0.0000
Level	Track of Pillai	0.2028	3.2430	0.0191
	Lambda of Wilks	0.7972	3.2430	0.0191
	Tracking of Hotelling	0.2544	3.2430	0.0191
	Largest root of Roy	0.2544	3.2430	0.0191

Table 26.5 Tests of between-subjects effect

Effect	Response variable	df	Mean square	F	Sig
Intercept	Unit investment intensity	1	1,058,024,509.5458	153.0143	0.0000
	Unit output efficiency	1	32,796,835,111.5485	14.8074	0.0003
	Plot ratio	1	40.0530	211.7684	0.0000
	Building coefficient	1	156,317.6311	520.7412	0.0000
Level	Unit investment intensity	1	42,021,233.1018	6.0772	0.0169
	Unit output efficiency	1	5,063,723,552.3698	2.2862	0.1364
	Plot ratio	1	1.0864	5.7442	0.0200
	Building coefficient	1	2,045.1446	6.8130	0.0117

could not be overthrown which confirms that unit output efficiencies of development zones at different levels are similar statistically.

It is shown from the above analysis that land use efficiencies of enterprises in development zones at state and at provincial levels are different. However, the difference is significant in indexes of unit investment intensity, plot ratio and building coefficient with no significance in index of unit output intensity. For enterprises in development zones, the first three indexes are viscosity indexes and hard to change after production and the latter is the critical index indicating land use efficiency of enterprises in production.

The descriptive statistical data of enterprises show that the mean values of unit investment intensity, unit output intensity, plot ratio and building coefficient of enterprises in development zones at state level are higher than those at provincial level. Since unit output intensity is not significant statistically, it could be deduced that unit investment intensity, plot ratio and building coefficient of enterprises in development zones at state level are higher than those at provincial level but there are no difference in terms of unit output intensity.

26.6 Discussions

This study analyzes land use difference of enterprises in development zones at different levels using multivariate analysis of variance. It is found that the method can better achieve the purpose of research. However, there are three problems in this research: firstly, impacted by industry policies of the administrative region, economic radiation ability and location factors, using the method to study land use problems of enterprises in development zones in a greater geographical range lacks theoretical basis, and the response variable variance equality is difficult to meet; secondly, the case category is limited with the industrial projects as the research object only ignoring other land use types in development zones which may lead to deviation of results; finally, the sampling method have to be further improved for better sampling precision and reducing statistical error.

The research results that, as to overall land use efficiency, there are significant difference between development zones at state level and those at provincial level; while in single index, unit investment intensity, plot ratio and building coefficient of enterprises in development zones at the two levels show significant difference but difference in unit output intensity is not significant, indicates that the admission standards of development zones at state level are higher than those at the provincial level, but the effect of after management measures is not apparent. Therefore, unit output intensity of enterprises is recommended as the crucial index of assessment of land use efficiency or economic efficiency of development zones, which influences upgrading, expanding or even degrading of them to urge the relevant management departments to take stock projects quality seriously so as to use the land intensively and economically.

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Chapter 27
Study on Spatial Differences of China's Urban Land Price

Haojing Shen, Changchun Feng, and Xiaojun Xiao

Abstract The urban land market price has always been a hot point in the land science. The high urban land price means high cost of land elements in urban economic development, and then the high urban land price can improve the efficiency of land resources use. As immovable land has spatial heterogeneity inherently, this study uses exploratory spatial data analysis to research the spatial heterogeneity of urban land price. The study finds that: there are significant differences in the market trading price of the national land market activity; there is obvious effect and constraints of the natural environment, economic development and policies, location and resource advantages on the urban land market.

Keywords Urban • Land price • Spatial heterogeneity • Exploratory spatial data analysis

27.1 Introduction

In the era of regional integration, the integration process of the regional land market is accelerated. Land's complementary and alternative is more significant, and the land price correlation increases among neighboring cities. Spatial heterogeneity and relevance of urban land prices have an important impact on China's regional policy. Regional perspective shed light on land resource field, which will promote regional development.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_27,

Immovable land has spatial heterogeneity inherently. On one hand, there is Microscopic heterogeneity. In 1960s, Alonso [1]; Muth [2] etc. studied urban spatial structure, they found that land price in city center is more expensive than it in city edge, which is influned by land demand and transportation costs [1, 2]. Following that, Walden [3]; John Landis [4]; David [5] etc. conduct depth study [3–5]. On the other hand, there is Macroscopic heterogeneity. Keiper [6]; Maise [7] etc. studied the differences of land price in different cities on the basis of classical rent theory [6, 7], then they found that land scale and density, population density and household income can influnce urban land price. Stephen Malpezzi [8]; Terri Mashour [9]; Keith Ihlanfeldt [10] followed this idea [8–10].

Liming Dong [12] and Changchun Feng [11] etc. proposed the urban land price evaluation in China after the reform and openness,. They used the benchmark land prices, land classification and other ways to assess the land prices of different cities and different sections [11, 12]. The research of urban land price spatial differences is very important to understand the current land market, to assess land policy and to improve the policy.

27.2 Data and Methodology

This paper studies the spatial heterogeneity of urban land price and its spatial distribution. The data come from *Statistical Yearbook of Land and Resources* [22], concluding 337 prefecture-level units excluding Taiwan, Hong Kong and Macau. Land users obtain the land use rights through administrative allocation, agreement, bidding, auction and listing. The last three (bidding, auction and listing) are recognized as market-oriented way, which is focus of this study.

According to the first law of geography, spatial economic phenomenon has spatial dependence, which is depend on the distances. This paper uses exploratory spatial data analysis (ESDA) to solve this problem. The method explores the characteristics and distribution of spatial data through spatial statistical based on the spatial data itself. And we can explore the spatial distribution patterns, identify the spatial outliers, and explore spatial heterogeneity and spatial correlation [13–15].

1. *Global Spatial Autocorrelation*. Global spatial autocorrelation is measured by Global Moran's I. In the next formula, xi is *region i's* spatial variable, x is its mean value, n is the number of region, w_{ij} is *region j's* spatial weights matrix which is next to region i. Spatial weights matrix is important in analysis, and we take K-nearest spatial weights matrix。 And then Global Moran's I is:

$$\mathrm{I} = \frac{n}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \cdot \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} wij(x_i - \bar{x})\left(x_j - \bar{x}\right)}{\sum_{i=1}^{n}(x_i - \bar{x})^2}$$

The range of Global Moran's I is $[-1, 1]$, and its mathematical expectation is $E(I) = -1/(n-1)$. Generally the number of observation region (n) is large, and in this case, $I = 0$ indicates that there is no spatial autocorrelation, $I > 0$ indicates that there is positive spatial autocorrelation, and $I < 0$ indicates that there is negative spatial autocorrelation.

2. *Local Spatial Autocorrelation*. Local spatial autocorrelation is measured by Local Moran's I and LISA map。 Anselin advanced Local Moran's I in 1995, since then local spatial autocorrelation has been taken as an usefull method in local spatial analysis to test spatial dependence in local scale. Thereafter other researcher advanced Local Moran's I scatter plot and LISA map etc. to test local spatial autocorrelation, which is more intuitive and visual [16–21]. Local Moran's I is based on Global Moran's I:

$$I_i = \frac{(x_i - \bar{x})}{\sum_{i=1}^{n}(x_1 - \bar{x})^2} \cdot \sum_{j=1}^{n} w_{ij}\left(x_j - \bar{x}\right) = z_i \sum_{j=1}^{n} w_{ij} z_j$$

Local Moran's I reveal four spatial association situations through Local Moran's I scatter plot and LISA map. It details the spatial patterns and processes and make the results intuitive and visualization.

27.3 Spatial Differences of Land Market

27.3.1 Land Market Activity's Spatial Differences

This paper uses frequency, scale and their marketization to reflect land market activity.

The national land market frequency and scale have obvious spatial difference character among provinces, which is East>Middle>West; but the difference of marketization of land market frequency and scale is West>Middle>East. The difference of marketization is not obvious in the whole country. Most provinces' marketization of land market scale is more than 65 % except Tibet, and about 9 % of all provinces' have high marketization is high, which is more than 75 %.

East. Because of convenient location advantage, the east region has been developing rapidly. The market frequency is high, and the difference between provinces is high. But the differences in marketization of land market frequency are not obvious, and most provinces have high marketization degree. The land market is developed in the east region, because the rapid economic development need land capital investment. So the land market scale is high in most provinces, but the differences are obvious within the region.

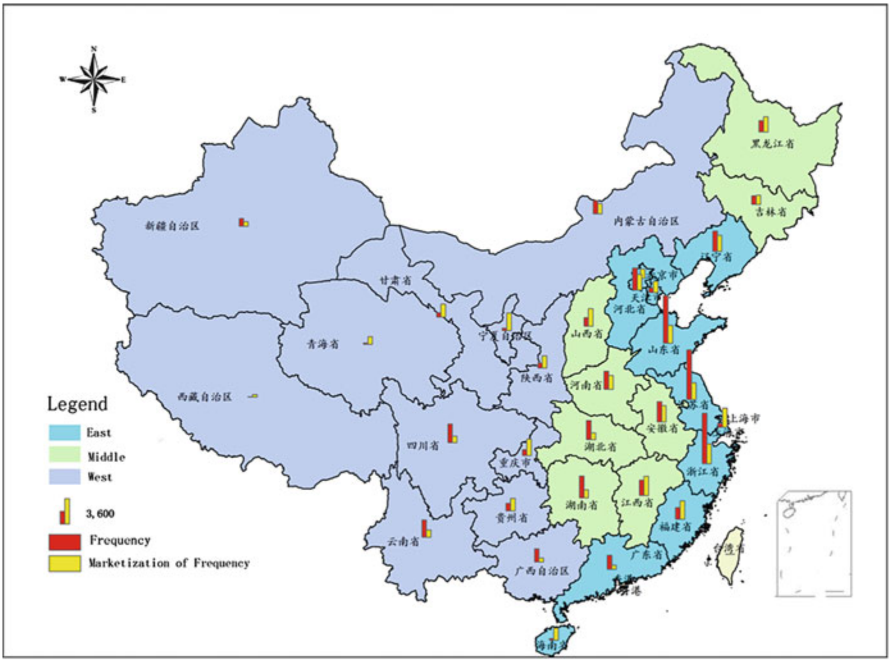

Fig. 27.1 The spatial differences of land market frequency

Middle. Because of the Rise of Central China Policy, the land market develops rapidly in the central region. Most provinces have a higher frequency of land market, and the differences between them are not obvious. The differences in marketization of land market frequency are not obvious. The central region undertake the industrial transfer from the east region, at the same time, most provinces are major grain province, facing the arduous task of farmland protection. So the land market scale is not very high, so is the marketization of scale.

West. Under the guidance of Western Development Policy, west region's economic development has been greatly improved, and the reform of land market has been constantly pushed forward. The level of economic development is quite different within the region, so is the land natural endowment condition. Although the development need land capital, the amount of land for construction is different. So the differences of land market scale are obvious.

Land market activity is constrained by natural resources and the environment. The region with low land market frequency and scale is in Qinghai-Tibet Plateau and Yunnan-Guizhou Plateau, and the condition of development and construction is bad. On the other hand, these regions are Restriction Development Zone in the national main function zoning, which have the important task of ecological conservation and environmental protection. So these regions' land market is not active (Figs. 27.1 and 27.2).

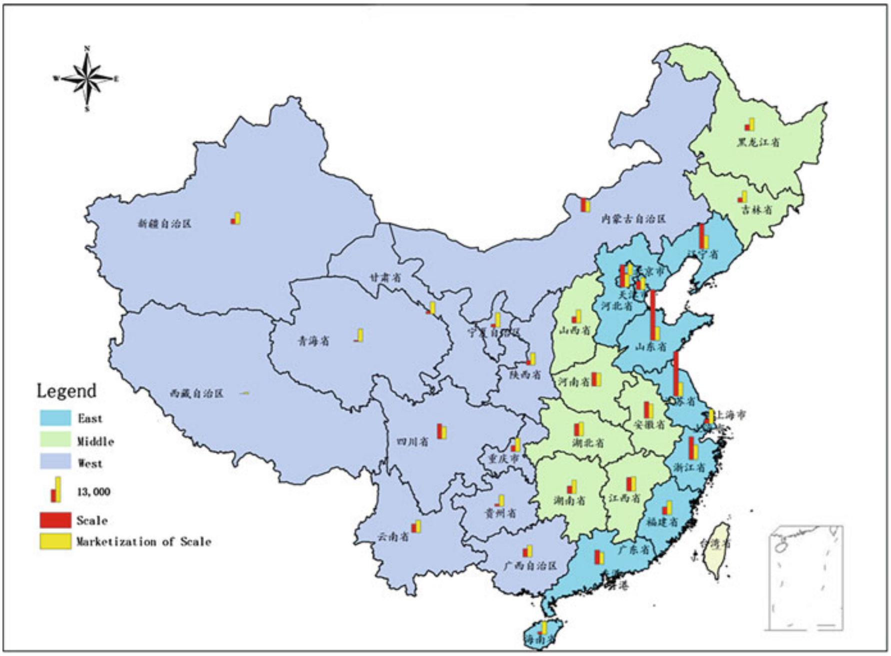

Fig. 27.2 The spatial differences of land market scale

27.3.2 Land Price's Spatial Differences

This paper divides the national land market price into five levels by using Quartile method. We found the city's land market price is high which owns special advantage. Special advantage can promote urban economic development condition more favorable than surrounding cities, so its economic development is higher and it may become a regional center. As the result, the urban land has high economic value.

Policy Advantage. Some of the eastern coastal areas are in the first group of special economic zones, their land market developed earliest. The urban land price and land market activity in this region is high. Provincial capital city's land price is higher except Sinkiang and Tibet. Provincial capital city is the seat of the provincial government and is the center of the province's political, economic, and cultural, so it induces large demand for land. As a result, the urban land price is high in these cities.

Location Advantage. On one hand, the more developed traffic network, the higher urban land market price . Developed road network can improve accessibility and enhance economic and trade links, so the transport hubs in western are first class cities. Such as Liuzhou in Guangxi Province, which is the transport hub of southwest region, has higher land price than surrounding cities. On the other hand, some cities has always been a regional center city because of historical heritage, whose land market price is higher. Such as Ganzi Tibetan Autonomous Prefecture in Sichuan Province has been a major city in which Chinese and Tibetan traded for many years. It was the center of “tea-horse trade” in history, and now it is also the center of trade and exchange of all ethnic groups.

Resource Advantage. Firstly, the richer tourism resources are, the higher urban land market price is. Diqing in Yunnan Province is famous for “Three Parallel Rivers”; Yan’an in Shaanxi Province has rich cultural resources and historical heritage which enrich its tourism resources; Anshun in Guizhou Province is a typical Karst region, and Huangguoshu waterfall is very famous. These tourist city develop modern tourism industry with its tourism resources, which is benefit for tertiary industry and enhance the urban land value. Secondly,Resource-based urban has high land price. The development of the mining industry can drive the development of the whole city, such as Ma’anshan Anhui Province, Daqing in Liaoning Province.

Industrial Advantage. Some of the industrial cities become a regional or national center because of its long-term development of some special industries. So it has absolute advantage which other cities cannot match. This advantages and opportunities drive the development of tertiary industry, absorb population, and enhance the land value. Such as Nanchong in Sichuan Province is silk industry base; Deyang in Sichuan Province is a major technical equipment manufacturing base; Bengbu in Anhui Province is the manufacturing center and business center of Northern Anhui (Fig. 27.3).

27.4 Spatial Patten of Land Price

Through the analysis above we can see that the national land market has spatial distribution regularities. The frequency, scale and price of land market have spatial grade distribution regularities. This paper studies their spatial association and analyzes the character and regulation of spatial aggregation and decentralization by spatial autocorrelation method.

27.4.1 Land Price’s Spatial Autocorrelation

This paper uses Moran’I to research global spatial autocorrelation of urban land price. As this paper focuses on the spatial correlation in adjacent spatial unites, it uses K-nearest spatial weights. It has been observed, each administrative unit is surrounded by 5–10 administrative unit generally, we choose $K = 8$, at the same time, $k = 4, 12, 16$ is used for test. The result shows that all global Moran’s I is positive significantly in 0.005 significant level, indicating that the national land market price has spatial autocorrelation. When $K = 8$, global Moran’s I is the largest (0.2524).

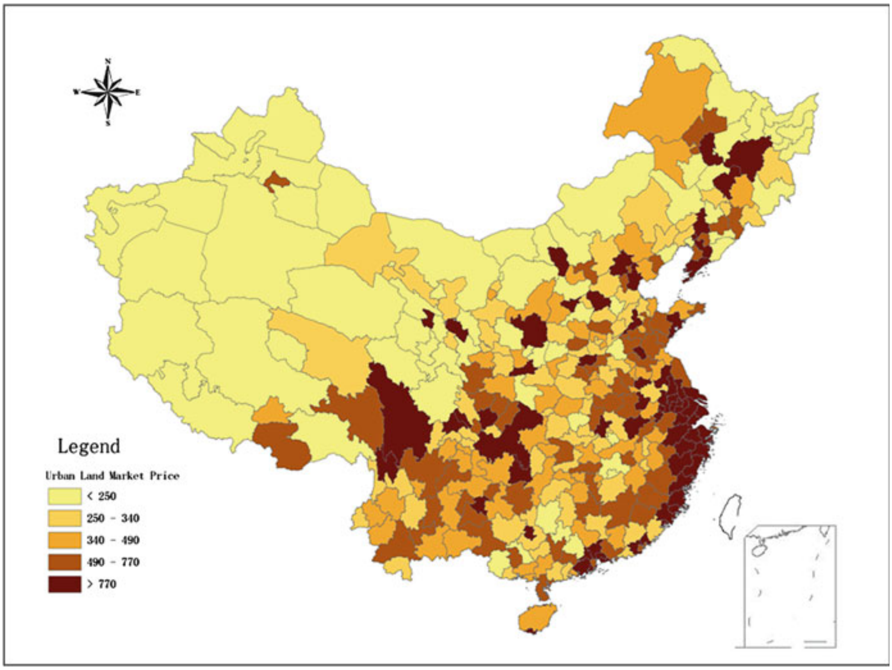

Fig. 27.3 The spatial differences of land market price

Table 27.1 Moran 'I and significance of urban land price

	Global Moran' I	sig.(199permutations)
Whole Country	0.2524	0.005
East	0.1375	0.05
Middle	0.0717	0.1
West	0.0621	0.1

Table 27.1 shows global Moran's I of east, middle, and west region when K = 8. Though the long-term's construction and development, east region's traffic network is developed, economic ties is close, and alternative ability of land marker is strong, so the spatial autocorrelation of land marker price in east region is stronger than the middle and west region. Although some cities belong to middle region, they connect with Yangtze River Delta closely in east region, such as Hefei and Ma'anshan in Anhui Province. In the national level, they have spatial correlation with surrounding unite, but in regional level this spatial correlation is weak. So the global Moran's I of the whole country is higher than that of east, middle, and west region.

27.4.2 Type of Spatial Autocorrelation

In this part, we use LISA map to analyze local spatial autocorrelation of urban land market price. The result shows that there is significant spatial autocorrelation in parts of whole country and it has four spatial autocorrelation types (Fig. 27.4).

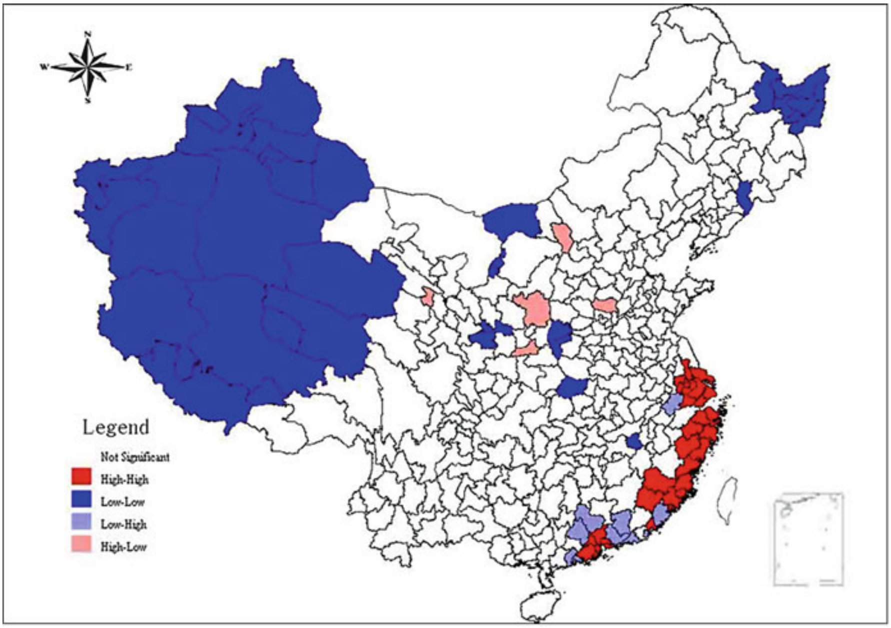

Fig. 27.4 Land price's LISA map of China

High-High type. The city's land marker price is high, which is the same as other cities surrounding. This indicates significant positive correlation. These regions concentrate in Yangtze River Delta and Pearl River Delta metropolitan and the southeast. They develop rapidly which need more land capital. At the same time, the strong economic links enhance the substitutability of the urban land market. Because of the scarcity of resources and the strengthen links of economic, urban land price and its spatial autocorrelation is high.

Low-Low type. The city's land marker price is low, which is the same as other cities surrounding. This indicates significant positive correlation. These areas are mostly plateau, mountain, desert and other remote areas, and the natural environment is harsh. Some of them are restricted development zones, and the construction condition is poor. Because of low economic growth and sparse population, the demand of land resources is low. So in these regions, urban land price is low but its spatial autocorrelation is high.

Low-High type. The city's land marker price is low, and the surrounding cities' land market price is high. This indicates significant negative correlation. In LISA map, it performances as "Low Value Depression", which means this city's land price is lower than surrounding cities significantly. These regions concentrate around high land price regions, such as the first level city in Fig. 27.3. They mostly belong to the third and fourth level city and are the transition zone from high urban land price to low.

High-Low type. The city's land marker price is high, and the surrounding cities' land market price is low. This indicates significant negative correlation. In LISA map, it performances as "High Value Island", which means this city's land price is higher than surrounding cities significantly. These regions mostly are the capital city of the middle and west regions. Due to the special natural environment and socio-economic development of the western region, as regional center the capital city's agglomeration effect of many economic factors is obvious. So land value of the capital city is significantly higher than the rest cities in the region. As a result, the spatial autocorrelation is negative in these areas.

27.5 Discussion and Conclusion

Firstly, the national land market activity and land market prices are spatial heterogeneity.

The east and middle region's land market is active and the marketization is high. The west region's land market is not active and the marketization is low. The difference of land market frequency and scale is high in east and west region but is low in middle region. The national difference of land market price is obvious, and the difference between the highest and lowest values is significant. The east region's urban land market price is significantly higher than the middle and west region.

Secondly, environment, resources, advantages, location, policy and economic development play an important role on the land market.

The national land market frequency and scale is consistent with the national large-scale topography and landform features. In west region, the environment is poor, the construction and traffic condition is bad, and so the land market price is low. Overall, in the developed region, the land market frequency, scale and price is high. Economic Special Zone and capital city develop rapidly because of the policy advantage, and its land price is higher than other cities within the region. The east region is the door of Reformation and Opening Policy; transport hub city is the core of the region, national exchange center city in history is still playing an irreplaceable role; these cities' land market price is high because they have special advantages. The rich cultural, tourism and mineral resources will enhance the urban land value.

Thirdly, there is spatial autocorrelation in land market price.

The national urban land market price has two kinds of spatial autocorrelation: positive and negative. Developed regions are High-High type of space autocorrelation; less developed regions are Low-Low type of space autocorrelation. Low-High type of space autocorrelation is always surrounding the developed regions; High-Low type of space autocorrelation is always surrounding the less developed regions.

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Chapter 28
Research of Development Mode of Urban Renewal Unit of Shenzhen

Honglei Lv and Changchun Feng

Abstract With the current process of rapid urbanization in Shenzhen, the shortage of construction land emerges. Many problems need to resolve quickly, especially the low utilization ratio and non-standard phenomenon. Urban renewal unit which was carried out in Shenzhen in 2009 hadn't played an important role. With the analysis and comparison of the common development mode of urban renewal unit, combined with the characteristics of Shenzhen, this paper focuses on researching and improving the suitable development mode of urban renewal unit of Shenzhen. I hope this paper can lay the foundation for urban renewal unit system in Shenzhen and urban renewal work in other areas.

Keywords Shenzhen • Residential area • Urban renewal unit • Development mode

28.1 Background

Shenzhen, the young city founded just more than 30 years, faces severe challenges of shortage of space resource earlier than other cities. With the rapid growth of social economic level of Shenzhen, the fact that land resource is more and more scarce and city development space is increasingly insufficient is becoming the bottleneck of restricting city harmonious development. According to the growth speed of construction land from 2000 to 2006 in Shenzhen, the rest of construction land can be consumed within 5 years. In this context, Shenzhen pays high attention on urban renewal work. Shenzhen treats urban renewal as important means to strategy transfer of economic and social development. Through urban renewal, Shenzhen hope to unceasingly excavated city potential, so as to improve the land use efficiency, promote the urban function and effectively resolve livelihood issue

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_28,

in some areas where there are harsh environments and security risks. Through providing space resource, urban renewal is the only way of urban sustainable development. Now in Shenzhen market demand of urban renewal is more and more intense and power of urban renewal is more and more urgent.

In 2009, "urban renewal act in Shenzhen" came. Shenzhen introduced the new concept "urban renewal unit" which is from Taiwan. But the urban renewal unit system of Shenzhen is still at a groping stage. There exits great gap between Shenzhen and Taiwan where urban renewal unit system is more mature. Residential area is the tricky renewal area in Shenzhen, because of property issues and management issues. It adds difficulty for the implementation of urban renewal unit, which especially requires more for development mode of urban renewal unit. With the analysis and comparison of the common development modes of urban renewal unit, combined with the characteristics of Shenzhen, this paper focuses on researching and improving the suitable development mode of urban renewal unit of Shenzhen. In terms of the process of urban renewal, Shenzhen goes ahead of other cities. Through the research of development mode of urban renewal unit in Shenzhen, I hope to lay the foundation for urban renewal unit system in Shenzhen and urban renewal work in other areas.

28.2 Urban Renewal Unit System in Shenzhen

In 2009, "urban renewal act in Shenzhen" came. Shenzhen introduced the new concept "urban renewal unit" which is from Taiwan. But urban renewal unit system in Shenzhen still has many defects. The system in Taiwan is sound. Especially the practice of development mode of urban development unit is rich, which is a good reference to Shenzhen.

Under the policy framework of urban renewal, Shenzhen used to confirm the space scope of renewal project according to land use type and land property. It leads to the fact that the original integrative urban space is artificially divided into the old village, the old industrial zone and the old residential area and so on. In many areas with intensive construction, the various above-mentioned types of land present in mix. And the space scope of all kinds of old areas can't be confirmed clearly. So renewal policy which divides land into different types is difficult to carry out. It directly leads to the fact that in many areas which need to renew, especially outside Shenzhen DC, it's difficult to carry out renewal work, because of land property issues and land use issues. Even if space scope can be confirmed clearly, they can't be planned uniformly. For some scattered renewal projects, we can't comprehensively take public interests and city integrated development goals into account.

How to integrate the space scope of renewal projects also need to resolve urgently. Urban land is redrawn in Japan. Hong Kong sets up nine reconstruction target areas. These show us that we should break from status quo that renewal scope is confirmed according to pope land ownership and land use status. Instead the government should delimit urban renewal unit proactively, in terms of public interests demand and city integrated development goals, and carry out the planning and management of urban renewal projects oriented to implementation. As far as urban planning management in Shenzhen, statutory plan is the most favourable platform to confirm urban renewal unit. Because statutory plan is not only one of the most powerful planning tools to protect public interests, but also has a broad social approval. It concerns a wide range of stakeholders so that it can take in and balance the interests of all parties to the greatest extent.

Shenzhen urban renewal unit system is the special planning in which procedure is made according to statutory plan and which has the same potency with statutory plan. It provides detailed planning and management basis for urban renewal. Under the guidance of statutory plan, urban renewal unit planning will further refine the function and distribution of urban infrastructure and public service facilities, project implementation timing, preliminary economic accounting of compensation for demolition, adjustment suggestions about land use right and so on. Urban renewal unit planning is the important tool to take urban renewal to normal urban planning management, which makes up for the shortcomings of current statutory plan. And in order to strengthen the urban renewal market behavior intervention from government plan, in principle only can the area which is listed on government urban renewal plan, has been classified as urban renewal unit and has the guidance of statutory plan be applied into urban renewal project by development body. It effectively avoids the phenomenon that development body develops at random for private interests, strengthens guidance supervision function on urban renewal work from government and guarantees urban renewal work to realize the social benefit maximization.

28.3 The Development Mode of Urban Renewal Unit

Chinese urban development is based on the whole social operation system transportation sharply. The game of all kinds of social forces is becoming the theme in this day and age. China has accessed into “the interest game times”. As a kind of behavior, the outstanding characteristic of urban renewal is that it’s an activity which includes the public, the private and community department. The government (department), developers and owners (and the tenant) are the main subjects of urban renewal activities. We call the complex and fast-changing relationship between public sectors and private sectors in urban renewal work the role relationship. The role relationship which all kinds of participants make around the authority-responsibility relationship of capital, decision and interests distribution decides the development mode of urban renewal unit. The development mode of urban renewal unit decides the content and result of urban renewal to a large extent. At present, in the areas with mature urban renewal unit system, such as Japan, Taiwan, Hong Kong and so on, there are some main development modes of urban renewal unit following.

28.3.1 Mode One: The Joint Venture of Civil

Joint venture of civil is that urban renewal unit original owners and land developers set up a renewal development company and finish the preliminary project in the way of holding and tnunan. The renewal development company finishes the preliminary project, such as relocation, land leveling, moving back and rebuilding and so on. After that, company rents the land as cultivated land through open tender. Developer finishes the later commodity house construction. After the preliminary project, the renewal development company dismisses by itself. Developer just need face the government during the later commodity house construction.

Through this mode, demolition and construction separate and former and later work are managed by professional management departments. The original owners participate in the former work through holding, so that the legal rights of the original owners can be protected fully, contradiction from relocation issue and property issue can be reduced and renewal procedure can be sped up.

But this mode lacks the effective guidance and supervision from the government. The original owners and developer maybe execute favorable policy, avoid unfavorable policy and even bribe the government officials illegally in order to maximize their benefit. During the later commodity house construction, developer maybe construct poor family and fewer supporting facilities in order to expand its profits. It leads to the fact that the huge profits are taken by developer, but the external costs are shared by the whole society. And through this mode demolition and construction are not unified so that it's difficult to control the renewal schedule. If in an urban renewal unit the quantity of the original owners is large, it's hard to balance them.

28.3.2 Mode Two: The Government Guidance, the Joint Venture of Civil

The government guidance, the joint venture of civil is that under the guidance of the government urban renewal unit original owners and land developers set up a renewal development company which takes care of all renewal work including relocation, moving back, rebuilding, new real estate construction and so on.

Through this mode, the former demolition work and the later construction work are unified. The renewal development company takes care of all renewal work so as to control the renewal schedule easily. The original owners participate in the former work through holding, so that the legal rights of the original owners can be protected fully, contradiction from relocation issue and property issue can be reduced and renewal procedure can be sped up. As supervisor the government guides the renewal work and avoids developer's speculation for profit maximization. It effectively guarantees renewal work towards the planning direction and social benefit maximization.

But the original owners and developer set up a renewal development company together, so it's difficult to coordinate some problems, such as company decision, the distribution of the management right, interests division and so on. If in an urban renewal unit the quantity of the original owners is large, it's hard to balance them. It's better that there is only one developer to avoid the decentralization of interests and the inharmony of planning management.

28.3.3 Mode Three: The Government Guidance, the Owners Taking It Alone

The government guidance, the owners taking it alone is that under the guidance of the government urban renewal unit original owners set up a renewal development company alone which takes care of all renewal work including relocation, moving back, rebuilding, new real estate construction and so on.

Through this mode, renewal unit original owners get huge profits with high enthusiasm. And it avoids many problems, such as relocation issue, property issue and so on. Through this mode, the former demolition work and the later construction work are unified. The renewal development company takes care of all renewal work so as to control the renewal schedule easily. As supervisor the government guides the renewal work and avoids developer's speculation for profit maximization. It effectively guarantees renewal work towards the planning direction and social benefit maximization.

But this mode requires more to the renewal development company which is set up by the original owners alone. What's worse, in terms of economic strength, technical strength, company management and so on, the renewal development company's level is low. It lacks professional and it can't guarantee the quality of project. So this mode will reduce the comprehensive benefit of the whole area. If in an urban renewal unit the quantity of the original owners is large, it's hard to balance them.

28.3.4 Mode Four: The Government Guidance, the Developer Taking It Alone

The government guidance, the developer taking it alone is that under the guidance of the government developer takes care of all renewal work alone including relocation, moving back, rebuilding, new real estate construction and so on.

Through this mode, developer with strong technical strength, rich experience and management ability can improve the land's market value and social effect so as to maximize the value of land development. Through this mode, the former demolition work and the later construction work are unified. The renewal development

Table 28.1 The comparison of four development modes

	Mode one	Mode two	Mode three	Mode four
Subject	Owner, developer	Owner, developer, government	Owner, government	Developer, government
Guidance of government	Bad	Good	Good	Good
Initiative of owner	Good	Good	Good	Bad
Benefit of owner	Good	Good	Better	Bad
Difficulty of the issue of property rights, relocation compensation	Small	Small	Small	Big
Control of procedure	Hard	Easily	Easily	Hard
Land development effects	Good	Good	Bad	Good

company takes care of all renewal work so as to control the renewal schedule easily. As supervisor the government guides the renewal work and avoids developer's speculation for profit maximization. It effectively guarantees renewal work towards the planning direction and social benefit maximization.

But in this mode, developer, between the original owners and the government, has many problems about relocation issue, property issue, planning of government, land price and so on. Renewal work is difficult to carry out. The original owners can't accept this mode easily due to the huge relatively concentrated interests. Developer prefers the areas with low removal cost and high rate of return to the areas with high removal cost. But in terms of city's overall development and public interest, the areas with high removal cost need renew more. So the goal of city's overall development and public interests will be damaged.

The comparison of four development modes, as shown in Table 28.1.

Compared with four modes, mode two involves all the stakeholders, namely owner, developer, government. It makes full of the government. Besides, it effectively guarantees the benefit of owner and the public. The owner is active, which reduces the difficulty of property rights and relocation compensation. In general, mode two can make better land development effects.

28.4 The Development Mode of Urban Renewal Unit in Shenzhen

With the rapid economic development and land development, there are a lot of special historical problems left in Shenzhen, especially residential area issues. For the urban renewal unit with a lot of residential areas, in order to resolve renewal issues, speed up renewal procedure and improve land utilization rate, we must choose the appropriate development mode combining the characteristics and bottleneck of renewal unit in Shenzhen.

28.4.1 Renewal Bottleneck of Residential in Shenzhen

In an urban renewal unit of Shenzhen, residential renewal is not only the main content, but also the difficult point. With the rapid economic development and land development, there are a lot of special historical problems left in Shenzhen, such as property issue, illegal construction and so on, especially in Urban Village of Shenzhen.

28.4.1.1 Property Confusion of Land and House

From October 28, 2004, all land is urbanized into state-owned land. Although the urbanization has been finished, land property is much more than ten kinds, such as collective construction land approved by the original country government, land for being rich, land for poor people, building land approved by district government, even construction land taken illegally and so on. And through the management system changing many times, original country collective land is delimited differently by different government in the different stage. The related policy about urban village fails to cover all scope and land property can't be confirmed clearly.

In terms of land use right, part of urban village land changes into illegal non-agricultural construction land, but the original country government can't get the legal use right of the other part of urban village land which isn't changed into state owned land including a lot of illegal construction. The confusion on property rights is the obstacle of demolition and compensation of residential areas, which bars renewal work from implementing smoothly.

28.4.1.2 The Proliferation of Illegal Construction

Urban village is originally the private houses which are built on rural homestead. With the rapid urbanization and industrialization, there is huge economic interest by renting in the urban village. So the villagers start to "plant house" instead of farming, which leads to the increasing inflation of size and number of urban village. Although the government has introduced policies many times to limit the construction standard of private house in urban village and set deadline of being illegal building, due to a variety of reasons the policies are forced to give in. There are unfair phenomenon between different village collectives and different villagers. It leads to the overbuilding binge again and again, which makes the scope of illegal construction huge.

There is rural land red line demarcated in the special zone. Most of the illegal construction is within the red line. Most of private houses have been rebuilt. The height of building is more than 8 stories generally and even topped 18 stories. Outside the special zone, it's worse. The illegal construction is beyond the red line in some villages. These illegal construction not only focus on urban villages, key development areas and transportation corridors, but also exit in water protect areas, ecological protect areas, green belt and so on. Some illegal activities are very rampant, such as illegal land trade, new land excavation and so on. There forms nascent invisible real estate market. And there exits o lot of small property housing.

There is a jargon in planning circles of Shenzhen, namely bypass the urban village during planning and avoid the problems about illegal activities and inefficiency. Confusion of property and weakness of management make these problems worse.

28.4.1.3 Employment Difficulty of Local Residents

The owners of residence are mainly local residents in Shenzhen, namely the original villagers. Due to the elements of high economic profits and social network formed by land and social ideology, the villager employ themselves and get considerable income by renting houses and providing freight service. They are very active in this market now. That means rent is the main income of local residents. During urban renewal we must consider local residents' employment problems and income source problems, in order to ensure the standard of living of the local residents.

28.4.1.4 Live Difficulty of Migrant Workers

With the development of economy in Shenzhen, a lot of nonlocal people pour into Shenzhen, especially villagers. It leads to a lot of housing demand. On one hand, the urban housing is limited. On the other hand, the rent of urban housing is much beyond the acceptable limits of the migrant workers. So under Chinese urban and rural system, the informal settlements in the urban village become the transition region for a large number of surplus rural labor population, because of low rent and close range to work place. During urban renewal we must consider the live problem and properly arrange basic life need of the migrant workers, which require more to urban renewal work of residential in Shenzhen.

28.4.2 The Development Mode of Urban Renewal Unit in Shenzhen

Based on the problems of residence in Shenzhen, the urban renewal unit of Shenzhen must be armed with the following characteristics: (1) to solve the problems about the property of land and house reasonably, or to avoid these problems to carry out renewal. (2) deal with the illegal construction in residential areas reasonably. (3) guarantee the original owners' interests and income in future fully. (4) consider the live issue of the migrant workers fully. (5) improve the land-use ratio of original residential areas and improve its economic value.

Through the comparison of the four development modes, the development mode two fits urban renewal unit in Shenzhen best, namely under the guidance of the government urban renewal unit original owners and land developers set up a renewal development company which takes care of all renewal work including relocation, moving back, rebuilding, new real estate construction and so on.

The original owners participate in the former work through holding, so that the legal rights of the original owners can be protected fully, contradiction from relocation issue and property issue can be reduced and renewal procedure can be sped up. As supervisor the government guides the renewal work and avoids developer's speculation for profit maximization. It effectively guarantees renewal work towards the planning direction and social benefit maximization.

But there are still some shortages and inadvisability in this mode. Based on these shortages and the characteristics of residential areas of Shenzhen, we can put forward the following suggestions for this mode.

1. We must make most of the effective guidance and supervision from the government in order to avoid that The original owners and developer maybe execute favorable policy, avoid unfavorable policy and even bribe the government officials illegally in order to maximize their benefit. The Government must review the project strictly. And only in line with the Government's planning direction, included in the government urban renewal plan, can be applied. It Effectively prevent the development at random for the private interests, strengthen the guidance and supervise of government in urban renewal work and guarantee the maximization of the interests of society.
2. It's better that there is only one developer to avoid the decentralization of interest and the in harmony of planning management.
3. In terms of the property of the renewal development company, the government must formulate the perfect regulations to avoid poor management due to property issue.
4. When the renewal development company is founded, the parties must delimit the management right distribution, interest distribution and so on in more detail in order to avoid the confusion in the future in order to avoid the confusion in the future.

28.5 Conclusion

Shenzhen founded just more than 30 years, faces severe challenges of shortage of space resource earlier than other cities. Urban renewal is the effective way of urban sustainable development. Because the value of land in Shenzhen is higher than other cities, there is more space of profits for urban renewal, which leads to better market demand and power. No matter economic development or social harmony development, urban renewal may have important effect on the future of Shenzhen. As the important way of social interest redistribution, there is the complex interest contradiction in the urban renewal unit. We must explore reasonable development mode for urban development unit in Shenzhen and deal with the interest distribution reasonably during renewal, which can lay the foundation for urban renewal unit system in Shenzhen and urban renewal work in other areas.

Shenzhen is not the only city which faces severe challenges of shortage of space resource. Shenzhen borrows experience of urban renewal unit from Taiwan. In terms of the process of urban renewal, Shenzhen goes ahead of other cities. Through the research of development mode of urban renewal unit in Shenzhen, I hope to lay the foundation for urban renewal unit system in Shenzhen and urban renewal work in other areas.

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Chapter 29
On the External Driving Force of Industrial land Prices in the Pearl River Delta: A Game Model Analysis

Bibo Zheng, Yuzhe Wu, and Xiaoling Zhang

Abstract It has been over 20 years that land was taken into the economic market as a factor of production. However, as it is influenced by the planned economic system in the past, the administrative intervention of governments has brought about the "market failure" on the allocation of the industrial land For all these reasons, a lot of industrial lands have been sold at very low prices. The losses of state-owned land and extensive land use have caused a lot of negative consequences to industrial land market and the management of industrial land. This paper took the perspective of the international game to investigate the industrial land price formation mechanism of the Pearl River Delta. Firstly, the conditions of industrial land in the Pearl River Delta and Southeast Asian countries like Vietnam, Thailand and Malaysia are analyzed to explore the industrial land prices in recent years. This is followed by a game theory model of international industrial land prices. In this way, this paper found the low-cost strategy from the governments should be prevented to avoid high social cost. Finally, relevant policy suggestions are put forward to encourage the appropriate use of industrial land use in China.

Keywords Pearl River Delta • Industrial land • Game model • Price mechanism

29.1 Introduction

Since 1992, China realized the historic leap of industrialization from the initial stage to Medium-term. The economically developed coastal regions have formed a three-industrial- structure based on traditional industries, high-tech industry and the Harbor

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_29, © Springer-Verlag Berlin Heidelberg 2014

Industrial prototype. However, the great achievement of China's industrialization is based on the path of construction land encroaching on the cultivated land. With the advancement of the country's industrialization, China's demand for industrial land is increasing, which leads to the expansion of industrial land. Meanwhile, in China, the development of industrialization is generally regarded as an important strategic to achieve higher economic growth. In order to obtain political achievements, the local governments generally take the race of lowering industrial land prices to attract investment, which brings many adverse consequences to the industrial land market and the industrial land management. To avoid the extensive use of industrial land, establishing a cooperation pricing mechanism of industrial land in the inter-regional is very important. At the same time, when we look at the world, we find that the competition in the international investment is also fierce staged. Therefore, in the process of setting prices, we also need to consider the pricing strategies of the neighboring countries. Currently, Southeast Asian countries come to be threats to China's Foreign Direct Investment, especially Vietnam,Thailand and Malaysia. These countries neighboring to China's Pearl River Delta have great potential for development. They also try to compete with China in the race of attracting international investment. Thus, international competition and game have a significant impact to the price setting of industrial land. This paper aims to find the external drive force of industrial land prices in the Pearl River Delta to study how international competition and game affect the land price of the delta, then finally find ways to improve the land price system.

29.1.1 Literature Review

In recent years, many foreign scholars took advantage of empirical analysis to explore the price of industrial land. Speaking of research methods, foreign scholars analyze urban industrial land price formation mechanism mainly through establishing kinds of data models. Canadian Urban Economist, Capozza and Helsley proposed the dynamic model of urban land prices to find out the driving forces which cause changes in urban land prices [1]. Another two Canadian Economist Michael Goldberg and Peter Chinloy carried out a series of system analysis on the demand for industrial land and other uses of land, the speculative demand of land as well as urban land supply and price [2]. They even established a balanced model of the land market. Bruechner, Adams, Wheaton, Paul attempted to establish land price model to discuss the spatial distribution rules as well as the impact of different investment conditions on the industrial land prices in different cities. Jieming Zhu found that labor and property were two local factors of manufacturing production cost during the changing process of Singapore's manufacturing. The change of the two factors prices contributes to the change of industrial land price, as well as industrial structure [3]. With empirical analysis, Hilary Sigman argued that joint and several liability would drive down industrial real estate prices, and also increase the vacancy of industrial land which deterred redevelopment [4].

The research on industrial land price mechanism in China is mainly concentrated on the origin of low-price strategy. In qualitative research, Luo Yunhui, Lin Jie used the theory of "public domain" to analyze the excessive competition on land price. They made a preliminary illustration about why local governments compete to lower industrial land price, and think the basic reason of the excessive competition is the universality of the public ownership system [5]. Wang Yuli studied the development of industrial land in Ningbo, and found out the fundamental problem is that China's rural land property rights are unclear, and local governments' management on industrial land are in their own way [6]. Li Junjie believed it was the competition among local governments that enlarges their "Incentives variation" and "Agent variation". One manifestation is the Prisoner's Dilemma of the preferential land policies in attracting investment.

In quantitative study, the game theory is common in the research of land price mechanism. Qin Xinglong built up an empirical model to describe the internal mechanism of industrial land price in the Yangtze River Delta region and the game among cities. He believed the game of the industrial land price is actually a game between the local governments [7]. Using Game Analysis, Wu Yuzhe found that Individual rationality pursues maximum interests in their own district. Therefore, when the interests outweigh the consequence initiated by cutting land price, the local governments would rather lower price to attract investment [8].

29.1.2 Methodology

Game theory is a study that works on making optimal decisions in conflict condition. As early as 2,000 years ago, a military treatise – The Art of War, which contained profound ideological of game theory had appeared. In the last 10 years, especially after Nash won the Nobel Prize in Economics, game theory research began to enter into the mature period of development. Now it is well-known that in a two-person-game, when the other one's strategy is given, whatever strategy the other side selects, each player can choose their own optimal strategy to achieve maximum utility. Nash equilibrium refers to such a strategy balance, that is for each participant, as long as other people do not change their tactics, he will not be able to improve their own situation. In other words, as long as someone else's behavior is determined, the competitor can have the best strategy, and the equilibrium is existed and stable.

29.2 Case and Data

The Pearl River Delta is located in the Southeastern part of Guangdong Province. It is close to Hong Kong, and faces with Southeast Asia across the sea. The sea land transportation is very convenient, known as the "South Gate of China". Since the reform and opening up, by virtue of predominant geological location, preferential

Table 29.1 2011 industrial land price comparison among the pearl river delta and three countries in Southeast Asia

Country(region)	The Pearl River Delta	Vietnam	Thailand	Malaysia
Land price(RMB/m^2)	795	260	380	135

Note: The data of the Pearl River Delta is obtained through the China Urban Land Price Monitoring http://www.landvalue.com.cn/, the data of southeast Asian countries is obtained through http://www.vnone.vn/Industry/,http://www.ieat.go.th/ieat/map/info/status_cn.html, http://202.190.126.187/cn/

policies of central and local governments' cheap land and human resources, the Pearl River Delta gave full play to the role for reform, and has achieved many notable achievements.

In the process of reform, Vietnam has continually learned experience of reform and opening up from China. At the same time, by absorbing foreign investment, Vietnam constantly improved the industry's modernization, and promoted the upgrading of the industrial structure. Thailand has been known as one of "Tiger Cub Economies", and attracted a lot of foreign investment in the 80s. Due to domestic political turmoil, the economy is slowing down in recent years. But it has solid industrial foundation, the trend of development is still cannot be underestimated. Malaysia takes advantage of abundant resources and unique geographic location, meanwhile commits itself to improve the investment environment and strengthen investment incentives. Now more than 50 countries, altogether 4,000 companies have taken Malaysia as their industrial bases overseas.

The above table (Table 29.1) shows that the average price of industrial land in the Pearl River Delta is much higher than the other three countries. In the three Southeast Asian countries, Thailand's industrial land prices are relatively high, thanks to its overall sale of industrial land and ancillary services sales model. Followed by Vietnam and Malaysia, the industrial land prices set between 100 and 300 RMB.

29.3 Modeling

29.3.1 Model building

This article assumes the total investment is fixed, and investors have to choose funding recipients between country A and country B who are players in the model. Investment is measured by its output and intensive use of industrial land use. As shown in Table 29.2, the land price strategies the two countries adopt determine their investment and land use station.

In order to quantify the build model, the paper also made the following specific assumptions:

1. Under the normal premium in both countries, intensive land-use and land-transferring fees just compensate the cost of preparation works of a construction.

Table 29.2 Policy game of land price between the two countries

Country A's policies	Country B's policies	
	B1(normal price)	B2 (low price)
A1(normal price)	Both intensive land use	A: Intensive, land use with a decrease in investment
	No effects on investment	B: Extensive land use with a increase in investment
A2(low price)	A: Extensive land use with a increase in investment	Both extensive land use
	B: Intensive, land use with a decrease in investment	No effects on investment

2. Suppose an investment project can generate annual production value of G, the production life of the project is n, and the output value in the project cycle is nG. Assuming the scale of investment project is large enough, so it can be broken down and invested in different countries.
3. Suppose country A and country B's investment attractiveness is determined by the comprehensive investment environment which embraces land price and country A can attract major share of investment with better investment environment, with m representing country A's share. Under certain conditions, the two countries come to such a balanced station: A:mG; B:(n-m)G, n/2≤m≤n.
4. If country A and country B both lower the land price, then causes the total land loss as L, which includes the direct price loss and the social costs caused by low price.
5. If one country attempts to lower price to attract investment, then part of the investment will transfer to this country. Investment transfer coefficient k is a multiplier of the original investment. Due to the expansion of investment in a country, the land loss will also expand accordingly. Suppose when the investment transfer coefficient is k, country A will generate land loss as mL/n, and country B will generate land loss as (n-m)L/n.

At this point, K meets the following conditions: k > 1; n-km > 0; n-kn+km > 0.

According to the above assumptions and the game theory, the earned value of the two governments include output value and loss of low price (consists of the direct price loss and the social costs caused by low price), then get Table 29.3.

This paper introduces a land loss coefficient w, and assumes total land loss L= nwG. Assume that the annual production value G is a basic unit, namely, G = 1. Meanwhile, in order to facilitate the calculation, Table 29.3 will be presented as win matrix, then the two countries' win matrixes will be:

$$A = \begin{pmatrix} m & n - kn + km \\ km - mw & m - mw \end{pmatrix} \tag{29.1a}$$

$$B = \begin{pmatrix} n - m & (n - m)(k - w) \\ n - km & (n - m)(1 - w) \end{pmatrix} \tag{29.1b}$$

Table 29.3 Policy game of land price between the two countries (indicated by parameter)

	Country B's policies	
Country A's policies	B1(normal price)	B2 (low price)
A1(normal price)	mG,(n-m)G	(n-kn+km)G, k(n-m)G-(n-m)L/n
A2(low price)	kmG-mL/n,(n-km)G	mG-mL/n, (n-m)G-(n-m)L/n

29.3.2 Balanced Game Analysis of Model

Nash in 1951 proved there was at least one pair balance in any two person finite zero-sum game. At this point, either side unilaterally changes the strategy will not benefit. Clearly, in the above model, country A and country B's decisions are interacting, but at least there is a balanced game.

If Eq. (29.1a) satisfies the condition $\begin{cases} \text{m} \geq \text{km-mw} \\ n\text{-}kn + km \geq m\text{-}mw \end{cases}$, it means the strategy A1 in any case is better than strategy A2, then strategy A2 is redundant. At this point, w≥k−1. When Eq. (29.1b) satisfies the condition $\begin{cases} n\text{-}m \geq (\text{n-m})(k\text{-}w) \\ n\text{-}km \geq (n\text{-}m)(1\text{-}w) \end{cases}$, it means the strategy B1 in any case is better than strategy B2, then strategy B2 is redundant. At this point, $\text{w} \geq \frac{(k-1)m}{n-m}$. In conclusion, when $\text{w} \geq \frac{(k-1)m}{n-m}$, low price strategy is needless for country A and country B. Similarly, when $\text{w} \leq \frac{m-n+kn-km}{m}$, both of the countries will adopt the low price strategy.

When $\frac{m-n+kn-km}{m} \leq \text{w} \leq \frac{(k-1)m}{n-m}$, it is a mixed strategy. Suppose that country A will take the probability of x to adopt strategy A1, and the probability of 1−x to adopt strategy A2(x∈[0,1]); Country B will take the probability of y to adopt strategy B1 and the probability of 1−y to adopt strategy B2 (y∈[0,1]). Then get the country A and country B's strategy probability matrix α, β:

$$\alpha = [\text{x} \;\; 1 - \text{x}] \tag{29.2a}$$

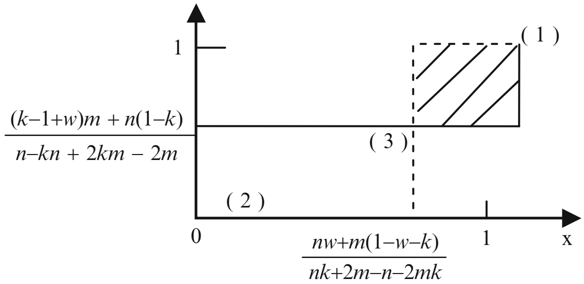
$$\beta = [\text{y} \;\; 1 - \text{y}] \tag{29.2b}$$

And then get the expected values of country A and country B.

$$\begin{aligned} E_A &= \alpha A \beta^T \\ &= [(\text{2m-2km} + \text{kn-n})y + (k\text{-}1 + w)m + n(1\text{-}k)]x + (km\text{-}m)y + m\text{-}mw \end{aligned} \tag{29.3a}$$

$$\begin{aligned} E_B &= \alpha B \beta^T \\ &= [(\text{n} + 2mk\text{-}nk\text{-}2m)x + nw + m(1\text{-w-}k)]y + [(k\text{-}1)x + 1\text{-}w](n\text{-}m) \end{aligned} \tag{29.3b}$$

Fig. 29.1 Country A and Country B's price strategy game balance



To make the expected value as large as possible, country A will use the mixed strategy listed below:

$$x = \begin{cases} 0 & \dfrac{(k-1+w)m+n(1-k)}{n-kn+2km-2m} < y \leq 1 \\ \text{any number between 0-1} & \mathrm{y} = \dfrac{(k-1+w)m+n(1-k)}{n-kn+2km-2m} \\ 1 & 0 \leq y < \dfrac{(k-1+w)m+n(1-k)}{n-kn+2km-2m} \end{cases} \tag{29.4a}$$

Eqaution (29.4a) shows three cases: (1) when $\frac{(k-1+w)m+n(1-k)}{n-kn+2km-2m} < y \leq 1$, $[(\text{2m-2km} + \text{kn-n})y + (k\text{-}1 + w)m + n(1\text{-}k)] < 0$. In this condition, only "x = 0" can ensure the value of be the maximum. It means that to make E_A as large as possible, country A will ignore the normal price strategy, so the probability of normal price strategy country A will take is 0. (2) When $0 \leq y < \frac{(k-1+w)m+n(1-k)}{n-kn+2km-2m}$, $[(\text{2m-2km} + \text{kn-n})y + (k\text{-}1 + w)m + n(1\text{-}k)] > 0$. In this condition, only "x=1" can ensure the value of be the maximum. It means that to make E_A as large as possible, country A will use the normal price strategy, so the probability of normal price strategy country A will take is 1. (3) When $\mathrm{y} = \frac{(k-1+w)m+n(1-k)}{n-kn+2km-2m}$, $[(\text{2m-2km} + \text{kn-n})y + (k\text{-}1 + w)m + n(1\text{-}k)] = 0$. The value of x has no effect on E_A. So country A can take any probability of x.

Similarly, to make the expected value E_B as large as possible, country B will use the mixed strategy listed below:

$$y = \begin{cases} 0 & 0 \leq x < \dfrac{nw+m(1-w-k)}{nk+2m-n-2mk} \\ \text{any number between 0-1} & x = \dfrac{nw+m(1-w-k)}{nk+2m-n-2mk} \\ 1 & \dfrac{nw+m(1-w-k)}{nk+2m-n-2mk} < x \leq 1 \end{cases} \tag{29.4b}$$

Combining formula 29.4a and 29.4b, we can obtain the Diagram 1. Taking advantage of the diagram, we can find the balanced decision in the game. The solid line and dotted line in Diagram 1 respectively represent the mixed strategy of country A and country B.

In Fig. 29.1, there are three intersections: (1) When $w \geq \frac{(k-1)m}{n-m}$, the balanced game is (A1,B1); When $w \leq \frac{m-n+kn-km}{m}$, the balanced game is (A2,B2); (3) When $\frac{m-n+kn-km}{m} \leq w \leq \frac{(k-1)m}{n-m}$, the probability balanced game is $[(x, 1-x), (y, 1-y)] = \left[\left(\frac{nw+m(1-w-k)}{nk+2m-n-2mk}, 1-\frac{nw+m(1-w-k)}{nk+2m-n-2mk}\right)\left(\frac{(k-1+w)m+n(1-k)}{n-kn+2km-2m}, 1-\frac{(k-1+w)m+n(1-k)}{n-kn+2km-2m}\right)\right]$.

29.4 Findings

The above analysis shows that when n, m and k are certain, the value of w determines the policies adopted by the local government. Next, the author will take the Pearl River Delta and Thailand for example to make an empirical analysis of the formation mechanism of the Pearl River Delta industrial land prices.

Assume that there is a project which can produce 850,000 RMB 1 year, and an industrial land of 1,500 m^2. According to the investigation of the resource endowments of the two regions, the author assumes $n = 15$, the Pearl River Delta occupies major share of the investment, $m = 8$. The coefficient of land price loss consists of two parts: direct price loss and the social costs caused by low price. If the normal price of the land is 600,000 RMB for 1,000 m^2, according to the data of Table 29.1, the price is merely 250,000 RMB for 1,000 m^2, then direct price loss of the land will be 525,000 RMB. If w_2 is ignored, then $w_1 = 52.5/15/85 = 0.041$. At this point, as long as the investment transfer coefficient $k > 1.035$, in other words, as long as the unilateral low price strategy can increase investment by 3.5 % or more, $w = 0.041 < \frac{(k-1)m}{n-m}$.

Similarly, for the Pearl River Delta, direct price loss of the land will be 105,000 RMB. If w_2 is ignored, then $w_1 = 10.5/15/85 = 0.008$. At this point, as long as the investment transfer coefficient $k > 1.008$, in other words, as long as the unilateral low price strategy can increase investment by 0.8 % or more, $w = 0.008 < k–1$.

Considering both conditions, when $k > 1.035$, both of the regions will take low price strategy. According to the results of the model, the balanced game is (A2, B2), which means both regions adopt low price strategy.

In the above case, if the governments of Thailand and the Pearl River Delta don't consider w_2, when $n=15$, $k>1.035$, then the balanced game will be (A2, B2),and both regions adopt low price strategy. Therefore, only to consider enough social cost, can the local governments change the above situation. Let $w_2=4w_1$, w_2 of the Pearl River Delta $=10.5/15/85 = 0.008$, then $w=w_1+w_2 = 5w_1 = 0.040$. At this point, let's assume $k = 1.04$, it means unilateral low price policy can increase investment by 4 %, then $\frac{m-n+kn-km}{m} = 0.035 < w < \frac{(k-1)m}{n-m} = 0.044$, the two regions will adopt a mixed strategy. The Pearl River Delta and Thailand will take the normal price strategy both with the probability of 100 %. It suggests that in the case that k is determined, increasing the social cost of the region holding major investment can push the players to transfer to the mixed strategy.

29.5 Conclusion

Combine the background of industrial transferring and upgrading, in order to curb the phenomenon of common low price strategy, it is necessary for governments to undertake all the social costs caused by low price. The author suggests that the central government should monitor the land price directly, and levy heavy fines on local governments for introducing low value-added, gas-guzzling or polluting industries of local governments. At this time, w is increased, if let $\mathrm{w} = w_1 + w_2 \geq \frac{(k-1)m}{n-m}$, then the balanced game is (A1, B1) according to Fig. 29.1, and both sides choose normal price policy. The implementation of normal price strategy improves the threshold of the Pearl River Delta's industry, then drives those enterprises with low land use capability and weak competitiveness out. Thus to facilitate the process of selecting the superior and eliminating the inferior. balance between open, promote the whole the competitiveness of the pearl river delta region, so as to enhance the competitiveness of the Pearl River Delta region as a whole.

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Chapter 30
Shenzhen Urban Renewal Mode Choice and Suitability Study

Zhigang Zhou

Abstract Urban renewal is an important way to transform the old districts to be a modern metropolis. Now the urban renewal will replace the new construction land as the main source of the Shenzhen land resources supply. But the promotion of urban renewal project is not satisfactory in the past years. How to improve the level of the urban renewal? In the paper the author has discussed the different modes of urban renewal in Shenzhen, made comparison of the five modes. But what kind of mode should be taken in different categories of urban renewal project? What are the advantages and disadvantages of the different modes? Which mode is suitable for the different case? Such questions have not been discussed much in the past research. The author has given the answer in the paper.

Keywords Shenzhen • Urban renewal • Mode • Suitability

30.1 Foreword

Urban renewal is a major urban development issues in many countries. It's the means to solve the fundamental contradiction of urban development. The old urban areas can be effectively improved to be a modern metropolis. Urban renewal is not a short-term behavior, but a long-term, persistent process. It contains protection, repair, alteration, update and many other contents, and often combined.

The concept of urban renewal in the United States: the self-transformation process of the poor environment of the community, the low standard, backward planning, the areas of poverty. During the mid-1970s, the United Kingdom proposed the concept of "urban regeneration" in British Metropolis Plan: a comprehensive and

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_30, © Springer-Verlag Berlin Heidelberg 2014

integrated ideas and actions to solve urban problems, seek a continuous improvement of a region in economical, social, cultural and natural environmental conditions.

The concept of urban renewal in our country's Urban Planning Law is: to transform the old districts of the city in order to improve living and working conditions to achieve the requirements of people's social, political, economic and spiritual life. Some of our planning experts proposed in recent years the concept of urban renewal: enhancement of the connotation of the urban development, reorganization of the structural in space, reconstruction of urban functions system, improvement of the level of the regional development.

30.2 The Background of Shenzhen Urban Renewal

30.2.1 The Significance of Shenzhen Urban Renewal

Shenzhen serves as the forward position of reforming and opening city, a small fishing village became the international city at the same time, also as a result of historical reasons left behind a huge amount of old housing estates, old industrial areas and other buildings. Shenzhen has only 142 km^2 of new construction land, and the expansion potential has been close to the limit. Although Shenzhen is a young city with only 32 years, also has to face the challenges of unsustainable space resources. According to The General Plan of Shenzhen (2007–2020) (Draft), the urban renewal will replace the new construction land as the main source of the Shenzhen land resources supply.

In the face of these challenges, pressures and demands, the Shenzhen Municipal Government, has taken the lead in the system construction of urban renewal early since the end of 2004, a pilot basis for the national experience. But after 8 years of practice, the promotion of urban renewal project is not satisfactory, which also exposed contradictions of the insufficient or absence arising of the government. In order to meet the industrial upgrading and modernization of urban construction, Shenzhen Urban Renewal Means has been implemented in December 2009. We can say that the success of urban renewal is to improve the living environment, realize the land intensive utilization, stimulate the city of vigor and vitality, is the premise of sustainable development [1].

Urban renewal is a redistribution of the interests of the community, government, markets and the public; owners, tenants and developers; sector, local and personal, complex conflicts of interest is always wrapped in the process. We can say that, both from the point of view of economic development or social harmony, urban renewal has an important significance of Shenzhen's future development.

30.2.2 The History and Status Quo of Shenzhen Urban Renewal

Because of the excessive pursuit of speed and short-term benefits in the early construction of Shenzhen, the problem of old urban architecture and urban functions has become increasingly prominent. Therefore, Shenzhen's urban renewal has produced back in the late 1990s, urban renewal activities gradually carried along with the large-scale urban construction. Shenzhen urban renewal which carried out by the end of the last century to nowadays, has gone through three stages:

The first stage: market-oriented, enterprises as the mainstay of spontaneous urban renewal. The success story of this period is the transformation of Huaqiang North by Vanke. The transformation of the market as the main driving force, the enterprise as the vanguard, the government seems to be rather slow.

The second stage: The transformation is characterized by government intervention, the organization promoting the villages to carry out large-scale reconstruction.

The third stage: government-led, relatively comprehensive urban renewal to include more aspects of the villages, the old industrial areas, old city. The characteristic of this period is the Government attaches great importance to the various departments of the comprehensive actions to actively promote. Because of the context of unsustainable land resources in Shenzhen, urban renewal has been identified as the focus of the Shenzhen Municipal Government. In September 2009, the Ministry of Housing and Urban, determined Shenzhen as the pilot city for urban renewal. It is understood that the city's need for urban renewal with a total land area of about 200 km^2. The main kinds of the objects are villages, old villages and old industrial areas. Shenzhen will strive to complete 176 km^2 of urban renewal before 2020. After the introduction of the Shenzhen Urban Renewal Means, the municipal government has approved 25 urban renewal projects.

30.3 Shenzhen Urban Renewal Typical Modes of Case Study

The urban renewal projects have been divided into three types in Shenzhen urban renewal means: comprehensive improvement, function to change, as well as demolition and reconstruction. Rules for the Implementation of the Shenzhen urban renewal means has been promulgated by the Shenzhen Municipal Government on January 21, 2012, which to further clarify the implementation details of the three urban renewal types. Different from the three types which divided in Shenzhen urban renewal means, the author summed up five different typical modes according to the characteristics of the implementation of the subject and the way of renewal in Shenzhen's urban renewal practice.

30.3.1 Government-Led Mode

30.3.1.1 Typical Case: Dachong Urban Renewal Project

Dachong village is located in the High-tech Park area. The project covers an area of 684,000 m^2, involving all types of buildings of more than 1,400 buildings, total building area of more than 100 million square meters, land for construction about 360,000 m^2, the resident population of nearly seven million people. The total investment of the project is 20 billion Yuan. In 1998, the municipal government determined to take transformation of this old village, in 2002, it became as a pilot renewal village of Shenzhen. In 2008, the working group of the Nanshan District Goverment had been beginning to work in the project till now. In December 2011, the contact has been signed (accounting for 99.4 % of the total). Now the demolition work nearing completion, and start building the first phase of the project.

According to the plan, the goal is to build international quality, to show the new communities in the future diversification of urban vitality. Important base for supporting a high-tech industrial park in Shenzhen and OCT scenic, and exemplifies the effect of economic restructuring and social transformation.

30.3.1.2 Mode Characteristics–Government-Led, Market Operation

The government-led mode is the innovation of the Dachong project. It's determined by the size of the project for municipal transformation properties and the project. It's the largest project in Guangdong Province. In order to ensure that urban renewal in accordance with the direction set by the government planning forward, The Working Group of Nanshan District Government officially stationed in the village in 2008, it took part in the entire process till right now. It is understood that there were 30 workers in the Working Group, including leader, deputy head of the government, Visible, the most important feature of this mode are: government-led, full participation, full intervention.

30.3.2 Developer-Led Mode

30.3.2.1 Typical Case–Caiwuwei Urban Renewal Project

Caiwuwei village located in financial center of Shenzhen, the overall renewal of an area of 120,000 m^2, covering the village all the unmodified region need to remove the old village area of 440,000 m^2. Currently, the Jingji Group has created a city landmark in Shenzhen, one of the complex set of office buildings, hotels, commercial as one of the world's highest buildings, is a successful case of urban renewal. The project has enhanced the brand development and operational capabilities. The building of Jingji100 will continue to introduce international Fortune 500 companies and multinational financial institutions' headquarters in China to build world-class corporate headquarters is located, hand in the world's top hotel management companies together to build a super-five star luxury hotel–St. Regis Hotel, which has been put into operation in the building. The shopping mall named KK-Mall also was opened in 2010 with the lease rate of 95 %. Through the first phase of urban renewal, the film area of city appearance and environmental greatly enhance the dirty, chaotic, and poor villages into urban high-end business district. It has provided about 360,000 m^2 of industrial space to meet the need of the Luohu District after the completion of the project. According to the plan in the next 5–10 years, the government will build more buildings over 400 m tall building in this area.

30.3.2.2 Mode Characteristics–Government Guidance, the Developer-Led

In the developer-led mode, the developers invested heavily in the acquisition of the original owners of the property, in addition to compensation to the original owners of the property, developers get the most of the property rights of the property. This process, the private houses of the villagers became the real estate products, with the certificates of title, succession, transfer, transaction. At the same time, the transformation to stay out of the commercial properties to the village AG, to promote the collective economic transformation and upgrading. Without worry and effort, the original owners have no repayment pressure, but most of the development gains have been taken by the real estate enterprise, the original owners can only be moved back to the room of compensation, the village AG has part of commercial properties, which can produce continual operating income after the urban renewal.

30.3.3 Village AG-Led Mode

30.3.3.1 Typical Case: Tianxia Urban Renewal Project

Tianxia is located in the Nanshan District, belonging to the node position of the Nanshan political and cultural center. Tianxia began the urban renewal project in 2006. Tianxia village AG decided that: All the 800 villagers' housing land would be stock-shares to take participation in the project's profit allocated to the renewal of the village. The so-called land shares, is an independent development project by the Village AG profit distribution to the villagers of the homestead area involved in the project as shares, rather than the villagers' original construction area to measure. "Housing land shares" mode can avoid many problems, such as general compensation for the demolition compensation mode to calculate the building area, this will cause the villagers not to construct illegal buildings [2].

In the development of Tianxia Jade Pearl project, Tianxia is no longer seeking a real estate company to help the renewal of old village, but their own loans, self-development. To develop the property, part of the villagers moved back, the rest of the products are in sale. After the repayment, all its sales revenue has been owned by the original villagers. Overall, this is called third-generation transformation of old urban. This mode can completely break the relocation compensation mode, the first of its kind across the country, will not dwell on the so-called “demolition compensation rate”. Villagers have homestead stake in city reconstruction project and participate in the project the distribution of profits. It can grantee the villagers’ personal interests and the overall interests of the reconstruction, establish a reasonable interest mechanism in land allocation, keep the balance of interests among different participants.

30.3.4 Comprehensive Improvement Mode

30.3.4.1 Typical Case: Xinwei Urban Renewal Project

Xinwei is located in the Xili town, adjacent with Shenzhen Polytechnic, covers an area of about 250,000 m^2. The area of the project covers an area of over 40,000 m^2, construction area of 120,000 m^2, about 20,000 of the resident population. The comprehensive improvement project of Xinwei is the first one of the one-time implementation of a comprehensive, systematic, comprehensive renovation project of single village. In 2007, the Nanshan District Government commissioned to design the Xinwei’s remediation. Status quo of the village basically remain serious outstanding problems on lower property, rental income as a low-end level of the village economic support, and low utilization of land resources, and villages in the poor overall environment is not suitable for the development status of urbanization for Xinwei village. The government had not carried out large-scale demolition and reconstruction, but given guidance and regulation, as to keep continuation of the original culture, to maintain the existing ecological [3].

30.3.4.2 Mode Characteristics–Government Investment, Market Operation, Residents’ Participation

This mode is focus on the internal contradictions, under the government’s input, guidance and regulation, the old village would become a harmonious community with the requirements of a modern city, so as to achieve the desired effect within the specified time, and on the basis of the renewal work, allowed to self-generated hematopoietic function, to achieve self-regulation, sustainable development of the concept of circular economy. A total investment of 46 million Yuan had been put in the renewal project for 2 years, which including fire safety, building facades, municipal pipelines, roads, transportation, environment, and landscaping improvements, as well as protection of historical and cultural relics. Now the project has been fully completed.

30.3.5 Co-ordination Mode of the Whole Village

30.3.5.1 Typical Case: Jinsha Urban Renewal Project

In order to break the plight of land resources, expanding urban development space, land readiness is to become an effective way. Pingshan New Distric has made innovative mechanisms of land readiness. As the pilot of land readiness in Shenzhen, it's one of the major reform projects of the government focus on promotion. The land readiness project in Jinsha community is entrusted with the hope of the area to explore the SAR integration, restructuring and development. There are all types of buildings for 2,456 in Jinsha community, including 1,361 illegal construction, About 1 million square meters of building area. February 11, 2011, the government had set Jinsha community as "The whole village co-land pilot community" to establish a co-ordination mode with government-led, community-carry on. In this mode, Government, collective and residents are all in a balanced sharing of the incremental benefits of land readiness. Through the adjustment of land readiness and planning, Jinsha community will build 4.3 million square meters of construction area of 1.69 km^2 of land. In order to prepare 1.69 km^2 of collective land, the municipal and the new district government will invest over 70 billion Yuan.

30.3.5.2 Mode Characteristics–Government-Led, Community Based

Land readiness is regarded as "the third land reform". The Pingshan District was selected as the pilot area, Jinsha has become a pilot in the pilot area. February 11, 2011, the Ping Shan District determined Jinsha as the pilot community. The whole village co-ordination mode is characterized by a "top down" and "bottom-up" combination of work. The integrated use of urban planning, land management, property rights and related policies, optimize the integration of urban space, dedicated to "package" to solve community problems left by history, strength the community collective economy, the elimination of backward industries, the introduction of high-end sustainable development of industry, so that the original villagers to gain more benefits.

30.4 Mode Choice Based on Advantages and Disadvantages

30.4.1 The Government-Led Mode

30.4.1.1 Advantages

The first is the issue of fairness. Government can protect the public interests in the mode. Also it can ensure that the parties involved in the relative balance of interests, including the balance of the interests of owners or tenants, the interests of developers, public interests. The government can require the developers to support municipal improvement of the supply of affordable housing. For example, Dachong requires developers supporting the construction of 2,000 sets of the affordable housing provided free of charge to the government. The high-tech zones and road network will be able to transform living facilities and perfect the appearance of the city, enhance the city image with the oversight and intervention of government. Followed is the issue of indemnification. Government-led mode can ensure that urban renewal will not give up halfway, guarantee the interests of the villagers. Because of the worrying about the renewal project, some villagers refused to sign the contract. The government had guaranteed to be responsible for organization building to move back to replacement housing.

30.4.1.2 Disadvantages

The first is efficiency. Government-led mode, government plays an important role in the level of administrative efficiency directly affects the efficiency of the progress of urban renewal projects. Such as Dachong project, it has taken over 10 years to complete the demolition work. Second is the cost. The government is constantly in the full intervention in the human resources and administrative resources. In Dachong project, the Government has arranged more than 30 people, including the leadership and staff at all levels in different government department.

30.4.1.3 Scope of Application

Applicable to large-scale renewal project which is difficult, complex with social contradictions, historical legacy of problems, the project have a significant impact on city strategic nodes, and related to the construction of the city's premier municipal matching items.

30.4.2 The Developer-Led Mode

30.4.2.1 Advantages

The first is efficiency. The developers involved in urban renewal projects are all based on profit maximization as the goal. Therefore, the developer will leave no stone unturned to accelerate the project, whether it is the demolition of negotiations or the construction of the building stage will be strict schedule management to ensure efficiency. Such as the Jingji Group in Caiwuwei financial district projects, and actively promote the updating of the Jingji Group only in the KK-Mall Shopping Centre and the Jingji 100 office revenue is very impressive.

Meanwhile, the intangible benefits and impact is immeasurable, both effective in improving the Area Habitat environment, to achieve a highly intensive land use, to improve the city's comprehensive competitiveness, enhance the image of the city, play a good role in promoting. Followed are the professional issues. The developer's main business is real estate development and urban operations, the government, the village collective organizations do not have outstanding advantages in many aspects such as market research, brand marketing, product packaging, production and sale of building products, the latter property management. Many urban renewal projects in the core of the city, regardless of the renovation of old villages or old plant that its goal is to improve the quality and value of the original property, which is exactly what the developers are good at.

30.4.2.2 Disadvantages

First is the question of demolition. With the growing awareness of the ownership, the developers in the resettlement negotiations are easy to fall into a passive situation, and lack of administrative resources to promote it. For the purpose of profit, making the demolition of an impasse in negotiations, public opinion tend to protect the so-called vulnerable groups–are removed and relocated, so, throughout the endless stream of "anti-demolition owner" phenomenon is not hard to understand. There are some influential "anti–demolition owner" in previous Caiwuwei and Gangxia projects. The Caiwuwei case is still end with the concessions of the developer. Second is the issue of fairness. One hand is the developers, owners equity, on the other hand, is the equity of the developer and the community. In order to speed up the progress of the project, some developers in the developer-led mode take strong measures to remove the owners' property, the owners' interests are jeopardized. For example, in order to speed up the progress of Niujiaolong urban renewal project in Ping Shan District, the developer deceived the owners. So the Government suspended its main qualification role of renewal after the owners' representations. In addition, the developers in order to obtain the maximum economic benefit in the product designing, positioning is often easy to ignore the public interest.

30.4.2.3 Scope of Application

Most of the project is in the center of the city with great potential in commercial development, and able to withstand high-intensity development, and a strong will of the residents of the transformation project. Updated floor area ratio and the degree of intensive land have greatly improved. Brand and strength to play a leading role in the developer also has a very high demand, a strong ability to integrate resources and development of operational capabilities.

30.4.3 Village AG-Led Mode

30.4.3.1 Advantages

The first advantage is the cost of demolition. Tianxia has broken the relocation compensation mode, the first of its kind across the country, it is no longer entangled so-called "demolition compensation than the overall interests of villagers" personal interests and retrofit projects to connect. No matter how high the floor was built, they only consider the homestead stake, so the mode can save a lot of the human and material resources in demolition. Second is the protection of the interests. In the Tianxia case, the products of the urban renewal have to be met the needs of the villagers first, the remaining part of the products are sale or rental to the other villagers to make a profit, the surplus income to be allocated in accordance with the basic share. This mode can better guarantee the interests of the villagers to allow the villagers to actually share the achievements of urban transformation.

30.4.3.2 Disadvantages

The first is the risk. AG-led mode of urban renewal under the premise of almost all led by the village AG updating work. This is due to the lack of development experience led to the professional management of risk, but also due to lack of capital strength lead to the risk of the project be unfinished. Village AG strength is not enough, barely self-development, may result in failure of urban renewal.

30.4.3.3 Scope of Application

Suitable for the old villages with better lot, and it requires all of the owners have a unified understanding of the importance of urban renewal, the village collective has good cohesion; also requires the village shares in the company's leadership has a good strategic vision and dare to face difficulty. At the same time, the Village AG should hire a manager experienced in real estate profession during the operation of the urban renewal process.

30.4.4 Comprehensive Improvement Mode

30.4.4.1 Advantages

The first is cost. The cost of capital investment requirements are lower, after all, the mode is not large-scale demolition rebuild, reinvent the wheel, but its guidance and remediation. On the other hand, time cost, such as in the case of the Xinwei, the project has been taken only 2 years to complete a comprehensive renovation. The project of the village has made an immediate effect. Followed is a harmonious mode. This mode is related to the issue of relocation compensation rarely. Almost all of the government's input, owners and tenants are the beneficiaries, the project promoted less resistance.

30.4.4.2 Disadvantages

The first is quality. The positioning of many political mode is the "face project", "image projects", they are often beautiful to the overall effect of the project, but is not necessarily practical. And is based on the original repair, subject to construction conditions and budget constraints, the quality is not optimal. Followed is the problem of sustainable development. The mode in pursuit of instant results, so the lack of long-term consideration in the planning and design, not thorough enough to solve some of the issues, and may even leave the troubles.

30.4.4.3 Scope of Application

Apply in lots, and even updates of the urban fringe of the old villages, old industrial areas. Such projects in the studio area has a more stable resident population and consumer groups, only the exterior of the building, law and order, fire, or to drainage issues need to be coordinated with the city's overall image.

30.4.5 The Entire Village Co-ordination Mode

30.4.5.1 Advantages

The first is the planning issues. This mode has large area development plan as a precondition for all types of buildings, municipal facilities and other resources within the community under the guidance of the government through resettlement, industrial replacement, and other means to co-ordinate arrangements. This government maneuvers out of a large number into a piece of available building land. Second is the issue of fairness. The community takes the main role in the mode, residents participate in principle, community residents make their own decisions, and seek common development. By promoting community transformation and development, equitable distribution of benefits, the original villagers can gain more benefits. The mode can reflect better the autonomy and participation of the residents.

30.4.5.2 Disadvantages

The first is efficiency. The mode is trying to work through a "top down" and "bottom-up" a combination of the integrated use of "package" in the planning, land, property rights and related policies to solve community problems left by history. The disadvantage of this approach is often unsatisfactory coordination between the various departments, there will be a buck-passing, thus affecting the efficiency. Second is the cost. Maneuvers into a piece of land can be developed, the government needs to invest substantial human, material and financial resources, stakeholders in the community within the resettlement compensation. In the Jinsha project, the government will invest seven billion on land preparedness.

30.4.5.3 Scope of Application

Area development intensity in the original SAR Area, there are large areas yet to be developed to build the gross land, even if there is a small amount of old villages and industrial areas, the building density is relatively low, the demolition of the replacement cost of low bit region many such projects for the preparedness of the government of large tracts of reserve land.

30.5 Conclusions and Findings

Shenzhen city will complete urban renewal projects of 35 km^2 before 2020, this is a great business chance for the Shenzhen real estate market, but also poses a severe challenge to the city managers. The first half of 2012 alone, there are four batches of urban renewal projects has been approved. The next 4 or 5 years, the project will be included in the update of three or four hundred. Facing such a large-scale urban renewal projects, we should think about how to start the renewal in order to achieve the desired goal, to maximize the overall efficiency of the renewal work. This is a question worth considering.

Fully visible, urban renewal is a complex process. When choosing urban renewal mode, we should take a careful analysis of the area of industrial development, facility capacity, the land stock and current status of building capacity and other constraints, not across the board turned to real estate development. We should consider the benefits of the project's economic, social, environmental and cultural aspects. Different urban renewal projects should take different mode. What is the government-led model, developer-led model, the AG-led model, a comprehensive improvement model or the entire village co-ordination mode, you should distinguish between the different update objects and realistic conditions. The government, owners, the village AG, the developers all should play what role in different mode? Which renewal mode to choose? It all depends on the situation analysis, which can not be generalized.

Shenzhen as an international modern city, the urban renewal target value orientation is built on top of the above concepts and definitions, covering the main content of the above concepts, reflecting the ideas of modern urban development, multi-target of the rich connotation of a comprehensive urban development, urban renewal value system.

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Chapter 31
Cultural Relics Preservation and Sustainable Land Use in the Central City

Mingxuan Yu and Yu Gu

Abstract This paper takes the heritage conversation and sustainable land use in the central city as the research object, and combines theoretical research with field studies and successful cases as the research method to explore how to resolve some problems emerging in the central city, which is short of land, for example: how to ease the contradiction between the conservation of the heritage and sustainable use of land, how to adhere to the core concept of "the integration of use and conservation", such as Establish accurate targets and core idea, Breakthrough the thinking of land uses, Distinguish the grade property of Land for the protection of cultural relics and etc.

Keywords Cultural relics preservation • Land scarcity • Sustainable use

31.1 Introduction

During the past 30 years, the economy in China has undergone rapid and great development, and the urbanization process has also entered into the unprecedented period; however, in our nation, one that has ancient civilizations and long history, especially in those modern cities that have a great amount of historical and cultural heritage, contradictions, particularly on land use, between cultural relics preservation and modernization construction and development, frequently occur. The third 5-year national survey on cultural relics came to an end at the end of 2011. The statistical results show that there are 766,722 unmovable cultural relics that have been registered all over the nation (Hong Kong, Macao and Taiwan excluded), ancient ruins accounting for 25.21 %, ancient tombs 18.19 %, ancient buildings 34.42 %, modern important historical sites and typical buildings 18.45 %, and caves temple

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_31,

and rock carvings 3.19 %.[1] In addition, the survey shows that 23,600 previously registered cultural relics have vanished because of the disappearance of natural weathering, inadequate human protection and the most destructive urban construction; among all the cultural relics, ancient ruins and tombs are in the severest situation, because more than 50 % of them have vanished due to urban construction.[2]

This contradiction is much more intense in the central city (mainly the inner cities) of modern metropolis with severe land scarcity. As a result, the core topic in this paper is: cultural relics preservation in the central city, especially whether there are solutions to the contradiction between conservation of building relics and sustainable land use? How should all walks of life, such as relevant government departments, enterprises with different attributes and all individuals, play their indispensable roles in cultural relics preservation and sustainable land use in the central city?

31.2 Research Thoughts

On the basis of relevant policies and regulations and at the context of clear quantitative and qualitative data analysis, this paper, by adopting relevant research theories of cultural relics preservation and land use as well as learning from the methods and practices of domestic and foreign excellent cases on cultural relics preservation and land use, presents the importance of the topic, the literature review, domestic and foreign excellent cases, conclusion and proposals. The research thoughts of this paper can be seen in Chart 31.1.

31.3 Research on the Necessity

31.3.1 The Solutions to Ease the Intense Contradiction Between Cultural Relics Preservation and the Development and Construction of Modern Cities Is Often to Pursue the Economic Development at the Cost of "Destruction of Heritage"

First of all, I would demonstrate the necessity of the topic research on "cultural relics preservation and sustainable land use". As the urbanization proceeds, there are generally two important stances to the contradiction: one the one hand, the attention is focused on the urban construction and therefore those heritage that inhibits urban construction shall be demolished and destroyed unless the economic

[1] Data source: website of the third national cultural relics survey

[2] Data source: Beijing Morning Post

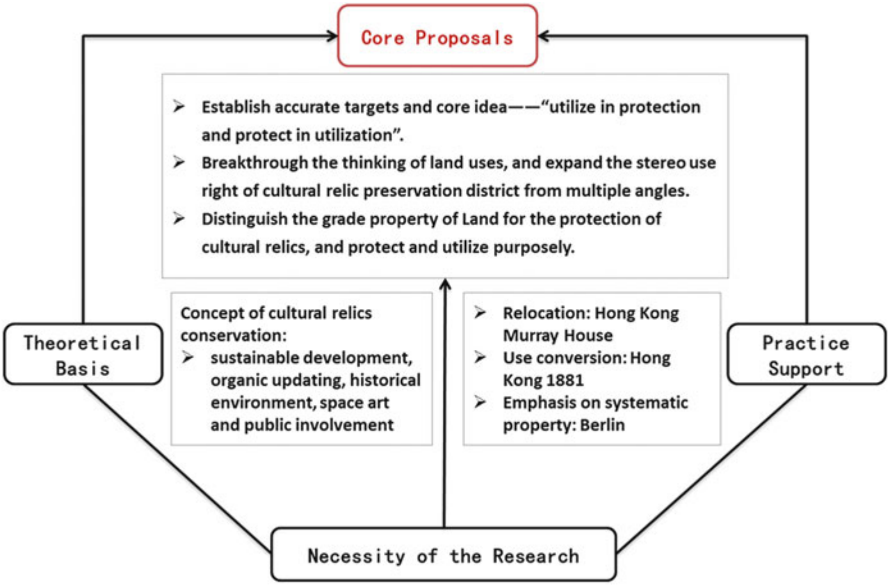

Chart 31.1 Article structure

power allows for cultural relics preservation; on the other hand, the completeness of heritage surpasses the urban construction and therefore cultural relics preservation is regarded as the "justified" reason for the non-development of economy. By definition, the second stance is quite rare because the developed economy is not only the core factor in securing a place in the world but also the basis for performance evaluations; in real practices, the first stance enjoys the dominance. Take Beijing as an example. City walls and towers were the most prominent signs in Beijing, but most of them, such as southwest buildings in outer city, Yongdingmen arrow-like buildings and Wengcheng buildings, surface signs of connecting bridge, southwest buildings in inner city, and Tiananmen Square yanchi buildings, have been demolished disastrously due to transportation construction after the establishment of our country, resulting in great regrets among the people.

31.3.2 Expanding Land Reuse Patterns Is a Necessity for Regional Coordinated Economic Development

"Too many functions and overloading pressure" is quite normal in the central city, for example, Beijing inner city, only accounting for 5 % of the total area of urban land, bears more than 50 % of the total traffic and commerce pressure in Beijing, making the conservation of inner city style and the improvement of people's livelihood quite difficult. Some data manifests that there are 54 city-level or higher cultural relics preservation units in serious danger.[3] Concluding from the above, due attention shall be urgently paid to cultural relics preservation and improvement of people's livelihood in inner city, which to some extent will remove the bottleneck in current modern urban construction to some extent. Consequently, the abundant historical and cultural resources, the roles of land resources, such as, the bearer and value-promoter, in the central city shall be fully made use of from the aspects of style conservation, industrial adjustment, and cultural development and so on.

31.3.3 The Integration of Use with Conservation of Heritage in the Central City Is the Key Measure to the Realization of Sustainable Land Reuse in the Region

Cultural relics preservation and land reuse in the central city seem unrelated or even contradictory, but at the second thought of it, we can actually realize sustainable land reuse if we can find a balanced approach that can avoid the economic development at the cost of destroying heritage and the pure cultural relics preservation regardless of economic development, realize the concept of "integration of use and conservation", and bring new impetus to urban economic development, add uncopyable city uniqueness, and promote urban modernization and intensive use of scarce land. Therefore, the benign integration of cultural relics preservation and urban construction in practice would definitely promote the long-term, balanced, and sustainable development of cities and land use.

Concluded from the above, it is doubtlessly an important issue to address well the relation or contradiction between cultural relics preservation and sustainable land use in the central city; as for the solution to the problem, if we focus on urban construction at the cost of cultural relics preservation, as the history tells us, not only the heritage will be devastated and cannot be recovered, but also will urban construction be the same without any uniqueness, resulting in nothing good but harm; if we just conserve heritage for the sake of conservation regardless of its use, large land resources waste and great economic resources loss will occur. As a result, the integration of the two is quite important and we have to adhere to the concept of "the integration of cultural relics preservation and urban construction in the central city" to ease the extreme imbalance between land supply and demand and to realize "the integration of use and conservation", which shall draw the attention of all walks of life.

31.4 Overview of the Concepts on Cultural Relics Preservation in Urban Construction

The cultural relics preservation in urban construction shall find its basis from the concepts listed in Table 31.1.

[3] Data source: The Beijing News.

Table 31.1 Concepts of cultural relics preservation in urban construction

Concept of sustainable development	Recycle ancient buildings and street space to improve urban environment and living space and sustain urban traditional style. Develop tourism resources to promote economic sustainable development by protecting heritage and historical environment.
Concept of organic updating	It is necessary to form organic updating concept in the process of urban protection and construction to conserve monomers and groups of buildings and cultural heritage, traditional space and environmental characteristics, cultural uniqueness and interest in life, making urban development and construction growing and sustainable.
Concept of historical environment	Since cultural relics preservation cannot go without the surroundings, it is necessary to respect local historical and ethnic culture, to comply with principles and concepts of historical environment protection, and to maintain the sustainability of urban historical environment.
Concept of urban space art network	It is a tradition to emphasize sequence and layer in urban construction to make the complex urban public space network in order and united. We shall conserve heritage in the central city and make it play a larger role in the new urban space network.
Concept of public-involved management	Protection and development of the heritage-conserving areas shall not only depend on government's unilateral power, but also depend on social organizations, units or individuals who shall get involved in the protection and management of the historic areas within the scope of their rights and obligations.

31.5 Excellent Case for Reference

Under the research of urban development cases at home and abroad, we found that all cities are not accompanied by demolishment of cultural relics in urban modernization process. This paper will analyze three excellent cases among the multiple famous cities and special zones.

31.5.1 Relocate: Murray House in Hong Kong

Murray House, built in 1844, is a Victorian building in Hong Kong. It has witnessed the historical changes of Hong Kong. As British barrack, it served as Japanese Military Office, Japanese Commander Department and also as execution ground with plenty of cells during Japanese colonial period. Then it served as government offices after the second world war. Murray House is the only ancient Victorian building in Hong Kong. Murray House, a three floors building, adopts the features of eastern and western buildings with giant granite as the main building materials. It adopts not only Chinese traditional roofs, but ancient European Victorian circular pillars. With special historical background of Hong Kong, Murray House is unique.

Murray House was originally located at Jinzhong Garden Road, north shore of Hong Kong Island, which is the key urban construction area and urban center of

Table 31.2 Systematic solutions for Berlin

Meaning and purpose	Specific method
Full respect and overall preservation	Overall repair, Relics remaining, Overall translation
Continue mission, reform and reconstruct	Mix the new and the relics, Use conversion, Integrate the styles

Hong Kong. However, Murray House gradually deviates from Central's regional function. In 1982, Murray House was required to demolish due to the construction of Bank of China Towel in Hong Kong. For its high historical value, the Hong Kong government determined to completely reserve the building and move it elsewhere by integral translation.

31.5.2 Use Conversion: 1881 Heritage, Shanghai Xintiandi

With an area of 130,000 ft, 1881 Heritage is located at Canton Road, Tsim Sha Tsui, and adjacent to Harbor City.1881 Heritage is a Victorian building with colonial features. It had been headquarter of Hong Kong waterside police from 1880s to 1996. And Tsim Sha Tsui is a major tourist area and shopping center. Therefore, Hong Kong government naturally adopts the use conversion mode to transform the former marine headquarter in the process of Kowloon economy development and urban construction. As the landmark of cultural tour and shopping in Hong Kong, now there are global shopping malls, restaurants, entertainment places and hotels. Shanghai Xintiandi also adopts the method of use conversion to protect cultural relics.

31.5.3 Systematic Reconstruction: Berlin Reconstruction After WWII

Berlin faced a large scale of reconstruction work after World War Two. During the reconstruction work, Berlin shall attach more importance to the historical relics. At that time, a set of systematic solutions were proposed under the research on ways to protect historical relics by people from all walks of life in Berlin. And Berlin determines to adopt different methods in accordance with the different cultural relics (See Table 31.2).

31.5.4 Fully Respect the Historical Relics and Carry Out Overall Preservation

The mode of overall repair mainly applies to buildings with significant history value, which are mainly representative buildings, such as the neoclassic

Brandenburg Gate. And the mode of relics remaining can also apply to buildings with significant values. Ancient relics are significant historical and cultural treasures that history has given to for people. For the valuable history relics, Berlin people would well preserve the remaining relics regardless of the smoldering rubbles. The mode of overall translation mainly adopts the advanced translation technology for buildings in German. This mode can effectively preserve the most valuable buildings in urban regions.

31.5.5 Continue the Historical Mission, Reform and Reconstruct

In view of most basic maintenance work for ancient sites, we shall completely preserve and protect the ancient sites. However, for buildings that have already disappeared, it shall be a waste to recover them. Therefore, Berlin people adopt the mode of mixing the new and the relics, use conversion and integrating the styles to continue the missions of the historical relics.

Mixing the new and the old relics has been a popular mode to preserve the historical relics in German and even in Europe. And in German, they adopt the mode of use conversion to preserve plenty of historical relics, such as changing mansion to museum, palace to school and factory to hospital. And the mode of integrating the styles mainly applies to ancient streets.

We shall carry out overall and systematic plans during the process of urban modernization and land exploitation. We shall carry out targeted mode to different relics, thus we can realize urban sustainable development, ease the situation of land supply and demand.

31.6 Solutions and Suggestions

31.6.1 Establish Accurate Targets and Core Idea: "Utilize in Protection and Protect in Utilization"

The purpose of protection shall be defined for the carrying-out of any cultural relics preservation work. Is the protection limited simply for the safety of cultural relics or combined with its sustainable application? Two different purposes defined two different protection methods. For pure protection, as long as the safety of cultural relics can be ensured, visual effect displaying can be ignored, so can the economic benefits. While it will be more complicated for the protection combined with displaying and utilization functions, which has to take into consideration the safety and sustainability of the cultural relics as well as the economic value of visual effect and subsequent utilization brought by protection method, and has to display the authenticity of history as much as possible, as well as to ensure the soundness and safety of cultural relics that are required to display in long-term exposure. Compared to the former, the cultural relic protection with this purpose tends to be more complicated and difficult.

However, among historical and cultural remains at central city area and old town of all types of cities in China, the cultural relics needing simple protection for the purpose of just protection are very few and nearly to none, and for most of them, the protection with the second purpose is more suitable. But in practice, "complete protection" is adopted in most cases because of simple and easy implementation, which will in one hand cause loss to its deserved economic value and serious waste of land resources, and in the other hand result in poor cultural relics protection and do impede its long-term development.

It has been found from practice that the core idea of "utilize in protection and protect in utilization" is the most suitable one for sustainable development. To properly utilize cultural relics is the most effective way to protect them. It is required to utilize and update cultural relics reasonably and effectively and re-spark the value of historical cultural relics in new era atmosphere, so as to turn them into "live history".

31.6.2 Breakthrough the Thinking of Land Uses, and Expand the Stereo Use Right of Cultural Relic Preservation District from Multiple Angles

In actual execution of cultural relic protection at the current time, the use right of land plane is still the main object of land supply. Supported by long-time practice, the procedure and thinking of this part has been pretty perfect, so there is no need to describe again in this text.

31.6.2.1 Right to Expand Space

According to Article 136 of Property Law: the use right of construction land can be established on the surface, over the ground or under the ground respectively. The newly-established use right of construction land shall not damage the established real right for usufruct. This indicates the use legality of space use right. The setting out of this new legal article also reminds us that the space use right can be increased on the basis of plane use right during our utilization of land so as to improve the utilization ratio of land in Cultural relic Protection District. For example, for the sake of the underground archaeological remains in Sevilla of Spain, the parking lot on the ground was changed into culture and entertainment square which stands as a new coordinate of the city. At this place, the right of air space can also be paid attention to, that is to say, to wrap the historical cultural relics that covers a large area into a modern building, which will not only reduce the damage to the cultural relics caused by climatic elements but also achieve highly efficient use of the land.

31.6.2.2 Right to Develop Adjacent Areas

Considering the public benefit and meager profit nature of immovable cultural relics protection work, developers show very limited enthusiasm to the participation. In order to attract developers and coordinate resources to the greatest extent, we suggest, the immovable cultural relics should be transferred with the surrounding land lots as a package when supplying lands. Attract developers through the commercial development profit of the surrounding land lots, and drive the increase in value of the surrounding lots through renovation and protection for immovable cultural relics, so as to achieve a win-win result of the government and enterprises. In addition, to protect the specific characteristics of cultural relics s, it is also required to specify in the form of additional articles that the use party shall undertake the repairing and protection responsibility of the immovable cultural relics within 1 year before obtaining the qualification to compete for the use right of the surrounding lots.

31.6.3 Distinguish the Grade Property of Land for the Protection of Cultural Relics, and Protect and Utilize Purposely

Different cultural relics shall be protected in different levels, and from the point of protection law of cultural relic, it is mainly classified into national, provincial, municipal and county level key cultural relics preservation units, historical and cultural city and historic conservation area. From the point of planning, it is classified into cultural relic architecture, repairing architecture, protection architecture, and preservation architecture, upgrading architecture, and finishing architecture. Specific protection and utilization manner shall be selected combined with goal-guiding principle targeting respective different situations. Detailed information of the cultural relic classification, protection and utilization purpose, operation mode, and local connectivity is shown in Chart 31.2.

Among them, cultural relic architecture shall be operated and managed by means of government protection in later period, such as building museums and memorial halls. For cultural relic architectures, it is required to note that the number of visitors shall be restricted and the time and frequency of shut-down for maintenance shall also be specified by the government; for repairing and protection architectures, as they are valuable to some extent in the respect of history and culture and cannot be used for absolute commercial purpose, culture industry can be developed in later period and to utilize them in protection in forms of Old Beijing culture and custom exhibition hall, traditional crafts store, tea house and chess club etc.; the rest preservation, upgrading

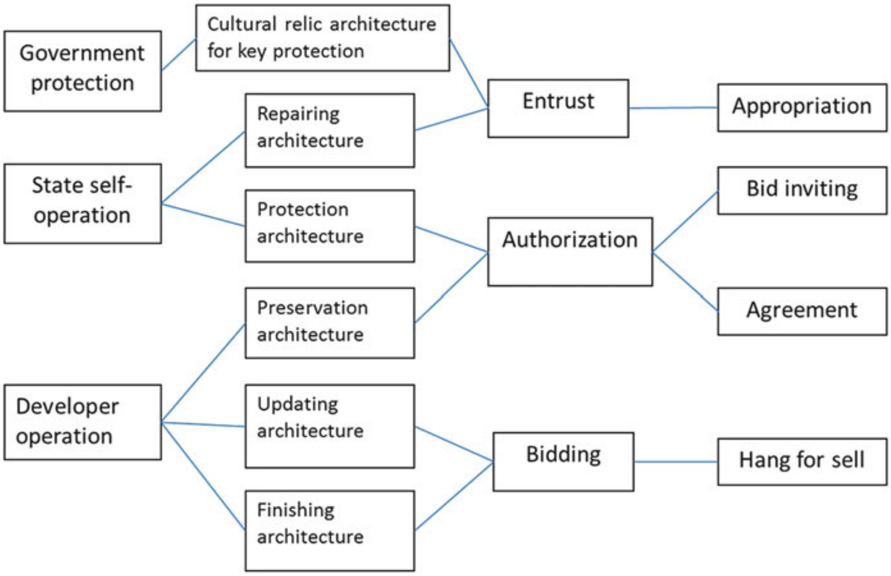

Chart 31.2 Planning of cultural relic classification and the method to protect the utilization object

and finishing architectures are only required to maintain their overall appearance due to low historical cultural value, and for them, the method to allow developers to operate by themselves can be adopted to attract capital investment so as to achieve good value circle and land utilization.

31.7 Conclusion

In conclusion, it is no doubt that proper handling of the relationship and conflict between cultural relic protection and sustainable utilization of land in central city is a rather important subject; as for how to solve the conflict, we learned from the experience and lessons of previous practices that the behavior to scarify cultural relic preservation for urbanization construction on one hand caused destructive and irretrievable loss to cultural relics and on the other hand resulted in the current "thousands of cities, but with the same appearance" urbanization construction outlook without any characteristic, which brings nothing beneficial but everything harmful; however, if protection is the only purpose without consideration of utilization, it will cause huge waste of land resources and loss of economic resources. Therefore, combination of these two thinking seems especially important,and it is a must to set up the idea of "Blend the cultural relic protection with urban construction in central city" and how to "protect in utilization and utilize in protection", so as to relieve the extreme unbalance of land supply and demand together. As for detailed measures, this text suggests to improve in the aspect of multiple expansion of land stereo use right of cultural relic district and adopting different utilization methods according to different grades of cultural relics etc. and put emphasis on the sustainable recycle of lands.

Both the protections of history and culture and urbanization construction development are issues concerning every subject of the society, and their conflicts can also be solved more effectively and reasonably only with the joint attention and efforts of all social walks. Therefore, the author herein appeals people of all circles to pay more and further attention to the protection of cultural relics and land recycle and contribute your effort to this cause.

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Chapter 32
Carbon Emission Trading Scheme to Reduce Emission in the Built Environment of China

Faye D.F. Ni and Edwin H.W. Chan

Abstract Carbon emission trading has achieved some notable results and created many business opportunities in western countries, and most importantly, it does help to reduce the emission in a moderate approach favored by both political and business sectors. The theoretical framework supporting the operation of carbon emission trading scheme is relatively comprehensive in western countries, however, these western based instrument and approach dealing with economic – environmental conflict are barely examined in the context of developing countries, for instance, China. This paper examines the theory of ecological modernization and economic instrument, establishing the link between theory (sustainability) and practice (carbon emission trading), synthesizing the considerations of carbon trading in the field of environmental, economic and social sustainability. This paper concludes that, there is a good potential for carbon emission trading could to be feasible and effective in the context of China, to contribute to the emission reduction in the built environment.

Keywords Carbon emission trading • Ecological modernization • Economic instrument • Built environment

32.1 Introduction

Carbon emission trading was brought to political agenda in 1997 with the enforcement of Kyoto Protocol. It provides flexible mechanisms for polluters to reduce emission in a cheaper and economic benefit measure. Carbon trading operates according to cap and trade, and offset schemes, in which, the cap is regulated by authorities and the offset is based on voluntary. In the cap and trade scheme, the commodity is 'allowance' or 'permit' authorized by governments to firms; on the other hand, the

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_32,

exchange good is certified emission reduction (CER) in the offset scheme. Kyoto Protocol is going to expire in year 2012, whereas, the gradually improved carbon market and the increasing market value have decided the continuing of carbon trading. In the past years, European Union has established the most representative regulatory carbon market, which is European Union Emission Trading Scheme (EU ETS). It is the largest multinational cooperation dealing with emission reduction and also one of the policy instruments of EU to meet targets set by Kyoto Protocol [1]. The Tokyo cap and trade program is a comparatively new scheme that trading emission and building carbon market in a city scale, and aim to spur a national cap and trade system in Japan. Besides these regulatory carbon markets, the Chicago Climate Exchange (CCE) runs a voluntary carbon market which is established even before the commenced of EU ETS.

In this study, the flowchart of carbon trading scheme is firstly established and addressed. Secondly, the underpinning theories are critically examined, based on which, the considerations of carbon trading in the field of environmental, economic and social sustainability are summarized. In the last section, with the review of carbon concern and built environment situation in China, the feasibility of carbon trading is discussed and concluded.

32.2 The Flowchart of Carbon Trading

The prevailing character of carbon trading is the flexible mechanisms in the trading process, which means authority provides options for business sector to achieve the emission reduction target. The flow chart (Fig. 32.1) is drawn according to the knowledge generated through abundant review of the scheme, which reveals the interaction between government sector and business sector, and the coexisted situation of different approaches in the scheme.

In this figure, the organization in the UN level conducting the emission reduction is United Nations framework Convention on Climate change (UNFCCC). In 1992, UNFCC had already published Article to address that both Annex I and Annex B Parties (developed countries) have to take climate change consideration into account, to the extent feasible, in their relevant social, economic and environmental policies and action [2]. In 11 December, 1997, Kyoto Protocol was adopted and entered into force in 16 February, 2005, which sets binding targets for 37 industrialized countries and EU (Annex I countries) to reduce Greenhouse Gas Emission (GHG) in the amount of 5 % of 1990 level from 2008 to 2012 [3]. There is traditional solution to fulfill the duty, such as tax, but Kyoto Protocol provides a more cost efficient way, that is the trading scheme. The market is required if there are trading, so authorities establish markets, which is perceived as a regulated market (also names compliance or mandatory market). Once the emission reduction duty laid on the business, options are provided. Polluters can choose the to fulfill the environmental response as well as achieving their own economic benefit by trading, or pay for the comparatively expensive tax, which is a type of fine. With the development for almost one decade, the emission market have been established

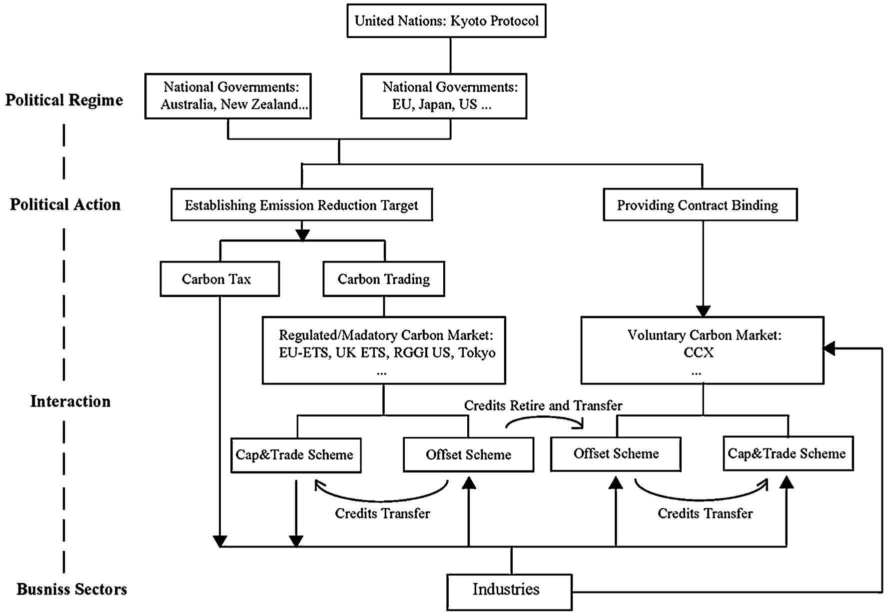

Fig. 32.1 Process of carbon emission trading

its own spot market, as well as futures and options market. This is a reason why people commonly perceive the emission trading market similar to the stock market and defines it as a tool making benefit in business. Carbon trading does share similarities with stock trading because environmental economics (which the theory of carbon trading is grounded) is a major sub discipline of economics, as Pearce stated [4], but it combines some traditional economics work with more recent perspectives on the choosing of policy instruments as well as the philosophy of sustainable development.

32.3 Ecological Modernization and Economic Instrument

32.3.1 Ecological Modernization

The significant feature, as well as advantage of EM is that it is not going to reconstruct the market economy or change social and political institutions radically, but aims to shift industry beyond 'end of pipe' approach towards anticipatory and precautionary solutions, which could minimize waste and pollution through efficient resource use [5, 6]. Afterward, the "pollution prevention pays" principle incentivizes the introduction of technological fixes into the production process [7]. And people believe it can offer a holistic 'pollution in the round' approach that recognizes the complex and interdependent nature of environmental problems [6].

Following such technological innovation, markets in green technologies are deemed to grow, along with stimulating the demand for green products which is so called 'green consumerism'. In this period, EM approach focuses more on the respective roles of states and their markets in ecological technology transformation [8–10]. Meanwhile, there is more and more attention on institutional and cultural dynamics in EM [10–13], the partnership and co-operation between government, industry, scientists and those moderate environmental groups creates an excellent idea exchange platform. More than the commercial benefits, social issues, for instance, jobs and better working or living environment are also provided, which is truly a positive-sum game [11]. In general, EM has the potential to make significant improvements at both macro-economic and micro-economic levels, and thus, is presented as a means accommodating capitalism with environmental challenge rather than environmental protection being a threat to capitalism [14].

The major controversial topic of EM is its "technological optimism" and "supposed technocratic character" ([15], p. 20), as technology and science are often claimed to responsible for environmental degradation. Even if excluding the conventional cognition of technology and science, "the limited information, shortages of managerial capacity, the unavailability of financial capital and risk aversion can all inhibit the rate of innovation in new technologies and techniques" ([14], p. 80). Christoff summarized that, technology is applied to emphasize increasing environmental efficiency and decreasing resource exploitation, but only in relative terms, because in the view of environmentalism, EM is only superficial or weakly ecological as the ignorance of ecosystems' integrity and cumulative impact on them [5]. Considering from the society, technological fixes in EM may obstruct the change of consumption pattern of individual citizens because people may think wrongly that technology is all purpose, especially in those industrialized countries with high consumption. But at the same time, it would be not appropriate to expect EM to change consumer's behavior, through the purchase of environmental friendly goods or other encouraged consumption pattern, as "shopping to save the planet does nothing to halt the inexorable overall growth of consumption" ([6], p. 232). More importantly, "the environmental impacts of what consumers actually do turn out to be very complex" and "environmental sociology has not yet been able to offer promising theoretical perspectives on how to conceive consumer behavior" ([16], pp. 50–51).

Since the provenance of EM is in the Western European industrialized societies, it is claimed to be too focused on changes within industrialized nation-state narrowly and therefore unable to integrate an understanding of the transformative impact of economic globalization on environmental relations [5]. EM is described as 'Eurocentric' which would limit its global appeal as a feasible national-level environmental reform program (Blowers 1997, cited in [6], p. 231). The nation-statist focus will make EM underestimate the globally integrated nature of resource extraction and manufacturing, and overvalue local achievements and environmental impacts but undervalue geographically distant factors [5]. In practice, EM is also claimed to provide limited opportunities or resources for the small or medium size companies to gain access to the discourse, because of the costs of greening might be unaffordable and the issues of equity and social justice raised by the broader sustainable development discourse are ignored [6]. One obvious problem is that people might not be able to participate in EM as their basic needs are still not met.

32.3.2 Economic Instrument

Economic instrument is a system that polluters are incentivized not only to avoid polluting but also reduce their polluting activities, and they could gain the fiscal advantage in so doing [17]. The economic instrument, which can be also referred as market based instrument (MIB), works with voluntary instrument and regulatory instrument to deal with environmental problems. The goal of economic instruments is to prevent market failure by applying the polluter pays principle (PPP) and provide the economic benefit incentive [6]. Eco-taxes are the most common measures in market based instruments. Economic incentive provides options for polluter – pay the tax or modify equipments – enabling the polluter to choose how to adjust to the required environmental standard [17]. This is one of the advantages of EI, when comparing with voluntary instrument and regulatory instrument. The economists considered "the market based instrument is more efficient and effective than command and control" (ibid, p. 163).

The core in the economic incentive is "internalizing the externalities of environmental damage" ([18], p. 138), which means provide monetary value to environmental goods. Costs and benefits analysis, basing on the monetary valuation, is supposed to be applied to investment projects and to policies [19]. In the discourse of EI, governments set up taxes and charges to discourage undesirable behavior; set up tradable permits to make environmentally damaging activities illegal; promote refundable deposits to reward environmental care by returning the deposit [18]. After then, government could manage these capitals to subsidy the private organization and household for environmental friendly actions. In the process, the government is effective and powerful to control the pollution activities. However, the popularity and effect cannot stop the criticisms to this instrument. For instance, it is argued that the regulators have to use resources to monitor the behaviors of polluters and performance, which are difficult and expensive [6]. And Jacobs [18] introduces that "some environmentalists have appeared to oppose the use of incentives because they do not like the idea of placing monetary values on the environment".

32.3.3 The Considerations

Generally, although there are criticisms about ecological modernization and economic instrument, they are still favored by authorities. Figure 32.2 are the considerations of the trading scheme to achieve environmental, economic and social sustainability through the review.

Environmental Sustainability	Economic Sustainability	Social Sustainability
• Internalized environmental value	• Appropriate economic growth rate to maintain the environmental conservation	• Economic equity for all participants (companies)
• Natural capital can be maintained from substitution	• Polluter pays principle to restrict pollution activities	• Environmental degradation impacts on the third party
• Maximized environmental quality matters		• The expensive sustainability
	• Economic incentives to encourage environmental protection	• Misleading of green consumerism
• Traditional command and control is not sufficient for environmental policy	• Technologies for substitution	• Developed and developing countries equity issue

Fig. 32.2 Sustainability considerations of carbon emission trading

32.4 China's Carbon Trading Development and the Built Environment

Sustainable development has been served as a strategic policy for years in China; however, as a developing country, economic growth has always been given much more priority from government than environmental concern. Rapid economic growth in China has lasted for three decades, since the reform and opening up in 1979, and some experts predict that growth in GDP is going to persist for the next 20–30 years. The whole society is going through a huge reconstruction which is at the cost of environmental and cultural destruction to a certain extent. The Kyoto Protocol did not clamp down on developing countries by the issue of emission reduction; even though, the contribution to climate change, air pollution and massive energy consumption from China is still a force that needs to be confronted. The Clean Development Mechanism (CDM) in Kyoto Protocol enrolls developing countries to mitigate the global environmental problems as well as getting subsidies and technology support. In before October, 2008, China had provided more than 50 % of the global CERs and EU based companies had bought more than 80 % of these CERs [20]. Since year 2008, China has established eight pilot environmental exchange platforms, in which, Beijing, Shanghai and Tianjin Environmental Exchange are the most influential and developed ones. These pilot projects are served to establish a national wide environmental exchange platform by 2015. The scenes of prosperity of these platforms do not contribute to a considerable trading amount of carbon emission though. According to a report in First Financial Daily, the trading credits taking place in the three China's leading exchange – Beijing, Shanghai and Tianjin in a year, is still less than what happen in the EU ETS in 1 day [21]. In order to promote and apply carbon market as a critical measure for emission mitigation, China is planning to regulate the primary emission sectors, placing cap on these industries from 2013.

The rapid economic growth and city regeneration with massive construction projects in China have lasted for decades. The "opening-up" policy in 1978 promotes and improves the investment environment, attracting numerous foreign investments and maintaining the Gross Domestic Product (GDP) on over 9 % growth rate per year [22]. The China's construction industry (CI) constituted about 20 % of the GDP in 2010, which is equal to an industry value around 1.14 trillion dollars [23]. The 20 % of GDP indicates that the massive proportion of CI is a far larger than is sustainable (ibid.). The huge market of CI provides around 24 million job opportunities which constitute more than 5 % of the total labor force in the country [22]. The economic growth, as some scholars address, brings adverse impact on environment. The emission pollution statistics have attracted both domestic and foreign researchers' attention. A recent research indicates that constructing building and city infrastructures has driven a substantial increase in China's carbon emission growth, the emission almost tripled between 1992 and 2007 [24]. Another report states that CO_2 intensive sectors linked to the building of infrastructures have become more and more dominant in the emission growth [25]. From the energy supply perspective, the burning of coal constitutes 75 % of the emission pollution [26]; building sector takes up 23 % of the total energy used in China [27]. Generally, the built environment in China contributes the majority of emission, and there are also great potential to promote the carbon reduction in this field.

32.5 Conclusion

There are many policies and standards continuingly released from authorities in China, which promote energy efficiency and the use of renewable energy in built environment. The increasing green buildings and low carbon projects do attract much attention and bring the fever. However, these green or low carbon projects only take up a small proportion in the total amount. The central government applies regulations and standards, in a top – down approach to achieve their environmental concern. But there are still many deficiencies to implement these regulations or standards, for instance, the un-balanced local economic level baffled green innovation; the lack of the market driven policy in energy efficiency and renewable energy in building practice bring the gap; as well as the cost to achieve these standards are still high [26]. According to these findings, emission trading is suggested to be incorporated to support the implementation of these green policies, providing a flexible mechanism with more economic considerations for built industries, to reduce the emission. It is clear that the top – down capacity and conditions to establish cap for the built industry have already achieved, so there are great potential and opportunities to develop the carbon emission trading to contribute the energy efficiency in the built environment, and radically reduce the emission and achieve environmental conservation.

Acknowledgements This paper is the result of part of a research project with research funding provided by The Hong Kong Polytechnic University.

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Part III
Housing Policy and Real Estate Market Development

Chapter 33
Study of Land Price Game Equilibrium and Countermeasure Based on Combination Selling Style Regulation

Xia-Zhong Wang and Wen-Dan Zhang

Abstract Land as the important element of house has the huge influence of the house price. But the policy of local government and land nature trait result in the failure of land market and land value invalidation. So government should regulate the land price and let the price back to the rational level. This paper from the point of all kinds of interest sides gamed the land price. Analyze the land selling style and the elasticity of land price regulation to search the efficient price regulation in real estate market. In the ground of land market, government, local government and developer have the different utility and object which result there are three sides in the land game. And the Nash equilibrium indicates that central government should take optimized combination supply method to regulate the land price to stabilize the house price. And local government should apply with the policy of central government to realize the utility hypo-optimize. The game between local government and enterprise about the selling of land, only to take the combination Optimized land selling method and increase the weight of biding can reach the purpose of regulating the land price.

Keywords Combination selling land • Land price game • Economic regulation

As so far, the problem of land price failure which arises from the power of manipulating market has becomes the obstacle in the development of real estate market. To make the real estate market more healthier, the government must regulate the land selling method, structure the ratio of supply and develop projects according to the situation of the development of real estate.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_33, © Springer-Verlag Berlin Heidelberg 2014

33.1 The Game Character of Selling Method in Resident Land Market and the Price of Land

The trading rules of “Bid Tendering, Auction and Quotation” are established around the country. Nowadays, there are four selling methods in the operation of residential land. The game character of every method and its influence to the land price are listed in Table 33.1.

The result that land is got by high price will push the price to the unbelievable level because of several bids in the short time. The degree of competition is less severe than the auction, for the interval of price is long in quotation. The result is not only depends on the price, but also considers the factors, such as the whole project and the price of house. In this point, bid tendering is advantageous for government to control the price of house. It is more suitable to economic regulation when the demand of house is enormous and speculation arises more frequently.

33.2 The Economic Regulation and Loosen in Market Economy of Residence Land

In order to prevent the waste of resources which are produced by the monopoly and information asymmetry, we introduce the price regulation [1]. The economic regulation and loosen in market economy of land was exist when the land payable system was published. The economic regulation and loosen are relation with real estate and the cycle of macro-economy:

1. Low price loosen stage for resident land (1987–1992). In 1987, we published the system that the land was used in limited time. In 1990, the State Council announced the No.55 clause which pointed out three land selling method:

Table 33.1 Comparison of game character of selling method in market economy of residence

Selling method	Auction	Bid tendering	Quotation	Bargain
Game method	One to more	One to more (some quality required)	One to more	One to more (have choice)
Target	Price of land	Multiple-orienting	Land price and projects	Multiple-orienting
Times of bid	Several	One times	Several	Coordination
Interval of bids	Short	–	Long(in a month)	–
Degree of competition	Most severe	Severe	More severe	Ordered by government
Price of land	Highest	Moderate	High	Low or none
Impression of enterprise	Capital	Comprehensive	More in capital, others is plus	Comprehensive

Notes: Bargain is forbidden in operating land. It is mainly used for the supply of residential which is hard to resolve in market economy bargain, bid tendering and auction.[1] It didn't rigidly demand which selling method should be used in operating land. In the stage, the bargain was the main-stream. As to 1992, in three land selling method, the proportion of bargain was 92 %. And the proportion of bid tendering and auction was 6 % and 2 % separately. The proportion of last two selling methods totally was 8 %.[2]

2. Low price regulation stage for resident land (1993–1995). In 1992–1993, the target of policy was to accelerate the development of real estate and prompt the real estate market into climax. Enterprise could speculate the land through the "low buy- high sell" method in low price loosen stage. The problem of low price loosen stage arose in 1992–1993. In December 1993, to regulate the land trading system and adjust the added revenue reasonably, government published the provisional regulations of the people's republic of china on land appreciation tax. It enforced the regulation of the price of land. After that, the real estate came into the adjusting, steady stage.
3. Low price moderately loosen stage for resident land (1996–1998). After the adjusting in 1993–1993, economy came to recovery. The government brought the policy up that real estate will be new economic growth point and consumer hot point. In this stage, the land selling method still the same as the policy in January 1995, which mentioned that if condition was permission, we will use bid tendering and auction. If there is difficulty in using it, we will use the bargain.[3] The selling method was loosened moderately. And it caused the situation that selling in low price arise.
4. Low price progressive regulation stage for resident land (1999–2004). On 1st, December 1998, the real estate market became market economy. The demands for the house which were depressed long-time released fully. The inequality between supply and demand pushed the price of house climb. Also was the land price (see Table 33.2).
5. In 2002, the 7th conference in Central Commission for Discipline Inspection and the 4th conference in Clean Government claimed that we should use the land selling method "Bid Tendering, Auction and Quotation" in every region and department [2]. The Notice About Law Enforcement Inspection in Implementing the Land Selling Method ordered that each town should establish he "Bid Tendering, Auction and Quotation" before the end of June, 2004. After 31st August, we must not use bargain to selling land for the problems left over by history. That is the famous "deadline of 8.31". It is a symbol of the situation that the supply of land should be more open and fair. However, it was also a beginning of the high price selling stage in resident land. Since the system

[1] Refer to article 1, clause 1oth in Interim Regulations of the People's Republic of China Concerning the Assignment and Transfer of The Right to The Use of the State-Owned land in the Urban Areas, in May, 1990.

[2] It is the same as i.

[3] Refer to article 12, clause 1th in Law of the People's Republic of China on Urban Real Estate Administration, on 1st, January, 1995.

Table 33.2 Average growth rate of price in land (1999–2004)

Year	1999	2000	2001	2002	2003	2004
Average growth rate of price	−0.8	0.2	1.7	6.8	8.35	9.3

Resource: China economic statistics and China monthly statistics (1999–2004), edited by author.

Table 33.3 Land transaction price index (2004–2009)

Year	2004	2005	2006	2007	2008	2009
Land transaction price index	110.1	109.1	105.8	112.3	109.4	105.4

Resource: China Statistical Yearbook

"Bid Tendering, Auction and Quotation" was adopted, auction and quotation have been mainly introduced; the proportion of bid tendering is small in many cities. Even, the record of bid tendering is still blank. This is an important reason for the high land price and house price.

6. The supply regulation in structure and high price gradual regulation stage (2005–now). As 2005 to now, the policy is all for regulating the continuous climbing land price and house. From the "Eight Country Provisions",[4] "Seven Ministries Documents"[5] in 2005, to "Six Country Provisions"[6] in 2006, they all required to adjust the supply structure, add the supply of land for commercial residential buildings and affordable houses in order to depress the price. The details of "Six Country Provisions"[7] have requested the concrete ratio of supply in structure. That was medium-low level price houses; media-and-small sized commercial residential buildings (contain affordable houses); and low-rent houses, all of which in land supply should not below the 70 % of the total amount in resident land. It proposed the "two limit and two competition" first time, and ensured the developer by bid tendering. Obviously, the details of "Six Country Provisions" not only have more limited effects on price of land, but also more maneuverability than "Eight Country Provisions". Land transaction price index fluctuated from 2004 to 2009 (see Table 33.3).

[4] On 26th, March, 2005, the State Council published eight provisions, the Notice about Stabilizing the House Price. We short it for "Eight Country Provisions". In article 3, it says that "adjusting the supply structure of house, the supply structure of land, increase the supply of land for commercial houses and affordable houses, and supervising the building".

[5] On 11th, May, 2005, the State Council transmitted the Opinions about Stabilizing the House Price which is published by the Ministry of construction, National Development and Reform Commission and so on totally seven departments. We short it for "Seven Country Provisions". Refer to article 2.

[6] On 17th, May, 2006, the State Council published six provisions, the Solution to promote the real estate health and development. We short it for "Six Country Provisions".

[7] Refer to article 6, Opinion of adjusting the land supply structure and stabilizing the house price, which was published by the Ministry of Construction and so on totally nine departments, on 5st, May, 2006.

"New Ten Country Provisions"[8] in 2010 put forward to further increase the effective supply of residential land, and explore new way of selling land. It will change the status quo that one gives higher price get the land, and relieve stress of house price rising.

33.3 The Analysis of Targets for Everybody in Economic Regulation Game

During the period of economic transition, there is a triangle land price game for the target of central government, local government and developers are different. The results of equilibrium in game will determine the policy route of price regulation in land.

In the price regulation game, central government at least needs to achieve the below targets: (1) Prompts the market economy in land in order to get recourses to be pare to efficiency, and rises the fiscal finance; (2) Prevents the speculation and bubbles in market, and keep the whole economy developing harmoniously; (3) Resolves the problems of difficulty in housing groups which cannot be settled under the market economy. Representing local interest, local government has double characters. Its targets: (1) Realizes achievement maximum in short ruling period; (2) Promotes the local economic development, boots the fiscal finance and the indicators such as GDP; (3) Under the compatibility with policy of central government, makes the discretionary decision and accomplishes the utility targets. It mixes the individual utility maximum.

It is not realistic to achieve system equilibrium through the mandatory supply which is provided by central government for the targets are different. We should take account for the local government effects in achieving system equilibrium [3]. It is the basis of land price game existing between central government and local government.

33.4 Land Price Game Existing Between Central Government and Local Government

Its activities effects may be conflict with the targets of central government.

1. Modify the model of land price regulation game

   (i.) The game players: In the model of land price regulation game, the players are central government and local government. Their relationship is "from top to down". Information is symmetry.

[8] On 17th, April, 2010, the State Council published ten provisions, the Notice on resolutely curb the fast rising of prices in some cities. We short it for "New Ten Country Provisions". Refer to article 5 and article 6.

(ii.) Action and strategy: In land price regulation game, central government has three actions to choice: (a) Low price regulation. (b) High price regulation. (c) Combination optimized land supply regulation. Therefore, the sets of action for central government are: S1 = {Low price regulation, High price regulation, Combination optimized land supply regulation}.

The local government has three actions to take for land price regulation accordingly. a. low price selling. b. high price selling. c. Combination optimized land selling. The sets of action for local government are: S2 = {Low price selling, High price selling, Combination optimized land selling}.

(iii.) The strategy of game: It is the whole plan for all players. The sets of strategy for central government are S1 = {Low price regulation, High price regulation, Combination optimized land supply regulation}. Accordingly, the sets of strategy for local government are S2 = {Low price regulation, Low price selling}, {Low price regulation, High price selling}, {Low price regulation, Combination optimized land selling}, {High price regulation, Low price selling}, {High price regulation, High price selling}, {High price regulation, Combination optimized land selling}, {Combination optimized land supply regulation, Low price selling}, {Combination optimized land supply regulation, High price selling}, {Combination optimized land supply regulation, Combination optimized land selling}.

(iv.) Target utility: According to the targets of central government and local government, the level of the utility depends on the different activity sets in game. Let the utility of central government is U1 = {S1,S2}. From the analysis of the above articles, in the game with local government, whether the central government chooses the low price regulation or high price regulation, the effect is still weaken in some extent by local government. And central government can't achieve its targets utility maximum. Therefore, the combination optimized land supply regulation is its optimal action. Suppose the utility for central government is U1 in this action. And the utility of other actions is less than U1. Therefore, wediscount the value of U1 with X_{ij}. That is X_{ij} U_1, i stands for the row (i = 1,2,3), j stands for the column (j = 1,2,3). In the same way, the actual utility of local government can be expressed by U2 = {S1,S2}. The utility is maximum when the action doesn't conflict with the central policy and land is sold in high price. Let the max utility be U2, and discount it with Y_{ij}. That is Y_{ij} U2. There is the possibility that negative utility comes for the strategy failure in the game. Hence, $-1 \leq X_{ij} \leq 1$, $-1 \leq Y_{ij} \leq 1$.

2. The application to model of land price regulation game and Nash equilibrium

The strategy of the land price regulation game can be expressed as below, we fill the strategy matrix 1 with the utility vector (U^1,U^2) which is composed with the utility of central government and local government. The utility is hypothesized above. We will apply the underline to analyze the Nash equilibrium of this strategy matrix.

Game Matrix 1 Strategy game for land price regulation

Central government \ Local government	low	High	Combination
low	$\underline{X_{11}U_1}, Y_{11}U_2$	$X_{12}U_1, \underline{U_2}$	$X_{13}U_1, Y_{13}U_2$
High	$X_{21}U_1, Y_{21}U_2$	$X_{22}U_1, Y_{22}U_2$	$X_{23}U_1, \underline{Y_{23}U_2}$
Combination	$X_{31}U_1, Y_{31}U_2$	$\underline{X_{32}U_1}, Y_{32}U_2$	$\underline{U_1}, \underline{Y_{33}U_2}$

The strategy of central government: (1.) Low price regulation. In the row one, the action of the high price selling from local government doesn't conflict with the low price regulation from central government. And it also could enable the utility of local government maximum That is $U_2>Y_{11}U_2$, $U_2>Y_{13}U_2$. We underline the U_2. (2.) High price regulation. In the row two, the central government prohibits the high price selling and the high price selling method conflicts with this policy. It will influence political career and be contrary to target utility if local government applies the high price selling. Therefore, the utility is minimum when applying high price selling. However, low price selling is little contribution to local economy. Hence, local government should take the method of combination optimized land selling in order to gain utility maximum when central government announces high price regulation. That is $Y_{23}U_2>Y_{21}U_2$, $Y_{23}U_2>Y_{22}U_2$, We underline the $Y_{23}U_2$ (Game matrix 1).

3. Combination optimized land supply regulation. In the row three, central government will publish a land selling policy which provides the ratio of land combination supply. Local government must follow the ratio. Otherwise it has risk of disrupting the bottom line to policy. Therefore, the combination optimized land selling is the best choice. That is $Y_{33}U_2>Y_{31}U_2$, $Y_{33}U_2>Y_{32}U_2$. We underline the $Y_{33}U_2$.

Strategy of local government: (1.) Low price selling. In the column one, it is obviously bad for target of central government if local government apply the method of low price selling. Only regulate it does central government increase utility because the other two actions is useless for low price selling method. It should action with low price regulation and attains the maximum utility. That is $X_{11}U_1>X_{21}U_1$, $X_{11}U_1>X_{31}U_1$. Hence, we underline the $X_{11}U_1$. (2.) High price selling. In the column two, the low price regulation has no effect on the high price selling. It has limited effect on controlling the house price. If central government applies the high price regulation, it will have negative effects on the land market economy. After all, the result is that it will decrease the utility of central government. Therefore, only does apply the combination optimized land supply regulation, it could boost the utility. (3.) Combination optimized land selling. In the column three, local government responses to the combination optimized land supply regulation. Also it utilizes the combination optimized land selling method. At this time, the central government gets maximum utility U_1. On the contrary, if central government applies the single method high price regulation or low price regulation when facing the combination optimized land selling everywhere, the effects must be limited in order to regulate the price the land price. Hence, we underline U1.

With help of the underline, we get the Nash equilibrium from the strategy game. It is {Combination optimized land supply regulation, Combination optimized land selling}.

The preliminary conclusion is, in the land price regulation game between central government and local government, local government game with central government for optimal development. However, central government limits the local government interest in land for its public interest utility maximum. The players of game all reach their equilibrium target utility. That is, central government should take optimized combination supply method to regulate the land price to stabilize the house price. And local government should apply with the policy of central government to realize the utility hypo-optimize.

33.5 The Analysis of the Land Price for Micro Body Under Land Market Economy

Under the selling method of "Bid Tendering, Auction and Quotation", developers could calculate the land price through the predict revenues from future projects. The land materials such as land planning, floor-area ratio, coverage rate and so on may be used to make decision. Besides the house price, the future landprice will be affected by all factors related to property revenues (such as the develop profits, develop cost, floor-area ratio and so on). The land price eventually is restrained by the following factors when developers seek to profit maximum:

Total land cost = selling price of completed houses-construction and installation cost-administrative expenses sales tax expenses-interest from investment-develop profits-payable taxes from buying land [4].

Suppose the development period is T years, and the average selling price of the project is F after completion. Let the discount rate is i. Hence, the present value of land price is $P = F(1+i)^{-T}$. The floor-area ratio is v; land area is m. So the building area is vm. Construction and installation cost (contains the cost of professional staffs) is C_f. The Proportion of administrative expenses in construction and installation cost is g. The develop cost is put even in development period T. Therefore, the present value of construction and installation cost $C = C_f(1+i)^{-T/2}$. The Proportion of sales tax expenses in revenue is f. The payable taxes rate of buying land is d. The develop profit margin is R. According to the Code for Real Estate Appraisal which is national standard, we could take the real estate value after completion for cardinal number to calculate the profits. After transposition and arrangement, we get the land price:

$$L = [P(1 - f - R) - C(1 + g)]\frac{v}{1 + d}. \tag{33.1}$$

Through the analysis of the formula, we know that the unit land price L has linear positive correlation with house price P. And the land price is constrained by house price. On the Contrary, land price also could push the house price for the cost factor.

If government wants to regulate the land price, it of course can adjust the floor-area ratio v, real estate transaction tax rate f, land transfer rate d and the other economic method to control the land price. And it also could change the land supply methods; increase the ratio of bid tendering in the land selling method to control the land price. However, the developers estimate the land price through P, C, R and g. Of course, the effect every factor impact on the land price L is different. Besides the house price P and the develop profit margin R, the remains in the Eq. (33.1) is constant and cost. And building area in develop project confirms when the land area and floor-area rate is known. It ensures that the cost C will not have large change. Therefore, the unit price of land is actually determined by the P and R. when the P is higher and R is smaller; the land selling price is higher. If the house price is stable, they dare not buy high price land in order to profit. Therefore, the land price will not rise sharply. Hence, on one hand, government should regulate the develop profit; on the other hand, it should regulate the land selling method to control the land price. Only by the two approaches, is the house price stable.

33.6 The Game Between Central Government and Local Government in Combination Optimized Land Supply Regulation: Market Decision Based on Land Price

In the bid tendering, developers provide the development plan, bid price to rating agency in sealed method. The rating agency will judge the winner according the land price, development plan and the moderate house price. The game model could be described as below:

(1) Players. Local government who is the land supplier games with the developers who are the land demander. It belongs to “one-to -more” game. The developers or their agents become a bid group: $N = \{1,2,...,n\}$
(2) Developers don’t know each other’s confidential information, including the bidding price (land price and house price) and development plan. It is an incomplete information Bayesian game. Local government need to appraisal the lowest land price S. The land price P_i which every player i bids belongs the confidential information, and the price each other is independent. Suppose the bidders are rational. Bidder i holds the idea that P_j which other players j bid is a random variable between the value of $[0, S]$. Its cumulative distribution

is $F(\bullet)$. Let the $F(\bullet)$ is a differentiable function. The probability of high price is $p_i : T_i \rightarrow \Delta(T_{-i})$. That is $\forall P_i \in T_i$. And $\forall P_{-i} \in T_{-i},\ p_i(P_{-i}|P_i) = \prod_{j \in N-i} F'(P_j)$, $i \in N$. Its type is $T_i = \{P_i | P_i \in [0, S]\}, i \in N$, noting it $T \equiv \underset{i \in N}{\times} T_i$.

(3) Developers bid the price at the same time. Price is sealed and bid just one-times. The price the player i bids is B_i. It must be non-negative. The strategy sets for every bidder is $s_i = \{P_i | P_i \in [0, \infty)\}$, noting it $s \equiv \underset{i \in N}{\times} s_i$. The bidder who bids highest price will pay for it and get the land.

(4) Utility. If developer doesn't get the land, its utility is zero. And the utility of bidder i is:

$$u_i : C \times T \rightarrow R$$

$$u_i(B, P) = \begin{cases} P_i - B_i & \text{if} \{i\} = \arg\max_{j \in N} B_j \\ 0 & \text{if } i \notin \arg\max_{j \in N} B_j \end{cases},\ for\ \forall B \in C,\ \forall P \in T,\ i \in N$$

(5) Because the competition targets of bid tendering is multiple-oriented. We should compare the house price and the development plan if the land price is the same. Therefore, it is different from the normal project which will choose the bidder randomly when the bid price is the same. Hence, the Bayesian game can be described as follow: $\Gamma^{\mathrm{B}} = \left(N, (C_i)_{i \in N}, (T_i)_{i \in N}, (p_i)_{i \in N}, (u_i)_{i \in N}\right)$ [5] . The sets of agent in the model is $T^* = \underset{i \in N}{\cup} T_i = \{P_i | \forall P_i \in [0, S], \forall i \in N\}$, the strategy sets of every agent P_i *is* $D_{P_i} = s_i = \{B_{P_i} | B_{P_i} \in [0, \infty)\}$. The combination strategy sets are $D = \underset{s \in T^B}{\times} D_s = \underset{i \in N}{\times} \underset{P_i \in T_i}{\times} D_{P_i}$, $\forall B = (B_{P_i})_{P_i \in T_i, i \in N} \in D$. Let the expected utility of agent P_I *is* π_{P_i}. It is equal $\pi_{P_i}(B) = \int_{T_{-i}} p_i(P_{-i}|P_i) u_i (B_{P_{-i}}, B_{P_i}, P_{-i}, P_i) dP_{-i}$. Therefore, the type agent can be expressed by $\Gamma = \left(T^*, (D_{P_i})_{P_i \in T^B}, (\pi_{P_i})_{P_i \in T^B}\right)$.

(6) The equilibrium solution for the Bayesian game in land bid tendering. $B^* = \left(B^*_{P_i}\right)_{P_i \in T_i, i \in N}$ is pure strategy Bayesian Nash equilibrium. If and only if every player i and every type P_I in T_i :

(7) $B^*_{P_i} \in \arg\max_{B_{P_i} \in D_{P_i}} \pi_{P_i}\left(B^*_{P_{-i}}, B_{P_i}\right) = \arg\max_{B_{P_i} \in D_{P_i} = C_i} \int_{T_{-i}} p_{-i}(P_{-i}|P_i) u_i \left(B^*_{P_{-i}}, B_{P_i}, P_{-i}, P_i\right) dP_{-i}$

Obviously, the price every agent bids is related with its type P_I. Hence, suppose the every agent bids with some rules of $\phi(P_i)$. Let $\phi(\cdot)$ is a differential increasing function and it is equilibrium rule. The expected payment for agent is:

(8) $\pi_{P_i}\left(\left(\phi(P_j)\right)_{P_j \in T_j, j \in N-i}, B_{P_i}\right) = (P_i - B_{P_i})\left[F\left(\phi^{-1}(B_{P_i})\right)\right]^{n-1}.$

(9) To make the problem simple, we set the $S = 1$, and $F(\bullet)$ is uniform distribution in [0,1]. Hence, $\pi_{P_i}\left(\left(\phi(P_j)\right)_{P_j \in T_j, j \in N-i}, B_{P_i}\right) = (P_i - B_{P_i})\left[\phi^{-1}(B_{P_i})\right]^{n-1} \equiv \pi_{P_i}$ (P_i, B_{P_i}) In the expected payment $\pi_{P_i}(P_i, B_{P_i})$, P_I is a given parameters. B_{P_i} is avariable. Agent maximizes the expected payment π_{P_i} through choosing the variable B_{P_i}. For the function $\phi(\cdot)$ is an equilibrium rule, we get the optimal value of π_{P_i} when $B_{P_i} = \phi(P_i)$. From the envelope theorem, We get $\frac{d}{dP_i}\pi_{P_i}$ $(P_i, \phi(P_i)) = (P_i)^{n-1}$. Solve this differential equation, there is $\pi_{P_i}(P_i, \phi(P_i)) = \frac{1}{n}$ $(P_i)^n + c$. And $\pi_{P_i}(P_i, \phi(P_i)) = \frac{1}{n}(P_i)^n + c$. Therefore, $(P_i - \phi(P_i))(P_i)^{n-1} = \frac{1}{n}$ $(P_i)^n + c$. Using the original condition that $\phi(0) = 0$, $c = 0$. So, $\phi(P_i) = B_i$ $= \frac{n-1}{n}P_i$.

The conclusion shows that, when there are many bidders, the bid price is close to the value the bidder i determine for land without considering other factors. That is $B_i \approx P_i$. It is the same as the land price L. And there is $P_i = L = [P(1 - f - \mathrm{R}) - C(1 + g)]\frac{v}{1+d}$. We analyze the effects that number of bidder impacts on the bid price further, we will find that the bid price will be above the 90 % of the bottom price for winning bidder when there are ten more bidders involve the bid. The degree of the competition is rather high at that time.

33.7 The Conclusion and the Suggestion for the Game

1. We must apply the optimized combination supply method to stabilize the land price. And increase the ratio of land bid tendering selling method in order t o regulate the land price [6]. Even though the degree of market in bid tendering is rather high, the price doesn't rise sharply as the auction. In addition, the land price is not the only standard for selling. Therefore, it could lead the developers paying attention to the quality of house not the house price. We must design procedures for bid tendering when the market is hot. And we could depress the price rising which is irrationally pushed by speculation if we stick to the standard that the revenue rather than market standard determines the bottom price of land.
2. We must enhance and perfect the market system for resident land. It is the basement of regulating land market and keeping land price stable. The land base system includes that: publication of the norm appreciation for resident land, land selling price guidance, regulation of selling method, trading public, and land price warning and forecasting.
3. We should norm the procedures of "Bid Tendering, Auction and Quotation" in every city. Build up a team of evaluation experts who possess both ability and political integrity, and perfect laws relating to "Bid Tendering, Auction and Quotation".
4. We should reform the administration management system for local government, perfect the assessment standard for political achievement, and build up a

multiple targets assessment system which considers the efficiency and fairness. In the condition of market economy, whether the central government or local government, they are not the interest bodies who pursuing the revenue maximum. They should be the organizers and the supervisors in market. Hence, chasing the interest is caused by assessment which is external incentive rather than internal incentive for local government. Only does local government change its short-term interest behavior, the effects of optimized combination supply method are maximum.

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Chapter 34
Trends in Chinese Academic Real Estate Research and the Review of Hot Topics

Ke Fu

Abstract On the basis of the 4,631 real estate papers in 1998~2009 from 524 journals included in CSSCI, this paper examines the trends of Chinese academic real estate research and then reviews hot topics in 2007~2009:real estate price and housing security. The results imply that Chinese academic real estate research have Chinese characteristics, but in terms of theory, need to be improved.

Keywords Trends in Chinese academic real estate research • Real estate price • Housing security • Review

Since the reforming and opening up policy, the real estate industry in China has taken on earthshaking changes. The real estate investment has increased from 10 million in 1986 to 36,242 billion in 2009 and the average number of employees in real estate enterprises has expanded from 66 thousand in 1994 to 195 million in 2009. Under this background, what is the current status of academic real estate research? What changes have taken place in research topics in the last decade? What is the current hot topic? Many papers on these issues can be found in foreign countries while few researches have been done on these in China. Therefore, with the questions above, this paper based on 4,631 real estate articles from 524 journals included in CSSCI (2008–2009) during 1998–2009,would examine the changes in the research topics in recent 12 years from a quantitative perspective and give a review of hot topics from 2007 to 2009, attempting to outline the basic sketch of the current status of academic real estate researches in China.

Project of Dong Guan University of Technology, The Research Status on Academic Real Estate in China(2010RQ04)

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_34,

34.1 Research Thinking and Methods

According to the papers on the topics of academic real estate in foreign countries, we can learn that Dombrow and Turnbull categorized the articles published in REE and JREFE during the period from 1988 to 2001, classified those articles by the topics and techniques [1]; Hardin et al. studied the topics of the articles which have been more cited by REE, JREFE and JRER [2]; Based on 5,697 papers chosen from 119 journals by JREL editors, Harrison and Manning, using JREL's classification, analyzed the trends in the main categories as well as the small categories in real estate area from 2000 to 2006 [3]; Chan el al. mentioned the international research focus and trends [4]; Manning et al. studied the hot issues of practical real estate articles [5]. Additionally, Jud made a 10-year review, in which articles published during the period from 1986 to 1996 on JRER were shown one by one in accordance with their topics, volumes, the authors' name and titles [6].

From what have been mentioned above, we can see that most of foreign scholars examined the trends of real estate research by referring to several widely recognized journals, such as REE, JREFE, and JRER. However, no classification is widely accepted. The JREL classification system adopted by Harrison and Manning in which the topics are categorized into 10 main categories and 56 small ones and the system consisted of 9 main ones established by Dombrow and Turnbull are comparatively comprehensive and systematic ones. When categorizing the papers, some foreign scholars make their judgments according to the keywords, while others rely on their personal judgments.

Since there aren't any Chinese academic journals that specialized in real estate, I choose the real estate papers in journals included in CSSCI (2008–2009), which are well acknowledged in Chinese academia. Here are the procedures: first input the name of the journal in the CNKI, and then choose "the year 1998–2009", "full article", "real estate" and "fuzzy matching". After that, select the real estate papers according to the abstracts or the main contents. In topics classification, combining the methods of Harrison and Manning's with Dombrow and Turnbull's, taking the characteristics of Chinese real estate research into consideration, I divide the topics into 14 main categories and 49 small categories, Given that keywords in some articles are not accurate, I classify the papers mainly according to their abstracts and contents. After that, I study the development of real estate topics over 12 years and summarize the literatures of hot topics in the latest 3 years.

34.2 A Review on the Development of Chinese Real Estate Research Topics During 1998–2009

With the aforementioned method, I have chosen 4,631 papers published during the period 1998–2009 to conduct this investigation. As the result shown from the statistical analysis, the number of papers on these three topics: real estate market, housing policy and housing market, real estate finance and investment has reached 2,367, accounting for 51.5 % of the total number. It is these three topics that constitute the focus of real estate researches in current China. What come second to these three topics are articles on real estate law, which accounts for 10.4 % with the number of 384. The next popular topic is real estate industry. There are 407 articles, accounting for 8.8 %. In contrast, only 80 papers on real estate education, financial accounting, insurance and non-residential real estate investment and management are published, indicating that few scholars have interests in these topics.

Topics in real estate finance and investment, housing policies and housing market have been so popular in Chinese academia during the period of 1998–2003 that as much as 630 articles on these topics could be found, accounting for over 43 % in the period. After 2003, scholars' concerns on housing prices and internal structures of real estate market has been increasing. These two topics even became the most popular ones during the period of 2004–2009, with 641 articles, which accounts for over 20 % of the total number of articles in the period. As to the research of real estate law, which is relatively stable, keeping at around 10 % in the period of 1998–2009. A fact we should notice is that since 2003, due to the special focus on the macroeconomic regulation and control issues, there has been a sharp increase in the number of articles focusing on the study of relationship between real estate and macro-economy,from around 5 % to more than 10 %. In addition, the absolute numbers of articles on these topics like land management and market, real estate agent industry and business management, urbanization and urban development have shown the tendency to grow rapidly since 2003 and keep to increase steadily in 2003–2009, except that the number of papers on real estate tax increased since 2003, but decreased since 2007.

More specific looking at the research topics, we can find out that in the small categories, housing finance in the real estate finance and investment category is the most popular one of all topics, whose number of articles has reached 397, ranking first. What comes second is the real estate price in the real estate market research with the number of 293 papers. And the next one is the housing security which belongs to the real estate policy and housing market category with 216 papers on this topic. These three kinds of articles make up 20 % of the total number of articles. Furthermore, topics including macroeconomic regulation and control, housing development, real estate industry and the law of its development, housing market and the internal structure of real estate market are also scholars' research priorities. However, if we look specific from different periods, although housing finance has always attracted much attention, there is an obvious downtrend in this attention as the real estate finance market especially the housing mortgage market in China is gradually mature. The decline seemed even more prominent after 2003, when an increasing number of scholars began to pay more attention to the climbing housing price. Nearly 10 % of the real estate papers published during the period of 2007–2009 was about housing price, from which we can see that high housing price existing in the real estate practice is also one of the researchers' key concerns. It is also important to note that after the 24th document promulgated in 2007, the trend of regulation has transformed from “market” to “security”, and low-income housing security has been intensified. The differences have led to an upsurge of the research about housing security in 2007 which used to be less popular. The total number of articles on this topic between of 2007–2009 made up over 8 % of all the articles, preceded only by that of housing price. Another hot topic is the macro-control. Research on this also appeared to increase steadily in 2005 when the government, in order to curb the housing price from rising too fast, brought forward the “Eight Real Estate Market Regulation Measures” and the “New Eight Real Estate Market Regulation Measures” to control the real estate industry from the aspects of land providing, tax, finance and the housing supply. There has been such a rapid increase since 2007 that articles on it have reached to over 6 %, ranking in the third place.

Coming to the relatively unpopular topics, we should give more attention to real estate education, the least popular topic, with only four papers in a 14-year sample period. Obviously, this research situation is extremely uncoordinated with the considerable demands for real estate employees. I think the cancellation of real estate major in university courses in 1998 played an important part in this imbalance. Moreover, only 23 articles pertinent to real estate statistics, a topic which should have deserved much attention, could be found. Undoubtedly, there is a great disparity in the use of statistical criteria as well as statistical indicators in China and western countries,which brings about a lot of problems when a comparative research is made. However, not enough attentions have been paid in spite of the less optimistic situation.

Overall, all hot spot issues in practice have been studied in Chinese academia. The hot spot issues in practice are also the hot spots in academia, which embody the most important characteristic of the subject of real estate is its practicality.

According to the studies of the trends of academic real estate researches in western countries, Jud pointed out that the hot spot issues that have been presented in JRER during the period 1986–1996, included investment, appraisal, corporation real estate, housing values, real estate agent, REITS, housing market, regions, environment and mortgage [6]; Dombrow and Turnbull found out that investment, mortgage, appraisal (including rental, price analysis and house appraisal) were the hot topics in REE and JREFE during the period from 1988 to 2001; housing (including housing market, property market, leasing market, seeking, matching and the development of segmenting market), non-residence (such as places for manufacturing, working, retailing and commercial centers), public policies (such as land use planning, tax, and public housing policies) tended to decline year by year [1]; Harrison and Manning believed that investment, residential real estate, appraisal, discussion on pure empirical research methods or techniques, real estate market analysis based on demographic data, property management, discussion on pure spatial location, REITS, tax were all hot topics [3]. Although the topic classification varied from author to author, it is still easy to note that in the past several decades, investment, appraisal, and judgment on property value have always been the research focus in the western countries.

Compared the real estate hot topics in China with those in the western countries, we can see that real estate investment is the research focus in both China and the western countries. On the other hand, because of cultural differences, different developing stages of market economy and real estate practices, the trends of topics also showed different characteristics. For instance, topics including housing price, macro-control, studies on the internal laws of the real estate industry and market, and housing system and policy are quite popular in China, while few researches on these has been conducted outside China. Also, pure theoretical researches on real estate are seldom in China but popular in western countries, which to a certain degree indicates that a systematic core real estate theories and methods haven't been formed yet in China.

34.3 A Review on Chinese Real Estate Hot Topics During 2007–2009

Over the recent 3 years, Academic real estate research in China has developed dramatically. The real estate papers published during 2007–2009 accounts for 39.2 % of the total 4,631 pieces of real estate papers. In order to understand the current research further, we picked out 59 papers on the most popular two topics from those ranking within top 30 % journals included in CSSCI (2008–2009). The followings are respectively summaries of the two hot issues:

34.3.1 Real Estate Price

In terms of the housing price, scholars have probed further into the reasons why housing price keeps rising in China. In the macro economy points, the demand (GDP) to houses have played an important role in long-term trends of housing price [7], the Gross Output, the previous housing price, interest rates and inflation rates have great effects on the housing price [8, 9], and some scholars hold that economic development factor is mainly responsible for housing price, while both monetary factor and income factor have lost their explanatory ability [10]. When considering the influences on different regions in China, credit quota, real interest rates, expected prices, property taxes affect housing price respectively in different areas of China [11, 12], and the fluctuation of exchange rates, the international hot money, the low global real interest rates and excessive liquidity have resulted in the volatility of the housing price [13–15]. In the micro points, local fiscal expenditure and local public service have significant effects on the rising of housing price, and at the same time, local public expenditure has long-term influences rather than short-term effects. Moreover, various kinds of public investment affect the real estate prices differently according to distinct property types [16–19]. In addition, developers' monopoly pricing [20], the imbalance of housing supply structure [21], irrational transactions [22], money illusion [23, 24], expectations [25], availability heuristic errors of psychological factors [26], etc., are all considered to be the important factors for high prices and volatility of housing prices [20–26]. Specific to the influences on individual cities, there is equilibrium relationship between housing price and economic fundamentals in Beijing, the institutional factors are the main reasons for the rising housing price by leaps and bounds in long-term run [27]. Therefore, even if the Olympics were held in Beijing, its influences were limited [27, 28]; the increase of Guangzhou housing price mainly is a cause of the contradiction between the government's monopoly to the supply of land and free market demand for commodity house [29]. Housing price in Hangzhou is mainly connected with prior housing price, the changes of money supply and interest rates [30].

In addition to the researches into the causes of rising housing price, some scholars studied why housing prices were different in distinct regions in China, such as the positive relationship between urban openness and housing prices [31], the characteristics related to physical comfort, humanities environment and urban sanitation all affect housing prices distinctly in different areas [32]. To be more specific, with "cumulative effect" and great "spillover effect", Shanghai real estate market drives the growth of housing prices in Zhejiang Province and Jiangsu Province,Jiangsu has a strong "spillover effect" on the housing prices in Zhejiang province too [33]. Some scholars studied the influential factors that cause different housing prices within a city. Location factors like the distance to the CBD, rail traffic, public transportation accessibility, elementary and secondary school education, commuting costs, landscape, etc. are all found to affect the housing prices [34–39]. What's more, some scholars studied the relationships among different types of real estate market. For example,the study of Qingyong Zhang et al. [40] showed that the residential market share comparison of the stock and the flow is the key factor that determines whether the stock or the flow will lead the price. Normally, the bigger of the market share will be the leader [40].

34.3.2 Housing Security

Chinese urban housing security system mainly includes housing accumulation fund system, affordable housing system and low-rent housing system [41, 42]. In 2007, the State Council promulgated "Certain Opinions About Solving the Urban Housing Difficulties of Low-income Families", which marked that China returned to lay equal stress on market and security from the excessive focus on housing marketization [43, 44]. Some scholars come up with the problems and some suggestions of urban housing system in China, which can be summarized as: financial investment limit, supply scale small, coverage small, some construction exceeding standard, the way of one-time supplier subsidies too simple, income assessment confused, the affordable housing policy be abused, housing distribution opaque and unfair, affordable housing areas being Poverty and marginalization and so on. The main reasons are the absence of the government's macro function, imperfect laws and regulations system, etc. [45–48]. Some scholars were inspired by researching and contrasting the practices of affordable housing abroad, such as models of the United States, Singapore, etc. [49–54]. The suggestions include making the government play its leading role, improving the law system, increasing financial investment, widening the channels of affordable housing construction, developing housing finance, scientifically identifying the low-income groups, strengthening and improving the supply of rental housing, etc. More specific suggestions include, for instance, the construction of new affordable housing in our country should be no less than 25 % [42]. When selecting the address, the whole city planning, different income groups be included, the availability of public transportation, etc. should be comprehensively considered [55]. In the construction of public facilities for affordable housing, government should purchase more public and quasi-public products [56, 57]. Considering the exit mechanism, the "contract counter-purchase authority" of common property can be tried for affordable housing, [58]. The subject of low-rent housing property should be identified, and the rent term contract system should be set up, etc. [58, 59].

Urban low-income housing security community contains different groups, and their regional differences are significantly, however, the purchasing power of all are decreasing [60]; Peigang Wang (2007) said that different groups can respectively take redistribution measures such as "aid distribution, compensated distribution, justice allocation, etc" [61]. In terms of special group for migrant workers, Junping Liao (2007) came up with setting up a detailed housing equity plan, referring to the British housing equity system [62]; Wanli Ma (2008) proposed to improve the migrant workers' housing security system after the investigation into migrant workers' housing situation in Hangzhou [63]. Gaopan Zhang (2007) studied the constructing models of old city's affordable housing in consideration of old city protection, having those middle and low income groups in mind who need to be reallocated in nearby area because of urban renewal [64].

For other income groups, based on the practice of price-fixed housing, Lieyun Ding (2008) set up the moderate income group housing supply system [43]; Yi Chen (2007) put forward building "parity room" to meet the housing needs of "the second kind of family" [65]; Yang Li (2008) studied common housing security system with reference to the mode in America, Germany and Singapore and then gave proposals on the operation of housing accumulation fund [66].

34.3.3 Summary

Overall, more than 70 % of the papers of the top two hot issues were published in journals of Economics Management and Human Geography, indicating the close relationship between real estate researches and the subjects of economy, management and planning in China. Scholars can use a newly theory to study the real estate problems in China. For example, in the study of housing price, the scholars comprehensively use various research findings of macro and micro economics, urban economics, finance, psychology, etc. at home and abroad. They study from extensive, unique perspectives, and aim to compare the practices in foreign countries with domestic real estate research results, pointing out that our country's characteristics, having enriched the real estate theories. In the research methods, some scholars use empirical researches, such as most papers on housing prices, some papers on housing security, can reach convincing conclusions by means of quantization. The main shortage is the lack in the depth of theory, especially in that of housing security. Some scholars only give simple description and conclusion of phenomenon. Some scholars lacking theory basis use mathematical models without clear explanation for the models or variables. In addition, the paucity of data and defects of the existing data, the limitation of relevant estate practices such as practices in affordable housing, also hinder the scholars' further study.

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Chapter 35
A Review on Housing Tenure Choice

Ke Fu

Abstract The research on housing tenure choice is one of the important topics in western real estate research. This paper reviews the current status of the study from the economic perspective, demographic perspective and social psychological perspective respectively. Moreover, this paper provides some inspirations for our research.

Keywords Housing tenure choice • Economic perspective • Demographic perspective • Social psychological perspective • Review

Do you want to buy a house or rent one? In western countries, it has been several decades to do the research of tenure choice. Most of the countries such as the United States, Australia, New Zealand, Britain, France, Singapore, Japan, South Korea, and China are encouraging residents to buy houses [1]. And owning a house becomes the preference of most people. For example, America's housing occupation ratio is above 65 % and that of other European leading countries except Germany reaches more than 50 % [2]. Why do people prefer to purchase a house rather than rent one? Under what kind of circumstances would people buy a flat? Is economic factor the only factor that people would take into consideration when deciding to buy houses? Such specific problems caught the attention of scholars and have been researched into deeply. The article sorts out of the relevant research results of western scholars respectively from three perspectives of economics, demographic and social psychology, focusing on micro factors rather than medium factors like market or macroscopic factors like the government policies, which pay more attention to the influence on the tenure choice. And it ends with the evaluation towards the results and some discussion about the enlightenment of the related researches.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_35,

35.1 Economics Perspective

Because of the high value of housing, most western literature in early phase adopted economics perspective when researching into the problem of tenure choice. Its theoretical assumption is that people are rational economic men, who pursue benefit maximization as to the choice of buying or renting in a given budget constraint condition. Income and cost usage are two most important explanatory variables, attracting most western scholars' attention.

Income reflects one's affordable capacity of economy of renting a house or buying one. The early model commonly used annual income as its independent variable. But Kain and Quigley [3] pointed out housing consumption has stronger correlation with residents' permanent income than with their annual income [3]. The research conducted by Struyk [4] found out that there is a nonlinear relationship between these two types of income and the possibility to buy a house. If income growth begins with positive influence, when it develops to some degree, it declines. While at the same time, its influence has much to do with family life cycle [4]. Jones [5] further pointed out that not only income but also liquefiable net wealth should be the key variable to forecasting the act of purchasing a house [5]. The modern model generally includes the annual income and wealth as the independent variable. With the development of housing mortgage market, Linneman [6] and Zorn [7] initiated a research in housing purchasing power limit area, where Linneman [6] found that income and wealth limit will reduce the possibility of buying a house and wealth limitation plays a major part in it. Fortunately, the development of mortgage market eases the situation. However, even if the capital market is developed, purchasing power limit still plays a counteractive role [6]. Zorn [7] also confirmed the counteractive of purchasing power restrictions and pointed out that the impact would be frustrated as macro-economy changes [7].

The comparison of cost usage between buying and renting can directly reflect its economical efficiency, which is one of the important variables used for traditional model to predict the behavior of buying or renting houses. Obviously, if the relative cost usage is higher when buying a house, people would rather rent one. In the calculation of cost usage, Rosen's [8] formula is often quoted. In this formula, the cost usage of housing purchasing has positive correlation with mortgage rates, depreciation and maintenance, property taxes, whereas it has negative correlation with tax burden in using buying houses encouraged by the governments and house prices appreciation [8]. Rosen [9] emphasized that the tax burden the government can deduct has a great effect on the large increase of housing occupation ratio in the United States after World War II [9]. Haurin and Gill [10] further introduced the relative cost into transaction costs and the time expected to live, finding out transaction costs and time expected to live affect purchasing decisions greatly. The lower the transaction cost and the longer the time expected to live, the greater the chance of buying houses [10].

Housing investment and consumption proposed by Henderson and Ioannides [11] laid a solid theoretical basis for the further research into the problem of buying or renting a house in an economic perspective. Their famous housing investment-consumption model points out the reason why a person decides to buy a house. That is because of two motives: investment and consumption. Assume the premise that the housing is in the same quality and tenants are the same with the homeowner's budget constraint and the chance of renting and buying is equal, people will determine to rent or buy a house according to the strength or weakness of the investment demand and consumption demand. Owning to the external characteristics of leasing (risk of agent), people will buy a house when investment demand is greater than consumption need (investment restrictions principle) [11]. Brueckner [12] developed the model, introducing the mean-variance combination framework under the premise of a variety of risk assets without considering housing. He also pointed out that the excessive consumption of housing is the rational decision result of imbalanced consumption benefits and investment portfolio [12].

Due to large variation of income, housing prices or cost usage of housing, the influence of the uncertainty on the choices to buy or rent attracts great attention. Fu's [13] research points out that because of the existence of liquidity limit, the income of the future changes in investment and consumption of housing would lead to two contrary effects. One is income effect which means that when future income increases, housing investment will decrease while housing consumption increases. The other is the substitution effect which suggests that when future income increases, since the risk aversion degree will drop, housing investment will consequently increase and housing consumption will reduce. The decision of buying or renting depends on the income effect and the substitution effect [13]. Robst [14] used several different methods to calculate income risk, and the result shows that the increased risk of income can lead to risk aversion, which will reduce the possibility of buying a house [14]. The empirical research by Sinai [15] showed that people would be willing to purchase a house and pay a premium so as to avoid the risk of the change for renting. In addition to studying the uncertainty of the single factor and the effects of changes [15], Francois [16] studied the influence of several uncertain factors on renting and buying and pointed out that when income and the rent of the covariant drops, or estate and future possible purchasing of other property covariant improve, the possibility of buying a house will increase [16]. Davidoff [17] research also represents that while income and housing prices co variability increase, the value the house people buy will reduce. Specifically, when the covariance improves by one standard unit, its value will reduce by $7,500. Its implied meaning is that people will withstand future risk change by housing investment [17].

In the economics perspective towards the problem of buying or renting, people's behaviors of buying or renting often are simplified into economic cost savings. When the total costs of buying a house is less than that of renting one, people will choose to buy a house. Even after considering demographic factors, we often think that these factors indirectly affect the option of renting and buying by changing these economic factors, such as past marriage that affects the behavior of buying a house by influencing the net wealth and mortgage proportion, the existing marital status that influences the behavior of renting or buying through the effect on expected living time in certain places which influences the behaviors of buying and renting a house [18]. Obviously, this opinion neglected and underestimated the effects of other noneconomic factors have on buying a house [19], whereas demographic factors are also very important. In the meanwhile, it is essential to include economic factors and demographic factors into the model of buying and renting [20–24].

35.2 Demographic Perspective

Rather than thinking buying a house is a simple investment or a consumptive decision, demographers/geographers and sociologists believe which is a complicated thing that is closely related to the changes of a family and the housing markets [23, 25, 26]. Demographic variable, family's scale, constitution, events (marriage and birth), members' age, race, gender, etc. have important influences on people's behaviors of buying houses.

Early in the fifties of last century, Rossi pointed out that housing events were closely related to household events. However, not until late in the eighties of last century, scholars continued to study them based on the former frame and found variables of family life cycle was closely bound up with housing. These variables included marital status, the number or the type of a family and age, which sometimes were considered to be the substitute variables of life cycle. These variables were decisive factors in buying a house. For one thing, the research suggested that buying a house means a permanent dwelling mainly when income and family conditions are relatively stable. For example, marriage is the promise of the stable family relationship. For another thing, the research also suggested that the family events themselves and the expectation towards the events, such as the plan or expectation of giving birth to babies may lead to changes in housing [23, 26, 28, 29]. The main conclusions of the research include the followings: couples with babies most probably have bought a house, while couples without babies are less likely to buy a house that couples with babies. There is the smallest chance that single person will buy a house. Among single persons, those who are divorced or widowed are more likely to buying houses, compared with those who are unmarried or single parent without babies. There are synchronization between marriage and buying a house. Children have positive effects on buying a house and the decision of buying a house always occurs during the time of living together or from marriage to having babies [21, 26, 30–32]. In addition, divorce always forces the owners of houses into tenants, which has a great impact on housing market.

The effect of family life cycle variables on buying a house can be influenced by national situation variables. German tends to buy a house when getting married or when having the first or the second baby. However, Holland tends to buy a house when getting married or within several years' marriage, so the birth of a baby has little effect on their behavior [28, 35]. People's concept and preference of different generations also matter. Even though families like couples with babies still occupy a large proportion in the number of people who have bought houses, the status has been reduced [36]. While single persons cover the smallest proportion, the possibility of buying their first houses has been increasing, compared with the married ones [29, 37].

According to the mechanism of action between family life cycle and housing events, Clark and Onaka [38] stated that the changes in family life cycle could directly lead to changes in housing while dissatisfaction had indirect effects. Moreover, static family life cycle itself could also impact housing decision [38]. Mulder and Wagner [28] thought during different family life cycles, people would hold different preferences and senses of the cost and benefits of buying or renting a house. What's more, buyers could gain different housing resources in different periods. These factors have great influences on housing decision [28]. In order to study the interaction mechanism between different factors, Cirman [39] had conceived a framework of how family characteristics (including demographic and economic indicators)affect the perception of tenure choice and restrictive factors (including the supply of rent, restrictions of renting house and financial restrictions),and then influence the tenure preference [39].

Due to the trend of the aging of population, aged people have a greater impact on housing market. More attention has been paid to their housing decisions because most of their fortunes exist in the form of housing property. In terms of traditional family life cycle, people would like to use housing property as a type of savings in some way in order to consume them when getting old. When analyzing the reason why old Americans transform themselves from an owner to a renter, Jones [40] found evidence that influences aged people's housing behaviors, including traditional family life cycle, improvement of the theory of life cycle (which suggested aged people will first consume most of their non-housing assets and then their housing property) and changes of family population [40]. However, a number of aged people actually are not willing to move [41, 42]. For that, some experts contribute it to great transaction cost (particularly mental cost). Therefore, it leads to reverse mortgage market, which helps them to consume their housing assets without selling their current assets. However, more evidence shows the converse conclusion. Venti and Wise [41] studied the residential behavior of old Americans aged from 58 to 73 and found they don't have the trend to reduce their housing property. If they do, it's always involved with great family changes, such as retirement and spouse-bereft, but health deterioration and children would not affect their decisions [41]. Afterwards, they found a similar conclusion after researching into the housing behaviors of people over 70 years old. They point out that house is not an asset used to accumulate money for retirement but is mainly used to provide a living environment [42]. Megbolube's [43] research also agrees that the liquidity constraint is not the main reason that contributes to seniors' housing decisions. He points out how seniors deal with their housing property has something to do with children's economic conditions. If their children are rich, they tend to reduce their personal housing property. If not, they tend to increase it [43].

Apart from family life cycle, gender, race, and people' buying and renting experience before should be taken into consideration. As far as gender is concerned, man plays a more important role than woman in financial resources (income and assets) when buying a house [32, 35]. Woman is more likely to move out of the house and rent one if their relationship breaks up [33, 34]. Among single persons, man is more willing to buy a house and pay more attention to the potential of making money than woman. However, compared with man, woman is more likely to be affected by her father's social position and her parents' marriage in housing decision [32]. Racial problem is becoming more and more prominent in housing market. The problem is attributed to the interaction between many factors, such as supply restrictions [3], purchasing ability limit [36], social preferences, urban structure and racial discrimination [44]. People's past buying and renting state also influences their housing decisions. Among married couples and aged people, it's found that people are more likely to buy a house in their next choice if they were owners before. Meanwhile, people tend to continue renting a house if they are tenants [21, 41, 43].

Parents' buying and renting state is of great importance to their children in housing decisions. Although so far they haven't figured out the mechanism of action in it, scholars gave out some theoretical explanations on this phenomenon, including the followings. Parents would directly offer their children financial aid; People are influenced by their parents' housing decisions and always choose to live close to them; those whose parents own their house have stronger desire to be an owner. Because house property stands for their socio-economic status, which makes their children take great efforts to reach a high position, at least as high as their parents [29, 35].

Synthesizing economics and demography, Dieieman [45] concludes four aspects, which influence people's housing decisions. 1. Family status: income, job, social status, productive members of a family, age of owner, marriage conditions, household population and race; 2. Family events including marriage, divorce, birth of a child, income and job changes; 3. Previous living conditions including the number of rooms, buying and renting state and housing style; 4. Economic and housing market conditions (not covered too much in this essay) including changes of housing prices, rental levels, teaser rates, inflation, new housing supply, housing structure and housing market in different areas. Generally speaking, it stresses how family conditions and people's previous living behaviors influence their housing decisions by the cross sectional model used in the research. While the time sequence model tends to show emergent events and changes of economic background [45].

35.3 Psychosocial Perspective

In addition to factors of economy and demography, social psychology also plays an important role in housing decisions.

Since the second half of the twentieth Century, more and more scholars have begun to study the concepts of housing or a family. The theoretical basis comes from deep research into family activities and the rise of consumptive sociology [46]. It is general accepted that house is not the compound of bricks and mortars, [47] but a place with safety, privacy and comfort, where we can express our personalities, savour and which stands for self and triumph [42, 48, 49]. House has not only physical characteristics but also social characteristics. Actually, from consumption angle, it makes little differences if we rent or buy a house simply with physical characteristics. But when we buy a house, it includes a series of complicated factors rather than corporality [50].

Rakoff [49] indicate that house is the outcome of culture with spirituality. While it provides essential substantial security, it also expresses the social position and communication. From an abstract sense, Americans want to solve the contradiction between personality and society, so they buy houses. For them, buying a house stands for self triumph, happy families, flow and stability, privacy and social participation, self-control and escape [49]. Foley [50] concluded several social implications of owning one's own house: (1.) It can reduce the investment of future economic burden; (2.) It stands for a man's social position; (3.) It encourages personal activities; (4.) It allows people to make free choices at home; (5.) It's a sense of identity for a family. Meanwhile, he pointed out that tenants have no rights to control a house and no opportunities to present him; Worse still, they even have to experience living alienation, which means the conflict between the tenant and the landlord would lead to estrangement between a tenant and a house [50]. Saunders [51] held that people who live in their own houses will have a sense of ontological security (which means self-confidence and reliance), which meets their need of control, freedom and relaxation [51]. Based on that, Dupuis [57] showed that the sense of ontological security is rooted in the following aspects: (1.) In a changing society and physical environment, house is a place with stability; (2.) House is a place where daily household activities are done; (3.) House, far away from social monitor, it's a shelter where self-control can be realized and a place that entirely belongs to us; (4.) House is a safe fortress that establishes one's identity. He also pointed out that it is the housing property right and a sense of family presence that make a house into a home. Having their own houses gives them a sense of security because unlike tenants, they don't need to worry that they will be driven out by the landlord [57]. Perritt [52] had found eight dimensions of houses of old women in physical level, including self-actualization, physical concerns and safety, sanctuary, social communication, emotional wealth, stability, regularity, independence and liberty, etc. [52]. From several angles of philosophy, phenomenology, sociology and psychology, Saizmaa [47] concluded that there are 24 concepts related to home. Moreover, he raised that home had five dimensions including physical dimension, psychological dimension, emotional dimension, social dimension and spiritual dimension [47].

Because housing is of great significance in men's social psychology, many researches found that what most people think is to buy a house to establish their own family [2, 21, 28]. Most stable families choose to buy houses in a certain period of time. To probe into housing decisions is to research into the problem of when residents will buy a house [5]. Furthermore, the idea of buying a house is rooted in social public culture, which reflects a value that society praises highly and life styles. In America, house represents the main idea of American Dream, [53] while in Australia and New Zealand, house is related to qualities such as success, frugality, self-motivation, aggressiveness, etc. [1, 54].

There are not so many western documents to authenticate directly the relationship between social psychological factors and housing decisions. Ben-Shahar [27] has ever found psychological indicators play a more important role in housing decisions, compared with economic indicators. However, it is not persuasive enough because he took students as specimen [27]. More researches are conducted in order to discuss how the decision of buying a house influences people's social psychology. For example, it can increase people's living satisfaction [55] and reduce poverty perception [2].

35.4 Summary

From the existing researches, we can see that we have achieved a lot on housing decisions in the perspective of economy and demography, which has developed and formed a theoretical system. But another serious problem is that there are many different factors which influence people's housing decisions. There will be deviation in variation coefficients if some important economic variables or demographic variables are omitted in the model, which would lead to unconvincing results. Even though modern measurement method can skillfully deal with the issue, most researches in early time were subject to this problem because of the limitation of methods or data [56]. In researches conducted by Haurin and Gill [10], it can be found that the deviation of effects that income and wealth have on coefficient towards to housing decisions would be greater if we calculate relative costs without considering transaction costs and expected time to live in a certain location [10]. Therefore, we have to be quite cautious when recalling our predecessors' relative achievements because lots of conclusions may have to be fixed by means of new measurements. On the other hand, we can clearly find out the vital relationship between social psychology and housing decisions even if more researches tend to emphasize the idea or concept of housing and home and social psychological requirements toward housing. However, there are not so many researches that authenticate directly from social psychological perspectives, so most of the existing results are qualitative studies rather than conclusions based on quantitative data. Consequently, we need to probe further into this area.

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Chapter 36
The Impact of Inflation Expectations on Housing Price: Based on the Economic Indicator of Consumer Confidence Index

Wenhong Li and Kun Qiu

Abstract Based on the economic indicator of Consumer Confidence Index, this paper prognosticates and analyzes the impact of inflation expectations on housing price. Combined with theoretical analysis, this paper presents a housing prices and multivariate regression model for scientific analysis with the sample of 1999 ~ 2010 housing market monthly data in China. Study found that inflation expectations can result in rise of housing prices, namely producers' and consumers' of inflation expectations, will intensively promote the imbalances of real estate market supply and demand and cause the rising housing prices.

Keywords Housing price • Inflation expectations • Consumer confidence index

36.1 Introduction

The real estate is a special asset with a dual-attribute, so people will purchase house assets to offset the possibility of inflation, which may boost a sharp abnormal, irrational boom in real estate prices. Although since 2010, the central bank raised interest rates frequently, to tighten market liquidity, but inflation expectations remain high, consumer confidence fell back constantly. Therefore, based on the analysis of the consumer confidence index, this paper analyses the influence of consumers' expectation on the future housing price and provides theory basis and experience support to make macro policy and prevent the real estate bubble.

The western country has a long history upon the real estate development and makes a more comprehensive research compared with ours in terms of theories of housing price with many articles and literatures published. For example, Anari and Kolari [1] have used the ARDL and recursion regression model to analyze the

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_36, © Springer-Verlag Berlin Heidelberg 2014

long-term effect which is placed on the housing price by inflation. Kontnonikas and Montagnoli (2002) have estimated the effect that caused by the housing price on the gross demand and inflation, finding out the housing price greatly influence the gross demand and a highly positive correlation between the fluctuation of housing price and the rocketing of future consuming price. Filardo [2], Goodhart [3] and other scholars have proven a correlation by means of theories and practical research respectively and pointed out that the housing price is conductive to the expectation of future consuming price. The domestic research upon real estate market is more focusing on the discussion of hot spots and key factors. Wang Weian [4] has found a stably functional relationship between the expected return of real estate and inflation expectation. Zhou Jingkui [5] has formed a Speculative theoretical mode which is suited the Chinese real estate and found out that the speculation is a important factors having the housing price rise. There're other scholars like Wang Yubao [4], Wang Hen [4] who bring in the asset price to form tools to analyze the change of future inflation rate and prove that the fluctuation of asset price is capable of forecasting the future inflation.

Above all, the existing domestic and international literatures about house prices have laid a good foundation. However, the existing literatures mainly focus on the channel and mechanism how asset prices influence the macro economic variables. Therefore, based on consumer confidence the economic indicators and combined with the housing market supply and demand relation theory, this article will take empirical analysis and test how future inflation expectations affect the future housing prices.

36.2 Theoretical Analysis and Research Hypotheses

Inflation expectations are often more terrible than inflation itself, and expectations is the main non-economic factors to affect inflation. Inflation expectations may influence consumers' and investors' market behavior, which may produce significant difference changes on the relationship between market supply and demand and finally raise inflation.

Due to expectation is forecast for expected future value of economic variables, inflation expectations is people' s estimation or inference of future inflation levels. As for our country, because the degree of interest rate marketization is imperfect, sentiment survey data can more accurately reflect the level of inflation expectations. In general, the rise in prices will aggravate the consumers of inflation expectations, increase the concerns of the weakening actual purchasing power and finally suppress the consumers' willingness to spend.

The Consumer Confidence Index (CCI) is an indicator designed to measure consumer confidence, which is defined as the degree of optimism on the state of the economy that consumers are expressing through their activities of savings and spending. It is a leading indicator to forecast the economy trends and consumption trend and the essential basis to monitor the changes of the economic cycle.

Since 1997, our national bureau began to draw up the statistics of consumer confidence index in China. After several years of practice, consumer confidence index has become an organic component of economic boom index system and it also forecasts price trend of the good index.

Based on the above analysis, this paper argues that consumer confidence reflect consumers' expectation and valuation about the family income level, which is based on various restricted subjective factors. One of the important factors of high expectations about inflation is the decline of the consumer confidence index. And to some extent, inflation expectations may disturb the market signal transmission and make the signal distortion. At the same time, it may intensify the actual inflation and eventually lead to the rise in the price of housing. So this paper puts forward the hypothesis: consumer confidence index and housing prices negative correlation.

36.3 Empirical Test

36.3.1 Sample Interval and the Selection of Variable

This article selects 1999~2010 monthly housing market data in China as the sample. This paper has selected 144 observations. In the model, consumer confidence index (CCI_t) is used to reflect inflation expectations. Then, per capita disposable income (Y_t) is used to measure demand. The residential completed area within this month (A_t) is used to measure supply. In addition, consider loan interest rate (R_t).

36.3.2 The Econometric Models and Descriptive Analysis of Design Variables

After defining all variables clearly, this article designs a housing price function model to test the hypothesis: $P_t = \alpha_0 + \alpha_1 CCI_t + \alpha_2 Y_t + \alpha_3 A_t + \alpha_4 R_t + u$

In this model, dependent variable is housing prices (P_t), and four independent variables. α_1, α_2, α_3 and α_4 respectively reflects the influence of consumer confidence index, demand, supply and the loan interest rate on the house prices. And u is remaining residue, $E(u) = 0$ and has nothing to do with other variables.

The descriptive statistics results of regression model variables have been shown in Table 36.1, so house prices in the 12 years had relatively large fluctuations.

36.3.3 Test for Multi-Collinearity

In the Pearson related relation matrix, the correlation coefficients between variables are less than 0.5, which indicate that this model has small possibility of multiple linear (Table 36.2).

Table 36.1 Descriptive statistics results of regression model variables

Variable	Sample size	Mean	Median	Standard deviation	Minimum	Maximum
P_t	144	3,004.95	2,682.13	1,014.96	1,694.04	5,508.01
CCI_t	144	109.32	110.03	3.77	99.99	114.46
Y_t	144	911.23	818.11	381.63	383.46	1769.34
A_t	144	3,154.33	2,403.01	2793.31	414.37	14,282.55
R_t	144	5.82	5.58	0.6236	5.08	7.47

Table 36.2 Pearson related analysis

	P_t	CCI_t	Y_t	A_t	R_t
P_t	1	−0.497**	0.932**	0.405**	0.088
CCI_t	−0.497**	1	−0.475**	−0.216**	0.276**
Y_t	0.932**	−0.475**	1	0.387**	0.107
A_t	0.405**	−0.216**	0.387**	1	−0.006
R_t	0.088	0.276**	0.107	−0.006	1

** means confidence (double measurement) is 0.01, and the correlation is remarkable

Table 36.3 Multiple regression results

Variable	Coefficients	T
Constant	2851.227	2.720**
CCI_t	−19.859	−1.999*
Y_t	2.329	23.218***
A_t	−0.012	−1.585
R_t	−11.035	−0.202
Adjusted R^2	0.871	
F	241.678***	

* means $p < 0.05$; ** means $p < 0.01$; *** means $p < 0.001$

36.3.4 Regression Analysis

From the result of regression (Table 36.3), the multiple linear regression equation can be built as follows:

$$P_t = 2851.227 - 19.859CCI_t + 2.329Y_t - 0.012A_t - 11.035R_t$$

In conclusion, consumer confidence index and housing prices are negative correlated, and t = 1.999, which means that in the 95 % confidence level, the consumer confidence index and housing prices are significantly correlated. Thus, in this paper, the results can effectively support the hypothesis, in other words, the consumer's expectations of future inflation has a certain degree of influence on housing prices.

36.4 Conclusions and Recommendations

Based on the sentiment survey data of consumer confidence index, this paper conducts theoretical analysis and empirical test and finally draws the conclusion that to some extent, the inflation expectations can boost housing prices.

From the perspective of the inflation environment, gradual increase of inflation expectations will support house prices. One reason is the negative effects of loose monetary policy during the past few years. There is a certain degree of inflation expectations in the market, and housing is the strongest asset which can fight against inflation, so people will try their best to buy house to offset the inflation. Another reason is the excess capacity of economic entity and the lack of investment channels, a lot of enterprises' and individuals' funds flow into the property market to protect their assets; as a result, it will continue to push up housing prices.

So only through rational management of inflation expectations, can make housing prices more stable. However, in reality, inflation expectations and inflation is not the same thing, but continuous accumulation of inflation expectations can make inflation occurs, and behavior under inflation expectations will worsen inflationary pressure. This paper puts forward some advices: Firstly, the economy policy must fully realize the cyclical economic operation rule and cannot act too hastily. Secondly, strengthen the regulation of currency to guide inflation expectations effectively. The central bank may take appropriate monetary policy to tighten market liquidity. Thirdly, make some adjustment in the administration. For example, establish monitoring and information dissemination in real estate prices. Fourthly, guide and resolve irrational inflation expectations. It is necessary to strengthen residents' investment education and guide reasonable investment. At present, speculation that "hot money" was flowing into China, amid mounting pressure for RMB appreciation, helped fuel buying of housing assets.

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Chapter 37
The Application of PFI Mode in Low-Income Housing

Ya-Chen Liu, Jin-Xing Yang, and Shuai Dong

Abstract This paper summarizes the origin and applicable fields of PFI mode, puts forward the viewpoint of applying PFI mode to low-income housing, then, analyses the feasibility of applying PFI mode from perspectives of the government, the private sector and the whole society,finally, gives some useful countermeasures and suggestions about the application of PFI mode in low-income housing.

Key words PFI • Low-income housing • Finance

37.1 Introduction

Low-income housing is a main component of social security systems. As an important measure to guarantee the low-income groups' housing rights, it affects social stability and economic development within comprehensive coordination. Therefore, government pays high attention to low-income housing. "The Twelfth Five-Year Plan for National Economic and Social Development of the People's Republic of China" puts forward that, during the year of 2011–2015, our country is going to build 36 million sets of low-income housing to make the national coverage of housing guarantee reach around 20 % and form complete housing guarantee system which is suitable for national conditions. As the main body of investment and construction of low-income housing, government, however, can't satisfy increasingly construction requirements in input and efficiency in the meantime under the current construction and financing mode. Therefore, it is urgent to introduce new construction modes to solve this problem. As a relatively new construction mode, PFI mode has solved many infrastructure problems for the UK, Japan and other developed countries successfully [1].

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_37,

PFI(Private Finance Initiative)originates in the United Kingdom, is put forward for the first time in 1992 by the British government. Its purpose is to strengthen the cooperation between the private sector and the public department, it is a kind of financing modes with optimization and innovation for public projects[2]. Under this mode, government department launches project, SPC (Special Purpose Company) is responsible for project's construction and operation, and provides service according to the agreement signed in advance. Government's purpose of applying PFI mode is not to obtain the final ownership of facilities but to get effective service, then provide to demand groups. Government purchases service which is provided by SPC within the definite time, after the limit period, the ownership of the facilities is handed over to the government or kept by the private sector in accordance with the agreement.

PFI mode is not only applicable to profitable urban infrastructures, but also can be used in the non-profit ones. The application of PFI mode in the United Kingdom mainly focuses on social welfare and infrastructure construction, in Japan, it focuses on social welfare and environmental protection.

Generally speaking, when applying to the fields of having social welfare quality, it is hard for PFI project to recoup the investment on its own operation completely, it usually requires government financing subsidies to offset. Introduction of PFI mode in the construction of low-income housing can promote private funds to participate in social capital investment and reduce government expenditure pressure,at the same time, government may share the risks of project construction and operation with the private sector reasonably to realize VFM (value for money) [3].

There is an important meaning for improving and developing construction mode of low-income housing to explore how to apply PFI mode to the construction of low-income housing in China.

37.2 Feasibility Analysis of Applying PFI Mode in Low-Income Housing

37.2.1 Analyzing the Feasibility of Applying PFI Mode from the Perspective of the Government

As a kind of quasi-public goods having the nature of public welfare, low-income housing is mainly for groups of low-income in the city, it is an important component of government projects for the people's livelihood.

Construction period of low-income housing is long and its pricing is limited by government to a great degree. Compared with investment of commodity house, its income is lower, the private sector does not want to take participate in it because of its chasing for interest rate. Under the background of large-scale construction of low-income housing, it is hard to satisfy investment requirement to rely on the central government and local government only, the construction of low-income housing needs more social capital, especially private funds to support strongly.

37.2.1.1 Reduces Financial Burden of Low-Income Housing Construction for Government

Construction mission of 36 million sets of low-income housing gives heavy financial burden to the central government and local government, especially to the local government, it is responsible for local construction of low-income housing directly. According to the reports of the national audit office of the People's Republic on June 27, 2011, by the end of 2010, the local government debt balance has more than 10 trillion yuan. Although the government is mainly responsibility of low-income housing, financing funds should rely on the private sectors' investment on the large scale. The introduction of PFI mode will greatly reduce the government's financial burden and promote to realize the goal of low-income housing construction.

37.2.1.2 Shares the Risks of Low-Income Housing Investment for Government

Applying PFI mode in low-income housing can effectively share the risks of the government in the process of project finance, design, construction and operation [4]. Sharing those risks which the government will not be able to withstand with the private sector can improve the efficiency of construction and operation in low-income housing. Under this mode, the government owns more time to pay attention to those macro problems, such as the operating system of PFI mode.

37.2.1.3 The Government has Strong Ability of Operation of Projects

It has been more than 20 years since project finance is introduced and applied in China from the 1980s, in this long process, the government has accumulated rich experience through a series of project operation process whether it is successful or unsuccessful in the field of project operation, so its ability of project operation has distinctly improved.

37.2.1.4 Improves the Efficiency of Low-Income Housing Construction and Reduces Operation Cost

It is a common problem that the government keeps low efficiency for infrastructure investment. Under PFI mode, introducing the private sector to construction and operation of low-income housing can make full use of the advantage of the private sector in management, technology, knowledge and other aspects to save the cost of project construction and operation.

To sum up, introducing PFI mode can alleviate the capital pressure and disperse governmental investment risk. In this operation mechanism, the government and the private sector can promote the using value of the funds and efficiency through cooperation. At the same time, the private sector can integrate its management skills, business skills and creativity into the providing of low-income housing to bring huge potential benefits for the government. The introduction of PFI mode plays an important role in alleviating fiscal capital insufficiency and solving the problem of private capital idle [5]. The application of PFI mode is beneficial to the development of housing guarantee system in China.

37.2.2 *Analyzing the Feasibility of Applying PFI Mode from the Perspective of the Private Sector*

37.2.2.1 Rapid Development of the Private Sector and the Abundant Folk Capital

After 30 years of reform and opening up in China, economy has developed rapidly, Chinese private enterprises experiences the process of development from weak to strong gradually. Chinese Private Economic Development Situation Analysis Report shows that, during the year of 2011, the scale of Chinese private enterprise increases continuously, at the same time, social savings balance has exceeded 25 trillion yuan. The huge folk capital provides great space for implement of PFI mode.

37.2.2.2 The Government's Firm Regulation of Commodity House Market

A multitude of private capital is invested into the field of construction and operation of commodity house owing to its high return of investment of commercial housing. However, with those policies issue, for example "Notice on controlling housing prices overheating in some cities by the State Council", the control power of the government is becoming stronger to the sale market of commodity house. A series of policies show the determination of the government to stabilize the real estate market, to restrain house price increase too rapidly and to prevent the high price in a few cities. At present, real estate developers encounter unprecedented pressure in land acquisition, loans and house sale. Investors cannot achieve expected benefits in the development and operation of the commodity house, some of them have started to convert idea and turned their attention to area of low-income housing, which is accorded with national policy orientation.

37.2.2.3 Favorable Policy for Low-Income Housing Construction

Low-income housing is semi-public good, which is related to a lot of low-income people's interest, the government gives the construction units various support on policy and tax, even offers subsidy directly in funds on the construction of low-income housing. "Announcement on low-rent housing, affordable housing and tax policy of housing lease related by the Ministry of Finance and the State Administration of Taxation" rules, complying with the conditions stipulated documents development business unit, the business tax, the house property tax, land use and the land value added tax will be exempted from the policy. In the currently overall recession of commodity house market, privileges in the land transferring and tax paying have attracted great attention of private investment to low-income housing.

37.2.2.4 Low Risk of Low-Income Housing Investment

Strict price limit of low-income housing that the government carries out, leads to the result that ROI(Return On Investment)is far lower than that in commodity housing investment. However, the service purchase deal ensures that the government has to purchase the buyback service after the completion of the project to ensure the stable cash flow of the project in the future. At the same time, transferring risks of policy and law successfully, also makes the risks of the private sector reduce greatly. In the current market background, the character of low investment risk in low-income housing makes the investment to be a good choice for idle funds of many private sectors in the society.

37.2.2.5 Sets up the Business Enterprise Brand and Improve Enterprise Reputation

The private sector can reward the society by the form of investing low-income housing. Through providing service of low-income housing, enterprises can build up good public praise and improve enterprise image to make contribution to enterprise brand ascension.

37.2.3 Analyzing the Feasibility of Applying PFI Mode from the Perspective of the Whole Society

Under the PFI mode, considering about its own interest, SPC will pay more attention to project cost of life cycle to make the whole project investment cost be less than the traditional ones, so achieving the goal of reducing the social cost overall. Introducing PFI mode to the field of low-income housing will greatly improve efficiency of its construction and operation, it will help more crowds who need to be safeguarded in residence to enjoy the benefit of low-income housing.

37.3 Countermeasures and Suggestions

37.3.1 Improves System of Policy and Legislation

Perfect policy and legal system is the security of putting PFI mode used into low-income housing successfully and widely. The central government should issue corresponding laws to provide a powerful support for private enterprises entering into the field of low-income housing construction and operation. Meanwhile, in order to ensure the construction and operation of low-income housing smoothly, government departments at each level should formulate homologous policies in finance, planning, subsidies and other aspects to encourage private enterprises to participate in the field of low-income housing.

37.3.2 Establishes and Optimizes Project Operation System

It is necessary to set up a complete project operation system when PFI mode is applied in low-income housing. It involves SPC, government, the private sector, financial institutions, consultation, design company, construction units in the operation process of low-income housing project. It needs to set up a kind of operation systems in which SPC as the center and each unit can give full play to the role of the project. This system should be based on the characteristics of low-income housing and the strength of the private sector in different areas, it can choose appropriate mode of operation and operation process. Attention should be paid to improve and optimize the operational system in the practice application continuously. According to the actual conditions of the operation process, analysing various problems which appear in the process of operation to realize the continuous improvement of the operating system.

37.3.3 Strengthens Government's Operation Ability of PFI Project

Although the government has accumulated abundant experience of project operation and the ability of project operation has distinctly improved, PFI mode is not yet put into use in the field of low-income housing in China, inevitably, there will be some problems which we have not met in the process of operation. According to the specific conditions of low-income housing, the government should constantly improve its ability of running PFI projects in reference to the operation experience of the UK, Japan and other countries.

37.3.4 Ensures the Strong Supervision of Government in the Process of Project Construction and Operation

The strong oversight of government in the process of project construction and operation is the guarantee of providing effective services of the low-income housing. The government should supervise SPC in the proceeding of construction and operation of the low-income housing project. Especially after purchasing service and providing it to the groups of housing demand, the government should provide supervision on SPC to ensure service's effectiveness.

It may arise a lot of problems when introducing PFI mode to low-income housing. For example, after the private enterprises enter the fields of construction and operation of low-income housing, how to carry on the effective supervision and guidance to guarantee the providing of effective service. At the same time, operation systems of PFI mode and the project negotiations ability of government on PFI mode may make enormous influence on those projects. Although, there will appear all kinds of problems when introducing PFI mode in low-income housing, the viewpoint of making use of private capital for the development of low-income gives a new way to resolve the problem of central and local government for insufficient finance in low-income housing. It is worth persistently exploring how to combine PFI mode with the real condition of low-income housing in China to promote the development of low-income housing in maximum.

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Chapter 38
An Survey of Young Faculties' Living Condition and Problem Solutions

Qing Wu

Abstract Young faculties are the major drive for college's and university's development. However, many of them are accompanied with housing difficulties due to short work experience and little wealth accumulation. The essay carries out a case study on Shanghai Songjiang University Town and aimed at identifying young faculties' housing problem through a survey and quantitative analysis. Through the survey, we can find the young faculties have a relatively low income and a relatively poor living condition. Despite that all the respondents living in the school dormitory are young faculties; the main body of market rental housing is also young faculties. Young faculties have a low housing satisfaction.

On the basis of the survey, this article suggests that rental housing for faculties can be established through the cooperation of university and local government at school concentrated area such as Songjiang University Town according to the existing public rental housing policy. Meanwhile, this article argues that financial institutions should promote the incremental repayment model to relieve the pressure of young faculties in the earlier period of repayment and improve their house-purchasing ability.

Keywords College and university • Young faculties • Housing difficulties

The young is not only the future of[1] our country, but also the main force to the social development. One's young time which is also a period of being deficient in material wealth and poor living conditions is the most dynamic period in his lifetime.

[1] This paper is funded by two projects: the first one is the project of Humanities planning of Ministry of Education, and the project number is 10yja630169; The second one is the project of Shanghai Education Commission, and the project number is 11ZS178, 12YS131.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_38, © Springer-Verlag Berlin Heidelberg 2014

Thousands of young people go to work in shanghai every year, and housing problem is the primary issue they have to face. This article is based on the survey of some questions such as the current condition of young faculties' housing problem. And it demonstrates the current condition of young faculties' housing problem through statistical analysis and quantitative data. In the end, some suggestions are put forward to help young faculties to improve the ability of purchasing houses.

38.1 The Basic Situation of the Research

In order to facilitate the investigation, the survey took place in all the seven colleges and universities in Songjiang University Town. During the investigation, 500 questionnaires were provided. And 432 effective questionnaires were reclaimed. The effective rate is 86.4 %. On the basis of literature retrieval in different areas, the objects of the survey are young faculties in college and university who are under the age of 35. For convenient for comparing, the objects also include faculties of other age stages.

The conditions of the respondents are as following: In the facet of gender, there are 210 men, accounting for 48.61 %, and 222 women, accounting for 51.39 %. The proportion of women and men are approximately the same. In the facet of age, there are 139 respondents under the age of 30, accounting for 32.18 %. One hundred thirty two people are between 31 years old and 35 years old, accounting for 30.56 %. Sixty one people are between 36 years and 40 years old, accounting for 14.12 %. Seventy five people are between 41 years old and 50 years old, accounting for 17.36 %. Twenty five people are between 51 years old and 60 years old, accounting for 5.79 %. And 271faculties are under the age of 35, accounting for 62.74 %.In the facet of educational background, 99 people hold doctoral degree, 210 people have master's degree, 107 people have bachelor's degree, and 16 people graduated from colleges or below. There are 309 people have doctoral or master's educational background, accounting for 71.53 %.In the facet of length of service, 96 people have 3 years or below working experience, 93 people are between 3 years and 5 years, 96 people are between 510 years and 10 years, 73 people are between 1,020 years and 20 years, and 75 people have 20 years or above working experience. More than 60 % of the respondents have 10 years working experience. In the facet of the family population size, 139 people have one family member, accounting for 32.18 %. One hundred thirty two people have two family members, accounting for 30.56 %. Two hundred forty people have three family members, accounting for 55.56 %. And 53 people have four family members, accounting for 12.27 %.

38.2 The Main Issues Reflected in the Investigation

38.2.1 The Young Faculties Have a Relatively Low Income

Through statistical and cross analysis, the personal monthly income is as follows:

We can find that most of the faculties' monthly income concentrates in 2,900–6,000 Yuan from Table 38.1, accounting for 57.9 %. The faculties under 30 years old concentrate their monthly income in 2,900–4,000 Yuan, and faculties who are 31–35 years old concentrate their monthly income in 4,000–6,000 Yuan. Looked from the weighted mean, we can see that faculties' monthly income grows along with age, and faculties whose monthly income is lower than the total average 5,724.2 Yuan is under 35 years old. Therefore, compared with the ordinary workers, young faculties' income is not so low, but their income is relatively low in colleges and universities.

38.2.2 The Young Faculties Are the Main Body to the School Dormitory and Market Rental Housing

Ten housing types are divided when we designed the questionnaire to investigate the housing conditions of the young faculties. Statistics show that as young faculties don't comply with the aided conditions which are necessary to Shanghai affordable housing and cheap renting house, there are no faculties living in the affordable house or the cheap renting house. The two options are excluded from the analysis. Specific results are shown as follows in Table 38.2.

From Table 38.2, we can see the proportion that faculties living in commercial house is above 60 %, which indicates that commercial house is the primary choice to faculties. The proportion of faculties under 35 years old who live in commercial house is the highest, achieves 53.5 %. However, the proportion of under 30 years old's faculties who live in commercial house is 38.8 %, which is relatively equal to the proportion (31.7 %) of faculties who live in school dormitory. The proportion (38.8 %) is lower than 49.7 % which is the sum of the proportion of living in market rental house and school dormitory, so the proportion of young faculties who live in commercial house is relatively low. All the respondents living in the school dormitory are young faculties. The proportion of young faculties living in market rental house is also high, achieves 83.3 %. It's evident that young faculties are facing difficulties in housing.

Two reasons lead to the results as mentioned above. On the one hand, most of the young faculties are living a bachelor's life, so they choose to live in school dormitory. On the other hand, young faculties under 35 years old have a low income, so they can't afford a house.

Table 38.1 The per capita monthly household income and age cross-analysis

Age[a] monthly income per person cross tabulation										
		Total								
	Count	<2,900	2,900–4,000	4,000–6,000	6,000–8,000	8,000–10,000	10,000–20,000	>20,000	Total	Weighted mean[a]
Age	Below 30	25	51	38	10	11	4	0	139	4801.8
	31–35	10	35	49	20	11	5	2	132	5672.3
	36–40	6	13	20	12	6	4	0	61	5905.7
	41–50	13	16	16	9	10	6	5	75	6878.7
	51–60	1	8	4	4	3	5	0	25	7220.0
Total		55	123	127	55	41	24	7	432	5724.2

[a] weighted mean is calculated by taking the median. The income below 2,900 is calculated as 2,900. The income above 20,000 is calculated as 20,000

Table 38.2 The housing situation and age cross-analysis

Age * housing situation crosstabulation

			Housing situation								
			Self-built house	Public house	Commercial house	High-end apartment	Villa	Market rental housing	School dormitory	Others	Total
Age	<30	Count	5	11	54	0	0	25	44	0	139
		% within age	3.6 %	7.9 %	38.8 %	.0 %	.0 %	18.0 %	31.7 %	.0 %	100.0 %
	31–35	Count	4	15	91	0	0	15	5	2	132
		% within age	3.0 %	11.4 %	68.9 %	.0 %	.0 %	11.4 %	3.8 %	1.5 %	100.0 %
	36–40	Count	1	6	47	1	0	5	0	1	61
		% within age	1.6 %	9.8 %	77.0 %	1.6 %	.0 %	8.2 %	.0 %	1.6 %	100.0 %
	41–50	Count	1	12	55	3	1	3	0	0	75
		% within age	1.3 %	16.0 %	73.3 %	4.0 %	1.3 %	4.0 %	.0 %	.0 %	100.0 %
	51–60	Count	0	6	19	0	0	0	0	0	25
		% within age	.0 %	24.0 %	76.0 %	.0 %	.0 %	.0 %	.0 %	.0 %	100.0 %
Total		Count	11	50	266	4	1	48	49	3	432
		% within age	2.5 %	11.6 %	61.6 %	.9 %	.2 %	11.1 %	11.3 %	.7 %	100.0 %

* means different age

Table 38.3 The housing satisfaction and age cross-analysis

Age * satisfaction crosstabulation					
			Satisfaction		
			Yes	No	Total
Age	<30	Count	34	105	139
		% within age	24.5 %	75.5 %	100.0 %
	31–35	Count	32	100	132
		% within age	24.2 %	75.8 %	100.0 %
	36–40	Count	17	44	61
		% within age	27.9 %	72.1 %	100.0 %
	41–50	Count	29	46	75
		% within age	38.7 %	61.3 %	100.0 %
	51–60	Count	11	14	25
		% within age	44.0 %	56.0 %	100.0 %
Total		Count	123	309	432
		% within age	28.5 %	71.5 %	100.0 %

* means different age

38.2.3 Young Faculties Have a Low Housing Satisfaction

In the facet of housing satisfaction, only 28.47 % of faculties are satisfactory with the existing housing condition. Three reasons can explain the result: deficiency in housing area, far away from school, and not belonging to his house. The investigation group use SPSS to do the housing satisfaction and age cross-analysis, and the result is as following in Table 38.3.

From Table 38.3, we can find that the overall satisfaction to housing conditions is low. It also indicates that the proportion of dissatisfaction decreases while the age increases, namely along with the age growing, the satisfaction is also growing. Faculties under 35 years old have a lower satisfaction than the other age groups.

38.3 Proposals on Alleviating Housing Difficulties Young Faculties Face

38.3.1 Rental Housing for Faculties Can Be Established Through the Cooperation of University and Local Government

According to the “Notice of Shanghai Municipal People’s Government on implementation opinions of construction and management of units leasing house made by Six Departments including the Municipal Housing Support and Administration Bureau” issued at August 23rd, 2009, the enterprise, industrial parks, universities and military units can use their own land to build or rebuild units leasing house which can be provided with to the workers for short term rental. “The regulation to carry out implementation opinions of construction and management of units leasing house issued by Shanghai Municipal Housing Support and Administration Bureau" at June 22rd, 2010 also makes several provisions on units leasing house.

In authors' opinion, universities can take themselves as the units to construct and operate the units leasing house. Shanghai Songjiang University Town as a school concentrated area can construct rental house for faculties based on resource sharing and through the cooperation of university and local government. And try to find a path which is not only conforming to university's reality, but also effective in solving the problems.

38.3.2 Promote the Incremental Repayment Model to Relieve the Pressure of Young Faculties in the Earlier Period of Repayment

Now the financial institutions' repayment models are the equality corpus and interest and the equality corpus. The monthly payment of the two repayment models is constant or decreasing year by year, which doesn't match the fact that young faculties' income increases with the increasing working experience. On the contrast, the incremental repayment model match with the fact.

In this article, the investigation group assumes that the total amount of loan is 600,000 Yuan, and the loan period is 20 years. Under the current loan interest rate, we can find that the early payment of the equality corpus and interest model is 3,926.66 Yuan, and the equality corpus model is 4,950 Yuan, the incremental repayment (the payment is 200 Yuan) model is 3,050 Yuan every year, the incremental repayment (the payment is 20 Yuan) model is 2,560 Yuan every month. The payment of the equality corpus model is 2,390 Yuan more than the incremental repayment model per month, about two times more than the payment of the incremental repayment model per month.

38.3.3 Change Ideas and Encourage Rental Housing

People's living concept has a great effect on people's residential behavior. The concept of owning a house is inveteracy in China. It's difficult for the young to afford a house in a short time. In some developed countries such as France and Germany, as the inhabitants are glad to rent a house, the homeownership rate is relatively low, just about 30–40 %. The homeownership rate in America is 68 % and 80 % in our country. When one's economic strength is not strong enough, house purchasing will put great pressure on one's shoulder, and at that time, renting house is a better choice. The society should take measures to initiate the young to rent, and improve the rental policy to make a good living condition at the same time.

38.4 Concluding Remarks

The article carries out a case study on Shanghai Songjiang University Town and makes a clear understanding on both young faculties' housing condition and satisfaction through a survey and quantitative analysis. Some measures and proposals are put forward to help young faculties to relieve the pressure in housing, and hope to play a role in improving young faculties' housing problem.

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Chapter 39
Empirical Study on Relationship Between China's Real Estate Price Growth and Market Power-Based on Statistics from the Nation, 30 Provinces and 35 Cities

Bianjiang Zheng and Wei Dai

Abstract In recent years, with the deepening of marketization, China's real estate price has been increasing constantly and attracts the general concern of the whole society. In order to restrict the excessive growth of the market prices, the government continues to strengthen macro-intervention. In market economy, the formation of real estate price depends on the real estate market conditions. The power comparison of supply and demand sides will have a direct impact on the real estate price changes. The real estate market power of the supply and the demand reflects their ability to influence the real estate price, reveals the market conditions as well as structure characteristics of real estate market, and has significant influence on the growths of real estate price. In this paper we adopt Lerner Index to measure the real estate market power. We choose the real estate market sales data of the nation, 30 provinces and 35 large and medium-sized cities as sample and estimate China's real estate market power and the average increase of real estate price. Based on that, we analyze the relationship between increase amplitude of real estate price and the market power. The result of the study shows that China's real estate price changes and the real estate market power present a positive correlation and real estate market power is one of the main factors influencing the changes of real estate price.

Keywords Real estate • Price changes • Market power

39.1 Introduction

In 1998 China cancelled the welfare-oriented public housing distribution system. With the implement of housing fund and the increasing of residents' income, China's real estate market represents a favorable trend and the price, as a problem focused on

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_39, © Springer-Verlag Berlin Heidelberg 2014

by the whole society, has been rocketing, especially from 2004. The rocketing housing price triggers a series of social and economic issues. The excessive growth of the house price becomes the important point of the macro-intervention. In market economy, the formation of real estate price depends on the market conditions. The macro-control of the real estate has to be based on the condition of the market. China's rocketing real estate price cannot be explained by the model of free market economy. The power comparison of supply and demand sides will have a direct impact on the real estate price changes. The market power reflects the ability of the supply and demand sides to affect the price and has significant influence on the growth of real estate price. With the increasing of demand rigidity, the sellers' pricing power is becoming stronger and the price is largely decided by the sellers (The following *market power* refers to the *sellers*' *market power*). We choose the real estate market sales data of the nation, 30 provinces and 35 large and medium-sized cities as sample and estimate China's market power and the average increase of real estate price. We analyze the relationship between the amplitude of real estate price change and the market power. The result shows that China's real estate price changes and the market power present a positive correlation and the market power is one of the main factors influencing the changes of real estate price.

39.2 Related Literature

The relevant research of the real estate price theory is adequately systematical and brings about lots of papers and treatise which has already been widely applied in daily practice. The research of price mechanism in foreign real estate market usually pays more attention into the functioning of the price mechanism and the factors which influence the real estate prices. Denise and William [1] used a model which is similar with "cobweb model" to analyze the fluctuation of real estate market. Meanwhile, they proposed a classification which divides the real estate market into capital market and consumption market and described the four quadrant models of the interaction between capital and consumption markets based on these two conceptions; Rosen [2] and Guilloches (1977) gave a systematic summarization of the theoretical frame of Hedonic pricing and proposed house price model which was widely used in the research of house price and living environment. Di Pasquale and Wheaton [3] studied the relationship between house rent and house price and generated the well-known stock-flow model. This model describes how property market and capital market achieve equilibrium by modulating various variables such as rent, price, number of new constructions and house stock. Gabriel et al. [4] established a house price model which contained both market demand and supply factors they figured that the population migration and the evolution of city structure could explain the fluctuation of house price in California in the past 20 years.

The domestic real estate markets have a short history. Because of the more and more intense house price conflict, the analysis of the factors influencing the house price becomes quite abundant. In the aspect of house supply, lots of scholar pay attention into the real estate cost. Zhang Hong and Li Wen dan [5], and Wang Xiazhong [6] believed that cost increase is the main factor of the rise of house price. Hu Ruixian [7] pointed out that the factor which determines the real estate price is nothing except cost and supply push. The demand control policy is hard to be an effective regulation measure. The government should focus on the cost control. Other scholars analyse the factors which influence the house price at the angle of real estate market demand. Wu Jianfeng [8] considered that the demand for better living conditions is the main factor of house price rising, along with the gradual increase of per capita wage; Zhang Daliang and Zhou Limei [9] made a research about how custom demand influences the house price; Qi Zhaozhen [10] had a analysis of the relationship between rent and house price; Zhang Hong and Li Wendan [5] analyzed how GDP influences the house price form economic gross angle.

Domestic scholars' researches of the market mechanism of the real estate are limited within some qualitative description. Some of the scholars realize that there must be some kind of interaction among land market, stock market and incremental market. Lou Jiang [11] described the theory of the city real estate market and makes a monographic study on the correlation between house price and land price; Gao Meicheng [12] realized that the stock market plays the main role of regulating the incremental market and claimed the opening of the stock market in order to promote the development of the entire real estate market. Zhou Huili [13] discussed that the differentiation of real estate products can enforce the monopoly power of the sellers and enhance their abilities of monopoly pricing. She considered that inner features of the real estate and market structures should be the starting point for restraining the excessively rapid rising-up of the house price. Kuang Weida [14] estimated Lerner index of Beijing and Tianjin. The results showed that the main market power of real estate was quite high in China's main cities and he concluded that the root cause of high house price is monopoly. Li Hongjin [15] calculated the panal data sectional data, historical data and Lerner index of different provinces. He claimed that the market competition of real estate was quite insufficient. The level of market monopoly was really critical and monopoly power could, to some degree, explain the house price rigidity in recent years. Wu Liping and Ju Fang [16] made an empirical analysis of the monopoly degree of real estate market and its effect in the excessively rapid rising-up of house price on the angle of market structure and market power. In addition, some other scholars studied house price factors based on real estate market intervention. The most important factor is the effect of Tax and macro-control.

39.3 Theoretical Analysis of Market Power Influences on House Price

In the real estate market, the price is decided by both sides of the market. With the increasing of demand rigidity, the sellers' pricing power is becoming stronger and the price is largely decided by the sellers. Hull Fanta Hector Seaman Index, Lorenz curve, and Lerner Index can be used to measure the level of market power. In this paper we adopt Lerner Index to measure the real estate market power. Lerner Index reflects the level of the monopoly through measuring the degree that the price (P) deviates from the margin cost (MC). The expression to calculate Lerner Index (L) is:

$$\mathrm{L} = \frac{\mathrm{P} - \mathrm{MC}}{\mathrm{P}} = -\frac{1}{\mathrm{E_d}} \tag{39.1}$$

Supposed $P = f(L)$, the rate of house price increase is:

$$g = \frac{\Delta p}{p} = \frac{f(L+\Delta L) - f(L)}{f(L)} \tag{39.2}$$

According to the definition of differential coefficient we can get the simplified formula:

$$g' = \frac{\frac{f(L+2\Delta L) - f(L+\Delta L)}{f(L+\Delta L)} - \frac{f(L+\Delta L) - f(L)}{f(L)}}{\Delta L} = \frac{f(L)f(L+2\Delta L) - f^2(L+\Delta L)}{\Delta L f(L) f(L+\Delta L)} \tag{39.3}$$

We can get formula 39.4 from formula 39.1:

$$P = \frac{MC}{1-L} \tag{39.4}$$

In formula 39.3, as the denominator must be positive number, we just need to take consideration with the numerator. We can get the numerator through the formula of price and the Lerner Index.

$$f(L)f(L+2\Delta L) - f^2(L+\Delta L) = \frac{MC}{(1-L)} \frac{MC}{(1-L-2\Delta L)} - \frac{MC^2}{(1-L-\Delta L)^2} \tag{39.5}$$

We can get the simplified formula 39.6:

$$g' = \frac{MC^2(\Delta L)^2}{(1-L-\Delta L)^2 f(L) f(L+\Delta L)\Delta L} > 0 \tag{39.6}$$

Therefore we can conclude that the amplification of price positively correlates with market power. The stronger the market power is, the faster the price increases.

39.4 Estimation of Domestic Real Estate Market Power

39.4.1 Selection of Relevant Variables and Data

According to the above-mentioned deduction, we can estimate the Lerner Index by the demand elasticity(E_d), which concerns with two statistics of the model: $\log y_{it} = a + b \log x_{it} + u$, the demand amount Y and the price X.. In the model, we can proved that b is equal to $1/E_d$. In process of Positive versus Normative analysis, we use the sales of commercial housing and the mean price of the commercial housing to replace. In the research process of this paper, we collect the real estate market saleroom and the mean price data of the nation, 30 provinces and 35 large and medium-sized cities.

The data of sales of national commercial housing as follows in the Table 39.1:

We also collect the data of the sales of the nation, 30 provinces and 35 large and medium-sized cities. All the data comes from China's National Bureau of Statistics, CEInet and China's economic and information statistical data base. Since the amount of the data is too large, we do not list it in detail.

39.4.2 The Analysis of the Calculation Results f Market Power

39.4.2.1 The National Calculation Results in Different Time Interval

Because the land access can be exchanged in 1987 and housing distribution system reform begin in 1998, we separately calculate the market power from 1987 to 1998 and from 1999 to 2010 and make a comparison in this paper.

This paper uses Eviews software through the model based on Least Squares method to regression analysis and result is in the Table 39.2:

From the upper table, we can see that both coefficient determinations of the two durations are significant. Besides, the Regression coefficients are significant and the margin of Regression errors are small. So the results of the regression of the model are comparatively ideal.

39.4.2.2 The Calculation Results of the Data from 30 Provinces

According to the statistics of provinces of China's real estate sales from 2000 to 2010, this paper uses Eviews software processing data based on Least Squares method. The following table is about the Lerner Index obtained in some provinces' real estate market and is based on the regression (Table 39.3).

Table 39.1 The data of sales of national commercial housing from 1987 to 2010

Year	Mean price (yuan)	Saleroom (ten-thousand yuan)	Sales volume(ten-thousand m^2)
1987	408.00	2,697	1,100,967
1988	503.00	2,927	1,472,164
1989	573.00	2,855	1,637,542
1990	703.00	2,866	2,018,263
1991	802.00	3,025	2,378,597
1992	1,050.00	4,289	4,265,938
1993	1,280.00	6,688	8,637,141
1994	1,409.00	7,230	10,184,950
1995	1,710.00	7,906	12,577,269
1996	1,806.00	7,900	14,271,292
1997	1,997.00	9,010	17,994,763
1998	2,063.00	12,185	25,133,027
1999	2,052.53	14,557	29,878,700
2000	2,111.63	18,637	39,354,400
2001	2,169.71	22,412	48,627,500
2002	2,250.20	26,808	60,323,400
2003	2,359.47	33,718	79,556,600
2004	2,713.88	38,232	103,757,100
2005	3,167.67	55,486	175,761,300
2006	3,366.79	61,857	208,259,600
2007	3,863.89	77,355	298,891,200
2008	3,799.94	65,970	250,681,800
2009	4,681.04	94,755	443,551,700
2010	5,032.33	104,765	527,212,400

Table 39.2 The result of the national real estate market's Lerner Index

Duration	Coefficient of determination (R^2)	T Statistics	Regression error	Regression coefficient (b)	Lerner Index (L)
1987–1998	0.9748	19.686	0.1837	1.9163	0.5218
1999–2010	0.9729	18.954	0.1670	2.9837	0.3352

According to T-statistics we can see that regression coefficients are significant and the root mean squared error is small. Therefore the regression result of selected sample is quite ideal from this model and can be used to analyze the market power.

39.4.2.3 The Results of the Data from 35 Large and Medium-Sized Cities

According to 35 large and medium-sized cities' annual data of commercial housing selling, we can get the coefficient of elasticity from this model by OLS method and then we can get Lerner index of real estate markets in different cities. The table below shows the reciprocal of elasticity of demand by regression through this model-the Lerner index of real estate markets in different cities (Table 39.4).

Table 39.3 The result of 30 provinces' real estate market's Lerner Index

Province	Coefficient of determination R^2	T Statistics	Regression error	Regression coefficient (b)	Lerner Index (L)
Beijing	0.613	3.984	0.313	1.248	0.801
Tianjin	0.922	10.846	0.197	2.135	0.468
Hebei	0.958	15.189	0.207	3.146	0.318
Shanxi	0.965	16.569	0.182	3.016	0.332
Inner ongolia	0.950	13.801	0.238	3.279	0.305
Liaoning	0.990	32.123	0.106	3.410	0.293
Jilin	0.940	12.559	0.275	3.460	0.289
Heilongjiang	0.924	11.037	0.282	3.109	0.322
Shanghai	0.875	8.352	0.172	1.433	0.698
Jiangsu	0.992	35.239	0.071	2.503	0.400
Zhejiang	0.970	17.994	0.097	1.749	0.572
Anhui	0.976	20.063	0.135	2.706	0.370
Fujian	0.946	13.274	0.154	2.051	0.488
Jiangxi	0.930	11.537	0.232	2.671	0.374
Shandong	0.989	30.000	0.101	3.016	0.332
Henan	0.989	29.630	0.129	3.830	0.261
Hubei	0.963	16.243	0.156	2.538	0.394
Hunan	0.967	17.005	0.208	3.535	0.283
Guangdong	0.952	14.122	0.170	2.395	0.418
Guangxi	0.887	8.840	0.487	4.309	0.232
Hainan	0.669	4.501	0.362	1.628	0.614
Chongqing	0.949	13.649	0.213	2.906	0.344
Sichuan	0.903	9.629	0.255	2.458	0.407
Guizhou	0.862	7.903	0.351	2.775	0.360
Yunnan	0.917	10.478	0.464	4.862	0.206
Tibet	0.648	4.290	0.794	3.407	0.294
Shanxi	0.969	17.621	0.149	2.630	0.380
Gansu	0.915	10.381	0.316	3.285	0.304
Qinghai	0.916	10.472	0.298	3.119	0.321
Ningxia	0.929	11.420	0.332	3.795	0.264
Xinjiang	0.852	7.598	0.467	3.551	0.282

Table 39.4 The result of 35 cities' real estate market's Lerner Index

City	coefficient of determination R^2	T Statistics	Regression error	Regression coefficient (b)	Lerner Index (L)
Beijing	0.773	4.881	0.176	0.860	1.183
Tianjin	0.948	11.260	0.155	1.748	0.572
Shijiazhuang	0.885	7.338	0.338	2.480	0.403
Taiyuan	0.884	7.300	0.264	1.926	0.519
Hohhot	0.981	19.121	0.115	2.207	0.453
Shenyang	0.706	4.100	0.733	3.005	0.333
Dalian	0.982	19.292	0.105	2.034	0.491
Changchun	0.919	8.884	0.310	2.756	0.363

(continued)

Table 39.4 (continued)

City	coefficient of determination R^2	T Statistics	Regression error	Regression coefficient (b)	Lerner Index (L)
Harbin	0.877	7.049	0.253	1.780	0.562
Shanghai	0.787	5.079	0.214	1.085	0.922
Nanjing	0.829	5.834	0.291	1.699	0.588
Hangzhou	0.937	10.176	0.159	1.621	0.617
Ningbo	0.923	9.188	0.131	1.201	0.833
Hefei	0.881	7.183	0.335	2.410	0.415
Fuzhou	0.850	6.304	0.215	1.356	0.737
Xiamen	0.964	13.740	0.111	1.531	0.653
Nanchang	0.947	11.171	0.253	2.824	0.354
Jinan	0.876	7.020	0.247	1.733	0.577
Qingdao	0.921	9.008	0.251	2.262	0.442
Zhengzhou	0.794	5.198	0.514	2.724	0.367
Wuhan	0.870	6.878	0.286	1.958	0.511
Changsha	0.796	5.228	0.551	2.883	0.347
Guangzhou	0.968	14.573	0.108	1.568	0.638
Shenzhen	0.943	10.739	0.144	1.547	0.646
Nanning	0.753	4.621	0.564	2.608	0.383
Haikou	0.581	3.116	0.509	1.587	0.630
Chongqing	0.174	1.215	3.388	4.115	0.243
Chengdu	0.773	4.888	0.374	1.830	0.546
Guiyang	0.950	11.565	0.184	2.133	0.469
Kunming	0.815	5.552	0.610	3.389	0.295
Xian	0.866	6.730	0.556	3.742	0.267
Lanzhou	0.209	1.358	1.034	1.405	0.712
Xining	0.788	5.107	0.585	2.989	0.335
Yinchuan	0.823	5.710	0.562	3.209	0.312
Urumchi	0.743	4.504	0.358	1.613	0.620

According to the regression analysis of sample data, the results of Haikou, Chongqing and Lanzhou only have a fitting degree of 0.5. The regression results are not appropriate to be used as standards for judging real estate market power.

39.5 Correlation Between Market Power and Fluctuation of House Price

39.5.1 Analysis Based on the Domestic Market Data

In order to analyze the relationship between the variation of domestic real state's price and the market power, We chose the consumption data of 1999–2010. We calculated the range of every year's house price and the annual Lerner Index

Table 39.5 The analysis data of the domestic market's house price of 1999–2010

Year	Sales	The sold space	The average price	Price variation (g)	Lerner Index (L)
1999	29,878,700.00	14,557.00	2,052.53	0.028792	0.090786
2000	39,354,400.00	18,637.00	2,111.63	0.027505	0.11673
2001	48,627,500.00	22,412.00	2,169.71	0.037099	0.154243
2002	60,323,400.00	26,808.00	2,250.20	0.048559	0.152302
2003	79,556,600.00	33,718.00	2,359.47	0.150208	0.493793
2004	103,757,100.00	38,232.00	2,713.88	0.16721	0.240948
2005	175,761,300.00	55,486.00	3,167.67	0.062861	0.339971
2006	208,259,600.00	61,857.00	3,366.79	0.147648	0.339275
2007	298,891,200.00	77,355.00	3,863.89	−0.01655	0.102617
2008	250,681,800.00	65,970.00	3,799.94	0.231873	0.301375
2009	443,551,700.00	94,755.00	4,681.04	0.075047	0.397881
2010	527,212,400.00	104,765.00	5,032.33	–	–

according to different sales and different average price. The data is shown below Table 39.5:

According to the result of the sheet above, we make the inspection of the linear logarithmic of the range of variation of house price and the annual Lerner Index, the results are presented below:

$$\mathrm{Log(g)} = -1.25178 + 1.062260\mathrm{Log(L)}$$

$$t = (-2.128489)(3.455575) \quad r^2 = 0.598816$$

In the linear regression of the price variation and the Lerner Index time sequences, deflective error coefficient measures the elasticity of the variation of price to the Lerner Index. According to the results above, deflective error coefficient 1.062260 shows that when the Lerner Index increases one percent, the range of price variation will rise 106.23 %. indicating that the annual Lerner Index of the whole domestic market has marked effects on the house price variation

39.5.2 The Analyses Based on the Data of 30 Provinces

In order to analyze the relationship between house price variation and the market power more deeply, authors chose the real estate sales data of 1999–2010 of 30 provinces. After calculating each province's increasing range of average price and Lerner Index of 1999–2010, we get the following data Table 39.6:

According to the results above, the authors made the inspection of the linear logarithmic of the range of variation of house price and the annual Lerner Index, the results are presented below:

$$\mathrm{Log(g)} = -1.708539 + 0.532438\mathrm{Log(L)}$$

$$t = (-16.47822)(5.477311) \; r^2 = 0.508482$$

Table 39.6 The analysis data of the 30 provinces' house price of 1999–2010

Province	The average increasing of the house price (g)	Lerner Index (L)	Province	he average increasing of the house price (g)	Lerner Index (L)
Beijing	0.12139627	0.801	Hubei	0.1054544	0.394
Tianjin	0.128897329	0.468	Hunan	0.1052938	0.283
Hebei	0.093886999	0.318	Guangdong	0.0852226	0.418
Shanxi	0.12165076	0.332	Guangxi	0.0843471	0.232
Inner Mongolia	0.11032863	0.305	Hainan	0.1623405	0.614
Liaoning	0.08145101	0.293	Chongqing	0.1121829	0.344
Jilin	0.0910491	0.289	Sichuan	0.1105766	0.407
Heilongjiang	0.08035466	0.322	Guizhou	0.0950131	0.36
Shanghai	0.1480259	0.698	Yunnan	0.0616362	0.206
Jiangsu	0.12780125	0.4	Xizang	0.1175084	0.294
Zhejiang	0.15801922	0.572	Shanxi	0.1267995	0.38
Anhui	0.12187646	0.37	Gansu	0.0916655	0.304
Fujian	0.1112796	0.488	Qinghai	0.0722934	0.321
Jiangxi	0.13959513	0.374	Ningxia	0.0859354	0.264
Shandong	0.1046993	0.332	Xinjiang	0.0787214	0.282
Henan	0.10662349	0.261	–	–	–

According to the results above, deflective error coefficient 0.532438 shows that when the Lerner Index increases 1 %, the range of price variation will rise 53.24 % indicating that the annual Lerner Index of the 30 provinces' market has marked effects on the house price variation.

39.5.3 The Analysis Based on the Data of 35 Cities

Regional characteristics of the real estate market is obvious, the data of cities' real state reflects the true characteristics of the real estate market better. The authors chose the real estate sales data of 1999–2010 of 35 cities. After calculating each city's increasing range of average price and Lerner Index of 1999–2010, we got the following data Table 39.7:

According to the results above, the authors made the inspection of the linear logarithmic of the range of variation of house price and the annual Lerner Index, the results are presented below:

$$\mathrm{Log(g)} = -1.300423 + 0.693153\mathrm{Log(L)}$$

$$\mathrm{t} = (-8.027268)(3.401730)\mathrm{r}^2 = 0.259621$$

According to the results above, deflective error coefficient 0.693153, shows that when the Lerner Index increases one percent, the range of price variation will rise 69.31 % indicating that the annual Lerner Index of the 35 cities' market has marked effects on the house price variation

Table 39.7 The analysis data of the 35 cities' house price of 1999–2010

City	Lerner Index (L)	The range of Price variation (g)	City	Lerner Index (L)	The range of Price variation
Beijing	1.183	0.186554	Qingdao	0.442	0.174647
Tianjin	0.572	0.164896	Zhengzhou	0.367	0.166765
Shijiazhuang	0.403	0.11501	Wuhan	0.511	0.154851
Taiyuan	0.519	0.179418	Changsha	0.347	0.135748
Hohhot	0.453	0.140617	Guangzhou	0.638	0.170938
Shenyang	0.333	0.118298	Shenzhen	0.646	0.479517
Dalian	0.491	0.123555	Nanning	0.383	0.105943
Changchun	0.363	0.131474	Haikou	0.63	0.192164
Harbin	0.562	0.113501	Chongqing	0.243	0.13861
Shanghai	0.922	0.179674	Chengdu	0.546	0.191542
Nanjing	0.588	0.167031	Guiyang	0.469	0.324786
Hangzhou	0.617	0.202468	Kunming	0.295	0.063712
Ningbo	0.833	0.31602	Xi'an	0.267	0.107182
Hefei	0.415	0.207847	Lanzhou	0.712	0.1321
Fuzhou	0.737	0.182972	Xining	0.335	0.133268
Xiamen	0.653	0.236318	Yinchuan	0.312	0.07395
Nanchang	0.354	0.139706	Urumqi	0.62	0.99148
Jinan	0.577	0.152432	–	–	–

39.6 Summary

In market economy, the formation of real estate price depends on the market conditions. The power comparison of supply and demand sides will have a direct impact on the real estate price changes. We proved theoretically that the magnitude of the house price changes is an increasing function of the Lerner index. Based on it, we choose the real estate market sales data of the nation, 30 provinces and 35 large and medium-sized cities as samples and estimate the effect of the nation's Lerner Index on the range of house price variation. It proved out that China's real estate price changes and the real estate market power present a positive correlation and the market power is one of the main factors influencing the changes of real estate price.

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Chapter 40
Analysis of the Investment Evaluation of the Uncertain Real Estate Project

Xingfang LI and Shiqiang ZHAO

Abstract The economic quickly development in China has provided opportunities for the real estate project investment. The rise in the real estate project activity has caused an increase in competition in the Chinese market. By the investment evaluation, the investors can control the project more confident and increase the competition abilities. This study analyzes the sources of the real estate project uncertainties. Based on the traditional financial evaluation, the paper introduces the new Adjusted Cash Flow Method, adjusted Discount Rate Method and the real option theory to resolve the uncertainties. Finally, this paper draws a conclusion that the three methods above are more suitable than the traditional ones for the uncertain real estate project.

Keyword Investment evaluation • Uncertain factor • Real estate

40.1 Introduction

The real estate project has come to the features with high effective and more valuation. More and more investors tend to the real estate project investment. But the environment which the investors have to face has been gradually changing. One is the environment of the project itself, the other comes from the surrounding conditions the project is in. all of these environment have influence on the real estate project and cause high uncertainties.

Facing with the uncertainties, the investors have to change the management method from extensive form to Fine-Grained form. It needs to analyze the feasibility of all investments. In order to reach the prospective goal of investment and

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_40, © Springer-Verlag Berlin Heidelberg 2014

provide basis for the real estate project investment, it is necessary for project financial evaluation to increase the consideration of uncertainties.

To solve these uncertainties and make the investment decision more accurate, we can improve the financial evaluation in some sides. Firstly, we can use the Adjusted Cash Flow Method that made some changes in the cash flow considering the uncertainties. Another way is that we can adjust the discount rate based on the degree of the uncertainties. Then if there are optional uncertainties, maybe the real option theory is the best choice. So the analysis is limited to how to consider the uncertainties factors in the financial evaluation in this paper.

40.2 The Current Situation Analysis

40.2.1 The Real Estate Project Status

Due to the stability of the China economy, the Real Estate market has been continuously marginally shrinking in the recent years. The quickly increase can be released by the data of the National Bureau of Statistics of China. The chart 1 shows the Accomplished investment of the real estates in China from 2007 to 2011. From the data we can see that the investment on the real estate project is still in the increasing, though various limited policies are formulated. This data can make another conclusion that the competition between the companies may be fiercer. (Fig. 40.1)

There are many different factors that have effects on the real estate project. We can classify them into two parts. One comes from the project itself. For example, the projects usually have huge investments and have long operating time. The other generates from the environment the project is in. all of these have influence on the real estate project and cause high uncertainties. Based on the process of the real estate project operation, The uncertainties are found in the decision stage and the process of the construction.

In the project decision, The financial evaluation is adopted to make the final decision to the project. During this course, it assumes that connecting between the projects does not exist and the result of one project has no influence on another. Once the project is decided, it will be ongoing at once. It doesn't allow altering the project optionally or stopping the project in the middle of it. In fact, because of the uncertainties in the procedure, the situation above may be happen at any project in the Real Estate.

During the operation, there are more facts that can result in the uncertainties, such as the change of the commodity price, the government policy, the purpose change of the investors and so on. The adjustment of all these factors has effects on the investment evaluation, especially influence the cash flow and the demand for the return.

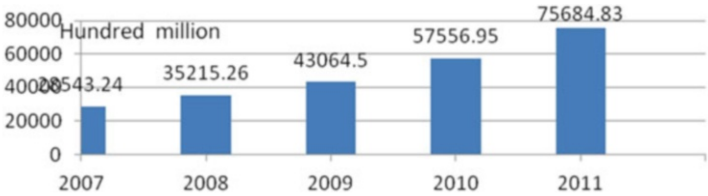


Fig. 40.1 Accomplished investment of the real estates in China

40.2.2 Investment Evaluation Status

At present, we usually use the real estate project financial evaluation method (2000) and the construction project financial evaluation method (2006) to make the project evaluation. Analyzed from these two methods, we can find it only focus on the existing financial data and has little consideration for the uncertainties not only in the beginning of the program chances but also during the following cash flow. Facing all kinds of the uncertainties, I think these two ways are lack of the uncertainties considerations. To make the financial evaluation more accurately, The uncertainties analysis should be added to the financial evaluation. This raises a question regarding the financial evaluation of the Real Estate project: How is the uncertainties analysis added in the financial evaluation based on the original financial evaluation.

40.3 Research Method

In this paper, three models are used for the research on the uncertainties: Adjusted Cash Flow model, adjusted Discount Rate model and the real option model. These models are the act of solving the different uncertainties using the various methods. The major problem is distinguishing the different kind of the uncertainty and using the suitable method. For example, if it is defined that the uncertain came from the year after year, the Adjust Cash Flow model was added in the financial evaluation.

Adjusted Cash Flow Model is one method that we must foresee various influencing factor in the future, then show them by the data in the cash flow, by this data we can adjust the cash flow and do financial evaluation.

Adjusted Discount Rate Model is a calculating the discount rate method that can have an consideration on the uncertainties' factors by taking the advantage of the capital asset pricing model.

The real option model proposes that the project profit created by the cash flow is equal to the total of the real value at present and the chance of choosing future investment. For example, if the company has an opportunity that he can acquire or sell one real assets, the price to this asset can be calculated by the real option model.

For this paper, there may be more uncertainties' that used the adjusted cash flow model and adjust discount rate model to solve the every year's expectant distant in the project operation forecast. If there is the option that affects the investment, the real option model is the better choice.

40.4 Model Establishments

40.4.1 Adjusted Cash Flow Model

For the adjusted cash flow model, two ways are used to solve the question. One is sure equivalent method and the other is decision tree method.

Sure equivalent method has three steps. The first is calculating the coefficient of variation and inquiring the equivalent units coefficient based on the connection between the risk degree and the equivalent units coefficient in Table 40.1. Secondly, take the advantage of the equivalent units coefficient to adjust the cash flow and ensure every year's cash flow on the uncertain state. At last, using the risk-free discount rate.

Decision tree method shows the cash flow and the probability of each cash flow by the tree structure. Then every year's mathematic expectation can be defined which is the cash flow considered the uncertain factors. The following is the specific steps.

Firstly, we must analyze the project uncertain factors in the future, happening probability and the cash flow in every state. It is assumed that the probability (Pmi) is in the year (m), then

$$\sum_{i=1}^{n} Pmi = 1$$

Secondly, based on the data we collected in the first step, we can show them in a tree structure. We take a two-year's project as an example, this decision tree model are set as following: (Fig. 40.2)

Thirdly, the mathematic expectation should be calculated. We can get it as following:

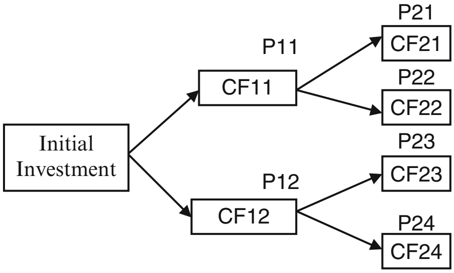
$$CFm = \sum_{i=1}^{n} CFmi \bullet Pmi$$

n represents the number of the branches depart from the former one.

Table 40.1 The connect between the risk degree and the equivalent units coefficient

Risk Degree	0.–0.07	0.08–0.15	0.06–0.23	0.24–0.32	0.33–0.42	0.43–0.54	0.55–0.7
Equivalent Units Coefficient	1	0.9	0.9	0.7	0.6	0.5	0.4

Fig. 40.2 Tree structure



40.4.2 Adjusted Discount Rate Model

For this model, we usually do the financial evaluation by the same discount rate, which means that the project would have more risk of the time is longer from the first year. However, this is not the same and every year has itself risk. So we must use the adjusted Discount Rate Method to adjust every year's discount rate. The following show the procedure.

Firstly, by investigating the information about the real estate project, we can analyze the cash flow and its probability in the future. Then we need to get its mathematic expectation (Ei) and standard deviation (Di).

Secondly, the coefficient of variation (Qi) would come out using the following formula:

$$Qi = \frac{Di}{Ei}$$

Thirdly, through the Delphi, we can decide the coefficient of the uncertain factors (β).

Fourth, each year's adjusted Discount Rate (Ki) would be calculated by the following method. Ti represents the discount rate without uncertain factors.

$$Ki = Ti + \beta \bullet Qi$$

At last, we can do the financial evaluation based on each year's adjusted discount rate.

40.4.3 The Real Option Model

In the Real Estate project, the real option can be classified to seven kinds. They are deferred investment options, option to staged investment, options to expand, options to scope down, option to switch, option to give up and option to grow up for company.

The first step is collecting the materials and deciding which real option would be included. Then we need establish the calculation model to get the real option value. Generally, the project value is formed by two parts: one doesn't consider the value of the real option and the other is the project real option value. The former is equal to the net present value without adjustment; the latter is calculated as following:

$$C = V(0) \bullet N(m_1) - I \bullet e^{-\beta t} \bullet N(m_2)$$

where
$$m_1 = \frac{ln[V(0)/I] + (\beta + \sigma^2)t}{\sigma\sqrt{t}}$$

$$m_2 = \frac{ln[V(0)/I] + (\beta - \sigma^2)t = m_1 - \sigma\sqrt{t}}{\sigma\sqrt{t}}$$

Explanation 2:

Variable	Significance
C	The valuation of the real option
V(0)	The total of the current worth
I	The project investment cost
β	Free-uncertain rate
t	Duration time
σ	The project changing variance led by Uncertain

The total valuation of the project is released:

$$ENPV = NPV + C$$

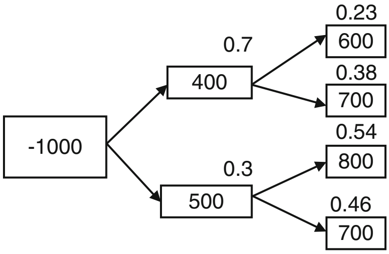
40.5 Simulation Results

40.5.1 The Material

One company wants to do a real estate project. So the company uses the financial evaluation to decide if they can operate this project. They must divide it to two stages. If the first stage is well, they may have the option to get the second stage. The second stage invests 1,000 million and it has 2 years. Its cash flows are forecasted in the following.

The First year	Cash flow	400	500		
	Probability	0.7	0.3		
The Second year	Cash flow	600	700	800	700
	Probability	0.23	0.38	0.54	0.46

Fig. 40.3 The tree structure



If they accomplish the first stage, they may have the option to operate the second stage. From the experience of the investor, the NPV of the first stage is -23.the free-rate is 11 %, the cost of capital is 20 %.

40.5.2 *The Process of the Financial Evaluation*

From the model above, we can establish the tree structure as following: (Fig. 40.3)

If we evaluate by the traditional method, The NPV of the second stage = −54.05 .the NPV of the two stage are both less than zero. The two stage of the project are not passed through. However, we consider the first stage as an option to get the second stage. Thus we can use the Real Option to solve the problem.

$$V(0) = 849.30$$

$$ENPV = NPV + C = 11.23$$

It is concluded that we can operate the two stages if we consider from the side of the real option.

40.6 Conclusion

From the case that we comparison the traditional method and the modified method, we can find we neglect the uncertain affect in the traditional financial evaluation, which may lead to the error. In this paper, we consider the different uncertainties and improve the financial evaluation based on the different uncertain effects. With the development of the real estate market, the competition will fiercer and fiercer, at the same time, the uncertain factors will more and more. So the uncertain researches in this paper will contribute to the development of the Real Estate.

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Chapter 41
The Changing Real Estate Supply and Investment Patterns in China: An Institutional Perspective on Affordable Housing

Yigang Wei, Patrick T.I. Lam, Y.H. Chiang, and Barbara Y.P. Leung

Abstract China's housing reform from 1998 onwards represents an institutional transformation of the real estate industry to a buoyant commercialized market. The institutional transformations generated by the policy reforms have led to substantial changes in the mechanism of real estate investment and supply. Through an extensive literature review and data collection, this paper depicts an investigation of the changing systems of real estate investment and supply in China after the fundamental housing allocation reform. The discussion focuses on the social housing provision systems, the real estate financing systems of developers and house owners, and the changing roles of real estate investment and supply. Due to the shrinkage of direct investment from state budgetary funds, the low affordability of the general public and other difficulties, a multi-layer housing provision system which the government designed earlier is expected to be less operative, and would lead to a conspicuous market disorder with an insufficient supply of housing to accommodate less- affordable families. The marketization process sees the reduced roles of state intervention and the growing effects of market-forces. Eventually, the profit-oriented commercial developers have taken a more proactive role than the government in housing investment and supply, but in a somewhat mis-matched manner.

Keywords Real estate industry • Supply and investment patterns • China

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_41,

41.1 Introduction

Housing affordability is not only an economic issue, but is also of key social importance. Therefore, the provision of adequate affordable housing for their citizens is a policy agenda of top priority for most governments. In the 17th National Congress of the Communist Party of China, President Hu Jintao declared the goal of housing policy as "families can be well accommodated" (zhuyousuoju). The Real estate market in China consists of several categories including residential, commercial, office, and others, according to the divisions of NBSC (National Bureau of Statistics of China). Whichever market variables being used in estimating, the housing sector contributes to roughly 80 % of commodity buildings in China, representing the most important category in the real estate market [1]. This paper, focusing on the housing sector, aims to investigate the changing mechanism of real estate investment and supply after the fundamental housing reform in 1998.

41.2 Review of 1998s Housing Reform

It is the 15th anniversary of the fundamental housing reform progumulated in 1998. China's real estate industry has grown remarkably since then and become a pillar industry in the national economy. The housing commodification reform has created enormous demands for private housing, since the housing resources were no longer provided as social welfare by the state. The booming housing demand is a necessary premise for the establishment of a real estate market.

In the old housing system, all housing units were centrally planned, funded through public fiscals, and allocated by the authorities. The local governments and working units (danwei) were responsible for housing construction, operation and maintenance. Most of the housing apartments, treated as social welfare goods, were directly distributed by government departments and state-owned enterprises to their employees free or at nominal prices. In this context, there was virtually no real estate market in a real economic scene.

China's housing reform is motivated by conspicuous failures of its old planned housing scheme which cannot adequately meet citizens' housing requirements and respond to demands for improved living conditions, particularly leading to excessive fiscal burdens to operate the housing system [1]. Reflecting on these problems, the Chinese government undertook a radical and complete housing reform in 1998, marked by the release of 'A Notification from the State Council on Further Deepening the Reform of the Urban Housing System and Accelerating Housing Construction'. The fundamental housing reform policy clearly ordered the state-owned enterprises to terminate house building and provision to their employees and switch to monetize the housing subsidies to support employees' homeownership in the private market [2]. After the reform, the housing industry has ended the centrally planned welfare-based system and transited to a more market-oriented real estate market.

There are a number of new characteristics of the property market after the housing reform. For instances, the government's role as the exclusive provider of housing has diminished and the state has changed to be a facilitator of the market; authorities' power and interventions over the sector are downplayed; housing construction by the private sector is encouraged; housing investment is no longer tied to government budgetary funds, and multiple sources of housing construction capital become available [2].

41.3 New Housing Supply System

China's new housing supply system is designed to meet housing demands for broad household types with different income conditions. There are four types of housing existing in the market, serving different groups of households, i.e., villas and high-grade apartments, the common commodity housing, affordable and economical houses, and subsidized public rental housing. Households normally meet their housing demands in three ways i.e., unsubsidized homeownership, subsidized housing purchase, and house renting. Three housing programs are promoted by the authorities to make house ownership and house renting affordable for middle and low-income families, i.e., 'the Economical and Comfortable Housing program (ECH) (*jingji shiyong fang*), the Housing Provident Fund program (HPF) (*zhufang gongjijin*), and the Cheap Rental Housing program (CRH) (*lianzu fang*). ECH and HPF programs are oriented to promote house ownership (eligible applicants are the moderate and low-income groups), while CRH is targeted to provide subsidized rental housing for low-income families who cannot afford housing. High-income families are expected to purchase commodity housing in the open market without social subsidies. These measures have become the three pillars of China's affordable housing system [2].

According to the 1998 housing reform, the Chinese government planned to accommodate 70–80 % of urban household by ECH; the high income group, representing 10–15 %, are expected to purchase high-standard housing in the market without subsidies; and the rest poverty-level family would obtain financial supports to rent houses using public or local government's subsidies.

The ECH program was launched in 1995 to help the moderate and low-income families solve house affordability difficulties. Housing developed under the ECH scheme is for sale in the open market for eligible applicants, not for rental. In a typical ECH case, the local government provides a beneficial package (profit caps) to encourage developers to be involved and to expand the productions of ECH buildings. Governments' investment, usually in forms of profit caps, is essential to enable the program, which typically includes provisions of free or cheap land through administrative allocations, waiving or reducing related tax and fees, with subsidized building credits. In return, the housing price level is strictly contained by the government to a lower price level. The cheaper-than-commodity housing objective is achieved by controls on project profits at a "razor blade" level, below 3 %. Another means is to control the housing unit areas with the 60–80 m^2principle. The small area design aims to contain housing units at a cheap, affordable, and comfortable level. An important aim is to discourage interests of those ineligible high-income buyers. The incentives of participating developers are mainly stemming from their social responsibilities and market reputations. Benefiting from these measures, the per square meter housing prices is 40–50 % lower than the market level [3].

The HPF program was established and applied to the nation-wide market in 1994. Learning from Singapore's Central Provident Fund experience, it is a compulsory saving scheme to support house ownership [4]. Under the scheme, institutions or enterprises and their employees are obliged to save a stipulated rate of monthly wages to a HPF account, which is dedicated to support employee's future housing consumptions. Benefiting from HPF loans, employees can secure a statutory amount of cheaper mortgage for house purchases. The mortgage rates for HPF loans are often 1 % lower than the market level. This fund can serve a wide range of housing purposes, including house purchase, building and upgrading, particularly for downpayment, and mortgage expenses [4]. The fund has raised 740 billion RMB and benefited 30 million people till 2004 [2]; with the population enrolled in the program being increased to 77.4 million in 2008 [3], and the total principal of HPF loans amounted to over 1 trillion RMB with 609 billion RMB's outstanding balance [2]. Apparently, the HPF program has contributed significantly to home financing and promoted home ownership.

The CRH program is a subsidized cheap rental housing scheme for the lowest income groups. The CRH housing apartment is designed in small housing size, normally less than 50 m^2. The targeted beneficiaries are the disadvantaged groups including the disabled, seniors, the sick, and extremely poor urban families. There has been substantial increase of housing demand from the urban poverty group due to the massive inflows of immigrants from rural areas to cities. To accelerate the development of CRH, the central government has promulgated regulations stipulating local governments to invest 5 % of land conveyance fee to their CRH projects.

41.4 Challenges of Social Affordable Housing Scheme

China's housing policy is implemented in a "top-down" manner [5]. In a decentralized process, there is a clear-cut power and responsibility division between the central and local government. The central authorities formulate the framework of housing policy and basic policy articles, while local governments are obliged to implement the policies and enact additional and detail regulations to suit different local market conditions [6].

In general, China's housing planning has not been rigorously and responsively implemented by local governments. There are some problems inhibiting the successful implementations of the three housing schemes. This section aims to identify the predicaments from an institutional perspective. As above-mentioned, the ECH housing is designed to serve the majority (80 %) of populations, signifying that ECH is crucial to the realization of China's affordable housing system. However, statistics reveal that the ECH development is lagging much behind the policy goal and public needs. The National People's Congress has shown concern to the slow development, pointing out that construction of affordable housing at province levels was lagging behind policy goals in 2009. The ratio of ECH buildings completed areas to total building areas dropped greatly from 8.4 % in 2004 to 4.1 % in 2010. Even worse, the market did not see positive signs of expanding the ECH scheme. It experienced a similar continued reduction in the percentages of ECH building starts, decreasing from 7.4 % in 2004 to 3 % in 2010. This is apparent lag between ECH development and the declared goals of 80 %. Three obstacles, namely insufficient investment (e.g., [1]), eligibility problems, and household registration system (hukou) are inhibiting the successful implementation of the ECH program.

There are various reasons for the inadequate investment in the ECH program. For example, local governments are often required to undertake higher proportions of resources and subsidy cost, while the central governments normally invest limited resources [2]. Except for some fiscally constrained cities and the undeveloped central and western regions, the central authority generally does not provide capital supports for affordable housing to local governments. Therefore, the success of housing reform is tied to the generosities of the local government. It is understandable that local governments generally have strong resistance and reluctance to inject resources. Particularly, as land revenues have become the primary source of fiscal revenues, this has generated a natural conflict between promotions of public income and provision of land for affordable housing [7]. The poorly conceived incentive is further circumvented by some negative attributes of CRH, because there is not an enforcement program.

The second primary problem of ECH is widely recognized as the 'eligibility issue', i.e., identification of the targeted low-income group from the wealthy families [2,8]. The qualification criteria are poorly monitored and implemented, since it is difficult to properly measure household income in China. Affluent families with multiple sources of incomes can easily meet the criteria [5]. The ineligible high-income groups often have strong interests in purchasing ECH housing and are keen on investing property assets. During the early years, the high-income groups constituted a large proportion of ECH housing buyers. The demands from these rich families for higher housing conditions and standards have led to large size design and higher price for apartments. The inflows of high-income families have squeezed out a large number of eligible applicants to the unsubsidized housing market.

Another main obstacle lies in the fact that the current housing affordable system is based on the household registration system. Only the urban citizens who have residence permission under the household registration system are eligible as the potential beneficiary. A large number of new city residents and the floating populations are excluded from the beneficiary coverage.

The CRH scheme also encountered similar setbacks. Local governments have poor incentives and weak financial capability to fund the CRH scheme. Housing completed under the CRH scheme only accommodate 547,292 households, contributing to 1 % of overall housing units constructed from 1998 to 2006, far slower than the goal of 10–15 % [4]. Although there are explicit regulations to guarantee financing of the program (e.g., stipulating local government to input 5 % of land conveyance fee revenues to CRH program), the lack of effective enforcement measures have thwarted the policy effects.

41.5 Commercial Developers Dominate the Real Estate Market

Market statistics provide rich evidence that, currently and in the near future, a multi-layered housing system as the government expected remains inadequately constructed. The slow development of the ECH and CRH schemes cannot meet the enormous housing demands created by housing reforms. Profit-oriented developers have subsequently taken a dominate role in the investment and supply of housing. The active involvement of private developers significantly contributes to buoyant housing investment and supply.

From 1999 to 2011, the overall investment in real estate industry and residential buildings respectively amounted to 6,174.0 and 4,430.8 billons RMB, representing a remarkable 15 and 17-fold increase. The levels of home ownership and living standards have been substantially enhanced. Common commercial buildings built by private developers have dominated the housing supply market. The importance of commercial buildings is verified by the enlarging disparity between total housing investment and ECH investment (refer to Fig. 41.1). The expanding differences indicate the rapid escalation of commercial buildings in the market. The ratio of ECH investment to total housing investment was reduced to 5 % in 2004 and further dropped to 2 % in 2011. Despite the limited base of ECH investment, the increase in ECH investment is also substantially lower than the growth in the housing and general real estate market, particularly experiencing several rounds of negative increase rates in ECH since 2004. In terms of housing spaces, common commercial housing generally composed roughly 70 % of building spaces in the 2010s real estate market. In striking contrast, ECH buildings represent a roughly similar market segment as the high-end housing, lower than 4.2 %. The growing importance of commercial developers in housing supply can be understood from both the housing demand and supply sides.

From the housing demand perspectives, average households normally find it difficult to squeeze into the reach of affordable housing, because of the insufficient provision of public housing and purchase restrictions under the household registration system. Besides, the affordable housing is normally less attractive relative to commodity housing, due to the lower housing attributes, such as less desirable locations, uncomfortable living spaces, outdated structures, and other factors which lower housing costs [5]. Thus, most middle-income families have to secure home

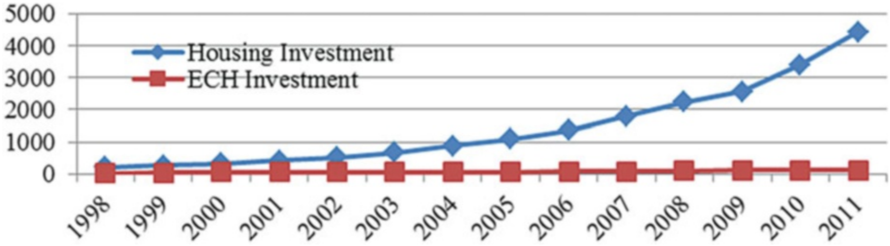

Fig. 41.1 Investments in the housing sector and the ECH program (in billion RMB) (Source: CEIC Database)

ownership in the unsubsidized commercial housing market which is developed by the private sector and was originally designed to cater for top-tier income families. This phenomenon is also echoed by Yiu and Xu [7] that "Subsidized housing in China is still unlikely to meet the demand for housing, at least in the short to the medium term, which renders the private housing market sector almost the only supply of housing in China" (p. 93). The rigorous demand for commodity housing has been financially enabled by the HPF scheme and a supportive residential mortgage market. From the developers' standpoints, the easy availability of bank loans and excess demands for housing are important impetus for the rampant investment.

41.6 Conclusions

Despite of the declared objective of the State Council to provide a multi-layer and functional housing system (consisting of affordable housing for 80 % of the population, subsidized rental housing and unsubsidized housing to the rest), the grand goals have apparently failed to be achieved. Unsubsidized housing built by commercial developers is dominating the housing supply in the current market [2,8]. The scarcity of affordable housing resources is the main reason to explain why households resort to "professional housing development industry" by developers. With the inefficacy of the social housing policy, the government has been blamed for the soaring prices on developers. To promote affordable housing, joint efforts from the central and local government are needed, particularly through sufficient and consistent commitments by local government to expand investments in public housing schemes.

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Chapter 42
An Empirical Analysis of the Relationship Between Real Estate Investment and Economic Growth in Shenyang

Yachen Liu, Jiaxin Xu, and Ning Liu

Abstract This paper based on the platform of Eviews 6.0, in the view of the relationship between real estate investment and economic growth in Shenyang using the methods of the cointegration theory, Granger causality test, and error correction model to study empirically the relationship between them. The empirically study result show that, in the long term, there exist the causal relationship, that is the real estate investment growth of Shenyang has significant effect on GDP growth, which can play a good role innuendo and prediction.

Keywords Shenyang real estate investment • GDP • Granger causality test • Error analysis model

42.1 Preface

Shenyang is located in northeast Asian economic circle and it is the center of the Bohai economic circle. As the center of the northeast of China, it has strong absorption radiation and driving force to the surrounding cities, even the whole country and the real estate industry as a important component of the modern industrial system, its development role in boosting to economic growth has attracted the attention of people. Then how the real estate industry create positive function to the economic growth of Shenyang, in which the industrial is as the main pillar industry. Thus became the key content of this paper.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_42, © Springer-Verlag Berlin Heidelberg 2014

Table 42.1 The logarithm list of Shenyang's GDP and REI

Particular year	lnGDP	lnREI	Particular year	lnGDP	lnREI
1998	16.0205	12.7837	2004	16.6907	15.0469
1999	16.0893	13.1568	2005	16.8524	15.2351
2000	16.1829	13.3698	2006	17.0422	15.4987
2001	16.2785	13.5683	2007	17.2685	15.8038
2002	16.4002	13.9646	2008	17.4480	16.1289
2003	16.5248	14.3883			

Data sources: "the Shenyang statistics yearbook" [6]

42.2 Data Selection

The paper choose the pull role, which is the total amount of investment of real estate played for the economic growth, as the inspection object, while select GDP, which is the measure of the total amount of goods and services, as a representative economic growth index, and select the real estate investment amount as main reference index of the real estate investment, with REI said. The time series of GDP and REI span for 1998–2008 [1–4]. The original data come from the past "Shenyang statistics yearbook". In order to prevent the time series data to create different variance, and consider the time sequence will not change the nature of the sequence and the relationship after the logarithm, and the data easily become stationary series through that, so before the further processing of the data, the paper approach to take natural logarithms to GDP and REI of Shenyang, the sequence remembered respectively as LNGDP and LNREI (see Table 42.1) [5]. All of the data analysis results are gotten in econometrics software E views 6.0 environment [7].

42.3 Empirical Analysis

42.3.1 The Test of Augmented Dickey-Fulley (ADF Test)

In order to avoid time series produced "false return" phenomenon, it is necessary for us to make the Stationarity Test, and the test method is the stability of unit root test. This paper used the ADF test type. Results list in the following Table 42.2:

The inspection results indicate that through second-order difference, the sequence of LNGDP and LNREI in 5 % of the significant level, show its test statistics corresponding magnitude than critical value. Thus refused to original hypothesis that sequence is not even, which has shown that sequence has unit root, so LNGDP and LNREI are stationary series, both for second order single whole, notes for LNGDP ~ I (42.2), LNREI ~ I (42.2). This paper involves two variables, and variables have the same single whole order number, so can go on the co-integration test for the next step.

Table 42.2 ADF test

Variable	ADF Statistics	DW	Probability	Critical value	Conclusion
lnDGP	0.871977	1.840303	0.8697	−2.00629	Unstable
lnREI	1.904743	2.137372	0.9721	−2.02119	Unstable
dlnGDP	−4.19547	1.732872	0.0536	−4.24650	Unstable
dlnREI	−0.35743	2.137784	0.5232	−4.2465	Unstable
d2lnGDP	−2.64069	1.708080	0.0155	−1.99586	Stable
d2lnREI	−2.3291	1.942776	0.0286	−2.00629	Stable

42.3.2 Co-Integration Analysis of the Variable Sequence

To choose Shenyang's GDP as the dependent variable, REI as the independent variable, using Engle-Granger two-step method for co-integration inspection, so as to analyze the long-run equilibrium relationship. First of all, create Monadic Linear Regression Model by using the OLS method, and then test its residual, to observe whether the sequence is smooth, if it is smooth, then can say they are co-integration, otherwise are not.

The first step:

Firstly, Under the premise of avoiding the model appeared circumstance that is against the hypothesis, approach the sequences of LnGDP and LnREI with reasonable regression analysis, and the structure of the regression equation is as follows:

$$\mathrm{LnGDP} = -0.02 + 0.061 \times \mathrm{lnREI} + 0.956 \times \mathrm{lnGDP}(-1) \tag{42.1}$$

Among:

$$R^2 = 0.998906479669203 \quad DW = 2.335961527359879$$

The second step:

Unit root test for the regression equation residuals. Make E as the residual sequence of the regression equation, then

$$E = \mathrm{lnGDP} + 0.02 - 0.061 \times \mathrm{lnREI} - 0.956 \times \mathrm{lnGDP}(-1) \tag{42.2}$$

Test results as shown in Table 42.3:

Because of the unbalanced error t statistic that get from the EG two footwork changed, it's too left compared with the ADF statistics. So for the said inspection results, it should make reference to the critical list EG inspection instead of direct comparing, as the following Table 42.4:

From compare the results and EG critical value table, t statistic value for 3.7521915, less than the 5 % significant level of critical value −3.59, show that at least 95 % confidence level in next reject the null hypothesis, and residual does not

Table 42.3 The unit root test of residual

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	−3.752191547489873	0.001960
Test critical values:		
1 % level	−2.847250364341893	
5 % level	−1.988197973323214	
10 % level	−1.600140081707661	

* Short for probability, is actually a test statistic more or less than the probability of sample observation value. If the P- value significance level is less than the given, that the original hypothesis is unlikely to be set up; if the P- value is greater than the given standard, is that there is no sufficient evidence to reject the null hypothesis

Table 42.4 EG inspection critical value table

		Test level α		
Number of variables N	Sample size T	0.01	0.05	0.10
2	25	−4.37	−3.59	−3.22
	50	−4.32	−3.67	−3.28
	100	−4.07	−3.37	−3.03
	200	−4.00	−3.37	−3.02

exist unit root, it is a stationary series. All in all, through the co-integration test, Shenyang's GDP and REI the two time series is a long-term equilibrium relationship.

42.3.3 Build Error Correction Model

The paper based on the error correction model (ECM), ECM is a short-term model, it can reflect the dependent variable short-term volatility is how to be decided. Build error correction model, the general method is adl model, Model form as follows:

$$Y_t = \beta_0 + \beta_1 X_t + \beta_2 X_{t-1} + \mu Y_{t-1} + \varepsilon_t \tag{42.3}$$

$$\begin{aligned} \Delta Y_t &= \beta_0 + \beta_1 \Delta X_t + (\beta_1 + \beta_2) X_{t-1} - (1-\mu) Y_{t-1} + \varepsilon_t \\ &= \beta_1 \Delta X_t - (1-\mu)\left[Y_{t-1} - \tfrac{\beta_0}{1-\mu} - \tfrac{\beta_1+\beta_2}{1-\mu} X_{t-1}\right] + \varepsilon_t \\ \Delta Y_t &= \beta_1 \Delta X_t - \lambda (Y_{t-1} - \alpha_0 - \alpha_1 X_{t-1}) + \varepsilon_t \end{aligned} \tag{42.4}$$

Formula (42.3) explain how the short-term volatility of dependent variable y is to be decided. On the one hand, it is influenced by the short-term volatility of independent variable accidents x, on the other hand, depends on the ECM. ECM reflects the variables deviation degree of equilibrium relationship in the short-term volatility, called equilibrium error. Due to the co-integration relationship between the GDP and its real estate investment, to investigate the short-term fluctuations variables, we choose a steady residual sequence as error correction projects to develop ECM models, the error correction model:

Table 42.5 Grange table r causality test

Null Hypothesis:	Obs	F-statistic	Prob.
LNREI does not Granger Cause LNGDP	8	4633.61	0.0108
LNGDP does not Granger Cause LNREI		6.36921	0.2816

$$\begin{aligned} \mathrm{D}(\mathrm{lnGDPt}) = {} & 0.00540 + 0.04431\mathrm{D}(\ln \mathrm{REIt}) + 0.97199\mathrm{D}(\ln \mathrm{GDPt} - 1) \\ & - 1.49196\mathrm{ECMt} - 1 \end{aligned} \tag{42.5}$$

$$R^2 = 0.893834 \quad DW = 2.285283$$

Among:

$$\mathrm{ECM}_{t-1} = \ln \mathrm{GDP}_{t-1} + 0.02 - 0.061 \ln \mathrm{REI}_{t-1} - 0.956 \ln \mathrm{GDP}_{t-2} \tag{42.6}$$

Type (42.5) type (42.6) show that, in the short term the independent variable real estate investment each 1 % growth, will cause the dependent variable Shenyang's GDP growth of 0.04431 %. Error correction of the coefficient of 1.49196 for-that when LNGDP in the previous deviating from the long-term equilibrium value, LNREI will make in the next in the opposite direction of correction, with −1.492 times the unbalanced state adjustments back to balance state.

42.3.4 Granger Causality Test

The above research and analysis show that the two time series, Shenyang's GDP and REI, are long-term equilibrium. Then if there is a relationship of causality, and the real estate investment is help to predict the regional economic growth, are not clear. And Granger causality test is not logical causality test, but see variables of mutual order, whether there is a variable in the early period of the information will affect another variable current information. So next we do the Granger Causality Test, the result as shown in Table 42.5 shows:

The said inspection showed that the original hypothesis "LNREI does not Granger Cause LNGDP" accept probability for 0.0108, show that 5 % of significant levels to reject the null hypothesis, explains namely of Shenyang city investment in real estate development is the Granger reason of it's GDP, and the original hypothesis "LNGDP does not Granger Cause LNREI" probability for 0.2816, show that 5 % of the level of significance under the original hypothesis that explain the Shenyang's GDP is not the Granger reason of its investment in real estate development.

42.4 Conclusion

According to the above research, there exist Granger Causality between Shenyang's investment in real estate development and its economic growth. Further analysis, Shenyang's GDP growth is not the main factors in pulling the real estate investment growth, and Shenyang's real estate investment make significant influence to GDP growth, that means every 1 % increase in REI, will pull the local GDP growth of 0.061 %. Can only say that real estate investment in a certain extent promote the growth of GDP. From 2002 to 2004, Shenyang's real estate investment development present situation of high growth, of which 2004 investment growth to 93.2 %, from 2005 under the state's macro-regulation it present in the buffer stage, Although the real estate investment is volatile industry in contrast, but from this paper analysis, Shenyang's real estate investment can play very good prediction effect for regional economy.

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Chapter 43
High Vacancy Rate of Public Rental Housing and Its Diversified Solution

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Abstract As a new type of subsidized housing which could cover much more population, public rental housing has gradually become a mainstream of subsidized housing across the country. However, a great amount of public rental houses which should really benefit low-income groups have been in a state of awkward high vacancy rate. Paper analyzed the current primary supply form of public rental housing and real residential demands of its target people, then summed up three main reasons on high vacancy phenomenon. Finally, paper makes a recommendation for government to take diversified measures, and expects such solutions could improve the effectiveness of public rental housing' allocation and embody its security functions.

Keywords Public rental housing • High vacancy rate • Government • Demand • Target people

43.1 Introduction

Housing and Urban-Rural Development released Guidance for Accelerating Development of Public Rental Housing, combining with six other ministries on June 12th 2010. A large number of public rental houses had been constructed by

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_43,

local governments throughout the country, and allocation had been conducted simultaneously as well. However, in recent years, “abandon to rent” phenomenon frequently occurred in many large cities. For instance, since government of Zhengzhou City Henan Province had provided first 1,353 public rental houses on December 26th 2011, the number of people who actually rented and moved in has not yet reached 100, resulting in 90 % vacancy rate [1]. Another example, at the beginning of 2012, government of Hongshan district Wuhan City Hubei Province released 899 pilot public rental houses to society. After background investigation, 317 households obtained qualification to apply, but only 210 households really moved in till March 5th. Seventy percent of apartment units, approximately, remain vacancy [2]. On the one hand, government collected a lot of public rental houses through construction, purchase, rebuilding and renting; on the other hand, vast low-income people who need to improve their living condition urgently, however, refused to rent government’s subsidized houses. Existence of long term high vacancy suggests that there is always a resource misallocation between government housing supply and real demand of its target people. What’s more, vacancy is not only a heavy financial burden for government, but also a great waste of public resources. Hence, this problem must be solved timely, correctly and efficiently.

43.2 A Brief Review on Actual Supply and Demand

43.2.1 Primary Supply Form of Public Rental Housing

Current supply forms can be divided into government leading types and social leading type. Government leading can also be separated into two types: (1) Government invests in new construction directly or the so-called “governmental developer” implements the construction with governmental subsidy. (2) Government purchases, rebuilds and rents apartments available in second-hand housing market, then allocates them to people after uniform renovation. Social leading type is that enterprises or institutions construct houses on their collective land, then allocate flats to their own staff or deliver these buildings to government for regional reallocation. Nowadays, participant initiative of social organization is restricted due to high risk and low profits of present operation on public rental housing. So, government leading types still play a dominated role. Table 43.1 presents summary statistics of low-income housing construction of Chengdu City Sichuan province in 2011.

Table 43.1 shows that the proportion of completed investment in public rental housing by Chengdu government has risen to 88 % of total completed investment in low-income housing, which implies that the subsidized housing has gradually stepped into ‘pure rental housing without property rights’. But in terms of supply forms, new construction area occupied 86.1 % of total completed area. In other words, primary supply form of public rental housing is still new construction by government.

Table 43.1 Summary statistics of low-income housing construction of Chengdu City in 2011

Item	Annual construction plan (set)	Annual investment plan (10,000 Yuan)	Completed units (set)	Completed area (10,000 m^2)	Completed investment (10,000 Yuan)	Proportion of completed area (%)
Total low-income housing	52,000	601,515	15,080	85.4	518,622.25	29.0
Low-rent housing	8,000	23,548	4,573	22.8	26,155.28	57.2
Affordable housing	5,000	45,683	886	6.5	21,534.48	17.7
Public rental housing	34,000	501,110	9,621	56.1	45,6232.6	28.3
PRC :New construction	34,000	475,309	8,523	48.3	430,431.6	25.1
PRC: purchase, rebuild or rent from market	0	25,801	1,098	7.8	25,801	–
Price-limited housing	5,000	31,174	–	–	14,699.89	0.0

Data resource: Report of low-income housing construction schedule of Sichuan Province in 2011

43.2.2 Primary Resident Demands of Target People

Public rental housing aims at benefiting low-income people. Because of restriction on job, income and life style, target people generally don't care much about house area, comfortability and aesthetic value, but are sensitive to rental level, public transport and living convenience. Their objective flats need to provide basic using function as well as good space utilization, and most important, must be located in a district where supporting facilities such as supermarket, kindergarten, primary school, and hospital are complete. However, 10–15 ㎡per capita living area is enough [5]. Majority of target people need to travel quickly and timely between workplace location and resident location. Such situation especially takes place on groups who gather in city service sector and occupy a large proportion of target people.

43.3 Cause Analysis on High Vacancy Rate

43.3.1 Remote Location Without Necessary Supporting Facilities

Public rental houses built by government often are located in suburb or even in urban and rural linking area where supporting facilities surrounded are terrible.

On the contrary, ‘urban villages’ where transport are well-developed, rents are low and daily life is convenient, could meet target people’s demands better, compared with public rental houses which could only offer comfortable residence [4]. Even though living conditions in ‘urban village’ is awful, its advantages are far more significant for target people.

43.3.2 Unattractive Rental Level

Generally, the gap between public rental housing’s rents and market value isn’t big enough in our country. Rents of public rental housing are usually 20–40 % lower than present private houses’, which have the same construction standard. But key point is that government formulates public rental housing’s rents according to current land price, however, rents of idle second-hand flats in market are rising slowly step by step. Hence, their amount of increase falls far behind current land price which has been rising so fast in recent years. Consequently, even if there are some discounts on public rental housing, its rent remains unattractive, especially when tenants take flexibility and convenience of renting private flats into consideration. Besides, house area of public rental housing is too large for target people. Due to relatively big area, although rental price of per square meter is low, an apartment’s total rents still beyond the reach of target people.

43.3.3 Improper Application Limits

Many local governments set plenty of strict and ‘hard’ limits for applicants, such as: registered permanent residence, how many years after graduation, gross income, how many years after getting the migrant population residence permit and provident fund level. Although such application limits aims at overcoming corruption, a large proportion of target people lose applicant qualifications. Worst of all, restriction of income for applying public rental housing isn’t higher enough than that applying low-rent housing, so that target groups who can afford the public rental house nearly exceed income limits. Take for example current policy of Wuhan government. Policy requires ‘new entrants’ monthly income under 2,500 Yuan’, but house area of main pilot public rental houses in Hongshan district is 65 ㎡ with rents of 11.13 Yuan per square meter [3]. So a new entrant whose income has reached upper limits has to pay about 1,000 Yuan (almost 2/5 of his gross income), which consists of 723 Yuan on house rents, cost of daily transportation, electricity and water bill, just for his residence. Rent level is based on market value, but limit on applicant’s income level is too low. That further decreased numbers of people who would like to rent.

43.4 Diversified Solutions

43.4.1 Implementing Various Allocation Methods Flexibly

1. When decides to adopt the 'reducing rents directly' method, government should formulate practical rental criterion based on comparable apartment's rents, which means references are not upscale houses in a gated community.
2. When decides to adopt the 'separating subsidy from rents' method, housing administration bureau should fully investigate tenant and his family members' asset, employment and income in detail, combining with industrial and commercial bureau, taxation office and labor bureau. Subsidies given to every tenant must be accurately quantitative, decided by investigation results. Most important, the policy should be carried out openly and transparently in process.
3. Government could act as a guarantee platform, which classifies tenants' requests and helps them rent idle second-hand flats, afterwards gives them subsidy according to family members' conditions. At the same time, government will also supervise and manage all landlords.
4. Government should consider applicant's real situation such as workplace location rather than some 'hard' limits like his household registration restrictions. Only distributing public rental houses according to tenant's actual needs, could housing resources be allocated effectively.

43.4.2 Constructing Buildings with Appropriate Design and Well Quality

As one aspect of main content of public rental housing's 'top design', various technical norms and rules haven't been fully established yet. So we need formulate unified regulations to control its design, construction, supervision, delivery and lastly, operation as soon as possible. Public rental houses' area must be within 60 ㎡ and give priority to 30 ㎡. Moreover, good use function must be provided and space also should be made full use of in such limited area [6]. When a project is finished, government should introduce experts' acceptance check to ensure its quality conformance. Besides, we should promote standardization in public rental housing's construction, which can reduce construction cost significantly, namely reduce rents indirectly, as well as speed up housing industrialization development in our country.

43.4.3 Resetting the Application Criterion

Local government should ease the restriction on application especially related to household income and transient population's residential time, according to feedback of renting state and current level of economical development, in order to extent [7] coverage. In addition, new criterion should be reset after target people's income, per capita living area and resident years are precisely evaluated again.

43.4.4 Changing Assessment Indicators on Local Government

When local government's performance is evaluated, growth of GDP shouldn't be the most important criterion of all. Otherwise, based on land finance, no government will take out mature or convenient district to build public rental houses that have quite a long payback period and lower rate of return [8]. So we suggest that actual occupancy rate and tenants' degree of satisfaction should be put into the performance evaluation system and accountability mechanisms of local government be implemented as well, in order to avoid bad tendency to pursuing completed residential areas only.

43.5 Conclusions

Our country puts forward a great goal of constructing 36,000,000 public rental houses in Twelfth Five-Year Plan period, which is not only a significant strategic decision that could further complete housing supply system in our country, but also a sincere effort that aims at promoting resident conditions of low-income people. Only starting from target people's real resident demands and taking diversified measures to improve construction and allocation of public rental housing, can such a livelihood project really make contribution to people.

Acknowledgements Author thanks Housing Reform and Protection division of Housing and Urban-Rural Construction Department of Sichuan Province for offering quantities of detailed statistics related to low-income housing construction in Sichuan Province from 2010 to 2011.

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Chapter 44
Research on Real Estate Sales Outsourcing of China

Feng Yang and Baihai Guan

Abstract Business outsourcing is very common in the social economy activities. The main motivation of general business outsourcing is to cut costs. Nowadays, real estate sales outsourcing is becoming a choice for more and more real estate developers. Real estate has its own characteristics like non-mobility. Through the analysis of seven characteristics of real estate sales that are different from general merchandise sales, this paper points out that real estate sales outsourcing motivation is different from general business outsourcing motivation whose main purpose is to cut costs, but the main purpose of real estate sales outsourcing is to improve product sales prices and shorten the sales cycle. On this basis, through the analysis of the factors that can affect real estate sales outsourcing, the paper establishes the decision-making model of real estate sales outsourcing by use profit maximization as objective function, and then proposes a thinking of decision-making practice of real estate sales outsourcing. Finally, in order to ensure the successful implementation of the real estate sales outsourcing and the full achievement of its expected goals, this paper analyzes the six works of the real estate sales outsourcing that should be done properly.

Keywords Real estate • Sales • Outsourcing • Motivation • Decision making

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_44,

In developed countries, the real estate market has entered the mature stage, second-hand housing transactions occupies the main share of real estate market. The proportion of new residential transactions is very low. But in China, the real estate is a newly emerging business, in a period of rapid development, the volume of annual new residential transactions is bigger than that of second-hand housing transactions.

Real estate development project includes many links in which the sales link is crucial for the success of real estate project. For real estate sales, the real estate developers generally have two kinds of modes for choice: (1) sell by themselves; (2) commission professional sales agent to sell, i.e. sales outsourcing.

With the refinement of social division of labor, and also in order to utilize the advantage of professionalization, at present, many real estate developers began to hire a professional sales agent for the sales work of real estate projects, for example, Chinese leading real estate company –Vanke is always adopting this sales model. But, there are also a lot of real estate enterprises selling their products by themselves. Then, what's the reason that encourages the real estate sales outsourcing and which factors can influence the real estate enterprise's decision? This paper will study these questions.

44.1 Theories and Motivations of Outsourcing

Business outsourcing has already existed for long time. Since the exchange and the market emerged, the business outsourcing has appeared. But the emerging of outsourcing as a proprietary vocabulary and as an academic research is from 1982 [1]. In the middle of 1990s, outsourcing developed rapidly with the development of IT industry.

The theories of outsourcing study are mainly as follows:

(a) The theory of transaction costs. New institutional economics thinks that all transactions have costs, according to Coase, the market and the enterprise are two ways of resource allocation and they can be substituted by each other. Which way should be adopted that depends on the compare between market transaction cost and enterprise organization cost. The main idea of transaction cost theory is that organizations can reduce the transaction cost by outsourcing. Thereby it can reduce the total cost, spread risk, obtain scale economy effect and avoid unnecessary investment. Management cost minimization is the main motivation for the outsourcing [2].
(b) The theory of core competence. According to this theory, the enterprise should focus their limited resources on the core business; strengthen their core competence, and outsource the non-core business.
(c) Resource capacity theory. Due to the scarcity of resources, the enterprise need acquire some resources from outside. According to resource capacity theory, enterprises should coordinate the usage of internal resources and external resources to seek a way of resources allocation with maximum benefit.

(d) Value chain theory. Because the required production factors on each link of value chain is different and any enterprise can not keep advantage on all links of value chain, therefore the enterprise only can develop its core business on the links on which it have comparative advantage, and realize each link's maximum contribution to the increment of value chain [2]. According to the value chain theory, outsourcing can integrate advantages of different companies in different links of the value chain, and realize the optimization of the whole value chain.
(e) Labor division theory. Adam Smith elaborated the advantages of labor division for productivity incensement in *The Wealth of Nations*. The Labor division theory regards outsourcing as the extension of labor division, thinks that outsourcing of part of business can be helpful for the improvement of professional productivity of contractors [3].

According to the various theories of outsourcing, we can summarize the motivations of outsourcing. But the most direct and most important reason is to reduce the cost [4]. In addition, to some extent, it is the need to focus their core business.

44.2 The Characteristics of Real Estate Sales and Analysis of Outsourcing Motivation

Compared with general commodities, the products of Real estate project have some different characteristics. Their sales modes and channels are also different from general commodities. Their outsourcing motivations are different too.

44.2.1 The Characteristics of Real Estate Sales

The products of real estate projects are immovable and have great value. They have characteristics of consumer goods and investment goods at the same. In the sales, they have some requirements and characteristics of their own.

(a) Field sales. General merchandises can be sold at multiple points through the sales network and channels such as malls, supermarkets and so on. But for real estate projects, the common method is to set up a sales department and sell at the project site. And, in general condition, only one sales department is set up for one real estate project, so there is only one sales point. But as for daily necessaries, we can buy them at the retail outlets everywhere.

(b) The target customers are regional. Most of general merchandises do not choose their customers by region, but the real estate is different. Because real estate is immovable, under normal condition, its target customers are the people who plan to live in this city. And, within a city, the main clients of a real estate project are concentrated in a certain area around the project, rather than the whole city.
(c) Professionalism of salesman. There are many factors who can affect the demand and price of a real estate project, such as traffic conditions, surrounding environment, surrounding infrastructures, public service facilities and of course, the condition of the project itself. As for the conditions of real estate projects, they can also be different from each other in many aspects, such as layout, orientation, floors, shared area, materials, quality and so on. In order to attract customers, we must present all advantages of this project clearly, answer customer questions, and dispel customer's misgivings. This requires that the salesmen should be familiar with the project on various aspects, and should have the professional knowledge of real estate. But as for most of the general merchandises, customers can choose them independently. They do not need the salesmen to explain the products for them.
(d) Customers are cautious about decision-making. A house may be worth hundreds of thousands of RMB, or even millions of RMB. It will cost a family several years or even decades of income to buy. So, purchasing a house is an important decision for a family. Therefore, clients will take it very cautious. They will consult the sale department, compare different projects and discuss with their family members before closing the deal finally.
(e) Low proportion of repurchase. Real estate is major assets of a family. In China, the repurchase of real estate is few, unless people change their working place. In their whole life, they may just buy houses for few times. For one real estate project, the cases of repurchase are even fewer. But for daily necessaries, the repurchase is often happened. So, for the sales of real estate, a marketing strategy that is totally different from the general commodities should be adopted.
(f) Word-of-mouth publicity is more important than ads. The value of a real estate product is normally great. Before closing a deal, the customer will consult the sale department, compare different projects and especially gather advices from family members and friends. So during exploitation and sales process of real estate projects, we should pay particular attention to the effect of word-of-mouth publicity. Let the people who have become your clients become your voluntary salesman of word-of-mouth marketing.
(g) Forward delivery houses dominate the market. General commodities are mostly in stock. But the real estate is different. Up to now, China applies advance purchase system. What customers buy are forward delivery houses. They go to the sales department, watch the sand table, pay the money and wait for the delivery of houses after a certain time. Therefore, there are certain risks for the customers, because eventually received products may have disparities with their expectation.

44.2.2 Analysis of Real Estate Sales Outsourcing Motivation

The previous research on outsourcing motivations mainly focused on the cost or cultivation of core ability. But compared with general sales, real estate sales have some different characteristics and requirements. In the decision making process of real estate sales outsourcing, the consideration focuses on maximization of profit rather than cost. The main purpose is to improve the price of project products, shorten sales cycle, and at the same time, concentrate their limited resources to develop their own core business.

(a) Raise the price, sales speed and profitability of projects. Being different form motivation of ordinary outsourcing, the motivation of sales outsourcing of real estate is not cost. In general, the sales outsourcing will increase the total sales expenses and costs of projects. Because for the real estate developers, the fees paid for sales agents are generally higher than the expense of hiring their own salesmen.

 Sales outsourcing of real estate is to sell the products in the shortest time and highest price under the assistant of sales agents with their sales experience and market sensitivity and realize maximum of profit.

 Real estate products are unique from each other. Different customers have different understanding on the value of the same house. The prices they can accept are not the same too. We can often find that two adjacent projects in the same region have similar related indicators, but their prices can be largely different. To a great extent, that is the result of project marketing. So purpose of the developers who outsource sales is to hope that the sales agents can explore project selling points, impress customers and raise the price of the projects. In addition, professional planning of sales agents can accelerate the sales speed and expedite the recovery of funds. Because the funds also have a time value, to recover funds faster, means more benefits.

(b) Focus on core business. In addition to raising the price of projects and sales speed, the motivation of sales outsourcing of real estate developers is to concentrate resources and develop core ability of enterprise. For real estate development, the niche marketing and program design is critical for a project. After sales outsourcing, developers can spend more efforts in the core business like project planning and design, and enhance the core competition ability of the enterprise.

44.3 Decision Making of Real Estate Sales Outsourcing

Real estate project has two kinds of sales mode: sales by developer itself and commission of sales agents. Which one is the most suitable for one's own enterprise? That is the question every real estate developers should face.

44.3.1 Influential Factors of Real Estate Sales Outsourcing

Influential factors of real estate sales outsourcing are mainly in the following four aspects:

(a) The experience of developers. If the developers have engaged in real estate development for a long time and have a considerable sensitivity and control capacity to the market, they can choose to sell by themselves; conversely, if their companies have not entered the real estate business for a long time and they are still in a rapid growth period, the sales outsourcing should be the choice.
(b) The scale of developer's companies. If developer's company is large in scale and has complete departments, he can choose to sell by himself. If developer's company is small, he should outsource the sales work to integrate external resources with the help of outside force and promote the development of the company.
(c) The strategic choice of developers. If the developers regard marketing ability as the core ability of enterprises, they should sell by themselves and develop the capacity in this area, in order to gain advantage in market competition; if the marketing ability is not treated as core ability, sales outsourcing should be chosen.
(d) Situation of developers' ability and human resources. According to the resources capacity theory, if the developers have strong marketing teams and good ability, they can be competent completely for the sales work and even can do better than the sales agents. If the developers are lack of human resources for marketing, they should choose sales outsourcing.

44.3.2 Decision Making Model of Real Estate Sales Outsourcing

There are many factors that can influence the decision making of real estate sales outsourcing. We will use profit maximization to analyze decision making problems of real estate sales outsourcing.

We assume the product quantity of a real estate project is Q, the development cost excluding sales cost of the unit product is C_0.

If the developers sell by themselves, Comprehensive marketing ability is e_1, the sales cost per unit product is C_1, $C_1 = f_1(e_1), f_1'(e_1) < 0$, so$C_1$ is e_1's monotone decreasing function. Assuming the average price of project products is P_1, $P_1 = f_2(e_1), f_2'(e_1) > 0$. The sales of project complete within the a period of time T_1, $T_1 = f_3(e_1), f_3'(e_1) < 0$.

If the sales outsourced, for developers the sales cost per unit product (including commissions paid to agents) is $C_2, C_2 = g_1(e_2) + C_3$,$e_2$ is Comprehensive marketing ability of sales agent,C_3 is the commission paid to sales agent by the developer (it is usually a certain proportion of project price), $\frac{\partial g_1}{\partial C_2} < 0$. In this condition, the average price of project products is P_2,$P_2 = g_2(e_2), g_2'(e_2) > 0$. The sales of project complete within the a period of time T_2, $T_2 = g_3(e_2)g_3'(e_2) < 0$

For the developer the discount rate of his capital is I,

If the real estate products are sold by developer himself, the revenue function is: $\pi_1 = \frac{Q(P_1 - C_0 - C_1)}{(1+I)^{T_1}}$

If the sale is outsourced, the revenue function is: $\pi_2 = \frac{Q(P_2 - C_0 - C_2)}{(1+I)^{T_2}}$

If $\pi_1 > \pi_2$, that means the income will be higher when the developers sell real estate products by themselves. If $\pi_1 < \pi_2$, that means the income will be higher when the developers outsource the sales work. If $\pi_1 = \pi_2$, that means the developers will get equivalent income from two the sales modes. But taking the core business into consideration, the developer should outsource the sales work too.

44.4 Matters Needing Attention for Real Estate Sales Outsourcing

Even if the real estate developers have made the decision of sales outsourcing, the developers should pay attention to the following aspects in sales outsourcing process, to ensure the achievement of expected goals of the projects:

(a) Select appropriate sales agents. Due to sales outsourcing, it is very important to choose a proper sales agent in order to ensure the realization of sales expectation. To choose a sales agent, the main inspecting contents include its past experience, success rate of its previous agency projects and the average sales cycles.
(b) The developers need dominate product positioning. In sales outsourcing situation, sales agents will participate in project planning and product positioning, and provide useful suggestions to the developers. But developers should take sales agents' proposals seriously, do not blindly believe sales agents' the project proposals. The developers must dominate product positioning and design. After all, finally it is only the developers themselves will be responsible for the ultimate success or failure of the project.
(c) The developers should check on the marketing plan carefully. After sales outsourcing, generally the sales agents will present marketing plan to developers. After getting approval from developers or amending according to their opinions, the sales agents will carry out the plan and the marketing costs are usually born by the developers. Because the sales agents do not spend their own money, they do not pay much attention about the efficiency of capital. They only hope that more marketing activities and more marketing expenses

are better. Therefore, developers should check carefully the marketing plans proposed by sales agents, cut those activities cost much money but the effect is not good, in order to improve the efficiency of marketing costs.

(d) The developers should be strong-minded on product pricing. Comparing with the developers, the sales agents are closer to the market and they know more about the market, so their t real estate project pricing is more accurate. But because most of Chinese real estate sales agents adopt the percentage commission system, sales agents is not eager to raise product price, instead they just want to sell the products as soon as possible. Therefore, for their own interests, sales agents may provide the scheme with its price below market level. So the developers need research the market while listening to sales agents' proposals. They should be strong-minded on product pricing.

(e) The developers should inspect and check the work of the sales agents. The relation between developers and sales agents is principal-agent relationship. It is prone to moral hazard and adverse selection problems [5, 6]. Therefore, the developers should inspect and check the work of the sales agents, make them to perform their obligations seriously, ensure efficiency of project sales working, and realize the expectation of sales goal.

(f) Reward and punishment system. In order to enhance the enthusiasm and initiative of sales agents, in addition to the working supervision and inspection, the reward and punishment system should also be applied. The developers should evaluate the work of sales agents objectively and fairly, and take reward or punishment measures according to the agent contract.

44.5 Conclusions

The products of real estate projects are immovable and have huge value. They have characteristics of consumer goods and investment goods at the same time. Their sales modes and channels are also different from general commodities. Each real estate product is unique. People's perceived values are different from each other too. The main motivation of general business outsourcing is to cut cost, but the main motivation of real estate outsourcing is to enhance the project price and sales speed.

The main Influential factors of real estate sales outsourcing are experience, company scale, strategic choice and human resources. On the basis of taking these factors into consideration, the developers can take profit maximization as goal of decision-making. The sales outsourcing should be chosen if its revenue is not lower than the revenue getting from self sales. In addition, in order to achieve the expected goals of sales outsourcing, the real estate developers should also do right thing in six aspects including choose of sales agents, rewards and punishment system and so on.

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Chapter 45
The Formation Mechanism and Reform Measures of the "Hollow Villages" in Peri-Urban Areas

A Case Study of Xiamen Off-Island Area

Xiaolu Dou

Abstract This paper attempts to survey of the typical "Hollow Villages" in Xiamen's off-island area, explore the formation mechanism of the "Hollow Villages", and to further clarify the interaction between the different elements of this mechanism. Accordingly, to find the governance of this phenomenon of institution system design method, and associated village transformation techniques.

Keyword Hollow villages • Formation mechanism • Institution system • Technique

45.1 Introduction

"Hollow Village" refers in the rural development process; accompany the expansion of the village area, new residential spread to the village perimeter and roads. But within the village still have a large area of the free homestead or free housing like "outside real virtual" and "New Side Old spatial form of the heart" alienation. In China, the presence of a large number of "empty villages", not only caused by the idle and waste of land resources, and also make the difficulties of village infrastructure supporting living services lag, decline the land use efficiency, seriously obstructing the new rural construction.

The proposed method of combining data analysis and field research to study the status of the typical "hollow villages" of Xiamen island region, in order to understand the formation mechanism of hollow village, transformation mode, experience and problems encountered. And in the system level analysis of its formation trip due to development, to governance model for further recommendations.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_45,

45.2 The Typical Hollow Village Description of the Status Quo –the Meizhai Residential Villages in Xiamen's Off-Island Area

45.2.1 Overview of Meizhai Village

The Meizhai village located northwest of the Tong'an south industrial area, close to 324 National Road and Lotus Road, whose distance to Tong'an City is about 10 km. The population is about 657, 222 houses of 2.96 people per household (2010).

Meizhai village is next to the Tong'an Industrial Zone, attracted a number of foreign population come here to work and live, at the same time provide employment opportunities for local farmers. For many years, due to the industrial zone development and policy driven, the conversion of the local economic structure is significantly. Less than one third of the population stay in the village, one third of the population work in Tong'an factories, one third the population of breeding industry and business services. Non-agricultural population is of nearly 60 %.

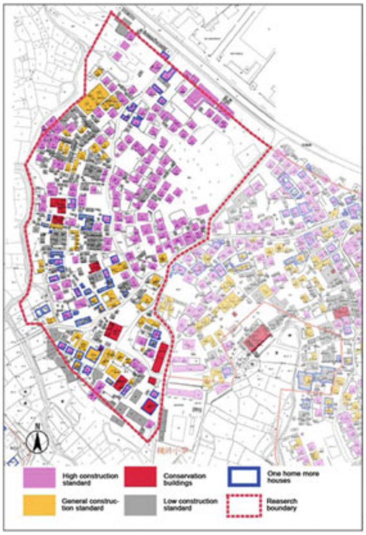
45.2.2 Meizhai Village's Hollow Status Quo

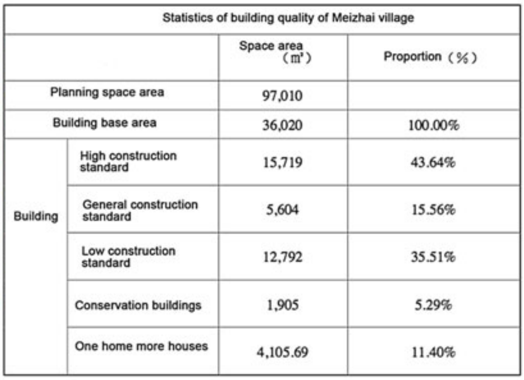
The Meizhai village's main housing construction period can be divided into three main phases, corresponding to the three residential forms.

- Old house – much built in the 1940s and 1950s, made of adobe or stone, more of courtyard style pattern, each hospital registration several number of households, average household about 10–20 m^2 area.
- Farm residences after the Reform and Opening up – mainly built between 1986 and 1995, better quality, usually detached single-family.
- New building – built in 2006, mostly for brick, concrete and framework structures.

Classified according to the structure of the building materials, using topographic maps, we make the general assessment of Meizhai village about the building mass distribution, as well as the status of "more than one house", the results shown in Fig. 45.1 and Table 45.1. (The calculation is based on the basal area of all types of building.)

Seen from the figure, the southwest side of the poor quality of existing homes located in the village area, good quality house located in the village east and the side of the road, the formation of a more visible space on differentiation. The west side of the status quo village has poor infrastructure and environmental health conditions, traffic inconvenience. The most of residents in the old house had moved out, only a small number of households with financial difficulties living, idle land situation is more serious.





Statistics of building quality of Meizhai village			
		Space area (m²)	Proportion (%)
Planning space area		97,010	
Building base area		36,020	100.00%
Building	High construction standard	15,719	43.64%
	General construction standard	5,604	15.56%
	Low construction standard	12,792	35.51%
	Conservation buildings	1,905	5.29%
	One home more houses	4,105.69	11.40%

Fig. 45.1 The building standard and the “one home more houses” situation of Meizhai village

Table 45.1 Statistics of building quality of Meizhai village

Statistics of building quality Meizhai village			
		Space area (m^2)	Proportion (%)
Planning space area		97,010	
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	Conservation buildings	1,905	5.29 %
	One home more houses	4,105.69	11.40 %

Seen from Table 45.1, Meizhai village poor quality construction accounted for 35 %, while “more than one house” building covers an area of 11 %, indicating that the village still has a large space and resource potential. It should focus on the old homestead and “more than one house”, to organize the land use, release the idle land.

45.2.3 *The Meizhai Village’s Hollowing Process*

Meizhai village’s homestead spread process occurs mainly after 1987. The new houses near the old village gradually spread to the northeast, otherwise some of the houses built directly next to the road, formation of the enclave. Gradually formed a

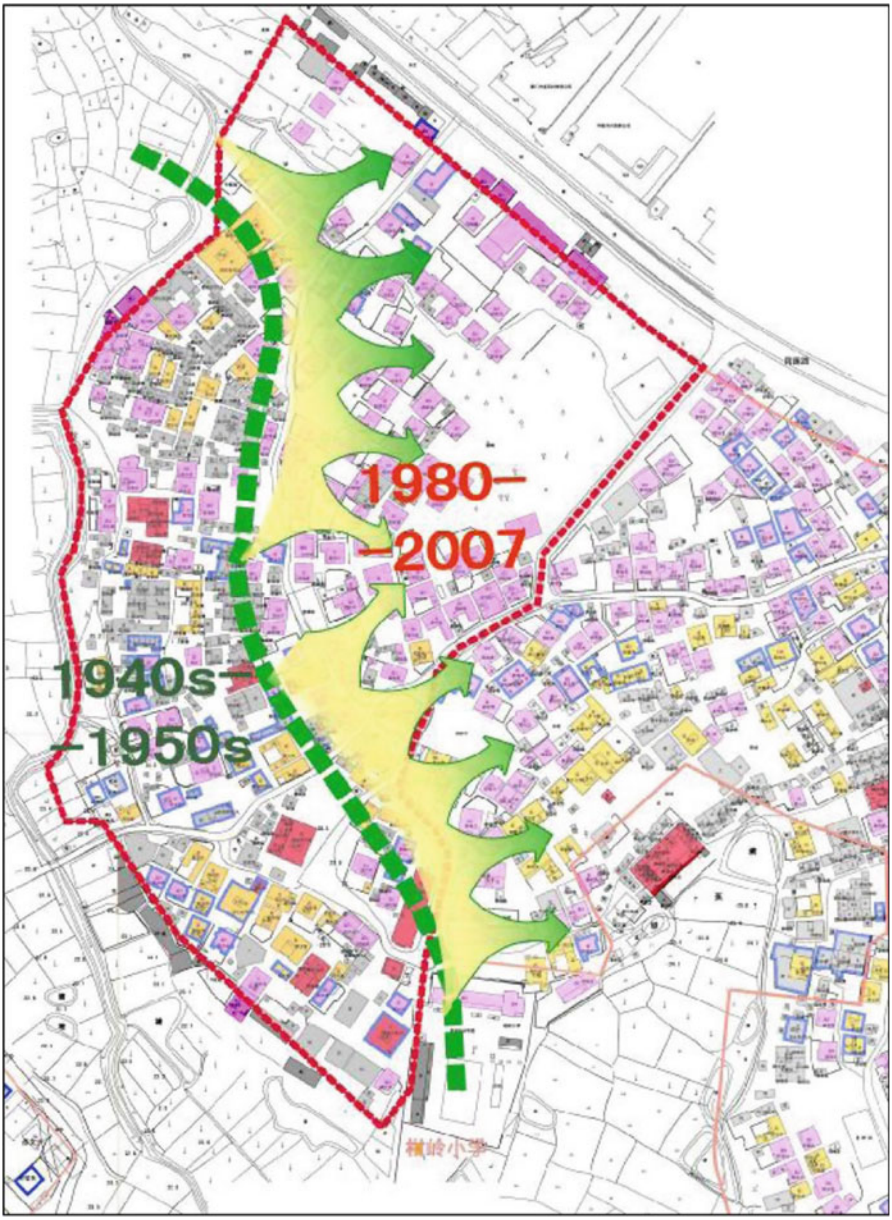

Fig. 45.2 The building spreads tend analysis of Meizhai village

pattern that village southwest side area away from the road full of dilapidated housing, poor environment. Because of the better housing and environmental conditions, new housing have chosen the road east side of the land near the highway (Fig. 45.2).

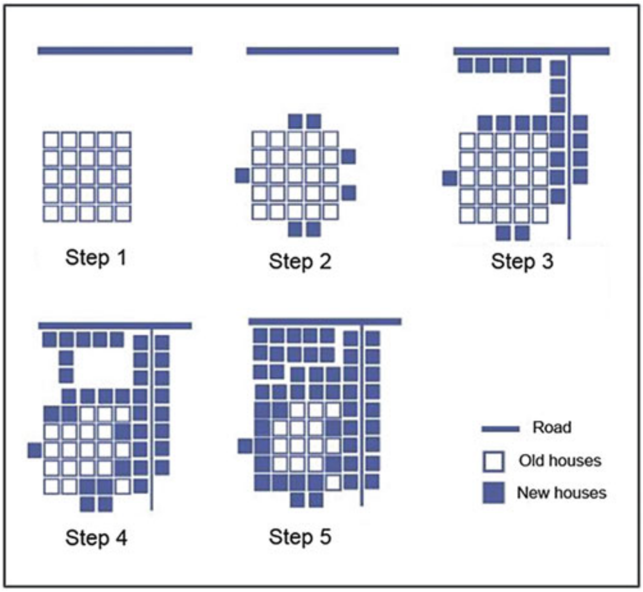

Fig. 45.3 The developing process of the general "hollow village"

Figure 45.3 illustrates the process of evolution in the general hollow village. In the early, because the periphery of the village area with better conditions, the new homestead along the village periphery road layout. To late, as the tight supply of post-village land, extended development will gradually become connotative development and release of land resources through the collation transformation of the old homestead.

45.3 The Formation Mechanism of Hollow Village

45.3.1 Conversion Factors of Population

Since the reform and opening up, our country has seen the rapid development of rural non-farm process, mainly presents rural economic structure of non-farm and rural labor force structure of non-farm.

Non-farm rural economic structure leads to two results, on one hand, the rural economy is no longer rely solely on land productivity, farmers have the opportunity to obtain a higher income from other sources, which may be to build a new house; the other hand, with the income of farmers increased, reliance on extended family to gradually reduce, the family household climax began to appear. The results of the two co-stimulated the housing needs of the farmers.

Conversion of the non-farm rural labor force structure, including several types:

- To the city: refers to migrant rural labor, and living in the city. This part of the transfer of labor often leads to changes in the structure and construction of new rural settlements, and lack of strength. The peasants into the cities and towns do not idle in the rural residential renovation construction, lead to agricultural land abandoned, and village decline.
- To the town: rural labor force during the day work near the center of the village/town, in the evening return to the countryside to live.
- The situ conversion: farmers-site career transition in non-agricultural industries.

In upon two circumstances, since the farmers' place of residence has not changed, the village can still maintain their original living structure, which is not prone to lead to the homestead population hollowing idle. However, due to the local economic structure changes, the increase of employment opportunities and improve of local farmers' income, combined with the farmers'strong wishes of the local long-term life, so flip the power of the new house.

In many villages, the increased household demand which leading "more than one house" phenomenon and the old houses'idle situation caused by the hollowing out of the population often coexist, with the conditions, breeding the generation of "Hollow Villages".

45.3.2 Land Productivity Effects of Factors

The phenomenon of "hollow villages" of the land idle and waste related to the relative output efficiency of the land. If a higher degree of conversion of the village economy, its agricultural land relative output less effective, the villagers will have power to take up agricultural land construction of new houses. If the village economy is not dependent on local production but rely on external labor export, the relative output efficiency of the collective construction land, the villagers through the village internal transactions to buy a new land building a new house cost lower, the villagers will be lazy on the old house accounted for idle land be used. If village land productivity gains increase, or the land as an important factor of production to support the local main source of income, the opportunity cost of idle land will rise.

45.3.3 Residential Construction Cost Factors

Farmers build new house in new agricultural land rather than demolition of the old is a direct cause to lead to the formation of "hollow villages". An important factor leading farmers to make this choice is residential construction costs, which includes the homestead acquisition costs, new house construction costs and turn converted construction costs. Demolition of old house and build new one are generally

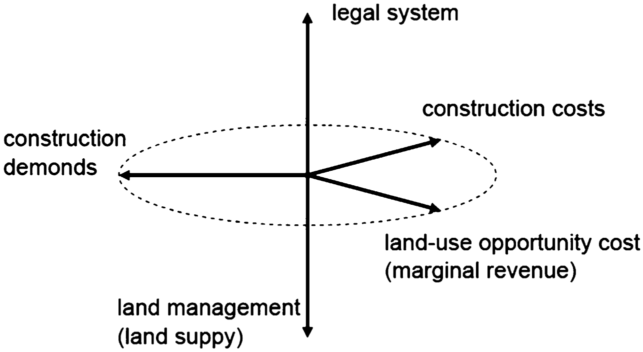

Fig. 45.4 The dumpling models of the formation mechanism of hollow villages

required to purchase or exchange the neighborhoods' homestead, so that building in the old homestead generally including construction costs, cost of purchase of the neighborhood homestead and the dismantling of existing houses, while the cost of housing on agricultural land that only includes the cost of construction, plus arable land loss of revenue due to the conversion of agricultural land. Houses outside the village always have convenient transportation, better ventilation and lighting, which is revenue building outside the village. Comprehensive cost-benefit comparison, the villagers easily prefer agricultural land than homestead.

45.3.4 The Legal System and Administrative Factors

The legal system form a system relying on land use; land management for government approval, planning and supervision in accordance with the law, directly impact on the supply and supply objects of the homestead, institutionalized constraints on the housing needs of farmers.

In summary, the formation of hollow village is the result of multiple factors, which can extracted five main factors: the non-farm economy and population, the legal system, land management, land-use opportunity cost (marginal revenue) and residential construction costs. On the basis of mutual influence of these five elements, we propose the "dumplings model" to explain the formation mechanism of hollow villages, when these five elements appear imbalance, they contributed to the "dumplings rupture", the coexistence of hollow villages and the spread of rural areas (Fig. 45.4).

45.4 Hollow Village Governance Status and Problems

The hollow villages' governance mainly involved in the role of local government and village collective organizations. Between them exist both cooperations and constraints.

In residential land management, the government is mainly responsible for three aspects: the approval of control of the homestead, the regulatory implementation of homestead use, organization of village planning. It usually by means of reduces the supply of land, financial support for new rural construction and administrative incentives to instigated the village collective organizations in the transformation of old villages and village construction.

The village collective organizations faced three tasks when conducting village governance: rise funds for demolition, evicted the appeal villagers and propose feasible resettlement program. In the case of financial difficulties and the single sources of funding, the village collective's funds for construction very dependent on the financial provision of government. Village collective relocation compensation and land resettlement compensation mainly from the internal financing of the villagers, which cause the village collective have difficulty to carry out large-scale demolition and resettlement.

In such conditions, the village collective in the hollow village governance often selects the following logic actions: the village collective organizations of the old house demolition and the construction of linear infrastructure combined to obtain the new rural construction funds of government. Road construction needs less demolition; actually avoid dealing directly with the hollow villages' old house demolition and resettlement issues. Instead an attempt by the road construction division of residential land border, and control the house construction on both sides of the road according the plan. Through long-term control and local environmental remediation improve the conditions of old land, lead to civil homestead transactions and spontaneous renovation, then updates to the new village areas rely on private voluntary force.

45.5 Exploration of the New Governance Model

The changes of the socio-economic environment will continue to put forward the demand for the new system. In the future, induced institutional change and mandatory institutional change will bound to interacting with each other, such as government through a series of project implementation (mandatory institutional change), prompting the induced institutional change factors change, the promotion of the new informal system formation and in part through a formal system to be clear and perfect. The most typical manifestations of this process is the start of the interests of the government's decisions, and residents to participate, in a variety of stakeholders in the form of the arrangement of this system have a clear positioning and function. It means that the full balance of the interests of all stakeholders, also means that the formal system and informal system compatibility.

45.5.1 The Use of Miscellaneous Land to Build New Homes Policy-Induced

Miscellaneous land is not a legal definition, generally refers to the garden of the village, idle, uncultivated land, yard. The four areas of miscellaneous places often have vague definition, and there is no clear ownership certificate. The current law strictly limits the occupation of cultivated land for housing, occupied by arable land need to apply for the farmers to use the procedures within the scope of planning and construction, and more difficult to be approved, therefore miscellaneous almost the only source of new housing land. Therefore, the state of miscellaneous land property rights affects the building behavior of the villagers, but also affect the ability of the village collective implementation of the management.

About the village land management, the privatization of miscellaneous land property rights hinder the easy implementation of spatial planning and equitable distribution of the homestead. Under the current construction of the shortage of village land, civil construction in greater demand, while the privatization of miscellaneous property rights weakened village ability to control and management of the residential construction, which is not conducive to the village collective self-restraint in residential construction.

Therefore, miscellaneous property, as the village informal system, the changes direction is shifted from the privatization to public ownership, the induction of the way by the government project to promote (such as the implementation of the transformation of old village construction project), prompting the miscellaneous privatization village refocus the miscellaneous land property rights, enhance village collective's management and control of the land.

45.5.2 Renovations of Existing Homes in the Policy-Induced

The most important content in the hollow village regulation is to promote the removal of vacant existing homes. Government, mainly through control of land supply and simplified approval procedures to encourage private turn converted the old house. In the future, government can take giving the individual more reward in old house conversion into account, such as housing loan concessions, an area of reward, to further promote the personal The old house translation alterations.

However, for the dismantling of the villages of the ancestral residence of a large old house can only rely on the village collective's unified action. The direction of institutional change and its induction should focus on how to promote the village collective construction and demolition operations to consider.

Combined with the previously described problem, we put forward three proposals: the first is the formal system should be clearly housing inherited the homestead property rights, and its convergence with "one home one house" system, trying to avoid incomplete property rights of right holders cannot make the best of circumstances. The second is the government should act a more action role in demolition of the old village, through the promotion of the project, increasing government investment, sharing the cost of the transformation of the village and the financial pressure in the demolition process, thus promoting the removal of the existing old house. The third is to grasp the possibility of institutional innovation, try to establish the incentives of the old house demolition.

45.6 Conclusions

In this paper, through a combination of literature and field research data, we construct analytical tools –"dumplings model"- to explain the formation mechanism of hollow village, and analysis the land management system and its management entity referred in "dumplings model". Further discussed a formal system and informal system of homestead in the operation of the private sector, the direction of institutional change and induction, as well as the technical issues need more attention. To "build new" and "demolition of the old" behavior as the center, analyzed its related institution and its operation mode, to determine the specific content of institutional change.

In this paper, I hope during above analysis, for the government to provide meaningful legislation and project management for individuals in rural areas housing and hollow villages in the future, in order to promote a stable and orderly institutional change, improve the efficiency of land use and balance the various stakeholders income.

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Chapter 46
The Effects of Subway Construction on Housing Premium: A Micro-data Analysis in Chengdu's Housing Market

Cong Sun, Siqi Zheng, and Rikang Han

Abstract As a sign of city development and prosperity, subway is not only an important public transportation for residents' travelling, but also an engine to real estate market and business booming around the stations. Moreover, the positive externalities brought by the subway will also be capitalized into the nearby properties. In this paper, the micro-data of new commodity housing units in Chengdu was used to estimate the premium effect during subway construction (Line 1 and 2) from year 2006 to the first half of year 2010. The empirical results suggest that the spatial and temporal housing premium are significant, and that the average home price is 7–14 % higher within 1.5 km around the subway station than outside the stations. Based on above estimation, the premium of residential land is more than 5 billion U.S dollars during the period, which can cover the subway construction cost (2.86 billion U.S dollars). The empirical results also provide some policy implication for urban subway construction and local public finance.

Keywords Subway • Premium • Home price

46.1 Introduction

Chengdu has started the construction of Urban High-speed Track Transportation Network since 2005. Rail transit can not only provide passengers with rapid, convenient, punctual and green service but also shunt road traffic and improve

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_46, © Springer-Verlag Berlin Heidelberg 2014

urban overall traffic situations, thus enhancing urban overall traffic accessibility and reducing carbon emission of urban traffic. In the long run, rail transit can greatly improve the transportation accessibility of suburban area and create a more proper city spatial structure, which could promote agglomeration of city central areas and provide guarantee for further development. Of course, rail transit has a most remarkable effect around subway stations. With the improvement of transportation accessibility around subway stations, more and more residents as well as enterprises will be attracted to gather around subway stations, as a result more investments of commercial and public facilities will also be attracted there, thus economic vitality of surrounding areas of subway stations will be greatly promoted. In a word, subway construction will bring great social and economic benefits, which is especially significant around subway stations. And these benefits will be capitalized into surrounding property, resulting in the premium of the surrounding real estate market. But there are quite huge costs in rail transit construction, taking Chengdu as an example, in which the total investment of the first-phase construction of subway line 1 and 2 reaches up to 18.3 billion, so it is a hot issue for scholars to research on how to calculate the effects on surrounding real estate market caused by subway construction and internalize the positive externality brought by subway construction.

This paper constructs spatial database based on geographic information system (GIS) with Chengdu newly built commodity housing. It aims at the construction situation of Chengdu Urban High-speed Track Transportation Network, references domestic and abroad research methods about subway effect analysis and economic evaluation, verifies the positive effects on surrounding housing market caused by the major subway line (Line 1 and 2) and quantitatively calculates the premium of housing as well as residential areas. On the above basis some suggestions are put forward on how to effectively utilize land premium to promote urban development construction as well as the stable and healthy development of real estate market.

46.2 Literature Review

Subway can bring premium for surrounding land and real estate housing. The economic mechanism is that subway foundation enhances traffic accessibility by providing people with more convenient trip; at the same time, people gather around rail transit site, arousing many kinds of business opportunities and attracting more investments, thus surrounding infrastructure can be improved. Under the construction of subway, premium creates as residents and real estate developers expect that subway will bring benefits to the neighborhood in the future and the future profits will be capitalized into the surrounding home prices. The spatial difference of the premium is called “Spatial Effect”. Moreover as time goes by, the premium degree will be larger because of more accurate information of subway and its attraction to public facilities. The premium change at different time is called “Time Effect”.

On the study of spatial effect, the international consensus is that on the premise of controlling other variables, the home price and the rent level will have a rising trend with a closer distance to subway [1–3]. As subway lines in our country is rising, domestic research mainly focuses on cities which have had subways or under construction, and the research also finds that home price around subway will get rising [4–8]. There are also some scholars doing calculation on increment brought by subway effect, of whom [5] have a calculation result showing that increment profit of real estate with 500 m radius range in each site of each phase of Shenzhen subway is 0.27 billion U.S dollars. Twenty sites of each phase amounting to 5.23 billion U.S dollars and 2.9 times of the first phase subway construction cost (1.79 billion U.S dollars) [5]. [8] have a calculation on premium brought by subway [8], of which the conservative estimate result is that Beijing subway Line 13 brings the premium of 8.2 billion U.S dollars for surrounding housing and they are enough to make up for the construction cost.

As for the study of time effect, there are big differences among different projects. Knaap [9] finds that light rail investment information has positive function on surrounding land price [9]; but [3] finds that the information promulgation of Miami new subway system at most has slight effect only [10]; however, research of [11] shows that Sheffield light rail project made a reduction of surrounding home prices at first, but the price had a recovery trend [11].

46.3 Data and Variables

46.3.1 Data

The projects under construction (or being operated) were Chengdu subway Line 1 and 2 till October 2010. These two subway lines were both approved to construct by the State Council on Aug. 13, 2005, and classified into three phases to implement. The total investment of the first phase engineering of Chengdu subway Line 1 was approximately 1.3 billion U.S dollars with Shengxian Lake at its north and Century City at its south, running across major urban zones. Its overall length was 18.5 km, which was all underground line. And it went to operation on December 27, 2005 and opened to traffic in October 2010; the overall length of the first phase of subway Line 2 was 23 km, and the whole line extended from northwest to southeast. Its sites were 20 with the total investment being 1.45 billion U.S dollars. Subway Line 2 started operation on December 29, 2007 and was expected to be on trial operation in the end of 2012.

Housing data used in this research is all collected and processed by Chengdu Municipal Urban and Rural Real Estate Administration Bureau. It is basic information of each bargain of commodity housing units from the first quarter in 2005 to the second quarter in 2010. After screening and rejecting of invalid (false) data, the final effective data sample data is 463,518 sets of housing. According to the spatial

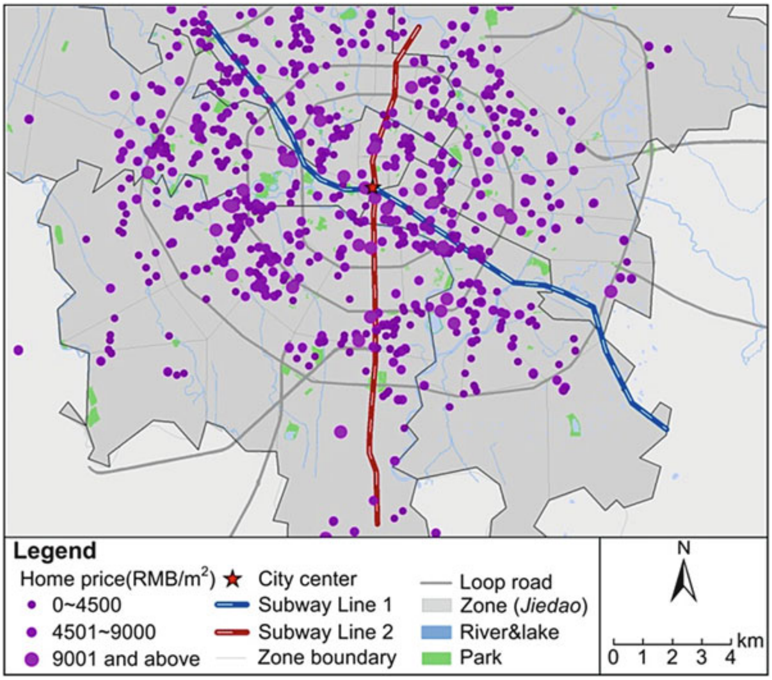

Fig. 46.1 GIS map of Chengdu housing units and subway spatial distribution

location, ArcGIS software are input to the 17 sites of first phase of subway Line 1 and 20 sites of the first phase construction of subway Line 2 and all the collected projects of commodity housing to realize specialization, thus to draw distance information from housing to subway stations for further analysis. Figure 46.1 shows the spatial distribution of housing units and subway stations in Chengdu.

46.3.2 Variables

This paper utilizes hedonic model for regression, the logarithmic form of home price is the dependent variable. This model mainly hopes to observe the different premium brought by different distance from subway site which is one of residential location characteristics. So, in order to get more accurate results, physical characteristic, other location characteristics and other characteristics are controlled. These variables and definitions are listed in Table 46.1.

As to the variable of distance to subway site, different distance dummy variables are separately adopted in different regressions to show the degree of subway effect in different regions and logarithmic values of distance to subway station are used to show the whole developing trend.

Table 46.1 Definitions of variables

Category	Variable & Definition
Dependent variable	Home price of unit area (Unit: U.S dollar/m^2)
Physical Characteristics	a) Room area of housing unit b) The approved sales area of projects c) Located floor of housing unit d) Total floors of housing unit
Location Characteristics	a) Located block. According to "loop and position" to classify 26 blocks. (dummy variable) b) Scope. Dummy variables of different spatial scopes around subway stations, such as 0–0.5 km, 0.5–1.0 km, 1.0–1.5 km, 1.5–2.0 km, 2.0–2.5 km and others. (dummy variable) c) accessibility to subway station–distance between housing unit and subway station
Other Characteristics	a) Sales duration time. The interval between project opening sale time and dealing time b) Whether the unit is completed house or forward house. (dummy variable) c) dealing year of this housing unit. (dummy variable)

The physical characteristics of housing consider the area of the housing itself and its floor as well as the whole area and the total floor of the project. As these characteristics have nonlinear effects on housing effects, quadratic term is added to control the nonlinearity, thus to control the housing characteristics from dual aspects of each housing and the whole project.

As to location characteristics, block dummy variable is used. As Chengdu is a typical single center city, 26 blocks are classified according to city loop roads and directions. At the same time, location characteristics inside blocks are assumed to have identical quality so as to control location differences among different blocks.

Housing sales characteristics and yearly dummy variable are also controlled. Sales characteristics mainly include whether they are existing unites or sales duration, thus controlling effects on home prices from different situations. Yearly dummies mainly control the increase of home prices in different years and effects from the external impacts on home prices in different years (*eg*. Global financial crisis in 2008).

46.4 Empirical Results

46.4.1 Analysis of Influenced Scope

Five dummy variables with five different distances range are respectively added to the subway influence scope, thus confirming the probable influence scope on surrounding home prices of subway (See Table 46.2). The regression results show that pricing level of commodity housing distant within 0.5 km from subway station

Table 46.2 Identify influenced scope of subway stations

Dependent variable: ln(home price)		(1)	(2)	(3)	(4)	(5)
Distance to subway station	within 0.5 km	0.052^{***}				
	within 1.0 km		0.022^{***}			
	within 1.5 km			0.022^{***}		
	within 2.0 km				-0.030^{***}	
	within 2.5 km					0.001
Constant		8.448^{***}	8.453^{***}	8.446^{***}	8.492^{***}	8.467^{***}
Observations		463,518	463,518	463,518	463,518	463,518
R-squared		0.486	0.485	0.485	0.486	0.484

t-value in parentheses; Physical, location and other characteristics of housing unit are all controlled but not reported here; $^{***}p<0.01$.

Table 46.3 Scrutinizing influenced scope of subway stations

Dependent variable: ln(home price)	(1)	(2)
Housing unit within 0–0.5 km from the nearest subway station (dummy)	0.140***	
Housing unit within 0.5–1.0 km from the nearest subway station (dummy)	0.074***	
Housing unit within 1.0–1.5 km from the nearest subway station (dummy)	0.075***	
Distance to the nearest subway station		−0.054***
Constant	8.377***	8.458***
Observations (within 2 km)	223,982	223,982
R-squared	0.532	0.524

Physical, location and other characteristics of housing unit are all controlled but not reported here; *** $p<0.01$.

is 5.2 % higher than those outside 0.5 km, those within 1 km and 1.5 km are 2.2 % higher than those outside, those outside 2 km are 3 % lower than those outside, however, the differences are very little for those inside 2.5 km. From results in Table 46.2, we can see that distance dummies coefficients have an overall declining trend with the widening of radius, and a positive negative turning point within 1.5–2.0 km. The above shows that the spatial effect of Chengdu subway decreases with the increase of distance to subway. The general influence scope is within 2 km and it is not obvious or just disappears when exceeding 2 km.

As commodity housing may be influenced by other factors, data within 2 km are chosen for further study in the following in order to avoid other disturbances while in the process of scrutinizing influence scope (See Table 46.3). With the same control of other factors' influence, equation (1) is a comparison between the commodity housing with the distance of 0–0.5 km, 0.5–1 km and 1.0–1.5 km and the projects within 1.5–2 km; while equation (2) is a logarithm value introduced to subway station distance. And the change gradient of home prices are analyzed directly.

The regression results of the above two equations both show that there will be a larger housing value within a closer distance to subway station, of which commodity housing value is more obvious for those within 0–0.5 km. And the commodity housing increment degree is far more than the ordinary housing within 0.5–2 km.

46.4.2 Estimation of Commodity Housing and Land Premium

Chengdu subway Line 1 and 2 obviously bring the premium of the surrounding into commodity housing units nearby stations. The increment of housing within 1.5 km of the radius and within 1.5–2 km is between 7 % and 14 %. To estimate conservatively, the increment of the dealt newly built housing is 1.71 billion U.S dollars. If calculated as commodity housing, the increment amount is 5.69 billion.

Table 46.4 Estimation of commodity housing and land premium

Scope (km)	Premium percentage (%)	Home price on baseline (U.S dollar/m^2)	Total amount of selling area of housing units (million m^2)	Housing premium in this scope (billion U. S dollar)
0–0.5	14.0	1141.30	5.53	0.88
0.5–1.0	7.4	1141.30	5.83	0.49
1.0–1.5	7.5	1141.30	3.92	0.34
				Total: 1.71

Scope (km)	Projection area of housing sample on residential land (thousand m^2)	Residential land premium per unit area (U.S dollar/ m^2)	Total area of residential land in the influenced scope (million m^2)	Residential land premium in this scope (billion U.S dollar)
0–0.5	27.99	3157.94	77.6	2.45
0.5–1.0	37.23	1322.86	132.3	1.75
1.0–1.5	25.54	1314.73	113.5	1.49
				Total: 5.69

The percentage of residential land in total land area is 30 %, the percentage of housing projecting on land in total residential land is 10 %.

The specific calculation method is as follow: (a)Calculate the average price of the newly built commodity housing within 1.5–2 km from subway station as the reference value; (b)Separately calculate the price appreciation in each spatial scope (0–0.5 km, 0.5–1.0 km, 1.0–1.5 km); (c)With the appreciation in each scope multiplies the total area of selling units, the overall premium in each scope can be known; (d)Add these premium of the three scopes, and then the total premium amount of the dealt newly built housing units can be calculated; (e)Transform housing premium into residential land premium per unit area, and estimate the total area of residential land in influenced scope; (f)Then we can estimate overall premium of residential lands in each scope and whole influenced scope (0–1.5 km). The calculation procedures and specific results are shown in Table 46.4.

46.4.3 Influence on Home prices from Time Effect

Subway's effects on home prices need to take time effect into consideration, which means changes of economy around stations at the key time. The so-called "milestone" refers to a demarcation points like subway's planning and design, working starting, finishing and operation, etc. In view of the operation status of subway Line 1 (till Oct. 2010) and the having been built for 2 years of subway Line 2, beginning date of construction time is quite proper to be the key time point in the analysis of time effect of subway. We classify time period into two parts (before and after work operation), representing the price gradient after work operation and differentials before work operation with cross variables and showing price before working operation change of surrounding land with distance variable coefficient. We find that the ascendant of surrounding home prices along the two subways after work operation is obviously larger than those before operation, which states that subway has an obvious time effect on surrounding home prices. After the work operation of subway, the final location of the station is confirmed, consequently, the future incomes brought by the station is much more riskless. Therefore, more investments will be attracted in the housing market surrounding subway station. As a result, a greater appreciation will be brought. At the same time, more enterprises and businesses will be attracted to have a layout in advance around subway station, thus improving the facilities around subway and bringing grater increment. Therefore, with the improvement of subway information and the strengthening of agglomeration effect, the total premium will realize gradually.

46.5 Conclusion and Suggestions

Governments should fully predict land premium surrounding subway and reasonably adjust time sequence of land grant. Rail transit is a public investment project. Land premium is an important embodiment of its externality and a social profit created by public investment. In theory, there should be some mechanism for value capture, which will also contribute to the recovery of the large amount of capital invested by subway construction. Different systems have different forms as to how to specifically implement the value capture mechanism, and the key is to connect the huge cost of subway construction with the profits brought by premium of the surrounding land. Therefore, before the land premium effect have a panorama (*eg*. When the subway construction hasn't begun yet), the governments should fully predict the possibility of premium when they grant surrounding lands. Premium should be taken into consideration when assessing base price. Great efforts should be made while granting lands to realize value capture, in order to make up for the subway construction cost.

Besides, city governments can also keep the most valuable part of land around the subway. Granting time should be reasonably grasped. This part should be granted after it has a more sufficient increment, so as to better appreciate the profits caused by land appreciation.

Combined Development Model should be adopted to relieve government expenditure pressure. Faced with huge subway investment, the government tends to be eager to make up for the construction cost by income of granting land, which may result in a relatively low granting price. Thus the deserved increment profit will lose. According to the experience of Hong Kong Mass Transit Railway, enterprises, with the ability of subway construction and real estate development in the mean time, are found to repair subway and develop the surrounding areas. The whole or parts of costs of subway construction are undertaken by enterprises, and parts of the surrounding areas are granted in a low price (even for free). Development enterprises get profit from the development of the surrounding real estate, which is enough to make up for the cost of subway construction, thus realizing a win-win situation.

In the long run, a restitution mechanism for increment profit should be built. If premium effect cannot be fully taken into consideration in the process of subway construction and operation, land premium will always be obtained by individual owner. But as the undertaker for subway construction investment and operation cost, government or subway construction enterprises have less appreciation of these profits. In order to obtain the more matching profits for governments, some countries and districts build a restitution mechanism for increment profit. California State Assembly in 1983 considered that the real estate around subway would get profits from subways. So they authorized the then Rapid Transit Bureau of Southern California to mark "Special Advantage Review Tax Area" around subway. Special property taxes are collected within these areas and used for repaying the published bonds due to subway construction, which lasts more than 20 years. In our country, similar methods can also be considered to be a system arrangement for premium recycling when system and social conditions are mature. Then each party can have a better coordination and matching between the investment of subway construction and the obtaining profits from subway premium.

Acknowledgments This research is supported in part by the National Natural Science Foundation of China (Grant No. 70973065), Major Project of National Social Science Foundation of China (Grant No. 09&ZD042) and Tsinghua University Initiative Scientific Research Program.

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Chapter 47
Discussion on Problems and Countermeasures in Indemnificatory Housing Management in China

Yu Fan and Hong Zhang

Abstract In recent years, to reach the goal that everyone has his house, the government pays more attention to the indemnificatory housing and increases the investment in it. All of these contribute to the indemnificatory housing construction and make good effects. However, there are some reasons that result in a great discount for the functions of the indemnificatory housing; the worse is leading to social problems. This paper analyzes the main problems existing in the indemnificatory housing management, introduces the management experience in Singapore and American. According to our country's present state, the paper proposes some suggestions.

Keywords Indemnificatory housing • Problems • Countermeasures

Indemnificatory housing is a government imposed on low-income families in the classification provided in the support process and limited supply, building standards, the sale price or rent standard, a social security nature of the house. That includes low-rent housing, public rental housing, affordable housing and limited sales price house.

We can see that in recent years, to reach the goal that everyone has his house; the government pays more attention to the indemnificatory housing and increases the investment in it. All of these contribute to the indemnificatory housing construction

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_47,

and make good effects. However, there are some reasons that result in reviewing not strictly and unfair allocation. One is the shortages of the policies, systems and their implement; the other is that the supply exceeds demand for the indemnificatory housing. These also make a great discount for the functions of the indemnificatory housing; the worse is leading to social problems. Therefore, strengthening and improving the construction and management of affordable housing is of great practical significance.

47.1 The Problems in the Management of Indemnificatory Housing

47.1.1 Auditing is not Strict, Higher-Income People Protection from Implementation

Since the construction of indemnificatory housing in our country, related policies have been to explore and try to, often the policies introduced, there will be some “loophole”, then the government to impose new measures targeted for the management of patches, then there will be a new problem. In 2007 the ministry of house and urban-rural development and other six departments jointly issued the Indemnificatory Housing Management Approach, for example, while the indemnificatory housing construction area, the purchase qualifications, pricing and trading of square are made specific provision,, but owing to lack of matching measures, problems and contradictions have appeared. Due to the examination strength for indemnificatory housing purchase and tenant is insufficient, some higher-income people mixed with, resulting in indemnificatory housing community park with a large number of luxury cars. Only by virtue of a paper that is to determine the applicant’s qualifications, will violate the government construction of indemnificatory housing in the original, Let those who should not within the scope of protection took advantage, is really more serious need for indemnificatory housing to ensure a normal life of people turned away. More serious is the people who really need for indemnificatory housing in order to ensure the normal life have been shut out.

47.1.2 Random Determine Qualification, Causing New Unfair

After the audit later there is often appear that the number of the purchase and rent eligible households is more than the number of housing supply. In this case, many cities determine the acquisition of lessee and purchase by random way. It avoids the social security problem such as disorder that caused by the queue up for the housing election. But can it really ensure indemnificatory housing purchase of justice and fairness? Many family get indemnificatory housing purchase qualification has row more than 1 year time until project opened, Different families qualify for approval of time different, varying degrees of financial difficulties, housing difficulties is also different, but ultimately who can get it only rely on luck, that with a lot of randomness. So, random on the surface, appears to be fair, in essence, is very likely to have been shut those most in need of housing to rent or purchase out, and causing another injustice.

47.1.3 Supervision Ineffective, Security Variable Speculation

According to the low-income housing management approach, affordable housing only can be used for live by those families who get qualification, and prohibit rent out. However, in some low-income housing residential area of Beijing, such as Huilongguan and Tiantongyuan, affordable housing illegal rental is banned repeatedly; Affordable housing has a large proportion of rental housing in the area. In 2006 REICO studio launched a survey, survey data show that housing rental rates accounted for 78.8 % of the total area of leasing transactions in Beijing Huilongguan, and Tiantongyuan. According to a 2010 chain of home real estate market research department data show that in the current stock of affordable housing in Beijing, the rental rate amounted to 20 %. Among them some typical areas is around 50 %, such as Huilongguan, Tiantongyuan. Rental rates are so high, showed that over half of the affordable housing was bought by wealthy. [1]

On the other hand, only prohibit leasing for affordable housing and limit-price housing not prohibit the sale in China, to sell only provided useful life limit (usually 5 years) after the expiration of the term can sell at market listing, then according to the price difference of same lots of ordinary commodity housing and affordable housing to pay revenue proportion to the government. It is the provision that makes affordable housing has no risk investment function, although the government regulated that sales of such housing must pay land leasing but the sale still has a big profit space, even more serious is that selling behavior has changed the nature of the housing, making the number of indemnificatory housing in decline.

47.2 Foreign Indemnificatory Housing Management Experiences

47.2.1 United States Strict Property Audit System

Affordable Housing has many types in United States; there are apartments for the elderly, a government-owned house, available for rent, available to buy. Service objects of these houses are those low income social stratums. In addition to the normal property management United States affordable housing manages mainly on the tenant's qualification cognizance to ensuring the really low income that could not afford housing groups stay and improving their quality of life. Property management company review of the tenant's income and property every year, usually in January of each year the notice to the tenant, and this investigation will continue into May.

The first step of Tenant property audit is tenants reporting his income, banking / asset and the other. Year income is examined in terms of content for six recent payroll, unemployment benefits, pensions, benefits and other; self-employed oath, supporting children letter; do not swear; return copy; certificate about school. Bank/assets area of review content for: recently 6 months of bank check account report; demand, regularly, annuity, stock, bonds, pension, housing loan and other information copies. If people once save Bank $5000 or more, or once increased has $5000 of assets, to proved it is from where; guests who has HSBC and the BP Bank of wealth took check table to Bank complete finished cross back; no property (industry) to cross sworn table. In addition to the above two areas audit has proof of residence, investigation of attorney, pensions, tax tables, student oath, if the new kids in the home reported the date of birth, social security number and so on. The second step for property management companies to do is written to the tenant to provide sources of income asset verification. the management company in Prior to May of each year reported tenant information to the government, after government review and found no problems, approved for the apartment industry (developer or Government agencies) subsidies, for example, affordable housing rental is US $ 672, with a difference of $ 470 market, Government subsidies to the developer $ 470 per month. [2]

Government should not engage in a subsidy, but check every year. The management system is that the government review the information reported by developer or information agencies, and developers or government agencies to review the submitted materials from property management companies, and property management companies verify tenant income property, according to the guest's income changes, adjust the rent-income ratio. If the tenant frauds during the audit process cheat the government, you would be in jail.

47.2.2 Singapore Clear Allocation Policies and Strict Allocation Procedures

For the purpose of fair housing support, Singapore housing development agency developed the public housing allocation policies and procedures. Public housing in accordance with the rental conditions are divided into two categories, one is the small-, mainly for hire; another is larger, mainly for sale. According to the above two cases, HDB has developed sales and rental housing allocation policy, and must perform to determine the housing allocation procedures.

HDB developed a strict standard of distribution and implementation of waiting queue system. According to family income, family structure and formation of public housing allocation waiting queue system, resident with different income and family structure participate in various types of housing development plan that formatted a strict hierarchy and serialization in the application, occupancy, rental and purchase. Singapore public housing application standards are established the basic framework of everyone has his house. Set out in the standard, public housing applicants must meet the following four criteria to be eligible, that is, citizenship, no private property, income level and family composition. In these four standards, citizenship and no private real estate is easy to identify, while income is dynamic change with the development of economy. In practice, HDB is based on the housing shortage degree and the change of income to dynamically determine the income ceiling [3].

Singapore group housing property owned by the government, the government has a set of strict management system. In order to prevent the use of housing speculation, Singapore government enacted the comprehensive laws and regulations, for the residents to purchase group housing and conduct strict monitoring. The Singapore government has made clear regulations about purchase procedures, conditions, housing subsidies, and distributed in accordance with the principle of fair. The government has formulated group housing access policy with the different income level. Singapore group housing system is open, rigorous and transparent. Singapore group housing purchase conditions have a strictly defined: according to the family income level to measure whether or not qualified to purchase affordable housing the basic conditions, and strict regulation of a nuclear family can only have one set of affordable housing, in a certain period of time cannot get to open market sale, high-income persons to give more restrictions etc. According to the Singapore government regulations, anyone in the sale of group housing must provide accurate, detailed information. Violating the regulations may be charged in a court. Government regulations are very transparent and comprehensive. In front of the law there is without any fuzzy space. On the premise of law uphold the principle of fairness, justice, equality, to ensure that the real benefits to those in need [3].

47.3 Recommendations for Perfect Indemnificatory Housing Management

47.3.1 Establish a Rent Based Multi-Level Housing Security System

Singapore government "public groups housing" policy basically solves is "living room", and then "having house". It is an effective way to provide low-income housing security that government direct intervention the low rent housing supply. The first security is the right of residence rather than a property right.

Our affordable housing supply systems there are still many problems need to be solved further. It is particularly important that we set up a rent based multi-level housing security system based on the current situation of China's national conditions, For the specific needs of the different security object, we must have the plan, the step, and different levels to solve the housing problems of low-income families, ensuring them have room to live in. Central and local governments should adjust the focus, increased investment in public rental housing and low-rental housing, narrowing the development and construction of affordable housing. To ensure the implementation of the "rent" give priority to low-income housing supply, to ensure the housing needs of the low-income population, instead of making affordable housing in disguise as a speculative investment platform.

47.3.2 Strict Property Audits, Increase Supervision Strength

Increase supervision strength, establish a scientific definition of the buyer's income standards, improve purchasing procedures, and standard approval process. Mainly because the relevant departments of the government legislation are not strict, ineffective enforcement of the law the problems appeared in the construction purchase and approval of low-income housing, Our country can punish those who purchase rent for affordable housing and false information of applicant to further clarify the regulators, builders and consumer responsibility and legal duty, not only to the use of improper means to get the swindlers rent low-income housing were found guilty, but the issuance of government personnel must earnest law and discipline, accountability. Not allowed officials and wealthy class fraud swindlers rent low-income housing. On the other hand we also can depend on the community neighborhood committee and other grassroots organizations.

47.3.3 Strict of Standard of Distribution, Implementation the Queuing System

The experience shows, public housing resources are scarce, there is always a demand is greater than supply. All countries set the standard of distribution for public housing allocation

On the indemnificatory housing allocation, need according to indemnificatory housing market supply and demand urgency to establishing strict, standardized, quantified and easy to operate and feasible specific criteria, According to family income, family structure to format the waiting queue system of public housing allocation. According to the housing difficulty degree and urgent priority queue allocation principle, The strict standard of distribution and waiting queue system, effective allocation of public housing resources, make the housing difficulties families solve housing problems.

47.3.4 According to the Income Property Status, the Implementation of Dynamic Management

In addition to the purchase and rent property outside the strict review, with the enjoyment of low-income housing family structure or conditions change, some families may no longer meet the conditions of guarantee, For example some low-income family, the children of employment increase in household income, economic conditions have improved, This situation should be dynamic management, according to the actual condition of family economic guarantee real-time adjustment. For low rent housing should be in the enjoyment of welfare after every period of time such as 2 years, regular income, property review, review results based on adjustment of rental prices, to withdraw from the rental housing. Provisions for public rental housing lease, expiry of the lease must to exit. For the family to purchase affordable housing if the actual income exceeds the standard, should be required to pay a percentage of the fund, or to exit, the income of the fund available for construction of affordable housing and subsidies.

47.3.5 Establish and Improve Internal Circulation Mechanism

The government development affordable housing capped-price housing executes is disguised subsidies, property buyers obtain housing benefits. As affordable housing and capped-price housing, secondary trade, target groups should be housing difficulties residents, therefore, affordable housing capped-price housing listed transactions should be implemented and the inner circulation mechanism. Internal circulation mechanism can ensure the application of economic housing policy goals; put an end to economic applicable housing speculation. Of course, price, rent determine are need for the research, repurchase to pay a certain evaluation and supervision cost.

47.4 Closing

Everyone has his house is the ultimate goal of affordable housing policy in China, The realization of this goal, to our country overall construction comparatively well-off society, compose to build harmonious society to have very important sense. Therefore, we must further improve the low-income housing policy, aiming at the problems of policy implementation, take the effective measures to solve them Allow more low-income persons enjoy the housing security, so as to realize the good wishes of the live and work in peace.

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Chapter 48
An Empirical Study of the House with Limited Property Rights: A Case of Shenzhen

Guoliang Ou and Zhongyuan Zhou

Abstract The house with limited property rights (HLPR) is a product of the unique structure of land dual system in China. In recent years, it has become one of the hot topics of the Chinese community. Especially in Shenzhen, it consists nearly 49 % of the total housing market. This paper describes the connotation and historical background of the house with limited property rights, reveals the reasons of its formation in Shenzhen. Through surveys and statistical analysis, we find out the mail problems of this kind of housing market, and then analyze the impact of it on housing market. Measures and suggestions are also provided in order to solve the problems.

Keywords Real estate • Land use • Land ownership • Shenzhen

48.1 Introduction

In recent years, the house with limited property rights (HLPR) has aroused extensive concern in the community. Government also pays much more attention on properly handling the problems brought by HLPR, and carries out special comprehensive survey gradually across the country. Shenzhen as the birthplace of China's reform and opening up, for historical reasons has left a huge amount of old residential house. In fact, HLPR is not a standardized terminology, and does not appear in our laws, regulations, or other property forms. The concept of the house with limited property rights only mentioned in northern areas, and it is called "Farmers house" in Shenzhen. In other words, the house built by the original native village or the village committee is called as HLPR or "Farmers house". Regarding with the specific conditions of Shenzhen, the residential construction market is divided into the following three

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_48, © Springer-Verlag Berlin Heidelberg 2014

categories: The first category is commercial house; the second category is HLPR, and the third category is the illegal buildings. The house with limited property rights in this text all refers to the buildings built on the original collective village land, but owned by people outside the village or city residents. In view of the seriousness and complexity of the problem of HLPR in Shenzhen, it is necessary to further investigate the actual situation of Shenzhen's HLPR, in order to enhance the government's profound understanding on its market problems and to provide a scientific basis for the proper treatment of our country's peculiar problem.

48.2 Reasons of the House with Limited Property Rights Emerging

48.2.1 Urban and Rural Land Ownership and Land Management System are the Roots for HLPR Emerging

According to the law, the urban land owned by the state, rural and urban suburban land belongs to the rural collective. Before 1995, land management departments carried out "Transfer of Rights and Interests "policy, and ruled that collective construction land must turn into state-owned before it circulates in the secondary class market. After 1995, the policy no longer emphasized the collective construction land have to be turned into state-owned, but did not clear out its new legal transfer path. The forty-third clause of the 1998 revision of "Land Management Law" regulates that: Any organization or individual requires the land for construction, must apply for state-owned land, but expect for initiating village-enterprise, constructing dwelling house for villagers, building public facilities, and undertaking public welfare approved by using village's collective land accordance to the law. The sixty-third clause stipulates that: "the right of using villager collective land cannot be sold, transferred or leased for non-agricultural construction". These two clauses deprived part of collective land development and disposition rights. Collective land can only be used to build villagers' own dwelling, village-enterprises, public facilities and public welfare undertakings, cannot be used for other development purposes. Although the law stipulates that "Rural land all belongs to collective organization; the villagers only have the right to use the land; the behavior of villagers selling their dwellings to city residents is not protected by law". However, there is no clear regulation on villagers selling their redundant dwellings that built on their old Homestead to city residents. Current laws are blank or have defection for HLPR. The legal principle of "do not prohibit means practical" makes legal loopholes for the truncation of HLPR.

48.2.2 Rising High Price is the Catalyst of HLPR's Formation; It Directly Promotes the Continued Warming Market of HLPR

Right now, city planning lands of our country are less and less, and land price is higher and higher, this situation induced the number of residential housing launched by the real estate market dwindling and the prices rising higher. At the same time, HLPR was developed on collective land in village; there is almost no cost for land. In addition, taxes, marketing expense, the cost of supporting development, the cost of project design and construction investment are all greatly saved, in which, the cost of development is only 1/3 of the real cost of commercial housing. The average price of HLPR is only 1/3–1/2 of the commercial housing in the same location, or even lower. The population in Shenzhen is about 13,000,000, and 350,000 HLPR (about 2,700,000 sets of houses) accommodate about more than 9,000,000 non-local population. A number of worker dormitories accommodate about 1,000,000 migrant population, the remaining 4.000,000 people are accommodated by about 1,200,000 sets of commercial housing. On this basis, 4,000,000 people live in about 1,200,000 sets of commercial houses; there seems no shortage of housing. Gao Haiyan, Director of City Operation Research Center, Academy of Social Sciences in Shenzhen, said "Putting village housing into city market will alleviate the supply and demand contradiction to a great extent for the middle and low level housing market. Chengjun, a city planning review officer, believed that the current price in Shenzhen no doubt has not yet reached the expect point. Then, when the high housing price keeps, HLPR can meet the housing demand with it advantages of low price and sufficient supply. No matter for leasing or for sale, it plays a positive role in controlling and even making downward of the price of housing market in Shenzhen to a certain extent. HLPR helps low-income city dwellers in Shenzhen realize "home ownership " with its low price of an average of about 2,000~4,000 Yuan per square meter compared to more than 10,000 per square meter of commercial housing. Low price urges more and more people willing to take risks to purchase HLPR. In other words, high prices that ordinary people cannot bear, force purchasers willing to take risks to choose HLPR, and also lead HLPR exist "reasonable" and develop. That is a natural reaction of the market.

48.3 Investigation and Analysis of HLPR in Shenzhen

Since Luohu District and Futian District are first developed regions in Shenzhen, the problems left over by history are not too much, the size and growth room of HLPR in those regions are limited. Currently, HLPR of Shenzhen mainly locates in

Baoan District, Nanshan District and Longgang District, and according to the statistic survey, HLPRs in these three zones account for 70–80 % of those of the entire city. In October 2011, I went to a town named Shajing in Baoan District to do the research; there is only one legitimate commercial housing project called " Xiyuan ", and the price margin of that is between 9,000 and 10,000 Yuan per square meter. However, for tens of HLPR, the price of them is only between 2,000 and 3,000 Yuan per square meter. The following is the survey of HLPR in Baoan District, Nanshan District and Longgang District. According to the distribution situation of HLPR in Shenzhen, the questionnaires mainly concentrated in Baoan District, Longgang District and Nanshan District. And in order to achieve the purpose of investigation, the main targets of the survey are the purchasers and interested purchasers of HLPR. A total of 500 questionnaires were issued, and 472 valid questionnaires were returned.

Questionnaire

Serial No.	Questions and options	A	B	C	D
1	Which type of house do you live now? A. Commercial housing B. HLPR C. Other house	31.30 %	34.30 %	34.40 %	–
2	Do you know what is HLPR? A. Know B. Do not know C. Know a little	34.30 %	25.10 %	40.60 %	–
3	Will you purchase HLPR without the property certificate? A. Yes B. No C. Cannot decide	34.30 %	20.70 %	45.00 %	–
4	What is the reason you purchase HLPR? A. Low price B. Cannot afford commercial housing C. High return for investment D. Other reasons	35.50 %	32.20 %	29.00 %	6.50 %
5	Do you think the risk of purchasing HLPR is high? A. High risk B. No risk C. Risk exists but not to high D. Do not care of the risk	21.40 %	6.30 %	49.60 %	22.70 %
6	How HLPR should be dealed with? A. Legalization B. Take back or removed C. Keep the present situation D. Others	32.20 %	19.50 %	3.10 %	45.20 %

48.3.1 Result one of the Analysis of the Survey

It can be learned from the field research that Bao'an, Longgang and Nanshan these three areas in Shenzhen have a large number of HLPR, where more than 80 % of HLPR are built on villagers' homestead. The majority owners of HLPR sell and lease them at a low price.

48.3.1.1 Of All Investigate Areas, Each Area Has Its Own Features

We found that rental price of HLPR is between 300 and 800 Yuan per month for a single room, 600 and 1,000 Yuan per month for one-bedroom and one-living room, 800 and 1,200 Yuan per month for one-bedroom and two-living room. Shenzhen housing price has far exceeded the capacity of the ordinary people after several years of price inflation. At the same time, the price of HLPR for leasing and sale is really low; HLPR could alleviate the housing demand to some extent and also play a role of lowing housing prices.

48.3.2 Result Two of the Analysis of the Survey

From the survey, we get statistics respectively from purchasers and people with no intention to purchase:

48.3.2.1 The Purchasers of HLPR

Firstly, purchasers can be divided into local villagers and residents (citizens and permanent residents). Most of the local villagers have a certain understanding on HLPR, and clearly know the difference between HLPR and commercial apartment. Among those purchasers, 34.3 % of them hope to get a self-built house, 37.5 % are for local villagers to live, and 21.9 % of the purchasers are for sale or leasing to increase income. They are optimistic about the future development trend of HLPR, and also give its cost-effective recognition. Compared to current high-priced commercial apartment, HLPR has the relatively larger demand. The price of HLPR is more attractive to non-residents of the local villages, while there are certain risks; the price is low and cost-effective. Though its public facilities is imperfect, up to 56.3 % people believe that HLPR will gradually be recognized by government, even when the demolition, it can also be offered certain subsidies. However, a lot of people believe that if they have a legitimate property will not consider purchasing HLPR. To purchase what kind of house depends on their income.

48.3.2.2 People with no Intention to Purchase

Among people with no intention to purchase, about 34.3 % of those already have legitimate property and do not value this kind of risk house. People would not purchase HLPR due to the houses are illegal buildings, the construction quality of the houses cannot be assured, and public facilities are not perfect. Moreover, having no property and without the intention to purchase HLPR accounted for about 18.8 %.

From the survey, people with very low income have no choice but to choose HLPR, because the price of the commercial apartment is too high, and the indemnificatory housing, affordable housing and low rent housing will never belong to them. In the survey, up to about 77 % of the people are with policy fuzzy and traditional concept, especially for migrant workers and local villagers. HLPR is a great temptation to realize their housing dream. While some investors think though HLPR may have a big risk, low investment can bring them high return. Selling HLPR helps to maintain and implement the basic rights for the villagers, and to find a path to convert assets into capital for them. The villager, as the seller of HLPR, on the other hand can also be a target consumer of HLPR. If HLPR can be constructed cooperatively by the developer and the village commitment, the villager can also be its consumer.

48.4 Countermeasures and Suggestions to Solve the Problems of HLPR in Shenzhen

It is well known that the presence and development of HLPR has brought a tremendous negative effect on social, economic and environmental in Shenzhen. The presence of it has caused great obstacles for Shenzhen's municipal planning and land use, attacked the real estate market, provided developers and purchasers who participated in the business of HLPR with unreasonable and illegal income, and finally caused losses to non-participants and the state. The basic principles to solve the problem of HLPR should be government-led, comprehensive consideration, analyzing specific issues, and balancing the government, developers and purchasers' interests, to build a harmonious and stable society in Shenzhen.

48.4.1 Regulate HLPR Illegal, Further Improve Relevant Laws and Regulations

Although the present laws and regulations relating to land management are inadequate, imperfect, and some of them are even conflicting, China's Constitution and land management laws and regulations make no provisions of the legitimacy of HLPR.

It is certainty that the construction of HLPR is illegal. To handle the intense social debate and repeated built of HLPR, our government should firstly clear out the period of disposal of them, then list the completed and on sales of HLPR inside the scope of the disposal, and immediately call stop of those not built and being built, and last make the announcement to the whole society. Later built HLPR shall be all dismantled, and the relevant parties shall be investigated. Meanwhile, relevant departments of our government should pay close attention to develop and improve the relate laws and regulations, establish the city main functional areas, unify classification criteria and circulation way of village homestead according to Shenzhen's municipal planning and economic development situation. At present, a large number of village committees still are violating development and construction on collective land. The proliferation of HLPR is due to the disruption market, and legislation and law are passed not timely and enforced not strictly. Of prior illegal land use, the penalties are all about "power abuse crimes and bribery crimes". In the future, to face the new illegal land forms, government departments should develop particular management practices and creative a new legal provision "the crime of destruction of land resources". Furthermore, for profit gained developers, government should undertake forfeiture or penalty. Shenzhen city hall should issue the relevant regulations and make real estate development enterprises and households pay land leasing. In the suppression of new property house to appear at the same time, the prior HLPR have to be settled to highlight legal fairness. For completed built HLPR, the developers and households should pay the corresponding taxes, at the same time, the developers and village organization shall responsible for administrative punishment, and their illegal gains should be confiscated on the violation of the land management law.

48.4.2 Research on Repurchasing HLPR as the Affordable Housing

According to incomplete statistics, Shenzhen's affordable housing only reach to about 10 % of Shenzhen housing construction land. In 2009, the government of Shenzhen plans to supply 111 ha as housing land, affordable housing land 30 ha, and to construct commodity housing 90,600 sets (total area of 8,100,000 square meters), 25,700 sets of affordable housing (total area of 1,348,000 square meters). For HLPR with qualified construction and not affect city planning, such as Liuxian Ju in Xili town of Nanshan District, its residential design, construction quality is nearly the same with ordinary commercial housing. Government could repurchase them as the welfare housing or low rent housing. Due to the current lack of laws and regulations, HLPR does not have legal circulate market. Government could acquire them as indemnificatory housing such as affordable housing, low rent housing and so on, not only can expand affordable housing supply, but also can reduce land and capital cost on indemnificatory housing. Making HLPR as indemnificatory housing can not only save social resources, but also meet the housing needs of low-income families.

48.4.3 Distinguish Categories to Legalize the Operation

It is admitted that the emergence and development of HLPR is a special "economic phenomenon" in the special period. HLPR in our country has its special external environment; it is due to the imperfect legal system during Chinese economic and social development and urbanization process. The supply and demand contradiction caused by urban housing supply shortages and high prices is the direct cause of its development, but the lack of the government management is root causes of its emergence and development, the government has inescapable responsibility. For different regions, different types and different time of HLPR, the government should have classification treatment based on fully clear of their situation. Mainly include: (1) For those HLPR in accordance with the township planning, and village or township government has admitted and issued the certificate, government allow retroactive legalization purchase procedures, but the developer shall pay all expenses to make the collective land into state owned land used for real estate development; (2) For the price of the legitimate commercial housing changed from HLPR, the government should organize all related institutions to asses a reasonable price, government could grant the legal property certificate to the original purchasers after they pay the differences of the original purchase price and the current evaluation price. The government acting as a middleman properly handles the interests among developers, property purchasers, and the government.

Above all, HLPR is no doubt a difficult problem for policy makers, and appropriate settlement of this issue matters government's image and social stability. Prohibiting by force will not only harm the interests of related parties, but also lead to social conflicts. However, if just let it be, it is bound to affect the social and economic development. Therefore, decision makers have to assess the situation, use scientific methods to settle this issue left over by history.

Acknowledgments The research was supported by Guangdong Province Philosophy and Social Sciences 12th Five-Year Plan Research Fund: GD11XGL09, and Shenzhen Polytechnic Research Fund.

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Chapter 49
Airport Noise and Residential Property Values: Evidence from Beijing

Antoine Nguy, Cong Sun, and Siqi Zheng

Abstract Cities are used to develop in the vicinity of transport hubs : formerly near waterways and ports, then around railways and highways. More recently, globalization requires cities to contribute to the international flows of passengers, goods and information. Thus, air transportation industry plays a major role in the economic development of an urban area. In China, the number of civil airports increased significantly in recent years. Most airports are built in suburban areas because noise generated by airports is considered as a disamenity towards neighboring areas. Some scholars have already studied this phenomenon – particularly in North America and Europe. In China, although this issue receives wide media coverage, the question is still discussed in the academic circle. The paper is based on transaction data in residential areas close to Beijing Capital International Airport. By using econometric models and estimating them via the hedonic price method, we derive the impact of aircraft noise on the willingness to pay for residential properties. The results suggest that a 1 dB increase in noise exposure leads to a 1.05–1.28 % depreciation of property values. This estimate is on the high side compared to other international NDI studies.

49.1 Introduction

Since China's economic reforms in 1978, the rapid economic growth and the opening of China to the outside world have come together with the important growth of air transportation industry. The soaring of the aviation activity has

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This research is supported in part by the National Natural Science Foundation of China (No. 70973065), Major project of National Social Science Foundation of China (No. 09&ZD042) and Tsinghua University Initiative Scientific Research Program.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_49,

required tremendous efforts in increasing the number of airport infrastructures. In particular, many airports have been constructed and have dramatically changed China's air passenger transport network. The number of civil airports increased from 77 in 1980 [1] to 175 in 2010, and a total of 220 civil airports is expected by 2020. Today, 61 % of the Chinese population has an airport at less than 100 km. In 2020, this proportion is expected to reach 82 % of the country's population. To achieve this goal, the government has to build airports close to areas that are more populated, that is to say, into cities.

In practice, there are many reasons why most airports are built in suburban areas or near the city's edge. First, building an airport requires a large parcel of land, generally several dozens of square kilometers to accommodate runways, terminals, facilities and internal transportation. While considering the location for building an airport, governments give priority to areas located far from the city center because the concentration of people living and working is lower in these areas, so the need to relocate people is less important. Secondly, after the completion of the airport, noise pollution generated by airports is considered as a disamenity towards neighboring areas.

The paper focuses on the negative externality of Beijing Capital International Airport (BCIA). Because aircraft noise is a non-market environmental good, we use econometric models to derive the implicit price of noise based on information about the value of properties located in the vicinity of BCIA. Then, the hedonic price method is used to estimate the Noise Depreciation Index (NDI) that reflects the depreciation of properties values caused by airport noise exposure. BCIA is an interesting case since it is the world's second busiest airport (79 million passengers in 2011) and it is located within the urban fringe of the metropolitan area of Beijing, a relatively urbanized area. Knowing the implicit price of noise is useful in order to implement more appropriate policy measures (e.g. compensation for people who are subjected to airport noise exposure), and land-use planning regulations.

The remainder of the paper is divided as follows. Section 2 provides a summary of aircraft noise studies from the literature. Section 3 describes the data and the econometric model used in the study. Section 4 presents the regression results. Section 5 concludes the study.

49.2 Aircraft Noise in the Literature

Since the beginning of hedonic price studies in the late 1960's, research has been prolific on amenities and property values. The hedonic price method is based on the hypothesis that, in a competitive housing market, the selling price of a property depends on its characteristics. Other things remaining unchanged, a property located with a better location will have a higher selling price. On the other hand, there are some disamenities which can affect neighboring properties and lead to a lower selling price. Their impact on housing prices can be derived by examining the willingness to pay for a particular attribute (e.g. distance to this disamenity).

An airport is a typical disamenity that can severely affect neighboring areas subjected to aircraft noise. The hedonic price function of a property can be expressed as:

$$\ln P = \alpha + \mu Z + \mu_N N + \varepsilon \tag{49.1}$$

where Z is a vector containing all characteristics excepted noise level, N is the noise level, α, μ and μ_N are the associated parameter vectors, and ε is the error term.

The hedonic price function only represents the locus of buyer and seller equilibrium points for each attribute, and parameter vectors reveal an estimate of the marginal willingness to pay for each particular attribute [2]. In particular, μ_N also represents the noise depreciation index (NDI), that reflects the willingness to pay for quiet (Eq. 49.2). More precisely, the NDI represents the average house value decrease caused by a 1 dB (dB) increase in airport noise exposure.

$$\mu_N = \frac{\partial \ln P}{\partial N} \tag{49.2}$$

More than 50 studies have focused on estimating NDI for many airports worldwide. Due to the large amount of aircraft noise studies, some scholars have collected NDI estimates in order to perform meta-analysis[1] of these estimates. Nelson (1980) [3] summarized 18 NDI estimates from 13 studies, and concluded that "the noise discount is commonly 0.5–0.6 %, although a higher value may occur in some high-income areas". Schipper et al. [4] and Nelson (2004) [5] also performed their own meta-analysis. Table 49.1 presents a summary of their findings.

These different NDI estimates indicate that housing prices do not react equally across countries. For example, Nelson [5] argue that Canadian airports impact more surrounding properties that in the United States. This variation can be due to different airport scales or different urban spatial structure. However, the use of different noise metrics or different estimation procedure also account for a considerable part of the variation in these NDI estimates.

The question whether NDI and wealth are positively correlated is still discussed in the literature. While Schipper et al. [4] constructed a "relative mean sample house price" variable and concluded that NDI estimates and wealth are positively correlated, Nelson [5] questioned the construction of the this variable since dividing the mean sample house price by the average per capita income in the entire urban area (instead of the mean income of the sample property owners) is obviously a misspecification. He carried his own meta-analysis and found that property values had no statistically significant impact on NDI estimates. This suggests that people of different wealth are willing to pay the same amount to avoid aircraft noise. Using

[1] A meta-analysis is a statistical analysis of research findings, which aims at comparing outcomes of studies that estimate a particular elasticity (in general). In our case, a meta-analysis is useful in understanding how "transferrable" these results are, and if these estimates are similar [6].

Table 49.1 Summary of NDI estimates meta-analysis

Author	Year	Number of estimates	Conclusion
Nelson	1980	U.S. (13)	NDI ≈ 0.5–0.6 %
		Canada (2)	(higher in high-income areas)
		U.K. (2)	
		Australia (1)	
Schipper et al.	1998	U.S. (21)	NDI = 0.9 % (non-linear specification)
		Canada (5)	NDI = 1.3 % (linear specification)
		U.K. (2)	
		Australia (2)	
Nelson	2004	U.S. (26)	NDI ≈ 0.5–0.6 % (U.S.)
		Canada (7)	NDI = 0.9 % (Canada)

the "PPP adjusted GDP per capita" as an indicator of a country's wealth, Wadud [6] performed a meta-regression and concluded that the NDI tends to be higher in developed countries. He predicted an estimated NDI of 0.23 % per dB in China.

There is only one study that does not use hedonic price method in the literature. By analyzing the results of contingent valuation surveys, Feitelson et al. [7] conducted a telephone survey in an geographic area near a major hub airport. They asked to home owners and renters about their willingness to pay (WTP) for a house in an area with no aircraft noise at all, and the same house with different levels of noise exposure. They concluded that the difference in valuation of these WTP are between 2.4 % and 4.1 % of house prices for home owners, and 0.9–1.5 % of rents for renters.

49.3 Data and Model

The study examines the housing market close to Beijing Capital International Airport, in Shunyi District. Located in the Northeast of the municipality of Beijing, it is considered as the inner suburb of Beijing. Second-hand housing transactions data from the Chinese "Woaiwojia" real estate agency were collected from several residential areas. We decide to consider only apartments that have been sold between June 2006 and January 2012 within a 5 km radius of Beijing Capital International Airport, since this area is particularly exposed to aircraft noise. The study area is represented in blue in Fig. 49.1.

Data on property transactions include the sale price, the transaction date, structural house characteristics (e.g. surface area, building age, apartment floor) and spatial characteristics (e.g. distance to the airport) for 130 transactions. Table 49.2 contains the summary statistics of the variables used in the study.

We use a standard hedonic price function with log-linear specification (see Eq. 49.1) to estimate the effect of airport noise on the willingness to pay for properties. We add year dummy variables to control for the general upward trend of the Chinese housing market, and consider the year 2006 as the baseline for the

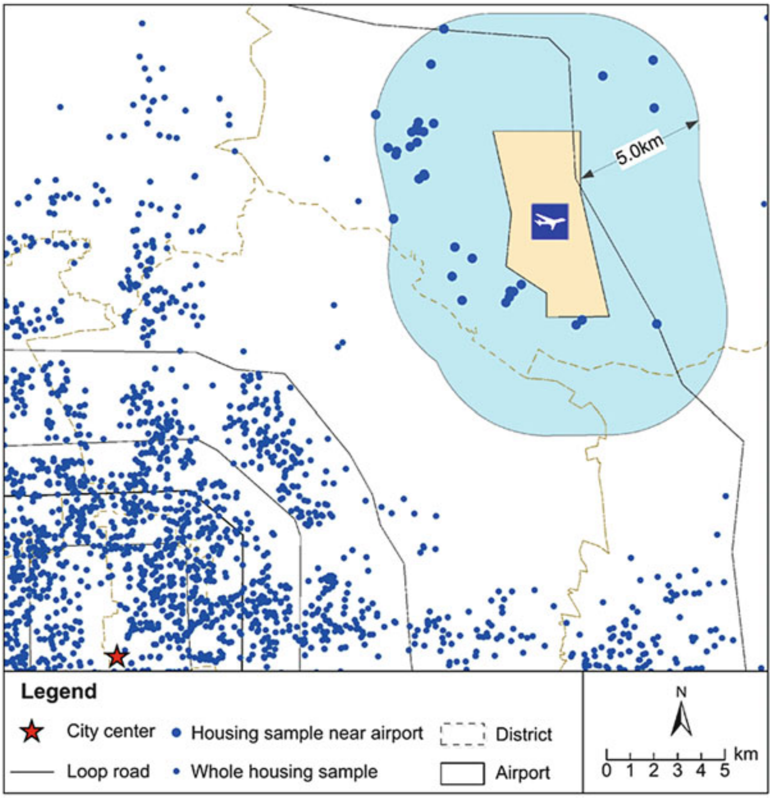

Fig. 49.1 Study area and distribution of sample properties

Table 49.2 Summary statistics

Variable	Description	Mean	Std. Dev.
Price	Transaction price (x 10,000 RMB)	123.98	97.9150
Area	Surface area (m^2)	94.795	65.1053
Floor	Apartment floor	4.8231	3.4382
n_ro	Number of rooms	2.2769	1.5800
n_ba	Number of bathrooms	1.1615	0.4278
n_li	Number of living rooms	1.2769	0.5430
Years	Building age (years)	7.9769	4.5808
Distance	Distance to the airport (km)	3.1829	0.7977

sample. Since we do not have any information about aircraft noise exposure in these residential areas, we examine the impact on property value of getting closer to the airport. Then, examining different noise contour lines (e.g. Pope [8]) enables us to estimate the increase in noise exposure when the distance decreases by 1 km. Noise contour lines are nearly ellipsoid-shaped lines with a major axis corresponding to the direction used by aircrafts for taking-off and landing, and a perpendicular minor axis. Getting closer to the airport by 1 km within the major axis direction generally lead to a noise exposure increased by 3–4 dB, while the same distance within the minor axis direction can increase noise exposure by 10–12 dB. In average, we suggest that a 1 km decrease in distance to the airport leads to an increase in noise exposure by approximately 7–8 dB.

49.4 Results

Regression results are presented in Table 49.3. Column (1) presents the regression results for the model that considers floor area as the only structural characteristic of properties. Column (2) estimates the model that includes all explanatory variables. We report t-statistics in parentheses under the coefficient estimates.

Results are quite consistent in both cases: the adjusted R^2 indicates that the explanatory variables account for 84 % of the variation in properties prices, that is rather satisfying given the small number of explanatory variables. All the signs of the regression coefficients are as expected. People are more likely to pay a higher sale price for a property with a higher surface area, the negative coefficient associated with the square of the floor area indicates that the relation between the percentage increase in property value and the surface area is not linear, but quadratic. In other words, property values increase more and more slowly as surface

Table 49.3 Regression results (^{a}, ^{b}, ^{c} = significant at 1 %, 5 %, 10 % level)

Variable	(1)	(2)
Distance	0.0840^{b}	0.0896^{b}
	(2.37)	(2.38)
Area	0.0126^{a}	0.0120^{a}
	(11.34)	(7.35)
Area^2	$-1.50^{c}10^{-5a}$	$-1.51^{c}10^{-5a}$
	(−5.70)	(−5.41)
Floor		−0.0020
		(−0.21)
n_ro		0.0402
		(1.05)
n_ba		0.0458
		(0.48)
n_li		−0.0683
		(−0.90)
Years	-0.0136^{b}	-0.0142^{b}
	(−2.24)	(−2.02)
Constant	2.6473^{a}	2.6068^{a}
	(12.65)	(10.67)
Fixed year effects	YES	YES
Observations	130	130
Adjusted R^2	0.84	0.84

area increases. The coefficient for the variable that indicates the apartment floor is not statistically significant. Within our sample, people are willing to pay the same amount to purchase an apartment at the first floor or at the tenth floor. People value more an apartment located in a building that has been constructed more recently.

Finally, we also perform a robustness test (not represented in the table) by replacing distance with its natural logarithm in the model. The coefficient associated to log(distance) is also positive and quite significant, suggesting that these results are relevant and reliable.

Distance to the airport and property price are positively correlated, that means that a property closer to the airport will sell at a lower price. In Column (1), the coefficient associated with distance shows that if the distance between a property and the airport decreases by 1 km, the value of this property *ceteris paribus* decreases by 8.4 %. When we add all structural characteristics as explanatory variables in Column (2), the property value decreases by 8.96 % for each kilometer. The two coefficients in both columns are similar, suggesting that the estimate is quite robust. Actually, without aircraft noise, airport is a positive amenity since an airport provides a high concentration of travel and employment opportunities. But in our regression results, the positive coefficient indicates that airport is a disamenity for residents who live close to it. This phenomenon is caused by noise pollution generated by aircraft and airport operations.

Based on the assumption that in average, a 1 km decrease in distance to the airport leads to an noise exposure increased by approximately 7–8 dB, this value leads to a NDI estimate ranging from a 1.05 % to 1.28 % decrease in property value per dB increase in noise exposure. This estimate of the NDI for Beijing Capital International Airport is consistent with other NDI studies, even if it seems on the high side compared to other international NDI studies. That may be explained by the fact that Beijing Capital International Airport has a particular status, as it is the world's second busiest airport in the world. It may explain why the NDI estimate is higher than expected. Table 49.4 presents the NDI estimates for the world's busiest airports, based on the summary of NDI estimates by Wadud [6].

It seems that NDI estimates for the busiest airports are generally above the average. It is easy to understand that a busier airport has to manage more passengers, so it has to be larger in order to contain all infrastructures and runways. This larger airport necessarily generates more noise pollution. This can explain why the NDI estimate for BCIA is so high, since most of airports studied in the literature are smaller airports.

In China, airports are particularly large. The busiest seven airports with an annual passenger capacity of over ten million (Beijing, Shanghai Pudong, Guangdong, Shanghai Hongqiao, Shenzhen, Chengdu and Kunming) – that account for only 5 % of all airports in China – represent 54.2 % of China's total airport volume. In order to manage the growth of the Chinese population, the government plans to build larger airports[2] instead of many small airports. This is consistent with the hypothesis that airport noise pollution is more important in Chinese cities.

[2] For example, Beijing plans to build its third airport in Daxing District, this airport is expected to overpass Atlanta Hartsfield-Jackson as the world's busiest airport.

Table 49.4 Summary of NDI estimates for the busiest airports

Rank (2011)	Airport	NDI estimate
1	Atlanta (Hartsfield-Jackson)	0.67 (1985)
		0.08 (2003)
		0.69 (2006)
2	Beijing Capital International Airport	1.05–1.28 (this study)
3	London (Heathrow)	0.71 (1970)
		0.62 (1975)
		1.51 (1996)
4	Chicago (O'Hare)	0.88 (2004)
5	Tokyo International Airport	No data
6	Los Angeles International Airport	1.80 (1971)
		1.26 (1994)

According the assumption that NDI and wealth are positively correlated, as China is still a developing country, the estimate of the NDI for BCIA should be lower than in the U.S. and in Canada. But the results of this study are not consistent with this assumption, suggesting that people of different wealth are willing to pay the same amount to avoid aircraft noise.

49.5 Conclusion

This paper analyzes the negative externality of Beijing Capital International Airport by examining the impact of aircraft noise on property values located close to the airport. According to the results of this study, aircraft noise severely impacts residential areas near BCIA. More precisely, if the distance between a property and the airport decreases by 1 km, the property value ceteris paribus decreases by 8.4–8.96 %. Then, we derive an approximate Noise Depreciation Index ranging from 1.05 % to 1.28 % per dB.

We should perform a survey of people living close to Beijing Capital International Airport in order to gather information related to perceived annoyance caused by aircraft noise. This would enable us to estimate more accurately the NDI, and then compare this standardized value to NDI estimates in other countries. In addition, we found no evidence that NDI tends to be lower in less developed countries. But China may be a particular case since Chinese airports are particularly large.

This study presents, however, some limitations. We have supposed that aircraft noise can account for all the negative effect of the distance to the airport on the variation in housing price, whereas it is obviously not the case. In addition, our dataset is relatively poor, and does not include enough variables. In the wake of the rapid development of geographical information systems (GIS), variables including proximities to transportation lines, retail outlets and green spaces could considerably improve the quality of data. Further research should focus on the actual influence of aircraft noise on the distance to the airport, as well as more consideration about other sources of noise pollution (e.g. highways and railways) that can also affect house prices.

At the end of the year will begin the construction of Beijing's second international airport in the South of the metropolitan area. It is expected to become the world's busiest airport. This huge construction project will require to relocate thousands of people, and may more will live close to this airport. Knowing the environmental value of aircraft noise pollution can enable the government to compensate people who will suffer from the construction of this project, in order to ensure the population's welfare and fairness.

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Chapter 50
Made to Order Real Estate Mode Based on Stackelberg Model and Cooperative Game Theory

Lianfu Jiang and Yang Zhang

Abstract As a represented of the made-to-order mode of commercial property by Wanda, it begins to spread rapidly throughout China, but there are some inherent problems in the process. This paper discusses the strategy about rent and rental area between retailers and property developers in order to maximize their profit, when retailers and property developers are respectively in non-cooperative game theory and cooperative game theory. Through longitudinal comparison of the model, to demonstrate the factors that influences the profits, through the mutual lateral comparison, to discuss the best strategy balance. This paper expects the cooperation between retailers and property developers can be more reasonable and rational, and the understanding of commercial property market development can be enriched and deepened.

Keywords Made-to-order • Commercial property • Stackelberg • Cooperative game theory • Retailer

50.1 Introduction

Commercial Property includes office buildings, industrial property, medical centers, hotels, malls, retail stores, shopping centers, multifamily housing buildings, warehouses, and garages. Therefore, the commercial property involves in the cooperation and the distribution of profits between retailers and property developers. The existing cooperation models between retailers and property developers include two patterns: leasing commercial real estate and buying lands. Retailers have to taking into account the long cycle of the return and the huge fixed costs on the investment of buying lands. As a result, most of them choose to lease commercial real estate.

In traditional leasing commercial property market, property developers and retailers are lack of cooperation, and each of them seeks the maximum profit

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_50,

independently. Property developers used to be the leadership position; they developed mature properties and trading area, and attracted retailers to join them by leasing. This mode that attracting investment after construction often caused property developers who grabbed city's top position, seized customer flow, but retailers lose bargaining power and had to withstand the high rental costs.

Another mode is the made-to-order pattern represented by Wanda. This concept is mainly in four aspects [1]: joint agreement, common participation, average rent, construction after attracting investment. Property developers and retailers make strategic alliance, and property developers involve in the previous work together with retailers to choose the site, reach the design scheme, and confirm the store layer, sales area. But the problem is when retailers seek higher profits, their target in the process will be contrary to property developers' overall planning. At the same time, due to the large sales area of the anchor retailers that offer economies of scale, the rent levels of anchor retailers are much lower than non-anchor retailers rent levels. But property developers have to rely on the anchor retailers' appeal to attract consumers. And therefore, the problem that the cost-benefit allocation between retailers and property developers in the process of cooperation is particularly important.

Benjamin et al. [2] find that as the retailer's sales area increase, the rent per unit may decrease. Although in many cases this view is reasonable, but not supported in other studies. Tay et al. [3] think the transaction costs and retail area are independent, economies of scale are more likely caused by the following reasons: each retailer occupies a larger retail unit, and the rents they need to negotiate are greatly reduced. Furthermore, as discussed above, the larger tenants have more bargaining capacity; enable them to reduce the extracted rents by the landlords. Associated with economies of scale, the greater the number of retail unit merged, the stronger bargaining capacity they have. Therefore, this study assumes that the area of shop is greater the lower the level of rent required to be paid.

This paper discusses the strategy about rent, rental area and between retailers and property developers in order to maximize their profit, when retailers and property developers are respectively in non-cooperative game theory and cooperative game theory.

50.2 Model Assumption

In made-to-order mode, because of the retailer's pre-intervention and cooperation with property developers, we can regard retailers as a leadership role, and retailers and real estate developers are of non-cooperative Stackelberg relationship. Assume that retailer's rent and income are meeting the following model:

50.2.1 Retailers' Attractive Model

Reilly portrayed business district known as Reilly's law of retail gravitation in 1929. Reilly believes that the trade area is more attractive to consumers in the surrounding area, and it is positive with the size of its sales area, but decreased with the distance from consumers to trade area. Hence, Reilly sum up the retailers' attractive model is that $A = \frac{\sqrt{S}}{D}$, A is the attractiveness of the retailers to consumers, S is the retailer's total sales area, D is the distance from customers to the store.

50.2.2 Retailers' Rent Model

John et al. [2] find that retailer' rent is divided into two parts, the fixed rent R and the excess rent R^*. Fixed rent is annual increase, and it remains unchanged within one year. The mode as follows:

$$\mathrm{L} = \sum_{t=1}^{n} \frac{\mathrm{R}(1 + \mathrm{ESCL})^t}{(1 + r)^t} + \sum_{t=1}^{n} \frac{\alpha \mathrm{D_t}(\mathrm{T} - \mathrm{T}^*)}{(1 + r)^t} \tag{50.1}$$

Where R is the base rent for the year the lease is initiated, $ESCL$ is the escalation percentage, r is the nominal interest rate, α is the overage clause percentage rent rate, T is the expected level of nominal sales in year t, T^* is the threshold level of sales above which the overage rent is payable, n is the lease term, and $\mathrm{D_t} = 1$ if $\mathrm{T} > \mathrm{T}^*$ and zero otherwise.

According to the above assumptions, we can get the retailer's income function as follows:

$$\Pi_\mathrm{R} = \frac{\sqrt{\mathrm{S}}}{\mathrm{D}} \times \mathrm{Q} \times \mathrm{P} \times (1 - \alpha) - \frac{\sqrt{\mathrm{S}}}{\mathrm{D}} \mathrm{Q} \times \mathrm{C_1} - \mathrm{S} \times \mathrm{R} \tag{50.2}$$

Where S is the sales area, D is the distance from customers to the store, P is the average sales, Q is the flow of people, C_1 is the average unit cost, α is the overage clause percentage rent rate, R is the base rent.

The property developer's income functions as follows:

$$\Pi_\mathrm{D} = \alpha \mathrm{PQ} \times \frac{\sqrt{\mathrm{S}}}{\mathrm{D}} - \mathrm{S} \times \mathrm{C_2} + \mathrm{S} \times \mathrm{R} \tag{50.3}$$

C_2 is the cost per square of the property developer.

50.3 The Analysis of Made-to-Order Mode

In the made-to-order mode, we assume the retailer and property developer are Stackelberg relation which retailer as a leader. As mentioned above, rent is equal to basic rent and excess rent. Retailer set the proportion of the excess rent to maximize its own profit. Property developer determine the lease area according to the retailer's decision-making, the retailer knows the reaction function of the property developer, and combines with its own income function to determine the best overage clause percentage rent rate.

50.3.1 Property developer's Optimal Strategy

As mentioned above, the property developer's incomes function as follows:

$$\Pi_D = \alpha PQ \times \frac{\sqrt{S}}{D} - S \times C_2 + S \times R \tag{50.4}$$

For property developer of the first derivative about area,

$$\frac{d\Pi_D}{dS} = \frac{\alpha PQ}{2d\sqrt{S}} - C_2 + R = 0 \tag{50.5}$$

Solving the problem, we have:

$$S = \frac{\alpha^2 P^2 Q^2}{4D^2 (C_2 - R)^2} \tag{50.6}$$

50.3.2 Retailer's Optimal Strategy

Retailer knows property developer divides S area as the sales area, and then retailer decides the excess proportion according to property developer's strategy.

Substituting *S* into (50.2), we get

$$\Pi_R = \frac{\alpha(1-\alpha)P^2Q^2}{2D^2(C_2 - R)} - \frac{\alpha PQ^2 C_1}{2D^2(C_2 - R)} - \frac{\alpha^2 P^2 Q^2 R}{4D^2 (C_2 - R)^2} \tag{50.7}$$

And then,

$$\frac{d\Pi_R}{d\alpha} = \frac{(1-2\alpha)P^2Q^2}{2D^2(C_2 - R)} - \frac{PQ^2 C_1}{2D^2(C_2 - R)} - \frac{2\alpha P^2 Q^2 R}{4D^2 (C_2 - R)^2} = 0 \tag{50.8}$$

Solving the problem, we have:

$$\alpha = \frac{(P - C_1)(C_2 - R)}{P(2C_2 - R)} \tag{50.9}$$

Then, we can get:

$$\Pi_R = \frac{(P - C_1)^2 Q^2}{4D^2(2C_2 - R)} \tag{50.10}$$

$$\Pi_D = \frac{(C_2 - R)(P - C_1)^2 Q^2}{4D^2(2C_2 - R)^2} \tag{50.11}$$

$$\Pi_R + \Pi_D = \frac{(3C_2 - 2R)(P - C_1)^2 Q^2}{4D^2(2C_2 - R)^2} \tag{50.12}$$

Analysis the expression of sales area S and rent sharing ratio α, we can get that in the non-cooperative game, the property developer's acceptable area is related to the rent sharing ratio, the higher the proportion of rent sharing ratio, the larger area that property developer is willing to sell. At the same time, when the rent increases, property developer's income will reduced within a certain range.

50.4 The Cooperative Game Between Retailer and Property Developer

50.4.1 The Whole System Optimal Decision

A cooperative game is a game where groups of players may enforce cooperative behavior; hence the game is a competition between coalitions of players, rather than between individual players. The difference between cooperative game and non-cooperative game is that the cooperative game is to maximize the collective profit as the goal; non-cooperative game is based on the objective to maximize individual profit. Hence, it may lead to the game equilibrium results changed. We regard retailer and property developer as one system to explore their overall profit. According to Π_R, Π_D come to the overall profit function of property developer and retailer as follows:

$$\Pi = \frac{\sqrt{S}}{D} QP - \frac{\sqrt{S}}{D} QC_1 - SC_2 \tag{50.13}$$

We can get that in the cooperative game, the base rent and rent sharing ratio do not affect the cooperation profit.

First derivative of π on S, we can get:

$$S = \frac{(P - C_1)^2 Q^2}{4D^2 {C_2}^2} \tag{50.14}$$

Substituting π, we can get:

$$\Pi = \frac{(\mathrm{P}-\mathrm{C}_1)^2\mathrm{Q}^2}{4\mathrm{C}_2\mathrm{D}^2} > \frac{(3\mathrm{C}_2-2\mathrm{R})(\mathrm{P}-\mathrm{C}_1)^2\mathrm{Q}^2}{4\mathrm{D}^2(2\mathrm{C}_2-\mathrm{R})^2} = \Pi_\mathrm{R} + \Pi_\mathrm{D} \tag{50.15}$$

50.4.2 Profit Sharing After Cooperation

As mentioned above, retailer and property developer's profit is increased after cooperation. According to the Nash equilibrium theory, the profit sharing model meets the following conditions:
Max

$$U = \left(\Pi_\mathrm{R}^* - \Pi_\mathrm{R}\right)\left(\Pi_\mathrm{D}^* - \Pi_\mathrm{D}\right)$$

s.t

$$\Pi_\mathrm{R}^* + \Pi_\mathrm{D}^* = \Pi \tag{50.16}$$

Solve it with Lagrange equation:
Max

$$\mathrm{L} = \left(\Pi_\mathrm{R}^* - \frac{(\mathrm{P}-\mathrm{C}_1)^2\mathrm{Q}^2}{4\mathrm{D}^2(2\mathrm{C}_2-\mathrm{R})}\right)\left(\Pi_\mathrm{D}^* - \frac{(\mathrm{C}_2-\mathrm{R})(\mathrm{P}-\mathrm{C}_1)^2\mathrm{Q}^2}{4\mathrm{D}^2(2\mathrm{C}_2-\mathrm{R})^2}\right) + \lambda\left(\Pi_\mathrm{R}^* + \Pi_\mathrm{D}^* - \frac{(\mathrm{P}-\mathrm{C}_1)^2\mathrm{Q}^2}{4\mathrm{C}_2\mathrm{D}^2}\right) \tag{50.17}$$

Then we have:

$$\Pi_\mathrm{R}^* = \frac{(\mathrm{P}-\mathrm{C}_1)^2\mathrm{Q}^2\left(5\mathrm{C}_2^2 + \mathrm{R}^2 - 4\mathrm{C}_2\mathrm{R}\right)}{8\mathrm{D}^2\mathrm{C}_2(2\mathrm{C}_2-\mathrm{R})^2} \tag{50.18}$$

$$\Pi_\mathrm{D}^* = \frac{(\mathrm{C}_2-\mathrm{R})(3\mathrm{C}_2-\mathrm{R})(\mathrm{P}-\mathrm{C}_1)^2\mathrm{Q}^2}{4\mathrm{D}^2\mathrm{C}_2(2\mathrm{C}_2-\mathrm{R})^2} \tag{50.19}$$

Through the cooperation and profit distribution, both of retailer and property developer's are increased, and the result is pareto optimality.

50.5 Summary

This paper studies the optimal decision problem of the made-to-order mode in the non-cooperative game between retailer and property developer. The made-to-order mode, while providing an alliance, makes property developer and retailer to compete for their own maximizing profit, but due to the presence of egoism,it is still to be a profit conflict in this alliance mode. Through cooperative game, retailers and property developers can achieve the coordination and harmonization of the profit distribution in the new environment and conditions, which is conducive to the sustainable economic development of our business.

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Chapter 51
Housing Policy Impact on Affordable Housing Production in Lagos Nigeria

Olatunji Olagunju, David Oloke, and Felix Hammond

Abstract It is a realistic expectation of the populace to demand adequate housing from the government as well as from the private sector. The government has realized that a combination of providers is the only way to meet the demand. In other more developed countries this combination of suppliers have struggled and housing policy and its delivery is constantly being reviewed. It is hoped that the recently revised national housing policy has considered the different implication and will endeavour to accommodate the variety of need.

The government in this new policy release has mustered various think tanks, and managed to proffer some solutions to the inept housing procurement.

Should we expect such high sustainable standards from a developing government trying to empower the people and gratify its population with basic amenities of shelter? The impact of construction is felt by all and Nigeria is a country with a huge housing shortfall, where everyone gets involved in self build.

This research aims to answer questions raised and analyze the challenges and opportunities facing the government in its policy implementation. It would aim to create a decision support toolkit that could assist the government.

Keywords Affordable housing • Building regulations • Government policy • Sustainability

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_51,

51.1 Introduction

This research is undergone to highlight the issues faced by the housing sector in the provision of affordable housing in Lagos state in a developing country like Nigeria. Nigeria is a country with a large population of over 155 million people (CIA Factbook 2011) spread across a diverse micro climate of equatorial in south, tropical in the center and arid in the north. It's presently the eightth largest country in the world, the most populous in Africa with a multicultural and varied group of people of more than 250 ethnic groups.

This paper would also explore circumstances in which housing policies are articulated and implemented in developing countries using Lagos state of Nigeria as a case study. In Nigeria we have only two dwelling units per thousand as opposed to 8–10 dwelling units per thousand as recommended by UN [1].

Housing Policy is concerned with the processes involved in state intervention in the housing market [2].

This paper will appraise impact of government policy in the provision of affordable housing units for a fast growing Lagos population. It is hoped this will identify some areas for change. Key questions arise such as: *With a population explosion and new policies can we equally provide affordable housing*? *Is it realistic to expect the same standards for affordable housing in Lagos in the south of Nigeria as you would in say Sokoto State in the North with less rural to urban migration and slum dwellings*?

The aim of the research would be to try to answer the above proposed questions including '*Is affordable housing in Lagos sustainable or is there a need in total shift from old policies and a price to pay*?'

In the pursuit of the aim of this research the study would seek to achieve the following objectives: (1)Conduct a literature review; (2)Collect data that are relevant to the research questions; (3)Analyze same and finally (4)develop a framework model or toolkit that can aid policy development and implementation of sustainable affordable housing in Lagos Nigeria.

51.2 Partnering and Profiting

The Lagos state government has over the years tried many forms of housing provision [3]. Its similar to what's been practiced in the UK of partnering with major house builders in a joint venture that would create a profit sharing structure. The contractor house builders are recruited as government cannot build this number of houses without external assistance. In the past they employed the labour directly themselves through the state ministry of works and housing. The huge overheads created by such a large workforce defeated the purpose going past a number of housing units desired to be built. There is however now a need to have an arrangement that would work for everyone involved. There could be lots of opportunities for investors if the right policies were in place. Examples can be given in the instance of the policy of backward integration which has allowed cement manufacturers to expand [4]. Its hoped that suppliers and manufacturers would benefit with the right policies. The need for policy consistency was crucial as a lack of it would drive away would be housing investors.

The federal housing authority is concerned at the plight of the low income earners and has begun to reserve 30 % of the housing units in each new sector of their development to that category of the population. This is under the 27 new partnership agreement signed by the federal housing authority last year [5].

51.3 Housing Issues and Affordability

The state government is at present struggling to pay the recently designated minimum monthly wage of 18,000.00 Naira. ($120.00) This is a similar scenario with the other states as the governors and commissioners in charge of the state purse have refused to accede to the federal government directive stating that their states cannot afford to pay all its salaried workers this minimum amount [6]. The low income of the average Nigerian makes home ownership challenging. A third of the nation in the lower income bracket can't get on the housing ladder. A fifth earns less than £30.00 per month [7] with Lagos being one of the worst in the country. Land prices are highest in Lagos and unaffordable to a good proportion. There are no jobs and the population is rising. Waiting lists are long for rental apartments, and landlords charge a premium with tenants paying almost half their salaries on rent [8].

Affordability is generally accepted as a household paying no more than 30 % income for their housing, and the populace are considered cost burdened otherwise, as difficulties can arise in paying for other things like food, clothing, transport and medical care [9].

The Minister of State Works and Housing and Urban Development in 2009, Mrs. Grace Ekpiwhere, was quoted as saying that Nigeria had an estimated 16 million housing shortfall. (This day, 2009) Also a claim that housing production would catch up by government and the private sector partnering to build at a rate of 400,000 new units per year seems untenable and unjustifiable. Building pace has been nowhere near that and present indications don't show any improvement on how the policy would bring that about. Acquiring mortgage debt is an insidious problem in Nigeria because of the imbalance of cost of building to an individuals earning power. Since the majority of the methods required in constructing a house are monopolised. As it were, these companies can fix the prices for the bricks, blocks and cement needed for construction [10].

Developing countries are, by definition known for their lack of economic resources, or the under utilisation thereof. Therefore most affordable housing schemes are located in areas of poor economic conditions which ultimately influence the housing policy (Mohlasedi and Nkado1997).

Housing has increasingly become a means to an end and rather than an end in itself. The end is personal fulfillment, concepts of lifestyle and identity are key [11].

51.4 Self Builders: The Majority

In Nigeria it's popular for the individual to want to build his own home. There is a feeling of pride and achievement that this gives him or her and a new status in their immediate family and society.

Almost every Nigerian has grown up surrounded by cement block manufacturers parading their products in their vicinity and understanding the concept of purchasing a plot of land. This land is usually bought at great cost especially in a state like Lagos where rural migration influx is high. The Land is left to wallow for a while until the individual is able to either clear and fence it or continue to commence construction works on it. The state government is keen for landowners to build in order to reduce the issue of already bought land being sold again to a third party illegally or encroachment occurring or increase in corrupt practices from government officials looking to harass house owners and builders [12].

It's not unusual for a construction project to commence and take up to 10 years to complete. It's usually as the self builder has funds that he progresses the works and building materials are often left idle on the site for months on end awaiting the next phase of development. Thirty to forty percent of the population lives in urban areas, with an average household of five persons. The occupancy ratios of houses in Nigeria is six persons for a room of 20 sq m. 60 % of Nigerians are without adequate shelter (under-housed and no housing). Residential home ownership is less than 25 % compared with 75 % internationally [13].

51.5 House Developers

In Nigeria house developers are a growing industry fed by services, society, safety and land security seekers. As issues surrounding landed property being sold to multiple buyers continue to be common in the high courts, it makes buyers wary of family land owners who purport to be the scion of the families and attempt to sell plots of to unknowing buyers keen to jump on the self build bandwagon.

House developers are trying to tap into this market of the populace suffering from a fear of falling into the hands of fraudsters. Also they are providing infrastructure which the government is meant to provide but are usually not able to. The provision of services infrastructure is a key requirement in any housing development as adequate roads, drainage network, water, electricity (if possible) and sanitation is key to creating a good sustainable development that would add value to the property. Majority of developments being provided by private developers tend to be overpriced and beyond the rich of the lower class who desperately need housing as they are the working class. Efforts by developers which are coming to fruition tend to be priced above the low cost housing levels. Even with the major shifts in policy and urban renewal scheme directed at reversing the distortions in the housing market we see slow progress.

51.6 Enabling Environment

The United Nations human settlement program published report confirmed that Africa is the fastest urbanizing continent in the world and that by 2030 Africa's collective population will be 50 % urban [14:1] growing report claims that The government's policies need to create an atmosphere that draws in external and internal investors, developers, self builders, material manufacturers/suppliers and all parties. Land use decree is been discussed over the years as a cog in the wheel of speedy, safe land acquisition. The deficiency of this part of the system is notorious. Also increasing cost of building materials with cement being the main culprit is another problem. The industry feels the government can and should ensure that the price of cement is lowered by allowing greater competition and also investing in research that would allow other materials to compete effectively on the same playing field. Government is also asset stripping and a good example is cement factories being sold off to private companies. The cost of cement is still not reducing rather a monopoly seems to be created.

51.7 Government Policy History

The Nigerian National Housing policy was formulated in 1991 with the aim of providing affordable housing to the populace and an example of government initiatives to improve the system. However the policies are not being properly implemented and where they are, they are not being well monitored.

This policy which was intended to be the solution to housing problems came in nine chapters. The most salient features of the new policy were. (1) Restructuring of the federal mortgage bank, to serve as an apex housing finance institution. (2) Mobilisation of savings through the establishment of the National Housing Fund NHF and ensuring continual flow of funds from various sources to the Apex institution for on lending to primary mortgage institutions for property development of which not less than 50 % shall be paid into the fund through the federal mortgage bank at an interest rate not exceeding 4 % (Madaki and Ogunrayewa 1999).

This policy was revised in 2004 to resolve problems in usage. A presidential technical committee on housing and urban development was set up by government to address these new housing reforms. It recommended the restructuring of the federal mortgage bank of Nigeria (FMBN) and the creation of real estate developers association of Nigeria (REDAN), and building materials producers association of Nigeria (BUMPAN). The new housing reforms created financial mechanisms and institutions that will make available to the private sector (developers) funds for the production of mass houses, and allow purchasers (mortgagors) to have easy access to borrowed money through the primary mortgage institutions [15].

Principal organizations on whose shoulders rest the mass housing delivery mechanism under the national housing fund (NHF) scheme include:

- The real estate developers association of Nigeria (REDAN) formed on 9th May, 2002.
- The federal mortgage bank of Nigeria (FMBN) – Act No 7 of 1977 and updated Act No 82 of 1993.
- The primary mortgage Institutions under the umbrella body of the mortgage banking association of Nigeria (MBAN).
- The building materials producers association of Nigeria (BUMPAN) formed on 4th March, 2004 [16].

51.8 Policy Implementation

One area to improve government policy would be in the building regulations or building code as it's referred to in Nigeria. It's aimed at curbing the anomalies such as the use of fake and untested building materials, lack of adequate building regulations. This would invariably arrest the incessant waves of building collapse [17]. There are still a number of cases of collapsed buildings and poorly built structures due to a poor implementation and monitoring. The building officers don't do their jobs adequately and there is corruption in the various sectors in charge of overseeing building works.

Policy makers do not start with a blank sheet and cannot easily reshape the housing stock in the short term. A fundamental constraint on policy and policy development is the legacy represented by the housing stock [18].

In order to strengthen political governance and build capacity to meet these commitments, the leader of the new partnership for Africa's development will undertake a process of targeted capacity building initiatives. These institutional reforms will focus on: Administrative and civil service, strengthening parliamentary oversight, promoting participatory decision making, adopting effective measures to combat corruption and embezzlement, undertaking judicial reforms [19].

51.9 Monitoring Sustainable Delivery

Globally building construction is responsible for the current atmospheric pollution and wastes generation. Globally, building construction is responsible for the current consumption of 25 % of wood and 40 % of aggregates, 16 % of water and 40 % of the energy annually spent [20] It is however observed also that the rising cost of building construction in Nigeria can be attributed to some other factors, which include high transportation cost, devaluation of national currency (Naira), uncontrollable prices of building materials and the over dependency on the importation of building materials [21] Starting with Lagos state in Nigeria the federal government have created a carbon awareness campaign, [22] however there is the need to take it to the next level by ensuring that the populace have a thorough understanding of what not doing things appropriately could involve and the dangers for the future generations. Sustainable delivery is defined also as cutting back now to ensure that the future would have enough. There needs to be a committee or appointments made by the president and his cabinet to give the public the understanding that this is being driven right from the leadership and authorities.

One accepted definition of sustainability is that proposed by the World commission on environment and development in their 1987 study commonly known as the [23]. Most advocates of sustainable development recognize that, for it to be realized, would require changes in human values, attitudes and behaviors. Raskin et al. [24] suggest that such critical value changes are needed to promote new quality of life, human solidarity and ecological sensibility to counter the present value system that places much emphasis on consumerism, individualism and the domination of nature [25].

51.10 Government Challenges

The government has major challenges as the millennium development goals set and accepted by the present government has highlighted some other key issues which are yet to be tackled by them. Millenium goal seven focuses on integrating the principles of sustainable development into country policies and programs; reverse loss of environmental resources. Nigeria has become increasingly urbanised in the past five decades. The proportion of the population living in urban areas rose from 15 % in 1950 to 23.4 % in 1975 and to 43.3 % in 2000 and projections indicated that more than 60 % will live in the urban area by 2025. A sizeable proportion is likely to live in slums if care is not taken [26]. The issue of primary education which if properly implemented would go a long way in helping to educate the masses about the dangers of indiscriminate energy consumption and the advantages of recycling. Although the economic situation has created a country of forced recyclers, there are still other issues of primary healthcare, gender equality, water, sanitation and Aids. The government can be made to realize that by creating a good housing infrastructure it would alleviate some of these issues especially water provision, sanitation and better healthcare. It would also reduce the transference of disease as less people crammed into a room or house and reduction in urban slums always minimizes transference of illnesses. In line with the MDG targets, financing focuses on developing city wide infrastructure and upgrading slums to improve living conditions and enhance economically productive activities [26].

Another challenge is that Africa has become increasingly uncompetitive, as a result of its weaknesses in governance and infrastructure, low capacity in science and technology and lack of innovation and diversification from primary products [27].

The federal government has very recently approved a new national housing policy for the country, to replace the 1991 housing policy noted above. It has promised to build one million housing units annually to meet the nation's housing deficit. Highlights of the new policy include the introduction of a mass housing policy, which would enable Nigerians, irrespective of their financial and social status to own a house of their own. (the nation 21/06/2012)

In developing countries where there is rapid urbanization, the problem of inadequate housing for the people, especially among the low income group, constitutes one of the major challenges to economic development and the welfare of citizens [28]. Given the challenges it goes without saying that there are significant measures that need to be put in place if the federal and state governments hope to provide appropriate and affordable shelter to Lagos urban poor and live up to their subscribed ideal of a city without slums [3].

51.11 Government Opportunities

Just as the country did and played catch up to the telecommunications age it's hoped that Lagos can play catch up to the housing delivery in a sustainable manner. Developed countries seem to be going back to basics in terms of using local materials and reducing drastically energy each house is consuming. The need to create warmth for example in a cold region demands a higher amount of energy. Hence it's hoped that Lagos state situated in the tropics which needs to cool its interiors mainly can design buildings and use materials that would be sympathetic to this area and climate.

If the rural areas utilized the local materials available to them and it was developed effectively by the NBRRI to a sufficient standard, it would be more attractive in terms of looks and cost for the local populace. The uptake would be massive and there would then be a fall in demand for cement like materials. These local materials like mud, clay and laterite would become growing industries for manufacturers and suppliers. This would create an income for this group and would encourage further research into uses and development of the material.

Government need to give incentives to the developers and self builders to use local materials as opposed to what they have been used to for years. Incentives would include, tax incentives, government subsidies on rates. As capital is highly mobile investors will favour the sectors/locations that provide the best risk/reward profile. Its hoped that Lagos state being a state highly sought after by foreign and local investors would attract groups of businesses and developers that would seek the medium to long term investment. Short term and overly complex public policies with limited effects on the profitability of investment projects are unlikely to attract private financial flows. On the other hand overly generous tax credits and regulatory incentives in the form of exceptions from environmental or labour laws could create economic distortions and harmful distribution effects [29].

Effective states – those that can promote and protect human rights and can deliver services to their people and a climate for entrepreneurship and growth – are the foundation of development. Without progress in governance, all other reforms will have limited impact. While there have been improvements in many African countries, weakness in governance and capacity is the central cause of Africa's difficult experience over the last decades. Improvements in governance, including democracy, are first and foremost the responsibility of African countries and people, and they take time and commitment [27].

51.12 Research Method

Research method will include having structured interviews with key government officials, developers and self builders. Also interviews with tenants looking to get on the housing ladder, questionnaire will be sent to all this groups, statistical surveys, case studies of housing estates built by developers etc. Also using the qualitative and quantitative methods and using SPSS packages.

The quantitative research approach offers results in precise measurements and tends to be good for confirmation and deduction. Determining the relationship between one and the other is usually achievable. It's found to be good for knowing how many or how much, as some data is in the form of numbers and statistics. Quantitative research is objective and seeks precise measurements and analysis of target concepts. It's been employed for the user's surveys and questionnaires as it's more efficient and able to test hypothesis.

Qualitative – As this is usually recommended during the earlier phases of the research project, [30] the design would emerge as the study unfolds. The data is in the form of words, pictures or objects. Qualitative research is subjective and individual's interpretation of events is important, e.g. uses participant observations and in depth interviews. This has commenced and is proceeding well. The qualitative method is also richer though time consuming, but less able to be generalized. The case study type of qualitative was also selected. Creswell [31] defines the case study as an exportation of a bounded system or a case (multiple cases) over time through detailed in depth data collection involving multiple sources of information rich in context. Some consider "the case" as an object of study [e.g. 32] while others consider it a methodology [e.g. 33]. According to Creswell, the bounded system is bounded by time and place and it is the case being studied.

51.13 Case Study

A case study housing development was used for the present research as it is ideal to meet research objectives. Three housing estates were identified namely:

1. Lagos State housing development in Ibeju, Lekki
2. Lagos State housing development in Igbogbo, Ikorodu
3. Amen Estates In Lekki

A case study is a type of field study defined as an empirical enquiry that investigates a contemporary phenomenon within its real life context [34] Case studies commonly see the researcher adopting several methods to collect data, including observations, interviews and documentary analysis [35]. Yin [34] described six sources of evidence that can be collected for case study research: documents, archival records, interviews, direct observation, participant observation and physical artefacts. Yin states that these are highly complementary and that a good case study will want to use as many as possible to enable triangulation of findings. The present research aims to use documents, interviews and participant observation.

51.14 Private Sector Initiatives

While decent housing is important to every individual, it must be re-emphasised that one of the continuing challenges posed by the unmitigated urbanization and influx of people into Lagos is the provision of adequate and affordable housing. Thus the urban nature of Lagos have not only resulted in the phenomenal rise in the population; number and size of settlements in the state, but had also manifested in acute shortage of adequate dwelling units, high rent rates and the emergence of slums.

Despite the many welfare programs competing for government resources and high cost of building materials which have made construction to become extremely capital intensive, the government says they are resolute about not only increasing the number of units built but also to create easy mortgage facilities for members of the public.

The government is determined to ensure that the housing sector becomes more vibrant but also realized that the housing situation in Lagos is too critical and capital intensive for government to address all alone. This has made the administration to redefine the role of government in the delivery process by enhancing the role of private sector players. They have therefore re-evaluated the operational environment with the aim of removing bottlenecks and strengthening private sector participation.

In addition to facilitating an enabling environment conducive for business to thrive, the government went further by making equity contributions in terms of providing land for genuine investors. The ministry has developed a template for appraising interested private developers as well as facilitating necessary sign-off from relevant ministries and government agencies on behalf of these developers.

51.15 Present Strategies for Encouraging Public Private Partnership (PPP) in Lagos State

To ensure an enabling environment and provide necessary support for Public Private Partnership (PPP) thereby making Housing Development attractive for the Private Sector, a template for Public Private Partnership was created.

- Government gives land as Equity
- Provides subsidy on Government Fees such as stamp duty and building plan approvals.
- Occasionally subsidizes cost of infrastructures. Provision of Infrastructures is thus treated as social responsibility of Government thereby allowing control over the prices fixed by Developers.

The administration has considered proposals from over 100 Developers out of which 26 proposals have been approved by the governor. The public – private – partnership initiated seems to be taking off as some of the partners have reached advanced stages of work [36].

51.16 Toolkit

A toolkit is being proposed and its likely to be developed in three parts namely (a) the principles will be highlighted, (b) the process will be shown and finally (c) case studies will be used to highlight the practical resource aspects. It's meant to help interpret the findings based on the information gathered using the 9 key areas of the sustainable code. This would be used as the key resource to draw conclusions on the way forward. It will serve to aid the users namely government planners and decision makers, house builders and home owners to make decisions. The toolkit can be defined as something focused around conscious, repeatable methods for gathering raw research from multiple sources in specific contexts and transforming it into real insight and information [37]. It's proposed that the toolkit will have a sustainability and affordability checklist as well as a menu of potential performance indicators.

This would be a systematic analysis of the prevailing surrounding situation to come to the most appropriate technological sustainable design policy for any proposed project. The toolkit as said will aim to look at the 9 key areas of the sustainable code focusing on design and technology of the materials as well as other factors surrounding creating affordable housing in a sustainable way. Energy & CO2 emissions is one of the bigger issues for sustainability and good designs can be created for the varied Nigerian climate by combining energy efficient construction with passive heating and cooling to achieve a sustainable society. Future buildings must be energy efficient, and energy conservation measures must be adopted in existing buildings.

The adaptation to natural surroundings and the people in the area is also significant to forming a seamless relationship with all parties involved in the development.

In the UK the code for sustainable homes and the ever tightening building regulations have had a big impact on house builders and ensured changed building practices. Likewise legislation needs to drive the move towards sustainability in the built environment in Nigeria.

The government needs to give incentives to consumers reducing their cost and to producers making it more viable to produce. As research meliorates the range of innovative materials and solutions for house builders to choose from also improves and helps to satisfy discerning consumers.

By 2020 45 % of global construction is projected will be in emerging markets like Nigeria. Over the next decade infrastructure construction is expected to grow by 128 % in emerging markets compared with 18 % projected growth in developed markets [38]. While 70 % of the global population will live in urban areas by 2050, [39] affordable housing is therefore a key issue to target to avoid urban slums.

51.17 Conclusion

Policy formulation must be centered on national interest. While designing policies that will promote investments and trade, indigenous businesses must not be exposed to harsh and unfair competition from better advantaged foreign peers. Thus policies must be designed that will give indigenous entrepreneurs a fair chance to build capacity and expertise. A strong illustration of this is the petroleum sector local content policy and this could be replicated across selected sectors where there is high job creation potential and Nigeria has a strong competitive advantage [40]. The house building industry definitely falls into this category and would benefit tremendously especially in the construction of affordable housing which requires various levels of skill sets.

A frame work toolkit will be created to assist the government and the officials assess the benefits and performance indicators for the policies to enable a proper delivery of a plan of action in line with the nation's sustainability agenda. This study aims to inform the development of housing policy and practice by identifying the key challenges likely to face inhabitants of Lagos state.

Emphasis is being given to providing nationwide infrastructure and basic services in poor communities across Nigeria under the community based urban development program. This is in addition to the implementation of a national urban renewal and slum upgrading programme [26].

With the country in a new dispensation with the just concluded national and local elections, it's hoped that the policies that are in place and new ones to be passed will be geared towards the national interest and effective speedy delivery of much needed services and infrastructure to the populace.

Its hoped as this research progresses for structured interviews, questionnaires to be sent out and further information gathered and analyzed to assist in coming to some reasonable outcomes that would be useful in creating policies of national interest, that would ensure that the financial, social, environmental and knowledge transfer requirements are met. There needs to be cooperation across the board amongst the building professionals and the policy makers allowing a proper synergy of both parties to work for the common good.

Housing policy formulation and implementation in the country must take cognizance of the socio economic circumstances and conditions of the people and reflect it in the policy. The present move or tendency on relying wholly on market forces of demand and supply and leaving housing to private initiatives will not solve the problem of housing shortages and quality in the country [41 pg.132].

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Chapter 52
Policy Responses to Improve the Quality of Housing for the Urban Poor: Case Study Delhi, India

Alpana Sivam

Abstract Urbanisation is a major global trend, with over half of the world's population living in urban areas. Nearly 70 % of the world's poor live in Asia. About 250 million do not have access to clear drinking water and sanitation, and another 250 million live in slums [1]. Urban poverty, associated with unemployment and the lack of access to adequate housing and services, is an increasing social problem in many Asian cities. The rapid growth rate of population in many major Asian cities exerts considerable pressure on these cities' governments to provide housing, infrastructure and services for a growing population. This presents a major challenge for urban planners and city managers to formulate policies and planning strategies to manage this development in a sustainable manner. This situation raises questions regarding how cities will be able to provide housing for the urban poor. Currently, housing for these communities in the majority of cities in developing countries, is provided by the informal sector, mostly in the form of slums and squatters. The aim of this paper is to identify policy responses to improve the provision of quality housing for the urban poor in Delhi, India.

Keywords Housing policy • Housing for urban poor • Housing quality

52.1 Introduction

In the coming decades, rapid urbanisation will be one of the major challenges in ensuring human welfare and a viable global environment [2]. It is estimated that a further 500 million people will be living in urbanised areas in the next 5 years; and by 2030, about 60 % of the world's population will reside in urban settlements.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_52,

Worldwide, urbanisation is a major challenge for urban stakeholders and city managers in providing sustainable housing for all, especially for urban poor.

According to recently released census figures, the population of India in 2010 was approximately 1.21 billion, which is almost equal to the combined populations of the United States of America, Indonesia, Brazil, Pakistan, Bangladesh and Japan [3]. The population of India increased by approximately 182 million from 2001 to 2011.

In some cities, an overwhelming number of people live in slums and informal forms of shelter on land owned by the state or public agencies. The percentage of informal housing in large cities of Asian countries varies from 20 % in Jakarta, to 92 % in Addis Ababa [4]. This housing is generally built illegally, or at least, built without legal tenure of the land which the housing occupies [5, 6].

The aim of this paper is to identify policy responses to improve the provision of quality housing for the urban poor in Delhi, India.

The Delhi, capital of India is used as a case study for this paper. This selection appeared viable as Delhi is one of the most urbanised cities in India, as well as considered one of the top ten urbanised cities in the world. A desktop analysis is used to address the aim of this research. Desktop analysis is essentially the utilisation of secondary resources, and is recognised as an efficient method for research [7]. It has the ability to be used prior to conducting extensive research to identify relevant key issues, informing the researcher with a overview regarding concerning issues which are to be potentially further investigated.

The first part of this paper briefly presents an overview on Delhi's current housing policies and housing system for its' urban poor and its constraints. Second part of the paper presents possible alternatives to informal (self-help) housing. Finally, this paper will conclude with an investigation into how and whether high density and careful design development, like Singapore and Hong Kong, is transferable to the Delhi context.

52.2 Housing Policy and Housing System in Delhi

First part of this section briefly gives overview on current housing policies of Government of India to house urban poor and second part presents the present housing system and its constraints.

52.2.1 Current Housing Policies

The government of India has embarked on a more ambitious plan with substantial financial outlays through the National Five Year Plans towards slum free cities. Since 2005, the government has initiated a series of centrally sponsored interrelated programs under the umbrella of Jawaharlal Nehru National Urban Renewal Mission

(JNNURM), towards housing economically weaker sections (EWS), as well as slum redevelopment, in over 63 cities and towns [8]. Provision of affordable housing for all and a better livelihood, shelter and basic services for all slum dwellers and the urban poor is the main objective of the plan. This project includes:

1. Basic Services to the Urban Poor,
2. Integrated Housing and Slum Development Programme,
3. Swarna Jayanti Shahari Rojgar Yojana,
4. Rajiv Awas Yojana.

The President of India, Pratibha Patil, announced 'Rajiv Awas Yojana – Vision of Slum-free India' on 4 June 2009 [9]. The same slogan was used by Singapore government in the 1960s and today, this country claims to be free of slums within their cities. One of the policies of the government of India is to house the urban poor in high density apartment developments (see [10]). This example demonstrates how this government is searching for various alternatives in replacing informal housing through legal housing.

52.2.2 The Present Housing System

Housing policies and programs in Delhi have changed frequently. Although the government has embarked on a variety of innovative housing programs, especially for the lower segment of the population, the coverage of these programs and schemes is marginal when compared to the overall requirements of the capital city.

The present formal system has failed to provide housing for everyone in Delhi. The most visible manifestations of the failure of city authorities are the numerous unauthorised housing settlements scattered around the city. The phenomenal growth and development of these informal settlements is a testament to the drive and initiative of the poor, and their ability to forge affordable housing solutions. Forty-seven percent of the population lives in the informal housing sector [11].

Delhi has three types of housing development, formal, informal and organic. These are similar to those in other developing countries [4, 5, 12–14]. Formal developments are those that have the legal sanction of the planning agency prior to the development; have been developed within the framework of government rules, regulations and controls; and have a minimum required standard of environmental quality and infrastructure.

Informal developments are illegal and de-facto, comprising unauthorised colonies and squatter settlements. These sectors have mostly emerged because of non-availability of unaffordability of housing in the legal housing market. The common characteristics of the informal sector are insecurity of tenure and low standard of infrastructure and facilities.

Organic developments are old and rural settlements (known as 'urban villages' in Delhi), that have evolved over a period of time without any conscious measures taken for their growth, have now been included in the urban development.

52.2.3 Constraints of Present System

Housing is a problem in Delhi for various reasons. The policy of large-scale acquisition, development and disposal of land forms the basis for urban and housing development. Development of land by private developers has been frozen, and the government has a near monopoly in the formal land and housing market. This policy has directly and indirectly contributed to increasing the housing shortage. Some of the housing legislation enforced in Delhi adversely affects the production of housing. For bank and financiers, although the housing finance system in India has improved, the aforementioned risks and constraints still prevail [15, 16]. It has been realised that governance failure is one of the major problems to provide housing for poor. Launching the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) on 3 December 2005, Prime Minister Manmohan Singh stated: 'A major failure of city governance has been our inability to address the needs of the poor.... Cities need people to provide services and our people need a decent place to live'.

In many developing countries, housing is still seen as social obligation rather than as part of normal economic activity [4]. There is the policy dilemma of whether to treat housing as a social good, or as a sector of the economy, as like other sectors of production and consumption. There may be also consequences, related to if the housing sector is treated as neither, as it is currently. Although housing is regarded as one of the basic needs in political rhetoric in India, it has generally been given a very low priority in public policy and investment.

Another constraint may relate to the frequent changes of government in India. Policies adopted by previous governments are often not implemented by its' successor, whereas in conditions of stability, reform is more achieved easily. Singapore, however, is a good example of where reform in housing has taken place in a climate of political stability [4]. Recent changes in government policy including: means to involve private developers, an increase in density, initiatives for developers to construct housing for the urban poor and the relaxation of planning laws and regulations demonstrates how the government is increasingly inclined to consider change in housing provision policy.

It is important to look for an alternative for informal housing in Delhi, to improve the quality of life of the urban poor. This is because health transitions are characterised by socio-economic variation and by the environmental qualities of living areas [17]. De Sousa [18] argues that there is a high correlation between socio-economic variables on the one hand, and the spatial distribution of mortality on the other. Squatter settlements presented the higher risks of mortality, especially among children. The improvement of squatter areas can reduce these risks and improve the urban health transitions among the poor and will improve the quality of life [12].

The following section will investigate alternative housing policy scenarios in other cities, in regards to the replacement of informal housing.

52.3 Possible Alternatives to Informal (Self-Help) Housing

Countries experiencing informal settlement growth are facing many problems associated with urban poverty, higher unemployment levels, social hardships and conflicts. Housing is a fundamental need in any society. Good housing improves the productivity of its' residents and thereby, contributes to their well-being and improves broader economic and social development within a society [19]

Over the years, various international organisations, national and local authorities have attempted to implement various policies and programmes aimed at housing the urban poor in Delhi. Many of these initiatives have proven ineffective [4, 12, 19]. Even so, this city will continue to expand because of rapid urbanisation. In Delhi, informal sector occupants occupy very small areas, because of the high value and scarcity of land. This pattern often results in highly dense, and overcrowded, developments. It is predicted that the urban poor in search of housing, will no longer be able to find public vacant land on which to squatter. This may exclude the neediest individuals from the informal housing market and will force them to become street dwellers.

This issue will need to be addressed in the near future through government intervention, as an increase in squatter densities is expected. Ultimately, this will lead to unhealthier living conditions for occupants, impacting upon both the health and social fabric of these communities.

In very general terms, it is possible to discern three methods for developing the low-income sections of the housing system. One method is aimed at combining finance, land, and resourcing policies to tilt the housing sector towards low-income affordability. This has been the approach adopted in Chile [20] and Singapore [21]. The second method is to provide ad-hoc elements which can increase housing supplies and qualities among low-income groups. Strategies, for example, can include mass small loan programmes; various types of subsidies; and the creation of a social housing sector. The final method involves the regularisation of tenure and in-situ improvement of squatter settlements. However, this method is often not very valuable in the long term, because of increased population pressures in these areas.

As mentioned previously, various programs and policies implemented by authorities in Delhi for the urban poor are generally unsuccessful. Therefore, it appears unlikely that self help housing, in form of informal housing, is the solution to house these communities. With the percentage of land availability expected to decline because of rapid urbanisation in the city, the Delhi government will need to consider other alternatives in combating the urban poor housing dilemma.

Singapore and Hong Kong are two very good examples of how state intervention has replaced an urban area's informal housing sector, through the provision of prototype design, high-rise and high-density apartments. For example, stakeholders in Delhi should aim to develop a housing delivery system for poor similar to Singaporean housing policy, by conceiving and operating this policy, and other social policies, as integral components of development. Singapore, along with Norway, are two of the only countries globally to implement this practice [12]. This method is unconventional, albeit effective, with a high level of supply and investment in housing resulting in wider savings in the overall economy.

The Delhi government must ensure that there is a constant supply of both resources and financing for housing, through savings accumulated through the wider community. If necessary, the government should enact statutory requirements, or taxing, to ensure mandatory compliance. There is also a need by government bodies to provide planning provisions and tax subsidies as incentive for developers to construct low income housing, as well as means for the inclusion of a certain percentage of low income housing in any new developments.

Housing developments need to integrate with current urban development so the land for urban poor housing could be strategically allocated. A holistic approach need to consider for housing development rather than in part for urban poor housing. This means that housing developments should be inclusive of all income groups.

Land is a fixed commodity and therefore, there are not many alternatives for housing. In rapidly urbanising cities, such as Delhi, high-rise and high-density housing is a practical option. This form of development may aid in improving the quality of life for individuals. For example, high rise and high density development could provide better access and quality of public realm, public open space and public facilities, resulting in a better quality of life. As land cost is approximately 50 % of the total cost of a dwelling unit in many residential developments [22], high density development certainly appears to ensure more affordable housing for the urban poor. Theoretically, high-density development appears to be one of the better alternatives for improving the living conditions and poverty level within Delhi. However, to discover the optimum level of density within this city, a detailed study between design density and cost will need to be undertaken, with specific consideration of the Delhi context. Without this detailed study and varying stakeholders' opinions, it is difficult to safely assume that high-rise and high-density development, like in Singapore and Hong Kong, is one of the best alternatives in ensuring Delhi is a slum free city in the future.

52.4 Conclusions

Rapid urbanisation is unavoidable in cities of developing countries. This process will ultimately lead to greater demand for housing for the urban poor. The provision of housing, in the future, will become increasingly difficult, especially as land is a fixed commodity, and land cost alone accounts for almost 50 % of the dwelling unit cost. These factors will place increasing pressure on the provision of informal housing. Ultimately, the nature of informal housing; including very high density levels, a lack in physical infrastructure and in social amenities; impacts upon its' occupants, resulting in unhealthy living conditions and posing a challenge for urban governance.

As land and finance is a critical factor of any development, it might be advisable to learn a lesson from the Singapore housing model, and replace the informal housing sector with high-rise and high-density public housing for the urban poor. Singapore has demonstrated that they have provided housing for everyone by replacing this informal housing. However, it will be difficult to transfer the Singaporean model to Delhi because of the contextual differences between the two cities. Singapore is a rich small country city, without rural hinterland. Therefore, a detailed study will be required in order to ensure the high-density housing model from Singapore will adequately represent the needs of stakeholders in Delhi, as well as being suitably adapted for the Delhi context.

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Chapter 53
The Real Estate Investment Strategy on the Case of SUNING Appliance Group

Mingxuan Yu and Zilong Wang

Abstract In China, it is widely recognized that real estate investment can provide long-term profit from which three generations of the family may obtain a benefit. Since the ancient times, the real estate investment has been one of the most popular ways of personal investment. Present research on real estate investment in our country is restricted to insurance companies. A large number of the top 500 enterprises invest in real estate distinctively. Why are so many companies zealous in the investment? How real estate investments benefit companies? This paper is expected to provide solutions through the case study of SUNING Group Co., Ltd.

Keyword Business real estate investment strategy choice

53.1 Introduction

The market structure would hardly like to be reformed after a period of rapid growth. How to break through the situation, carries on the strategic layout, and grasp the investment direction are the issues that every mature enterprise will think about. With the "reform and open" policy, the economy of China developed steadily. The entrepreneurs have built their wisdom based on the experience, in which the most important is alternative strategy and investment decisions. For relatively mature enterprise, stable cash flow and low margin profit of the traditional business pulled them to find other investment channels. With the specific trait real estate investment draws most CEOs' attention.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_53, © Springer-Verlag Berlin Heidelberg 2014

53.2 Research Methods

This research takes the advantages of varies methods including case analysis, expert communicate and financial analysis. The methods aid logical orderliness to this article. The purpose of the article is to conclude suggestions for enterprises faced with industry bottleneck (See Charts 1 and 2).

53.3 The Distinctions of Real Estate Investment

Commonly there are two ways to invest in Real Estate, house purchasing investment which is to purchase the already-built real estate and development investment which is to exploit the new-built real estate independently.

No matter whether enterprises would hold the property for the rental return or transfer to other investors for short-term profit, real estate investment is an efficient

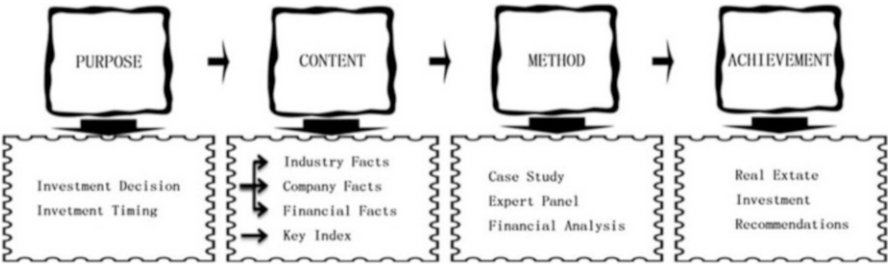


Chart 1 Article structure

Chart 2 Technology roadmap

Table 53.1 The distinctions of real estate investment

Distinctions	Purposes	Mechanism
Maintenance and appreciation of values	To reduce the risk and obtain the value increment	Real estate properties are durable and there is a mature transaction market
Superior Profitability	To obtain long-term booming income	Sell or lease to the end users
Tax saving	To evade tax	Through depreciation expense and financial leverage
Quality guarantee	To liquidize the remnant assets	There has an active demand and widely endorsement

approach. So the real estate investors usually have four aspects of needs of consumption and profiting, maintaining and increasing the value of their property. Real estate property main have shops, office buildings, residential, warehouse and other forms. The enterprises or individuals may throw good money into real estate industry according to their own requirements (See Table 53.1).

53.3.1 Real Estate Investment Possesses the Advantages of Maintenance and Appreciation of Value

Along with the advancement of urbanization in China, the price of commodity house is in general trend of rising, which is also an international experience. The inherent advantage of maintenance and appreciation of value has dramatically reduced the investment risks. And the good cognitive basis as well as the mature trade market has made real estate investment to be an excellent income channels. With good management and reasonable layout enterprises can successfully make the property ascendant.

53.3.2 Real Estate Investment Can Get Relatively High Stable Income

Real estate investment is often thought to have higher revenue. According to relevant research shows that the real estate investment return usually achieve 20 % or more, some individual project can reach even as high as 50 % . Holding real estate property can also bring out in stable earnings, which help enterprises smooth accounting profit with rational financial planning. At the same time, the rental income has a certain growth, for enterprise to bring the long-term stable income.

53.3.3 Real Estate Investment Has Special Tax Savings Function

The real estate industry is capital-intensive industry. By transforming to a large precipitation assets it would produce large amount of depreciation expenses, which can offset the net profit. In addition, the real estate investors commonly make use of high financial leverage. This process would relatively ease the enterprise financial pressure and take full advantage of financial leverage tax shields.

53.3.4 Real Estate Is the Quality Collateral for Enterprises

Enterprises have a lot of capital performing as fixed assets, in that way capital did not been full used, which is a great waste. As a major investing way for individuals and enterprises real estate investment have relatively good liquidity, and therefore to a bank, and other financial institutions is the greatest guarantee. Relative to the large-scale equipment, intangible assets real estate has its unique advantage.

53.4 Case Analysis

The subject of this article is SUNING Appliance Group-the parent company of SUNING Appliance Co., LTD, which is a Shenzhen listing. The SUNING Domestic Appliance Group holds a 13.47 % of SUNING Domestic Appliance Co., LTD. Another major shareholder is Jindong Zhang who possesses a proportion of 27.9 %. SUNING developed from a home appliance store to a respected household appliance chain retail enterprise in two decades. Along with the expansion of SUNING's retail chain real estate investment flickering. Why would SUNING invest in real estate? Is that a correct decision?

53.4.1 Case Background

SUNING Domestic Appliance Co., LTD (SZSE 002024) a subsidiary company of SUNING Domestic Appliance Group was founded in 1990, in Nanjing, Jiangsu, China. As a leading household appliance chain retailer SUNING Appliance (SZSE 002024) listed in Shenzhen, becoming the first domestic IPO of the appliances chain enterprise, ranking the front row in the industry by market value in July, 2004. By the end of 2011, SUNING opened nearly 1,700 stores in more than 300 cities in mainland China and had more than 170,000 employees. On the list of China Top 500 Private Enterprise published at 8thNovember, 2011, SUNING Appliance Co., LTD. ranked in third place. The development of SUNING can be divided into four stages (See Tables 53.2 and 53.3).

Table 53.2 Development history

1990–1992	Tiny feat	In December, 1990 Jindong Zhang started his business in air-condition selling with his brother. The sales scale dramatically reached to 107 million
1993–1999	Savage growth	In 1993 SUNING won a victory in the commercial war against local mall tycoons. At the end of the year sale scale achieved to 302 million, almost triple to that of 1990. Then SUNING began to expand its distribution channel during the next few years. At the year of 1999 SUNING achieved sale budget which is as large as 3 billion
2000–2008	Braving waves	In the new century SUNING gradually turned into a managed modern enterprise and took steps to chain management strategy. In the year of 2003 SUNING introduced 3C business pattern and gradually constructed its core competitiveness. "SUNING" became a famous brand which customers regard as a representative of quality and reputation
Since 2009	Setting sail	In the year of 2009, 117 billion sales ensure SUNING exceeding GOME to be the flagship of the industry. At the same year SUNING became the first majority shareholder of Shimizu Corporation, and purchased Hong Kong CRM Co. SUNING was eager for international competition

Table 53.3 Product Structure

Category	Income(in thousand)	Proportion
T.V., Stereo, DVD Player	23,696,928	25.63 %
IT Products	17,148,892	18.55 %
Refrigerator, Washer	15,687,100	16.97 %
Telecom Products	12,373,602	13.38 %
Air -condition	11,272,584	12.19 %
Small Appliance	11,066,883	11.97 %
Service Business	909,611	0.98 %
Others	309,777	0.34 %
Total	92,465,377	100 %

AS the parent company SUNING Appliance Group strive for broader scope of business along with the nationwide expansion of the retail business. Since 2002 SUNING has set foot in real estate investment. SUNING revolved hotel, shopping mall, residence around exploitation of real estate, and fostered a series of affiliated real estate brand including "SUNING Galaxy Plaza" and "SUNING Appliance Plaza".

53.4.2 Business Condition Analysis

By 2000, the whole sale of the industry turned to be RMB 296.9 billion, and exceeded 700 billion in 2006, 800 billion in 2007. Then the growth rate dropped significantly, although the "4 Trillion Stimulating Plan" and the policy of "Home

Chart 3 Sales scale

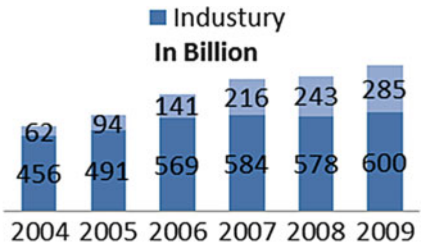
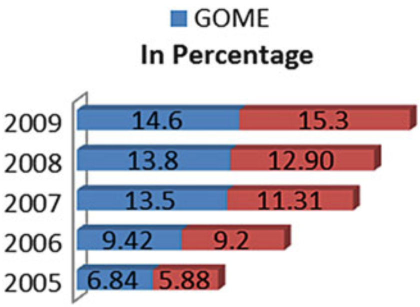


Chart 4 Compare of SUNING and GOME



Appliance to the country" temporarily spurred the selling of household appliance. On the whole, home appliance industry would never experience the upsurge appeared in the first decade of twentieth century. At the same time, the industry concentration greatly ascend, the occupation ratio of the top three home appliance retailers has risen from 5 % in 2000 to 32 % in 2009 (See Chart 3).

In this phase, conventional stores like grand bazaar and emporium got away from the city center. Chain store gradually became the mainstay of appliance retail selling. But on the other hand the rapid increasing of the number of retail stores aggravate the competitiveness of the industry, the site selecting for outspread shop has becoming increasingly difficult. Retailers are forced to set up none profit and smaller spot in small cities and even rural countries to occupy the market. Although the domestic appliance industry still have a potential increase for annual 8 %, SUNING could not anchor its hope on retailing aiming in greater gains (See Chart 3).

After a decade of rapid development competition in household appliance industry was exacerbated, and the whole trade growth started to slow. After a series of mergers and acquisitions, industry concentration greatly improved (See Chart 4). Home appliance retail enterprise was hard to get excess profit through the expansion of scale.

The monetary capital was merely 66 million in 2002, but increasingly boomed to 10.57 billion in 2008, which means that company have large number of idle money not to make full use of (See Chart 5).

Chart 5 Monetary capital

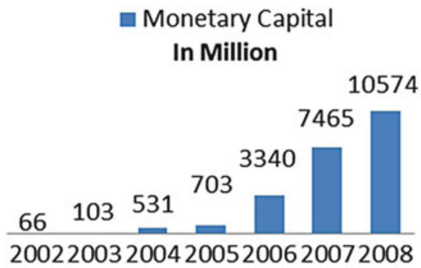


Table 53.4 Sales growth and occupancy and net profit of SUNING

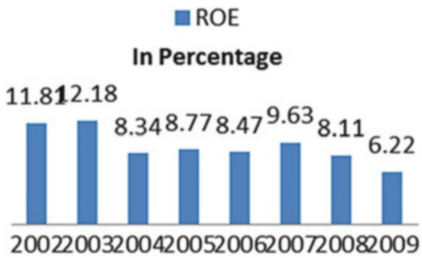
Year	Sales growth	Store quantity	Occupancy	Net profit (in million)	Net profit growth
2002	111.89 %	–	–	58.56	131.91 %
2003	71.14 %	–	–	98.9	68.88 %
2004	50.94 %	84	–	181.2	83.22 %
2005	74.99 %	224	5.88 %	305.63	93.5 %
2006	64.16 %	351	9.20 %	720.3	105.43 %
2007	53.48 %	632	11.31 %	1523.17	111.46 %
2008	24.27 %	802	12.90 %	2259.93	48.37 %
2009	16.84 %	942	15.30 %	2988.5	32.24 %

The formation the large scale of idle capital mainly result from the applying of the business model called Generalized Financial plus Unrelated Business Income pattern. The Generalized Financial pattern is initiated to delay the payment for suppliers so the retailers could make benefit through the suppliers' money. The leading retailers such as SUNING and GOME would postpone 3–6 months in paying suppliers. The Supplier NBRE Ratio of SUNING had increased from 55.22 % to the peak of 73.49 % in 2007 and fell back to 63.5 % in 2008. It is such an unreasonable convention for manufactures that triggered lots of rebellion and believed will no longer sustain in the future. And the so called Unrelated Business Income pattern represents the abuse charges paid by suppliers in the name of approach fee, shelving fee, management fee and advertising. These earnings ensure retailers' ability to provide cheaper goods which could in turn enhance their bargaining power. The net profit of SUNING increased from 58.56 million to approximately 3 billion in 2009. But the flourishing went along with crisis. The net profit growth dramatically decreased 131.91 % in 2002–32.24 % in 2009, which means the profit margin dropt severely (See Table 53.4).

ROE, which measures the return for shareholders, steadily reduced in low speed from 11.81 % in 2002 to 6.22 % in 2009 (See Chart 6).

According to the annual report of SUNING Appliance CO. LTD, SUNING has to pay a large amount of money for the leases. In 2006 the rents need to be paid was 950million, and that number increased to 1.56 billion in 2007 and 1.85 billion in 2008. It should be blamed that the immigration to metropolitan intensified the construction between supplies and demands of land and space.

Chart 6 The ROE tendency



53.5 The Decision Making of Real Estate Investment

The growth of the home appliance retail business is slowing down and future expansion space is very limited. It is hardly to increase the sale by the means of building new store. Meanwhile, because of the limited market, new stores would impact the original profit. SUNING can establish its business in third, fourth cities which imply fewer margin and higher risk. No one would like to undertake that kind of risk without advisable compensation, hence to seek new business, is the inevitable decision for SUNING. Except for real estate industry none could meet its demands (See Table 53.5).

As the process of urbanization of China is still far from finished, according to the relevant research, there still has a 15 years increase for real estate industry to develop. Although the process of urbanization will slow down in the future, but the vast population amounts of China provide the expansion space for real estate industry. In the case of YOUNGOR, the revenue get from real estate investment became an important component of its whole revenue since then. The proportion of real estate business increased from 17.5 % to 50.05 % in 2010 which occupied the half of the amount.

In general, the require of a large amount of capital is considered to be one of the weaknesses of the real estate investment, but to some extent none of other industry can absorb such a large amount of money as same as the real estate industry, such as Beijing market, the average price of housing have been over 20 thousand RMB per square meters, commercial property is much more expensive. The value stability of real estate investment has become the natural protection of SUNING'S amount of cash book value.

Real estate is considered as an industry which can provide excessive margin. The average annual return of real estate industry ranges from 20 % to 30 %, some project even higher. Take VANKE – a real estate enterprise for example, since 2003–2007, the average profit ratio of main business is over 20 %, although impacted by the global financial crisis in 2008 the profit ratio of main business is only 15.53 % this year, the profit ratio rebound quickly after 2008 (See Chart 7). Real estate developers will generally use commercial real estate loans as a lever to improve the rate of return.

Whether real estate development investment or property investment, holding property can alleviate the operating pressure for SUNING bring by rising rents. Previously, SUNING will pay amount of money to the landlords for expensive rent,

Table 53.5 Business condition analysis

Dilemma faced by SUNING	Characteristics
Slowing MOIG forced SUNING to find new growth point.	It is mainstay industry that faced with strong demand
Large idle capital need to be fully used	It consumes large amount of capital and has long investment cycle but has the trait of maintenance.
Reducing ROE inspired SUNING to invest in high profit project	It always brings high profits and has the trait of appreciation of value
Increasing rent encouraged SUNING to hold its own real estate property	It can provide stable rental return
Without much permanent assets, SUNING faced with the difficulty in getting a loan	It is high quality collateral

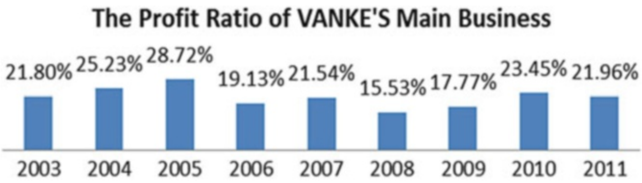


Chart 7 Profit ratio of VANKE

Table 53.6 Depreciation of SUNING and WANKE

	SUNING		WANKE	
Year	Sales	Depreciation	Sales	Depreciation
2003	6,033,716,430	20,172,089	6,380,060,435	138,517,446
2004	9,107,246,657	35,580,810	7,667,226,237	151,157,487
2005	15,936,391,188	62,656,373	10,558,851,684	171,742,908
2006	26,161,252,000	114,742,003	17,918,331,518	245,054,758

and most of the rental contract is short-term contract. The rent will rise along with the economic boom, which will restrict the space of profit. If SUNING can hold its own real estate property, not only the company could receive an additional rental income, but also be able to control the rental expense.

Real estate investments will form lots of assets precipitation, these huge fixed assets produced depreciation each year, and effectively reduced the actual amount of the tangible income. For example, from the sheet below it can be seen that in the sales part, these two companies are running neck and neck, but in the depreciation part, WANKE is much more than SUNING (See Table 53.6). If SUNING invest in real estate industry, it can reduce its amount of tax to be paid by the large amount of depreciation. In addition, the real estate developer will often use the financial leverage, which can play the role as tax shield.

Real estate is recognized by most investors as high-quality collateral, whether to Banks, as representative of the financial institutions, or other creditors. It is mainly

Table 53.7 The main projects

Category	Project	Acreage	Space
Commercial property	Galaxy International Plaza	10,000	110,000
	Plot NO.163 of Nanjing Road, Shanghai	13,700	100,000
	Plot of Renmin Road,Wuxi	23,100	250,000
	SUNING Appliance Plaza	–	100,000
	Project of ACFIC, Beijing	17,700	170,000
	Project of PengCheng Square, XuZhou	–	37
Residential property	ZhongShan International Golf Project	2,449,000	–
	TianQi Garden Community	31,400	80,000
Logistics property	Logistics base	–	–

because the following features of real estate: location rigidity, which means that the property is hard to transfer; durability, which extends expires of benefit; Maintenance and appreciation of values, which can used as hedge against inflation risk; relative normative trading market, which imply a simplified value assessment.

Real estate investment has some other potential benefits, such as could raise enterprise's prestige and promote enterprise image. The tall buildings and large mansions would be regarded as the strength of enterprise. In addition, real estate development is the represent of the social responsibilities by satisfying the demands of residents.

53.5.1 The Context of Real Estate Investment of SUNING

In 2002, SUNING fist set foot in the real estate industry, and from 2007 to 2009, which is the operating conditions transition period of SUNING's retail business, real estate investment of SUNING start into the fast lane. SUNING Real Estate Co., Ltd, a subsidiary of SUNING, formed its business territory consist of 3 business section, that is the commercial, residential, and logistics industrial real estate. One of the most representative commercial real estate projects is SUNING Appliance Plaza and SUNING Plaza.

Real estate development closely combined with retail business: the commercial brand attracts customers, reduce the difficulty of attracting merchants; holding the property reduces the rent pressure, upgrade the overall competitiveness of SUNING.

Logistics industrial real estate investment and the original business also bring out the best in each other: retail business increase logistics property requirements and promote the fast ripe of industrial real estate project; industrial estate constructs the SUNING logistics network and bring benefit into e-commerce market.

By the year of 2011, the strategy territory that consists with home appliance retail and real estate investment has been formed basically (Table 53.7, Chart 8).

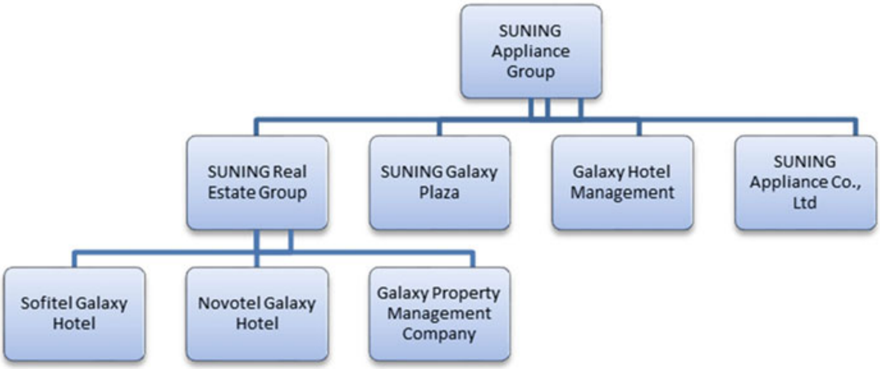


Chart 8 Company organization

53.6 Summary and Recommendation

After SUNING laid the status in retailing industry, the development room became limited, the growth in sales is slowing, rent pressure is rising and the problems of unused capital appear. By the means of real estate investment, SUNING built the business kingdom which is vigorous and competitive.

The case research implies that real estate investment is able to improve the competitiveness of the enterprises and support the development of business when the enterprise developed to a certain degree. The general features in this stage perform like: the sales growth continuously reduced; Original industry was significantly concentrated; profit ratio could hardly be increased through the extension of traditional business; the return on equity ratio is small and the sales margin is very low.

The trend of sales growth rate and profit growth rate are the effective indexes for estimating the future development space of enterprise. It is a warning signal that the sales growth rate or profit growth rate continues to deteriorate, shows the development of the original industry of the enterprise in slowing. The real estate investment opportunity emerges when the absolute cash terms reach the high stop relative to the other companies in the industry. The real estate is a capital intensive industry, that trait determines real estate industry to be a suitable business for the enterprises step into the crossroad.

Investment opportunity always appears together with risk. Enterprises have to thoroughly analysis the matches between new project and former business according to its own characteristics.

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Part IV
Project Management and Facility Management

Chapter 54
Investigating the Underlining Factors of Critical Project Success Criteria for Public Housing Delivery in Ghana

E. Adinyira, E. Botchway, and T.E. Kwofie

Abstract Public housing supply remains one of the least given attention in Ghana over the past three decades. Successive Public Housing Building Projects (PHBPs) attempts have been unsuccessful due to a number of reasons. Among these is the lack of clearly defined success criteria which guides and measures PHBP success. The adoption and application of critical success criteria (CSC) is to deliver project successfully, attain enhanced output, develop framework to help track key project results and to enable the appropriate allocation of resources. This research seeks to establish what constitute critical success criteria for PHBPs in Ghana and investigate and reveal the unique underlining factors among them through a questionnaire survey. Factor analysis was conducted on the responses on 13-identified criteria to reveal and discuss their underlining characteristics. The result revealed four components in order of significance as '*Time, Cost and Quality Management*',' *Satisfaction, Health and Environmental Safety*', '*User Affordability and Design Consideration*' *and 'Cost of Individual Units and Technology*'. This outcome will enable Project Managers (PM) and stakeholders involved in PHBPs to channel appropriate efforts and behaviours towards ensuring the attainment of success and also help in formulating policies and developing frameworks towards successful PHBPs delivery.

Keywords Public housing • Critical success criteria • Factor analysis • Project success • Ghana

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_54,

54.1 Introduction

'Project success criteria' is seen as a result area which organisations must focus on in order to manage projects successfully [1]. Traditionally, project success has been seen by the PMI's iron triangle of cost, time and conformance to requirement (quality). In recent time, research has proved that this is not a satisfactory success criteria and more is required beyond this. The reality is that the notion of success is a much more complex issue and often an illusory construct [1].

The purpose of modern project management is to conduct successful projects. The identification of appropriate critical project success criteria for PHBPs in Ghana is however important for enabling the appropriate allocation of resources and also help develop framework to help track key project results [2], [3]. This is because if the meaning of success was generally agreed and determined before the start of the project, it could be related to a satisfactory project typology and this relationship would significantly help those responsible for formulating the project and management to ensure success [4]. This paper seeks to identify the critical success criteria (CSC) for Public Housing delivery in Ghana as well as reveal their inherent characteristics through factor analysis.

54.2 Nature and Characteristics of Public Housing

Public housing refers to a form of housing tenure in which the property is fully owned by a government authority, which may be central or local [5]. The underlining factor is that its provision is not for profit and aims at providing affordable housing units for the medium and low income bracket of the population. The main receptacle of public housing is to provide affordable housing targeted at the working class, low income bracket and the poor. Its consideration, details, rentals, requirements and other criteria differ from continent to continent, region to region and country to country [6, 7].

54.3 Methodology

Both primary and secondary data collection methods were employed. Extensive literature review, structured interviews and discussions with key stakeholders such as project managers, project participants and policy formulators on the subject was done and the result used in a pilot surveys to establish the thirteen (13) critical success criteria for PHBPs in Ghana carried in Table 54.1. The identified thirteen (13) critical success criteria were used in a questionnaire survey to elicit the respondents perceived level of importance of each variable on a 4-point Likert

Table 54.1 Definition of potential cuccess criteria

Variable	Name of variable	Definition
[a]CSC 1	Overall project cost	Final out-turn cost for overall project and infrastructure such as road networks, street lighting and social facilities.
[a]CSC 2	Cost of individual house-units	Final out-turn cost for individual house-units.
[a]CSC 3	Overall project duration	Time taken to complete entire project including provision of infrastructure such as road works and street lighting
[a]CSC 4	Rate of delivery of individual house-units	Time taken to deliver individual house-units
[a]CSC 5	Overall project and individual house quality	Quality of entire project including associated infrastructure as seen by client and the road works and street lighting
[a]CSC 6	Overall client satisfaction	Satisfaction of Client with overall project Outcomes/individual house unit including infrastructure Provision
[a]CSC 7	Extensive admission of natural ventilation/lighting on individual house-units	Extent to which natural ventilation and lighting are incorporated into the design
[a]CSC 8	Overall risk containment	The extent to which all kinds of risk can be contained or minimized managed on the project
[a]CSC 9	Overall /individual house unit environmental impact	Impact of construction waste, environmental degradation and pollution and waste from individual house unit (rubbish, sewage, drainage) on the general public
[a]CSC 10	Health safety measures with individual house-units	Health and safety in terms of health hazard posed by the living environment, poor materials construction practices.
[a]CSC 11	Technology transfer/innovation	The extent to which new technology significantly improves the design and construction of a living space by decreasing installed cost, increasing installed performance and improving the construction process is applied and easy integration of local artisans
[b]CSC 12	Extensive use of local materials	the extent to which there is greater usage of local materials as against imported ones to reduce cost/ make it affordable
[b]CSC 13	Easy and cheaper to maintain	easy and cheaper to carry out maintenance over time

[a]Criteria from literature source: Ahadzie et al. [26]
[b]Criteria from field data

scale. Factor analysis was used to reduce the variables into an easily understandable cluster. The respondents were drawn from industry through the ‘snow-ball’ sampling approach of people with extensive and considerable experience on public housing in Ghana. Out of the 107 respondents reached, 73 valid responses were received, constituting 68.2 % response rate.

Table 54.2 Reliability factor and KMO and Bartlett's test

KMO and Bartlett's Test			Reliability statistics		
Kaiser-Meyer-Olkin measure of sampling adequacy.		0.752	Cronbach's Alpha	Cronbach's Alpha based on standardized items	N of items
Bartlett's test of sphericity	Approx. chi-square	302.213	0.782	0.762	13
	Df	78			
	Sig.	0.000			

The data analysis carried out comprised factor analysis of the dependent variables to reveal the underlining characteristics and also to reduce them into a more easily understandable cluster [27].

54.4 Results

This section presents the results of the analysis carried out on the data collected during the main questionnaire survey. One pertinent issue regarding factor analysis is the appropriate sample size for undertaking the test and in establishing the reliability factor, the Cronbach's reliability test is the most often used [8]. Table 54.2 present the results of this test as well as that for the Kaiser-Meyer-Olkin measure of sampling adequacy.

The Cronbach's reliability test conducted as seen in Table 54.2 above gave a test result of 0.782 (Cronbach's alpha). The Cronbach's alpha of 0.782 (0.8 approx.) suggests that the overall research instrument reliability (internal consistency) was acceptable for factor analysis. Also the Kaiser-Meyer-Okin (KMO) measure of sampling adequacy and the Bartlett's test were conducted. From Table 54.2 above a KMO of 0.75 and the Bartlett's Test of Sphericity shows a substantial value and thus confirm a sampling adequacy for the use of factor analysis. This showed that there is significant relationship between the variables and that the population was not an identity matrix. Normally the KMO statistic varies from 0 to 1.0. With a score of 0 meaning that the sum of partial correlation is large relative to the sum of correlations. This also indicates that there is diffusion in the pattern of the correlation and hence factor analysis is inappropriate [8, 9]. Also a value close to 1.0 indicates that the patterns of correlation are relatively compact and that factor analysis will yield distinct and reliable results or factors [8]. It is generally recommended that the KMO value should be greater than 0.5 if the sample size is adequate [10].

As recounted above and having satisfied the tests for the reliability of the survey instrument, sample size adequacy and the population matrix, the data was condensed through the factor analysis using the principal component analysis (PCA) with varimax rotation. Also the commonalities involved were extracted preceding the PCA. The summary of the commonalities are found in Table 54.3 below.

Table 54.3 Test of commonalities

Communalities	Initial	Extraction
Overall project cost must be on budget/cheaper	1.000	0.531
Cost of individual house-unit must be affordable	1.000	0.811
Overall project duration should be on time	1.000	0.811
Rate of delivery of individual units	1.000	0.741
Overall project and individual unit quality	1.000	0.707
Client/user satisfaction	1.000	0.641
Extensive admission of natural ventilation and lighting	1.000	0.663
Overall risk containment	1.000	0.634
Overall and individual unit impact on environment	1.000	0.628
Health and safety of individual units	1.000	0.469
Technology transfer and innovation	1.000	0.541
Extensive use of local materials	1.000	0.609
Easy and cheaper to carry out maintenance	1.000	0.632

Extraction method: principal component analysis

The commonalities help explain the total amount an original variable shares with other variables included in the analysis and this is essential in deciding which variables are to be extracted finally. From Table 54.3 above, the average commonality of the variables after the extraction was 0.65. As indicated in Field [8] the conventional rule on commonalities is that; extractions values of more than 0.5 at the initial iteration indicates that the variable is significant and should be included in the data for further analysis and test or otherwise be removed. The eigenvalue and factor loading were set at conventional high values of 1.00 and 0.50 respectively [8, 11]. Also applying the latent root of criterion on the number of principal components to be extracted suggest that four (4) component should be extracted as their respective eigenvalues are greater than 1.00 as shown in Table 54.4.

From Table 54.4, four main components were extracted with eigenvalues greater than 1.0 using a factor loading of 0.5 as the cut-off point. The first principal component (component1) accounted for 30.31 % of the total variance whilst the second principal component (component 2) accounted for 15.74 % of the total variance. The third principal component (component 3) and the fourth component (component 4) accounted for 10.47 % and 8.23 % of the total variance respectively. From Table 54.4, the final statistics of the principal components analysis and the components extracted accounted for approximately 64.75 % of the total cumulative variance. The cumulative proportion of the variance criterion says that the extracted components together should explain at least 50 % of the variation. The 64.75 % gained is indeed greater than the assumed minimum of 50 % of the cumulative section.

As noted by Norusis [12], the interpretation of results of Principal Component Analysis (PCA) can be improved through rotation, thus the rotated component matrix was selected and is displayed in Table 54.5. The rotation suggested the behaviour of the variables under extreme conditions and maximizes the loading of each variable on one of the extracted factors whilst minimizing the loading on all other factors and it is

Table 54.4 Component transformation matrix

	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
Component	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	3.940	30.308	30.308	3.940	30.308	30.308	3.250	25.001	25.001
2	2.046	15.738	46.046	2.046	15.738	46.046	1.999	15.375	40.376
3	1.361	10.469	56.515	1.361	10.469	56.515	1.940	14.923	55.300
4	1.070	8.234	64.749	1.070	8.234	64.749	1.228	9.449	64.749
5	0.832	6.397	71.145						
6	0.766	5.895	77.040						
7	0.687	5.288	82.329						
8	0.581	4.466	86.794						
9	0.455	3.500	90.294						
10	0.408	3.142	93.436						
11	0.383	2.945	96.381						
12	0.300	2.308	98.689						
13	0.170	1.311	100.000						

Extraction method: principal component analysis

Table 54.5 Rotated component matrix

Variables	Component 1	2	3	4
Overall project duration should be on time	0.891			
Rate of delivery of individual units	0.827			
Overall project and individual unit quality	0.752			
Overall risk containment	0.689			
Overall project cost must be on budget/cheaper	0.563			
Client/user satisfaction		0.769		
Overall and individual unit impact on environment		0.736		
Health and safety of individual units		0.593		
Easy and cheaper to carry out maintenance			0.767	
Extensive use of local materials			0.721	
Extensive admission of natural ventilation and lighting			0.532	
Cost of individual house-unit must be affordable				0.864
Technology transfer and innovation				0.525

Extraction method: principal component analysis
Rotation method: varimax with Kaiser normalization
[a]Rotation converged in seven iterations

the best factor output solution for interpreting factor analysis [12]. A thorough assessment was undertaken to critically examine the presence of any complex structure and also components that had only one (1) variable loading on them.

54.5 Discussion of Results

From Table 54.5 above, the entire four components had more than one variable loading on them. From the critical examination of the inherent relationships among the variables in each component, the following interpretations were deduced for each component. Component 1 was labelled as: Time, Cost and Quality Management, Component 2 as: Satisfaction, Health and Environmental Safety, Component 3 as: User Affordability and Design Consideration and Component 4 as: Cost of Individual Units and Technology.

54.5.1 Component 1: Time, Cost and Quality Management

From Table 54.5, the first principal component contained five (5) variables. These variables and their factor loadings (in brackets) were 'Overall Project Duration (89.1 %), Rate of Delivery of Individual Unit (82.7 %), Overall Project and Individual Unit Quality (75.2 %), Overall Risk Containment (68.9 %) and Overall Project Cost (56.3 %). This component accounted for 30.31 % of the total variance. A critical examination of this component confirm the traditional iron triangle of success criteria [13] and this suggests that though several arguments and researches have been done to identify other measures of success criteria such as satisfaction, health and safety, it is still very much relevant to count project success on PHBPs in terms of on budget (cost), on time and conformance to standards and quality [14]. As noted in many researches on project management in general, the issue of delivering project on time, reducing cost, delivering on highest standards and mitigating the effects of any incidental risks that are likely to throw the projects out of control has engaged the attention of many project management practitioners and researchers in general [15].

Given the huge housing deficit, and successive governments resolve to provide housing through PHBPs affordable schemes which some still remain incomplete and on the drawing boards, several innovations and applications that are geared towards increased efficiency and reduction in time and cost, improved quality and reduce effects of incidental risks are of great necessity. Again cost and time planning, risk management and conformance to quality issues in PHBP schemes still remains very crucial and should be taken very serious if any success is to be attained.

54.5.2 Component 2: Satisfaction, Health and Environmental Safety

Again from Table 54.5, the second principal component contained three (3) variables. These variables and their factor loadings (in brackets) were 'Client/User Satisfaction (76.9 %), 'Overall and Individual Unit impact on Environment (73.6 %) and 'Health and Safety of Individual Units' (59.3 %). This component accounted for 15.748 % of the total variance. This component was labelled satisfaction, health and environmental safety. Following the arguments over the need to view project success beyond the 'iron triangle' of Cost, Time and Quality, User/Client satisfaction, Health and environmental safety has been argued through several literature as an essential criteria to the expansion of attaining project success [13].

Satisfaction as a process of evaluation between what was received and what was expected is the most widely adopted description of customer or user satisfaction in current literature. Customer/user satisfaction in the property industry offers several benefits. Kamara and Anumba [16] define customer satisfaction as "the extent to which a product's perceived performance matches a buyer's expectations." If the product performance falls short of expectations the buyer is dissatisfied. Based on the Square root model of project success criteria and measurement, environmental health and safety emerged as critical criteria which are of prime concern at both the pre and post delivery stage [13]. Many adverse health conditions are linked to inadequate housing. Furthermore, there is a strong relationship between housing quality and perceived health: the better the dwelling, the better the health status. This is because a dwelling will house three or four generations and people spend a large part of their lives at home, health considerations rightfully belong at the core of all housing policies (EU, 2010).

The ever increasing demand for houses and coupled with the acute shortage and increasing household size have led to compromise on a lot of health and safety standards. As noted by Morel et al., [17], as the demand for housing continues to increase coupled with several interventions to meet demands, the design schemes and widespread increase in the use of high energy materials such as aluminium, concrete, steel, cement and finishes must comply with regulations and standards aimed at protecting the environment and improving the health and safety levels at homes. Given the above, all stakeholders, project managers, building professionals and agencies involved in PHBPs in Ghana must exert enough effort aimed at ensuring practices that enhance and protect the environment and also improve health and safety in homes in any housing scheme.

54.5.3 Component 3: User Affordability and Design Consideration

Drawing from Table 54.5, the third principal component contained three (3) variables. These variables and their factor loadings (in brackets) were 'Easy and cheaper to carry out Maintenance' (76.9 %), 'Extensive Use of Local Materials' (72.1 %) and 'Extensive Admission of Natural Ventilation and Lighting (53.2 %). This component accounted for 10.469 % of the total variance. This component was called User affordability and Design consideration. The component agrees with many arguments and decisions reached as a means of ensuring that housing developments in Ghana becomes affordable for the populace. High cost of building material coupled with the over dependence on imported materials constrain several efforts aimed at providing affordable housing in Ghana [18]. According to Amoa-Mensah, [19], Ghana's housing industry has been saddled with high important content in conventional designs, foreign materials and specifications coupled with the general non-use of proven local alternative. Cost of construction has been set above many people's budget due to the over dependence on foreign materials which the depreciating Ghanaian cedis has always made it very expensive. Also Osei-Tutu and Adjei-Kumi [20], accounted that the cost of cement which is a major material in the housing building industry, increased from GH¢1.4 to GH¢2 (about US$ 2.8 to US$ 4) from August to December, 1999. Again the absence of a well developed local construction material industry [19] makes this criterion though good but a daunting task. This is because the cost of building materials constitutes about 65–70 % of the overall total cost (Osei-Tutu and Adjei-Kumi, [20]) and a deliberate policy and actions to reduce and control this places PHBPs on a right footing to attaining affordability.

According to Ahadzie [21], home owners rate adequate day lighting and ventilation in homes as the first and major critical criteria than any other factor. In the current wake of energy crisis and coupled with annual increases in the electricity tariffs especially in developing economies, a conscious attempt in developing energy sensitive PHBP schemes that are commensurate with the income levels of it users will be a laudable achievement. In view of this, all efforts and policy framework on Public Housing delivery must aim at optimising the use of the natural elements of lighting and ventilation so as to ensure low or minimal operation cost in its lifespan.

54.5.4 Component 4: Cost of Individual Units and Technology

Lastly, drawing from Table 54.5, the fourth and final principal component contained two (2) variables. These variables and their factor loadings (in brackets) were ‘Cost of Individual Units must be affordable’ (86.4 %), and ‘Technology Transfer and Innovation’ (52.5 %). This component accounted for 10.70 % of the total variance. The component was termed Cost of Individual Units and Technology. The significance attached to the cost of the unit can be seen from its high score registered (86.4 %). The cost of housing unit either for outright purchase or rental purposes is very critical in measuring the affordability index of PHBPs.

Currently rental charges range from $40 to $200 for one through to three bedroom apartment. Monthly salary levels of public sector workers range from $70 to $3,000 (CAGSS, 2011) for ordinary labourers through to top senior managers. Cost of houses for purchase range from $15,330 to $86,000 (SHC, 2011), for one bedroom to four bedroom apartments. Making public housing affordable especially to the marginal and average bracket of the population of any economy remains the highest ranked objective. Given the repetitive nature of housing schemes compared to one-off construction projects is the essential benefit or advantage of reaping cost effectiveness from repetitive construction methods. Technology emerging together with cost of individual units suggests that the full benefit of technology and innovation can enhance the attainment of affordable individual units. Introducing more efficient and effective means to housing production has the potential of addressing some of the most critical affordable housing shortages [22].

Against this background, it is essential that policy framework and interventions in public housing delivery schemes must aim at ensuring the adoption and application of technology that is cost efficient and harness the benefits of repetitive construction as well as being able to be learnt easily by local artisans, enhance delivery and making life better for the society and the country at large.

54.6 Summary

It is critical for project stakeholders to understand what they consider as a successful project and the set criteria used to measure them. In order to avoid any surprises at the end of the project, there is an urgent need to identify the different perspectives of what success means before the project goes live. It is also vital to remember that success criteria are the standards by which a project will be judged. Success criteria have changed considerably through time and moved from the classic iron triangle's view of time, cost and quality to a broader framework which includes benefits for the organization and user satisfaction.

54.7 Conclusion and Recommendations

The subject of project success criteria and its determination has had considerable and extensive discussion and research in project management practice. In so much as widely asserted that success criteria is unique and cannot be generalized for all projects due to the nature and variability of all projects, the questionnaire survey revealed thirteen (13) success criteria. Respondents with high level experience and exposure gave their level of importance in their response. Also the thirteen (13) critical success criteria identified can be summarized into four main cluster components as itemized in Tables 54.4 and 54.5. That is for effective implementation of policy and framework for attaining success on PHBPs in Ghana, the main areas to thoroughly consider are 'Component 1: Time, Cost and Quality Management', 'Component 2: Satisfaction, Health and Environmental Safety', 'Component 3: User Affordability and Design Consideration' and 'Component 4: Cost of Individual Units and Technology'. These accounted for 64.74 % of the total variance.

According to (Shenhar et al., [23]) project success and criteria is seen as a strategic management concept where project efforts must be aligned with strategic long term goals and criteria. The identification of an appropriate 'Success Criteria' is thus of interest to project based organisation so that they can have an ongoing framework to help track the key project results [2]; [24]. Again, knowledge of the key critical success criteria is very much important for enabling the appropriate allocation and concentration of resources [25]. Against this background, the finding of this research is essential for industry, stakeholders, PHBP participant and housing and project management researchers to adopt and develop public housing models and housing policies that could be monitored, evaluated and tracked for the attainment of success so as to improve delivery.

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Chapter 55
Research on Life Circle Environmental and Social Costs of Construction Projects Based on Emergy Analysis: An Example from Xiamen

Hong Zhou and Wangshu Yang

Abstract Whether a construction project is a success or not relates to environment, economy, society and other factors. Civil buildings should not only meet the living, but also weigh the impacts on ecological environment and social issues it brings. Environmental and social impacts should have deeply reflected in the construction cost, however, not calculated. The benefits of building energy conservation, new technologies for environmental protection, excellent project management and organizational capacity does not reflect in the construction cost. Therefore, current system of construction cost could not reflect the real price of building products, and we must find a new way which can scientifically reflect the life cycle energy consumption of building products according to the principle of environmental economics, ecology and social economics.

On basis of the emergy analysis method, this article focused on identification and quantitative analysis on environmental and social costs of the single building, and taken an empirical analysis on an example from Xiamen. It has a far-reaching significance for reasonably priced of the construction environmental and social costs, for the sustainable development strategy, and to better reflect the people-oriented concept.

Keywords Emergy analysis • Ecological impacts • Environmental costs • Social cost • Social impacts • Construction project • Construction cost

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_55,

55.1 Introduction

Over the years, the price of building products is calculated based on the cost of valuation theory. With the research and application of the theory of building energy consumption and life cycle cost, the environmental costs of the residential building products and the social costs quantitative calculation became a new problem. In the existing system of cost we considered little about the environmental and social costs, even not included. Price of building materials, for example, appears to be relatively cheap raw material for concrete, will be dried up by current exploitation rate 30 years later in China. Existing materials prices were benefited by regression method, and the calculated by use value rather than absolute value. The rise and promote of emergy theory and emergy analysis provides an absolute value metric ideas and methods to solve the above problem. Emergy is the available energy (exergy) of one kind that is used up in transformations directly and indirectly to make a product or service. Emergy is an expression of all the energy used in the work processes that generate a product or service in units of one type of energy. In this paper, we do methods and empirical research by the use of environmental and social costs based on emergy analysis method to calculate the residential building products.

55.2 Literature Review

1. Social evaluation
   Social evaluation of large-scale construction projects were taken seriously by scholars in recent years. World Commission on Dams project gave top priority to social evaluation. Social migration caused by the large-scale projects, and the resulting social costs and social and cultural changes [1]. Their research showed that local people faced the potential risk of being infected schistosomiasis when they migrated because of major projects construction like the Three Gorges Project, South-to-North water diversion project and Returning Land project. The whole life cycle costs of the three major projects included in the health and epidemic prevention and patient cure for healthy expenditure in form of increasing social costs [2].

   As the in-depth research on the Sustainable Development and post-industrial stage of developed countries faced a lot of infrastructure Sustainable operations and maintenance costs (Bouwer 2009), life cycle cost became the project sustainability evaluation tool.
2. Large-scale project cost range
   In recent 20 years, scholars began to pay more attention to the social costs of large-scale construction projects. The calculation of the social cost by summing up generally includes the adverse effects of four aspects: natural environment,

public property, human society and the regional economy (Xiao 2005). Gilchrist [3] made a quantitative study of the social costs.

3. The plight of the cost valuation theory
   Current cost valuation theory about calculation on the value of resources is the benefit regression analysis method in China, pursuing economic output. Against the limitations of this method, (Bakshi and Fiksel 2003) Bakshi and Fiksel proposed it is crucial to the development of "eco-centric" approach because environmental issues are a multi-disciplinary and cross-disciplinary interactions.

   Yang followed the social cost is defined in Allouche [2] and made qualitative analysis of social costs of the whole life of the construction projects. Wang came to a conclusion "the social costs of quantitative calculation seem difficult to solve" [4].
4. Ecological theory and methods in engineering
   In recent years, the application of ecology expanded the engineering fields. Emergy analysis about building had just been arisen: Buranakarm evaluated recycling and reuse of building materials by using the emergy analysis method [5]. Jalali used emergy approach to evaluate deconstruction effectiveness including building materials of the concrete walls [6]. Hong Zhou and Wangshu Yang had calculated the emergy in the engineering project [28] and looked upon the engineering system as a subsystem of the ecosystem. Emergy analysis in Civil Engineering is in the ascendant. Emergy analysis method has its advantage to simulate and analyze the natural environment [12], measure the contribution to economic development in any environment, to make up for a monetary standard which cannot measure the defects of nature contributes to the economic development [7]. Huang used emergy analysis method to analyze the material flow of urban infrastructure (Huang 2003). Wang discussed the price system of the sustainable strategy of building products (Wang 2005). Emergy analysis method is also used in the regional labor transfer [8]. Hu-ning Expressway expansion project is to calculated the first large-scale projects example in China [12]. Combination between emergy analysis and emergy life cycle assessment are applied to a target information and technical analysis of complex systems for maximum power and zero emissions (Ulgiati 2007). Integration of Life Cycle Assessment methods, raw material input and the transfer process of environmental systems, and the establishment of environmental management information system were done (Eun 2009).
5. Emergy theory to analyze social problems in large-scale projects

Research in this area needs to be developed. Before this, the emergy theory is applied to the value assessment and history and the development of plans and policies to value analysis and evaluation

1) Assess the energy value of the development plans and policies
   Emergy analysis indicated what kind of development plans and programs can contribute up to wealth (emergy) waste at least. In some parts, the early emergy assessment indicated energy measurement can test the following policy: the choice of plan, planning of urban spatial structure, the optimal population

density, scientific research and education, allocation of funds, the net profit of economic growth, labor evaluation and information.

2) The history of value analysis and evaluation
The historical emergy analysis and evaluation is a carried out. Woithe (1994) evaluated the energy flow of the American Civil War in 1860, indicating the status of slaves, resources, external communication and war key factor transformity. On the economic aspects of the paper (Boyles 1975), Boyles pointed out the use of modern monetary evaluation criteria contained in the energy.

3) Emergy analysis of the social cost in the project life cycle
Social costs, hidden, does not direct the performance of quantitative cost and must resort to other means of conversion costs can be directly measured, which makes it difficult to calculate than the economic costs, but these costs are still is there. At present, the practice of engineering construction, we often only emphasis on the management of the economic costs while social costs is considered less. Subjectively because we consider the financial impact of the project itself much more than external effects such as environment, society. We still do not pay enough attention to the national economy evaluation of the project, although the external effect evaluation, but often a mere formality. Social costs are difficult to measure objectively, which has a practical bad effect on its position in practice. According to transformities determined by Odum emergy method, we should add cost elements transformities that have never calculated, mainly including the cost elements of our social transformity in China, which related to the level of social development in China, such as labor, landscape resources and cultural relics such as these factors indicators are very different with the United States. We calculate one by one.

55.3 Methodology

55.3.1 Basic Principles of Emergy Analysis

Traditional project cost calculation does not reflect the project's impact on the surrounding ecological environment, and actually projects affected the surrounding environment and animals and plants in it by dynamic light, heat, noise, electromagnetic radiation, and so forth, especially inevitable impact on human beings society.

Combine life cycle with emergy analysis, we divide the project into five stages: idea, construction, operation, decoration and demolishment to calculate.

During the whole life cycle environmental cost, due to the indicators of each stage of the project impact on the environment is different, according to the theory and the environmental impact of the whole life cycle theory, the construction cost of the project emergy evaluation system will be in phases: project planning, construction engineering, decoration, operations and maintenance and dismantlement. About

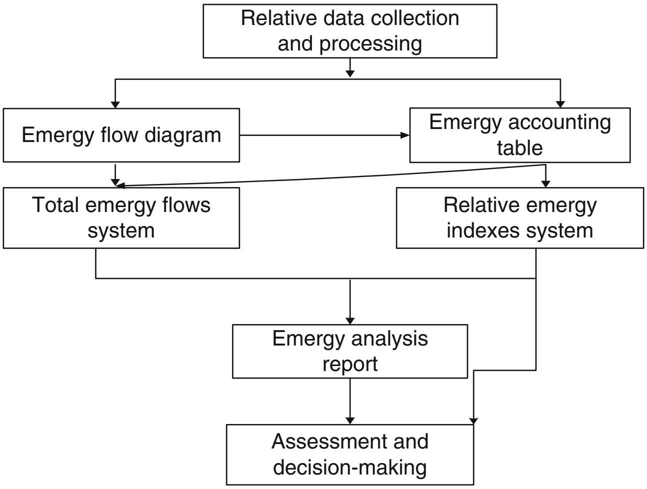

Fig. 55.1 Emergy-based analysis sustainability assessment of a construction project ecosystem

calculations and formulas details follow odum method. Figure 55.1 presents the flowchart with the previously mentioned intermediate products.

55.3.2 Emergy of Animal Reduction

Species emergy: genetic information emergy is the product of geological evolution. For an eco-economic system, it both embodied in biodiversity and rare species. System biodiversity emergy is multiplied by the transformity of the bits of system biodiversity Shannao Weaver index H bits.

$$H = \sum_{i=1}^{s} \frac{N_i}{N} \log_2 \frac{N_i}{N}$$

Ni – number of individuals of species
N – S species overall.

According to the principle of "disappear when the information carrier, the information disappears" shows that when a species disappears, this species, genetic information also disappeared. The rare species emergy are geological emergy consumed by the evolution of the species. Ager estimated 2×10^9 years of geological evolutionary history, and there are 1.5×10^9 mineral species (Lan 2002). Therefore, the energy of each species should be:

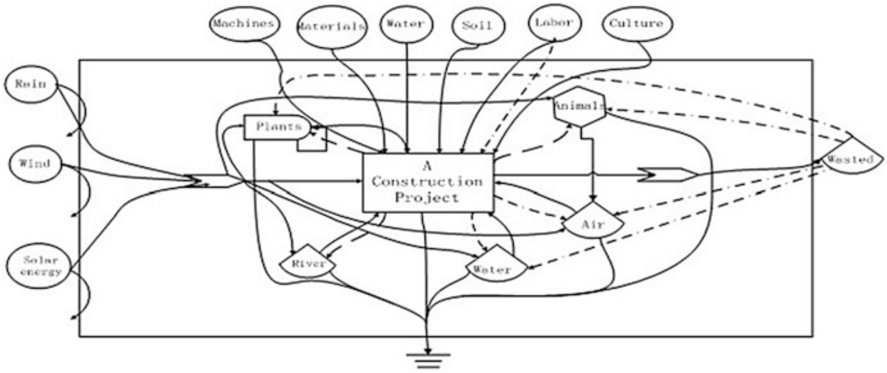

Fig. 55.2 Emergy system diagram in a construction project

$$\left(9.44 \times 10^{24}\text{Jsej/year}\right)\left(2 \times 10^{9}\right)/1.5 \times 10^{9} = 1.26 \times 10^{25}\text{sej/SP}$$

For the rare animals emergy of a specific system is the product of this system on a rare species of support for the species. The support rate (P) is a contribution to the survival of a species, the following formula is: $p = (m/M)(t/12)(s/S)$.

m - number of individuals of the species in the system, M: total number of individuals of the species living on Earth, t: the year/month of the species in the system life time, S: area of the system, s: the area of the actual activities of the individuals of the species within the time t. (Fig. 55.2).

55.4 Case Study

55.4.1 Basic Indicators of the Project

The project is located in A3 # Building at Hubian Lake in the Xiamen Island. The annual average wind density on Xiamen Island east coast is 170w/m^2. The average annual precipitation in Xiamen is 1.14 m/y. The project covers an area of 4226.02 m^2, construction and installation period is 300 days, Total cost is 33 million. In the construction that consumed 2,900 t cement, 2,900 t concrete, 12,500 m^2 wood template, 1600m^{3}cement later. Main material of the above items together accounted for 90 % of the total project cost. Operation period are 30 years, and both decoration and demolition duration are 6 months.

Surrounding the lake reservoir area is 0.9092E + 6 m^2. Average water depth is 9 m. Around the project the number of species 784 kinds of species, and rare species is the national second class protection animal egrets, after the construction we found 20 healthy adult egrets were lost. This monomer is Shimao A3#, designed by Zhongyuan Construction Design and Research Institute. Wastewater, waste gas, solid waste and other indicators are the valuation of the construction department of Xiamen.

55.4.2 Engineering Ecosystem and Emergy

55.4.2.1 Some Assumptions

1. All the formula comes from [9] The sources for and equivalence of transformities used in this report. Transformities used in this paper are given to three significant figures and shown for the 9.44, 9.26 and 15.83 E + 24 sej/y baselines. Units are sej/j except where mass (g) is noted, thus the units are sej/g. An exception is that the emergy per unit of education level is sej per individual and the emergy to dollar ratio (sej/$) is used for services. The 9.44 baseline was used by Odum [9]. It has since been superseded by the 9.26 baseline, but it is reported here because many transformities in the older literature are given relative to this baseline. All the Transformity baseline 15.83 E + 24 sej/y. Tidal energy, earth cycle and wave energy do not change.
2. Emergy-monetary value: 2012 Xiamen total emergy estimate in accordance with the estimate method (Huang 2005). Xiamen's total energy value is 5.696×10^{23} sej, and divided by the total GDP of Xiamen in 2011 (169 billion yuan), then emergy-currency ratio of 2.72×10^{12} sej / $.
3. In general the impact of the lake and surrounding buildings, such as the population to reduce equally the method the average total impact to the single building, the lake has more than 500 buildings similar monomer for the calculation of convenience, we assume that there are 500. Then the single building affection is 1/500 of the overall impact.
4. Engineering data source is from the Zhongyuan Construction Design and Research Institute prepared project documents. Estimation is the approximate estimate of the project through the instance of similar projects, and other projects can be based on this case mode sets of raw data into the appropriate project calculations.
5. The society emergy cost in this case should be included in the labor force (respectively in the Table 55.2) and the demolition of the arrival of the demographic changes (the original residents in the site are 85, all been relocated to other placed. The new owners are 506, who are mostly strangers. While due to the demolition the cultural emergy original residents of is broken, cultural emergy lost is about 8.42×10^{20}sej [9] (Table 55.1).

55.5 Conclusions

Because these values are basically the annual average for the unit of measurement in accordance with the duration of these stages, we conducted a simple sum of the following findings:

I =763.51million

Table 55.1 Species emergy in this project area

Category	Species	Emergy/10^{18}sej	Em value/10^6\$
Plant	245	13.54	4.98
Invertebrate	380	35.72	13.13
Amphibian	40	4.04	1.49
Reptile	21	1.97	0.72
Bird	58	27.17	9.98
Mammal	17	1.60	0.59
Total	761	84.03	30.89

According to Xiamen in 2011 GDP: 169 billion yuan, Em means Emergy-monetary

In accordance with the traditional cost calculations as a year as follows: J =33million and a bit

Clearly: $I \geq\geq J$.

The difference of the I and J are mainly flora and fauna loss (especially rare species) to reduce the ecological costs and society impacts cost, also operation cost, while the reason is uncontrolled sound, light, heat, wasted air, water and soil pollution and other factors as well as too much cost of social costs. We should take a green ecological design in the planning and design, take seriously into account the concept of people-oriented. In construction, green construction techniques and protective measures must be taken. In the operation green energy and low carbon way of life also must be taken, which no doubt greatly reduce our and developers' the ecological inputs.

In this paper the main stages which is inquired and calculated does not include the construction project planning and design stage, because we believe that does not involve the emergy loss, but the results of our study is precisely served for this idea stage. Whether a successful project or not is mainly related to the planning and design, the most important stage, thus we can use emergy analysis to the planning ideas comparison, to determine the pros and cons of the project. Simulate each plan for each emergy situations, and analyze the selected total energy consumption (especially non-updatable emergy), and the ecological costs caused by the system will be the best option.

To sum up:

A. This article provided a feasibility study stage can be used to filter the optimal solution to various factors (especially from the ecological environment and social costs point of view) of the building program evaluation;
B. This article established a simple ecological price evaluation system, and this system can be used to distinguish between the eco-residential buildings and residential construction;
C. To a certain extent, methods and ideas used in this paper filled the blank situation emergy theory research in the construction in China;
D. This project is a single building, smaller social cost, mainly about the social costs of labor and demolition. The overall Xiamen original residents were moved out also undermined the cultural structure of the project site in the demolition, thus which were the social costs.

Table 55.2 Life cycle emergy analysis in single residential microsystem (all calculations accord to Odum method)

Item	Item value/sej	Em/$
All input (I)	2261.82E+18	831.55E+6
1. Solar energy	1.55E+13	5.70
2. Wind energy (max)	5.70 E+16	2.10 E+4
3. Rain, chemical potential	4.09 E+14	150.37
4. Rain, geopotential	2.34 E+15	860.29
Indigenous non-renewable energy		
5. Lakes, chemical energy	6.57 E+9	2.4 E-3
6. Soil losses	2.37 E+20	8.71 E+7
7. Erosion, topsoil losses	2.66 E+15	465.03
8. Main rare animals losses (Egretta garzetta)	1.51E+20	5.56 E+7
9. Live biomass (trees)	3.52 E+19	1.29 E+7
10. Biodiversity	5.82 E+20	2.14 E+8
11. Main building materials	50.773E+18	1.87 E+7
12. Electricity Energy	2.76 E+15	1.01 E+3
13. Water use	5.43 E+12	1.996
14. Physical labor service	5.37 E+19	1.97 E+7
15. Management labor service	5.75 E+19	2.11 E+7
16. Machine	5.2E+19	1.91 E+7
17. Equipment and facility in the operation (30 years)	2.86 E+19	1.05 E+7
18. Solar energy	4.65 E+14	170.96
19. Wind energy	1.71 E+18	6.28 E+5
20. Rain, chemical	1.23 E+16	4.52 E+3
21. Rain, geopotential	7.02 E+16	2.58 E+4
22. Electricity Energy	1.93 E+17	7.10 E+4
23. other maintaining	1.57 E+19	5.77 E+6
24. Management labor service	8.40 E+19	3.09 E+7
25. Water	2.15 E+18	7.9 E+5
26. Maintain (10yrs one time) in demolition	3.24 E+19	1.19 E+7
27. Physical labor service	1.53 E+13	5.625
28. machine and transportation	4.42 E+19	1.63 E+7
29. Social cost (culture lost)	8.42 E+20	3.10 E+8
All output (O)	185.08E+18	6.8 E+7
30. Solid waste (construction)	1.10 E+20	4.04 E+7
31. Solid waste (decoration,70d)	1.28 E+19	4.71 E+6
32. Living rubbish (operation)	1.40 E+18	5.15 E+5
33. Solid waste (demolition,70d)	9.03 E+18	3.31 E+6
34 . Industrial wasted water	4.93E+19	1.81 E+7
35. Living sewage (construction)	1.03 E+16	3.79 E+3
36. Living sewage (operation)	2.55 E+18	9.38 E+5
37. Wasted gas (construction)	7.34 E+13	26.99
38. Wasted gas (decoration)	1.44 E+15	529.41
39. Wasted gas (operation) CO2	3.08E+16	1.13 E+4
Building real value=I-O	2076.73764E+18	763.51E+6

Acknowledgments This research is financially supported by The Project Sponsored by the Scientific Research Foundation for the Returned Overseas Chinese Scholars, State Education Ministry (The Project-sponsored by SRF for ROCS, SEM).

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Chapter 56
Evaluation Research of the Maturity Level of the Organizational Project Management of Supervision Enterprise in Transition Period

Yucheng Pang

Abstract Recently more and more supervision enterprise began to accept the ministry of construction requirements and tend to transform into the engineering project management enterprise. It set the new request to the level of enterprise project management and their own internal project management system. After analyzing the background and related concepts of organization and project management, the author constructs evaluation model of the project management maturity and supervision enterprise organization at transition period from the organization's strategy, project management, project management methodology, project management office, project management control system, organization level project management information system six aspects.

Keywords Transformation • The supervision enterprises • Project management at level of organization level • Maturity

56.1 Introduction

Construction supervision in the urban construction and engineering construction plays an important role. China started project supervision of experiments in 1988 from experimental unit. In 1996, the overall implementation of engineering supervision system in the field of construction made obvious social benefits and economic benefits, and got the wide recognition of the society. Supervision has become an indispensable part of engineering construction. But we must soberly realize that quite a number of supervision enterprise in our country that mainly engaged in the supervision work construction at present, seldom well performed the management

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_56,

function of the cost, schedule, contract, and so on in the scene. Project supervision cannot adapt to the need of development of engineering construction.

The evaluation of project management is divided into three levels in the internet. The first is the assessment of personal project management skills, the second is the evaluation of the specific project management, the third is the assessment of the organized the project management maturity. As for the supervision enterprise at transition period, as it treats project as its way of operating, both the improvement of personal project management and the specific project management are the foundation of well-developing enterprises. But only combining the improvement of project management at organizational level with enterprise strategies, and setting up good project management system and operation mode in general can it be possible to make enterprise bigger and stronger in the fierce market competition. In the optimizing and improving of project management at organizational level, its maturity level plays a vital role.

56.2 Project Management Maturity Model at Organizational Level

Since 1990's, the study of project management began to change from the management of a single project to the methods of using project management to achieve its strategic goals by enterprises and organizations [1]. Project management maturity model was developed in this context, which is used to assess the enterprise present project management ability, and help the enterprises to continuously improve their own management. Its concept mainly comes from the "capability maturity model" of software industry. A good project organization maturity model, should be able to provide a range of essential factors, and can divide project management maturity into different stages according to different elements, and can put forward clear characteristics and requirements of each stage. In this way, the organization can evaluate the stage they are in according to f the characteristics and demands of project management capability maturity model, in what aspects in the future still need to improve, then to form a unit recognizition at each management level, and to continuous promote optimization and ascend of organization level project management system.

Original project management maturity model was greatly affected by capability maturity model. So far, there are more than 30 project management capability maturity models have been used by enterprises and organizations [2]. New models are continuously developed, but there isn't a model is widely recognized and set down as a standard. Among them the more influential are (Kerzner) Project Management Capability Maturity Model, CMMI (Capability Maturity Model Integrated) Model and so on. Organization level Project Management Capability Maturity Model (OPM3) is proposed by PMI at the levels of Organization and Project Management. It has a prominent advantage in domain of the evaluation system, Model framework and application field.

The first dimension of OPM3 is the four cascades of maturity : standardized, measurable, controllable and continuous improvement; The second dimension is nine areas and basic process of the project management; The third dimension is three territory of organization project management level, including single project management, project portfolio management and project portfolio management. OPM3 expanded the scope of the project management, project management concept by tactical layer rise to strategic layer [3], the goal is to "help the organization through the development of its ability, successfully, reliable, and deliver the project achieve its strategic" according to the plan [4].

But because we have not considered our country's political, economic, cultural environment and actual situation of our country's enterprise project management. From the aspect of practical application effect, the existing project management capability maturity model cannot evaluate and improve our country's enterprise project management skills effectively [5]. This paper studied the supervision enterprise organization capability maturity model at transition period, and will be based complete on the basis of improving OPM3 model, and avoid the disadvantages of the pertinence of OPM3, improve the scientificalness and practicability of the model.

56.3 Construct of Organilzation Project Management Maturity Model of Transition Supervision Enterprise

A. *Analysis on plane level*

Through the analysis of Chinese project management system, international project management professional qualification standards and combined with the current situation of domestic transition supervision enterprise's organization project management capacity, we divide the model into six planets: organization strategy, Project management rule, Project management method, Project management office, Project management control system and organization project management information system.

- Organization strategy
  Organization strategy is mainly refers to the internal and external environment analysis ability of project operation, requirements and positioning ability of project, whole project planning ability. It mainly focus on three points: one is the goal oriented, no matter any strategy, only under specific clear goals precondition the discussion and practice will be meaningful; 2 long-term effects, strategy for the future, grasp of the organization's overall development direction; 3 resource commitment, strategic often involves resources as a strategic direction commitment.
- Project management rule
  The establishment of organization project management system, needs to make clear the organization structure, working process, post and personnel, performance appraisal and so on, which asks for the establishment of clear

project management system in the organization, and define the mission of project management within the enterprise, importance, and define project management organization structure, responsibilities and rights.

- Project management method
  The unity and complete project management method reflects organization project management maturity directly of an enterprise. Project management method, the main purpose is to define the project life and divide each stage, define project management process and standard, project milestones, make clear the involved departments and their respective duties, make clear the work and regulation of each stage, carry out works into specific position and personnel. In a enterprise with consistent project management method and process, through the unified project management method, different project management has a good copy ability.
- Project management office
  Whether to establish a project management office, what the function of the office, is two important indexes of measuring the organization project management maturity. In the early stages of establishing project management office, project management office can only assist the project, help the project manager and functional manager to support work [6]. Then gradually, it becomes a project consultant, coordinating resource of multiple projects and copying project management exercise. As developing, it likely become a strategy designer of a organization project management, thus it plays a more and more important role in the improving process of organization project management maturity .
- Project management control system
  Enterprises with high project management maturity, should have project monitoring system at all levels respectively, control and manage the plan for the project examination and approval, state tracking, performance tracking, change the examination and approval, problem tracking, clients satisfaction and project member satisfaction. Project management control monitoring system is an important security of achieving multiple project goals; its complete degree directly reflects the organization's project management maturity.
- Organization project management information system
  For project management office, it will be very sweaty and low efficiency if only by artificial management for many projects cost, schedule and quality, information when they face many projects at the same time. It will need to build a project management information system, through the system to collect and process information and dynamic data, and at the same time through system to exchange and communicate information in different departments and personnel to realize the different personnel cross-regional, cross projects cooperation. Organization project management information system has another important mission that is knowledge management. Through the knowledge management, the project experience, knowledge, data can be accumulated, so as to share for other projects and avoid make the same mistake again.

	Chaos Level	Standard Level	Optimized Level	Continuous Improving Level
Main Characteristics	● Enterprises lack of consistency management ● Project success mainly depends on personal efforts	● Projection has unified methodology ● Project success depends on the synergy of individuals and organizations	● Complete organizational project management system ● Unified project success thinking	● Supporting appraisal and incentive system ● Mechanism for continuous improvement
Detail characteristics	● Lack of project management common language ● No standard working process ● Big difference between projects management ● Experience is hard to replicate	● Forming tools and templates ● Project control checkpoint ● Project monitoring system ● The primary project management office Project training system is set up	● Project development and enterprise strategy synergy ● Senior project management office ● The project manager career planning Project experience in stitutionalization	● Complete project management benchmark ● Complete program management office ● System, method, process of continuous improvement

Fig. 56.1 Organization project management maturity model of transition supervision enterprise

B. *Organization Project Management Maturity Model of Transition Supervision Enterprise*

According to the serious imbalance status of current transition supervision enterprise's organization project management capability, this paper divides the organization project management maturity model into four stages: chaos level; standard level; optimized level and continuous improving level. Figure 56.1 is an organization project management maturity model of transition supervision enterprise.

The model's six planes are corresponding to organization project management maturity's four levels, Table 56.1 lists the performance of enterprise at all planes of the organization project management maturity at different levels

56.4 The Application of Organization Project Management Maturity Model of Transition Supervision Enterprise

Organization Project Management Maturity Model can provide a series of guidance for improving organization project management level, help enterprise to find out the defects existing in project management, and encourage enterprises to improve at the base of understanding their own organization level. For enterprises with large scale, strong strength can rely on own power to organize the organization project management maturity evaluation. The advantage of this way is that the enterprise can formulates target-oriented evaluation process and method, based on the enterprise's fully understanding; the disadvantage is likely that it is difficult to find out problems, justice has insufficient. For medium scale enterprises, whose

Table 56.1 The performance of organization project management maturity model's levels and planes

	Organization strategy	Project management rule	Project management method	Project management office	Project management control system	Organization project management information system
Chaos level	No conscious of strategy management	No project management rule	No unity project management method, no common language between projects	No project management office, the project manager manage the whole project	No project management control system of enterprise plane	No organization project management information system
Standard level	Sound strategic planning	Sound project management rule	Consistent project management method and process	Established project management office, but only support and assist project ministry ,	Through Project management control system to monitor many projects	Through the project management system to convey file and transmit project information
Optimized level	Organizational strategy realize the dynamic management	The project management rule is consistent and harmonious between enterprise level and project ministry	Project management method has improved through accumulated experience	Project management Office will be able to realize the project advisory function	Through project management control system to compare and correct the project implementation according to plan	Through the project management information system to share project information and dynamic data
Continuous improving level.	Management rule changes continuously	Project management system has optimized and improving mechanism	Established coordination mechanism of project management method improving from enterprise to projects department horizontally and vertically	Project management office acts as project management strategic planners, project coordinator and controllers	To tracking analyze and contrast the project planning and actual performance, and predict the future trend of project, and response in advance	Through the project management information system to manage knowledge and transfer the accumulated project experience into organizational experience.

own assessment of the not enough, may have the aid of external forces (professional consulting company or project management experts) to evaluate organization project management maturity, this kind of means has the advantage that it can combine their own advantages with external advantages, then conclude an objective assessment conclusion.

For transition supervision enterprises who want to make some improvement on organization project management maturity, using the maturity model, should first learn as much as you can about the model based on the concept, the more standard meaning, familiar with project management organization level connotation and the composition of the model. Then contrasting to status of all levels and combined with situation of enterprise, you can identify the current basic characteristics of organization project management and figure out the position of four levels. So you can accord the overall level that the enterprise wants to reach, focus on those characteristics need improvement, and make the appropriate improvement plan. Once the plans decided, the enterprise must carry out it step by step and along the organization project management maturity. After completing the plan after a series of improvement activities, should assess current organization project management maturity state, thereby improving plan, to the next higher levels of circulation.

56.5 Conclusion

This paper established a concise and practical organization project management maturity of transition supervision enterprise, then practiced in some enterprises and got a good effect. However, the following points need to pay attention to when research and apply the organization project management maturity of transition supervision enterprise into practice.

The ascension of organization project management maturity is a gradual process. The maturity of organization project management is not achieved overnight; profit from maturity evaluation will be a long-term process. It is necessary to train and educate the foundational project management theory and method within enterprise.

Enterprise shall establish a maturity goal suit itself. Not every enterprise has to reach the highest level, they should set a challenging and could be realized maturity level target combined with strategy and current situation of enterprise.

It is necessary to focus on the continuous improvement and continuous improvement. Organization project management maturity stresses continuously improve, even if the enterprise achieved the theoretical highest goal of maturity level, there also has space to improve and developed. Every certain period, enterprise should review the consistency of organization project management practice and enterprise's strategy.

Defining each level is not the purpose of organization project management model; actually, it wants to find shortcomings of enterprise itself. Each enterprise's characteristics is different, so there is no specific measure is applicable to any enterprise to improve its defect. Transition supervision enterprise should have independent consciousness, and constantly examine themselves, accumulate experience, so the model can be used for itself and become a powerful project management company in the fierce competition.

Acknowledgments This research is supported by Science Project Plan of Ministry of Housing and Urban-Rural Development of the People's Republic of China (2009-R3-22)

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Chapter 57
Review and Research on PPP Pattern in China

Xiaosu Ye and Chunmei Xu

Abstract Financing approach has been applied in PPP project for more than ten in China. In practice, there are many mega-projects have applied this approach, such as 'the Shenzhen Shatou Thermoelectric power station project in 1984' and 'the "Bird's Nest" project of National Stadium', which has helped Chinese project managers gain successful experience in the PPP project. "Theoretically, there are a lot of exploratory and fruitful research on the PPP concept and classification, about the risk assessment and interest sharing in the process of cooperation, cooperation mechanism construction, legal relationship of cooperation etc. All of these literatures have set up a sound theoretical basis for studying PPP projects in China." "Twelve-Five" is an important period for China's next 5 years in the people's livelihood protection, urban construction and sustainable development of social economy, so it is also the important development stages of PPP projects in China. This article proposed clear definition and essence of China's PPP to explore the operational mechanism of China's PPP and realization of scientific management of PPP projects, through the summary, the induction and the analysis of existing literature achievement.

Keywords PPP (Public-private- partnership) • Partners • Public infrastructure project • Research and review

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_57,

57.1 Introduction

PPP project is the mode of financing to achieve public project construction, and it is also a supply of public products. The PPP pattern is a pattern of private closely related to public sectors along with the diverse needs of public project. In the seventeenth century, United Kingdom Association of pilots and private investors to build a lighthouse [1], started a public project of public-private partnership practice. In 1984 China constructed Shenzhen Shatou B Power plant [2], which started the practice of public-private partnership of China's earliest public infrastructure. In 1992, In order to improve the level of infrastructure, solve the problem of lack of funding of public services and the lack of effectiveness and financial efficiency of public sectors, "public-private partnership" concept was put forward by the British Chancellor of the Exchequer Kenneth Clarke firstly.

The twenty-first century is the rapid development stage of China's urban scale of investment and construction, and public-private partnerships in the content and form of public project are also becoming more and more widely. In recent years, academic community formed a lot of the research results are available for reference, but there are a number of explanations of the concept of China's PPP which have been unable to form a consensus of views in common so far, the content of research focuses on the risks and benefits-sharing and the actual effect of the theory investigation is insufficient, the scope of research is wide spread and running a government specification of mechanisms are insufficient. So in light of China's system background to analyze essence, the theory and the realization way of Chinese public project public-private partnership pattern to further promote the in-depth research on PPP theory and system innovation in China is of great significance.

57.2 Study on the Concept and Classification of PPP

57.2.1 PPP Research and Definition in Foreign

PPP is public-private partnership. Western developed countries have established the perfect institutional framework by applying PPP project, which benefit from their study in the theoretical foundations and practical experience. Theoretical studies mainly made a reference basis from the four angles. First, the relational contract theory, Tony Bovaird [3] believes that the PPP is the new partnerships and alliances, which has the difference with the transaction contractual relationship and has the relational contract characteristics, therefore the corresponding government way also should absorb the government principle of the relational contract [3]. Second, from the perspective of transaction cost economics, it proposed the important function of transaction cost in the PPP and importance of the relational contract trusts [4]. Third, property right economic viewpoint, Peter Scharle [5] presented how property rights of private sector works involving in Government provision of public goods works, that is what property rights arrangements have resulted in the largest remaining joint [5]. Fourth, it regards PPP as a society to gamble, Grou [23] believes that putting phenomenon, experience, and discussion of the PPP into the broader perspective of the game environment, conducive to a better understanding [6].

Based on the results of theoretical studies and the success and failure in practice of PPP project, the various countries to the PPP scientific connotation explained seeks common ground while maintaining difference, Example (1) the definition of Canadian PPP National Committee (1999) is that PPP is a co-operative relationship between the public and private sectors which is based on each experience, through the appropriate allocation of resources, risk sharing and benefit-sharing mechanisms, in order to the best meet in advance clearly defined public needs [6]. Example (2) the definition of United Nations Training Institute [7] is that PPP covers all institutionalized cooperation between the different social systems advocacy, aimed at solving some complex issues within the local area [7]. Example (3) Standard and Poor (SP 2005) thought that PPP is the medium of the long-term contractual relationships between public and private sectors, including risk-sharing and multiple departments proprietary technical personnel and financing share, in order to achieve the desired policy outcomes.

The essence of PPP concept lies in: ① It clear that the PPP is a cooperative relationship partnership between the public and private sectors, which is the key of PPP to distinguish from other project financing model. ② It has defined this kind of partner relations is the relations contract form, which is to achieve the purpose of public demand, rather than simple interest. ③ It proposed a public-private partnership implementation of PPP project which needs long-term, effective public policy or the system specifications to meet the public demand ultimately. ④ It clarified the basis for cooperation of public and private sectors are based on property rights relations and resource sharing, risk-sharing and benefit-sharing during the cooperation to achieve the policy outcomes of the ideal of public projects. Above conclusion to our research on PPP provides a reference of experience.

57.2.2 Domestic Concept of PPP Explanation

In the early stages of our country urban infrastructure construction has a number of public-private partnership patterns, such as BOT (Build-Operate-Transfer) and so on. At the beginning of the twentieth century our country introduce the PPP pattern, and the understanding and interpretation of the PPP general reference overseas explanation. So far, our country academic circles are still not unified for a definition of PPP. As shown in table 57.1 summed up representative explanations of PPP in recent years.

The differences of the above concepts, it is important to clear the "partnership" Namely, the organic unity of the particularity of China's partnership with the international common practices

Table 57.1 The PPP concept of interpretation summarized in our country

Concept explanation / Literature	(1) PPP is a long-term cooperative partnership between the public and private sectors through a formal agreement builds up in infrastructure [20]	(2) PPP is one kind of operational mechanism of the public and private sectors provide the infrastructure product/service through establishing partnership [10]	(3) PPP is one way of construction and service that the enterprise to obtain the special permission right of management of the government to provide infrastructure, the public utilities by the government responsible in the tradition [21]	(4) PPP is the mode of financing of private enterprise and the public sector cooperation [22]	(5) PPP refers to the public sector and the private sector in order to provide public goods or services, implement public benefit of specific public goods to established cooperation contractual relationship throughout the life cycle of project [13]	(6) investment decision problem of new PPP project can be defined as a optimal investment strategy of public service based on market supply and demand conditions [14]
Jia Kang, Sun Jie (2009)	√					
Yan Ling (2011)	√					
Guan Xishu (2011)	√					
Zhou Huining (2011)	√					
Zheng Zhiqiang etc. [21]	√					
Lian Hongjun [20]	√					
Wu Guofang (2011)	√					

Liu Juan (2011)	√				
Zhu Xiuli etc. (2011)		√			
Yuan Yongbo etc. (2011)		√			
Li Fenglan (2011)		√			
He Shoukui (2009)		√			
Li Jinbo (2011)			√		
Wang Shouqing etc. (2011)			√		
Chen Liuxin (2006)			√		
Wang Geng (2011)				√	
Yang Chao, TangYing (2011)				√	
Yao Yuanyuan [26]					√
Ye Xiaosu etc. [25]					√
Ma Jun (2011)					√
Yao Pengcheng etc. [26]						√

"√" represents the corresponding data support the view (Source: own drawing)

Partner 1: Our country “the public department” is the investment entities of project including the government and the government control section, public utilities management departments, institutions etc.; Partner 2: Our country “the private sector” is defined as the enterprise, company or personal etc. participation side in the investment and financing body; Partner 3: Social third party surveillance main body including public, independent surveillance specialized consultation organization and government regulators. The concept of another core point is the mode of cooperation, namely “new 36” in State Council explicit statement “encouragement and guidance folk capital” participation in infrastructure construction. Therefore, the mode of cooperation will achieve through business investment and the government signed a legally binding agreement or contract documents. Cooperation of public-private partnerships is a series of complex contractual arrangements. The cooperation aims to improve the efficiency of resource allocation of public projects or productivity of a release, in order to improve the effectiveness of the supply of public goods and to achieve “value for money” of public project [15], rather than entirely by the private ownership substitution public ownership system, formation of private sector monopolies in public operation.

Therefore, the Chinese-style PPP is a mode of relational contract with the full life in the project which was set up by the public and private sectors for the provision of public goods or services, to achieve public benefits of a particular public project partners, financing, construction, operation and management of partners.

57.2.3 The Nature of PPP

Nature refers to the inherent fundamental properties of the thing itself. The basic properties of PPP projects is throughout the process for public engineering projects of cooperation financing, construction, joint management, transfer projects with the way of relational contracts. Wang Shouqing (2007) believes that the project financing refers specifically to the narrow sense project financing, that is, “financing through project” rather than generalized project financing. Han Yanchao [28] believes that the nature of the PPP project is the chooses the collection expansion the process of public department and the personal department, is also process of exchanging advantage between the public and private sectors [8]. Li Xiaodong [8] believes that its essence lies in the processes of public department and the private sector to achieve advantage complementary, simultaneously is also the process for public department with operates privately the department relative participation degree to realize the Pareto most superior in the infrastructure construction [17]. PPP was generated from the basic properties of the supply of “public project”, according to viewpoint of C.V. Brown and P.W. Jackson [29] [18], social goods can be divided into public goods and private goods, Public goods from the public demand, and therefore it must be provided by the Government. It is due to the formation of the government to provide public programs, economic characteristics of public goods reflects in natural monopoly, public welfare, the property of the public property and externalities of public projects.

The purpose of understanding of the PPP nature lies not in how they provide public programs, instead how to achieve the best results to meet the public interest in this way, namely PPP has realized Zero-sum game of the government resources and the social resources and there are quite a large competitive advantage [15], cleared off complex contractual relationship which forms in the PPP project cooperation and innovation for a system framework for protection PPP project successfully including series of laws and regulations, management mechanisms, incentives, contracts, etc.

Therefore, the essence of Chinese-style PPP, on the one hand, it contains the extension of the public and private, on the other hand includes universality connotation of cooperation main body. In cooperation essentially, on the normative rules of engagement and operating mechanism to provide the public product or the service for the public by the means of establishing contractual relationship of new partner. Therefore, there is no need to strictly divide into broad and narrow sense of the PPP pattern, to form a unified and clear definition of PPP, which provide theoretical basis for policy formulation, the mechanism design and the management system construction of PPP project.

57.3 Cooperation Mechanism of PPP Research

Since the founding of the nation, construction of the city public project has always been managed by the administrative instructions of government, from the establishment of project, construction to operations are coordinated managed by the State or local government. After the reform and opening up, it started the multiplex investment system gradually. In 1999, Shenzhen Shatou B power plant transfer smoothly, which implemented project finance of the infrastructure; In 2000 China has enacted "construction project owners systems"; In 2005 China has tried out a series of institutional reforms of the government projects such as an "Agent", which started system reform of public project management. On one hand, one of the necessary conditions for successful PPP projects investment and financing decisions are the risk allocation and sharing in the project selection process; On the other hand the PPP projects are usually large-scale, more investment, technical complexity, long construction period, wide, high-risk, so financing risk and allocate research of PPP project is necessary [9].

57.3.1 Risk and Allocate Research of PPP Project

57.3.1.1 Risk Management and Assessment Method Research of PPP Project

Public-Private Partnership exists conflict of interest, which is basic factor for risks of PPP projects. Cui Jun (2005) summarized financing risk factors which include the main risk categories and principle of risk-taking of project. Wang Yaowu, Sun Chengshuang (2003) put forward a dynamic risk management framework of project.

Jin Deming (2005) proposed the project risk integration management pattern has the modern risk management significance. Risk evaluation method study of PPP project began in recent years. Li Sheng (2004) etc. utilize the fuzzy judgment method to carry on the appraisal to the BOT project risk [10]; Liu Xiaojun (2005) etc. according to the TBT principle to proposed bid risk, the financial risk, the construction risk, the market risk and the investment environment risk of the infrastructure project and carried on the effective management measures [9]; On the basis of risk analysis that includes expert scoring method, statistics probability method and so on [11]; Chen Ling [12] proposed risk management procedures for infrastructure projects [12]; Yin Yilin [13] does a PPP project risk-sharing research reviewed, the statistics has obtained the risk share method which mainly include is the matrix method, the analogism, the statistical analytic method and mathematics modeling [13] .

Through the above analysis shows that the method for risk evaluation of PPP projects in China are mainly qualitative methods and quantitative analysis method. At present the assessment method theoretically is feasible, but practices simple, operational and the usability is insufficient. Therefore, there is need for projects focusing on simple, effective and pragmatic.

57.3.1.2 Research on PPP Projects Risk-Sharing

The problem of PPP mode using a variety of risks and rational allocation, the domestic scholar has conducted the research from the different angle. The risk allocation of view in the study of Wang Shouqing (2000) is the most representative. He argues that the main performance of the PPP projects in China such as foreign exchange risk, political risk and so on. He proposed risk sharing three principles of the PPP project which is for practical guidance the public sector and private-sector negotiations in PPP project [14]. Li Qiming (2008) proposes nine principles of the risk assignment [25]. Yin Yilin [13] is of the view that the risk-sharing of PPP project is done by means of risk transfer usually among in a number of subjects, which is mainly achieved through complex contractual arrangements. Simultaneously he has pointed out risk sharing research of the PPP project existence three weak links, that is, risk-sharing process evaluation, risk share proportion determination as well as relationships of the risk-sharing with other aspects [11].

The above study shows that the current study regard the public-private partnerships as a unified model, namely does not distinguish different specific pattern of the property rights in a public-private partnership model, especially the similarities and differences of risk allocation between the different modes [26], which remains to be in-depth exploration of specific rules. On the other hand PPP project is form of modern relational contract, rather than a purely commercial contract which is lack the study of legal relationship between the PPP project contract systems and different contract currently. Third, in the area of research of policy risks, at present, effective public policy and mechanism of government to implement is lack, which becomes obstacles of promoting the PPP project implementation effectively.

57.3.2 Theory Research of Governance

Concepts of foreign project governance are adhering to the Williamson's transaction cost economics framework [15]. However; domestic project governance concepts are given the similarities in company with the project as an economic organization, draw on the ideas and methods of corporate governance theory, combined with agency theory, stakeholder theory to analyze. Although the domestic and foreign scholars have the entirely different research ideas, they affect mutually, seeps mutually and share a common goal [28]. Public project governance is a process of establishing and maintaining a good order for project transactions through a system in the process. As regards the results of project governance, from a macro point of view, it creates an institutional environment in the project market; from the microscopic point of view, it establishes and maintains a good order in the project transaction interior [29]. However, the public project is different with the enterprise which took take the profit as the goal economic entity, it pursue the personal interest, and public projects are initiated by the government in order to meet the needs of the public and their pursuit is public interest. This feature of the public project will determine its governance objectives cannot be confined to a party's interests, but should serve for the interests of many stakeholders in public projects, in order to achieve the relationships between stakeholders in coordination and convergence of interests, thereby achieve the goal of the project value [16]. For a certain public projects, project governance is divided into the internal governance and external governance. Basic characteristics of internal governance is based on internal institutional arrangement of property rights as the main line, its carrier is project organization; External is based on external institutional arrangements of competition as the main line of, its carrier is the market system [28]. Since the project governance theory appears in the 1990, which attracted the attention of many experts and scholars, Such as Martinus and Stephen (2006) believe that project management methods and techniques (operational level) simply guarantee short-term success of the project, and complete project management (strategic level) is the guarantee of long-term success of the project.

Representation scholars of domestic research project governance (and their research team) have three, and their focus is different: Professor Yin Yilin and his research team mainly aims at the public project (including government investment projects), they focus on the economics perspective to study. Professor Ding Ronggui and his research team are more concerned about the governance of multi-organizational cooperation projects, and they believe that project governance must be from management perspective to study, rather than the point of view of economics [17]. Professor Sha Kaixun and the research team discusses construction projects or the system stratification plane question of construction market, but rarely explicitly put forward the concept of project governance [32].

Above research mainly concentrates in the foundation of microscopic stratification plane cooperation pattern of public project company, which belonging to the internal mechanism design of cooperative process and at the initial stage of the study. At the macro-government level, it has not carried out effective governance mechanism research of PPP projects, which is lack of research from top-level PPP project governance mechanisms. The public project government mechanism is one kind of management pattern of control operation, and establishes an effective way to promote the organization and operation of the PPP may embark from three aspects: ① The government innovates in the PPP organizational structure; ② Community establish effective independent monitoring mechanism and the mechanism for public participation; ③ Project company interior establishment scientific governance mechanisms.

57.3.3 Research on Mechanism of Government Management and Supervision

From concept definition to governance studies, in fact, it is inseparable from the Government subjects of public projects. Government as the initiator in the PPP model and focus representatives of public interest. It is not only the public project sponsor and the participant, also is supervisor of project, there are double functions of supervision and cooperation at the same time. Government with his "double" role is the basis to explore the positioning and management of the PPP project.

(1) Management functions of the Governments in PPP projects. Franchising project and the price of monopolistic product follow cost pricing combined with price hearing in China. Our country proposed the suitable price control of PPP project, which can cause the social economy efficiency enhancement. Zhao Yu [18] etc. discusses the monopoly industries into gaming and performance evaluation of control and the impact of regulation on social welfare and consumer surplus [18]. On the basis of analysis of the regulatory status quo of the Government of the PPP project, He Shoukui, Fu Hongyuan [35] proposed to improve the regulatory body, determine the boundary of government oversight reasonably, select the scientific regulatory pathway, to promote the healthy development of PPP mode of public project [34].
(2) Incentive measures of the Governments in PPP projects. Ren Zhitao [19] analyzed public-private partnerships in the field of China's infrastructure and research the objective function of the principal - agent relationship under the condition of information asymmetry between government departments and private sector, and has carried on the gambling analysis to incentive problems under the public and private partnership [19]. Wang Shouqing (2009) etc. believes that government incentives including investment sponsorship of government, government financing assistance, the government guarantees, tax relief and development of new markets. The private sector fully affirmed the validity of various incentives, which scored the highest is tax relief measures, score minimum is the Government sponsored investment [36].
(3) The government participates in the localization of PPP project. There are there participants in PPP mode Governments, including private and public, the overall objective is tripartite satisfaction. Although the goals are very different

from the concerns of the three parties in the target system of PPP projects, but the tripartite target system is not completely independent, instead, cross together, only three parties varying degrees of emphasis on the same target [37]. Therefore, there is a need for the Government to have a clear goal in the management, which is more beneficial to the implementation of the PPP project.

Existing research shows that Government involvement in PPP projects in China, its participation main body displays in the local authority or the government department, or government authorized financing platform. However, it is lack of effective legal basis and institutional support, and cooperation is far from degree of fair, open and fair institutionalization, which hinders China's PPP projects to institutional development, so it is necessary to study from two aspects: First, theoretically clear the role, status and management body of government in PPP, and the multiple roles of Government as participants and regulators how to separate; Second, in terms of regulations and policies, and explore the establishment of government PPP policy guidelines, standardize operation mechanism, in order to ensure the PPP project the development.

57.4 Review Summary and Future Research Directions

From the research background and environment, special system environment of China provides a new opportunity for the public and private cooperation research. Investigated the role of public-private partnerships in special system of China, which will help us a more comprehensive understanding the function of the public and private cooperation that displays in the infrastructure project, to rich existing research results. At present of Chinese scholars study the relation and impact on public-private partnerships between the background of the different systems and public-private partnership, different institutional backgrounds are also fewer.

From the research methods, on the one hand, multiple choices of the risk analysis methods provide the basic conditions for the public-private partnership public project. For example He Tao and Zhao Guojie etc. (2011) presented using a game theory approach, Gao Huiqin etc. (2011) introduced a VFM review methods, Hu Li etc. (2011) proposed that revises the PPP project benefit assignment model with SHAPELY. On the other hand, these methods are lack of comparability and consistency, which has affected the usability. Research methods of Risk-sharing do not combine with it technology, so its application are lack of progressiveness. Therefore, practicality and versatility of risk sharing ways of PPP to be further explored.

From the study area, there are many new issues of the public-private partnership of the public projects are worth exploring in China. Under the market economy conditions, PPP project contract management theory and the form of practice contract system to be studied in China. From the benefit relations aspect, the relations among the interest of the government, the private sector and the public has not carried on combs theoretically, which deserves further study. In the building of cooperation mechanisms, the achievement of how to establish top-level public-private partnership mechanism of the government is less. From fair participation status, the research of how to achieve true equality to achieve cooperation more effectively, which involve less. From the admittance condition of personal department, in the process of public-private partnership on public projects in China that are involved specific conditions of accessing for private sector access,which is lack of demonstration of the system.

Therefore, theoretical breakthroughs and system innovation not only is the effective way of realizing PPP project financing in China, but also more important is realistic need of providing the public product and the service for society and the general public.

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Chapter 58
The Life-Cycle Management of Indemnificatory Apartment Projects

Peng Mao and Lifei Wang

Abstract The construction of indemnificatory apartments is a hot social concern in recent years. Its success or failure will have a significant impact to the social security business and the quality of people's life. Compared with the general real estate projects, the implementation of indemnificatory apartment projects has more needs to have a scientific management method to carry it out smoothly. The Life-Cycle Management (LCM) of indemnificatory apartment projects is a comprehensive management throughout the total construction process, guarantees the projects' scientific and systematic, and is indispensable to construction of indemnificatory apartment projects. This paper divided the indemnificatory apartment projects life cycle into four phases and analyzed the effect of the LCM. Based on the status quo of indemnificatory apartment projects and life-cycle management theory, the life-cycle management focuses of indemnificatory apartment projects in each phase were studied. This paper expatiated on the key points of indemnificatory apartment projects LCM systematically and could help improve the operation efficiency of indemnificatory apartment projects.

Keywords Indemnificatory apartment • Life cycle • Life cycle management (LCM)

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_58,

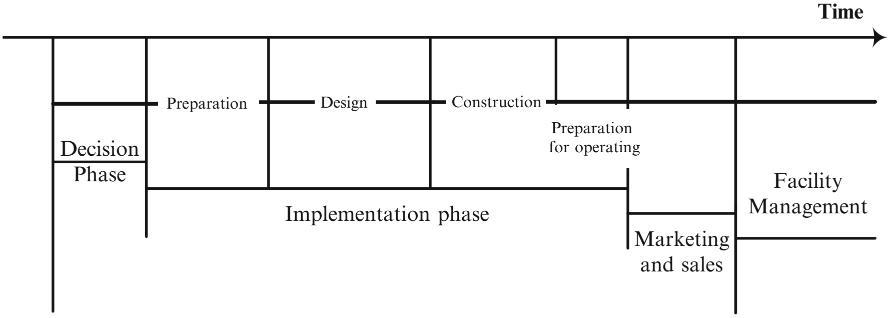

Fig. 58.1 The division of indemnificatory apartment project life cycle

58.1 Introduction

In 2007, to curb the excessive growth and solve the housing difficulties the government proposed political objectives of the construction of indemnificatory apartment projects, and since then indemnificatory apartment projects began to become a building boom. In Premier Wen's 2010 government report it proposed that we should continue the large-scale implementation of indemnificatory apartment projects and proposed the goals of three million units of indemnificatory apartment and 2.8 million sets other kinds of shantytowns housing [1]. In December, Department of Housing provided ten million sets of indemnificatory apartment and various shantytowns housing tasks in 2011 [2]. To respond positively to this national policy, local governments and construction units participate into the construction of indemnificatory apartment actively.

58.2 Division of Indemnificatory Apartment Projects Life Cycle

Construction projects at different times have different jobs and milestones. And because of the special requirements in quality, cost, organization and management, the indemnificatory apartment project life cycle can be divided into decision phase, implementation phase, marketing and sales and facility management according to the management emphasis of each stage (Fig. 58.1).

58.3 Effect of Indemnificatory Apartment Projects Life Cycle Management (LCM)

The Life Cycle Management (LCM) applies a series of advanced technological means and management and integrates the processes of planning, construction, production, operation, maintenance and recycling for the long term interests. Under the premises of rational planning and design, quality construction and safety production, the management goal is to be overall optimal of project life cycle. The indemnificatory apartment projects LCM is a systematic integrated management based on the life-cycle theory and plays a significant role for indemnificatory apartment projects and various stokeholds.

1. From the system point of view the indemnificatory apartment project LCM implements a unified management involved all aspects and helps improve the operational efficiency.
2. The indemnificatory apartment projects LCM focuses on the life-cycle stages of interaction and contact and reflects the indemnificatory apartment project's own requirements. So it can ensure the consistency of the project objectives.
3. The indemnificatory apartment projects LCM requires all participants timely communicate to promote the goals in the exercises of their duties and project tasks.
4. The indemnificatory apartment projects LCM is favorable to the government the right to exercise their management responsibilities effectively and ensures the project carry out smoothly.

58.4 Management Contents of Indemnificatory Apartment Projects LCM

Decision Phase. This phase refers to building plans for investment, developing land supply strategies and then determining the project plan by responsible departments under the state construction tasks of indemnificatory apartment. The investment housing project research carried out by the responsible authorities in the investigation of local conditions about the low-income families is the focus of the phase, including sources of funding, the proposed housing types, housing areas and access to exit mechanism etc.

1. The factor of funds influences the project investment in the whole process of construction. According to national policies, indemnificatory apartment construction funds should come from the government primarily. And the subsidies for indemnificatory apartment, property management and others also require significant capital investment, which means that there is a large funding gap in building indemnificatory apartment [3]. The key to solve the current is to encourage private capital intervention and develop new financing models. The construction of capital investment process involves the three of government, enterprises and banks, to facilitate the effective management of funds a special account should be established and the whole process of capital flows and the use of funds should be published, so the funds can be earmarked to prevent illegal.
2. The access and exit mechanism of indemnificatory apartment is a treatment method that prescribes when can purchase and what to do after exceeding the

standards. It is implemented by documents through local management practices and is a very important part of the indemnificatory apartment management, and the foundations of purchasing and selling.

Implementation Phase. Indemnificatory apartment in the implementation phase includes design and construction, and the important and difficult management contents in this phase including the followings.

1. The indemnificatory apartment standardized design
   In the process of planning and design it should pay attention to make full use of service facilities around the original, and the concentration of new housing communities should try to make facilities complete. Besides, according to the standards corresponding percentage of property houses for business purposes can be deployed in indemnificatory apartment, and its income will be used as the property management operation costs. A reasonable proportion of commercial real estate can also be used to improve living standards of the community and become a financial subsidies source of funding in later property management.
2. The construction management of indemnificatory apartment projects
   The main manager missing is the most important issue facing the construction management. The investment, planning approval, land supply and other processes need the co-management of relevant state departments, making the indemnificatory apartment project have many managers but no one responses for the construction management. Furthermore, because the project management is basically done by developers, who driven by profit maximization in the construction process, can hardly prevent them using their rights to do something by certain means to damage the quality and duration [4]. The government should establish a special administration participating in the whole process to supervise and provide guidance. Meanwhile, this participation is not just in construction management, but to participate in the entire life cycle, and is also not a micro-management, one by one to look over, but macro-control supervision.
3. The price control
   Indemnificatory apartment policy is intended to protect the poor, but the emergence of some problems such as that affordable housing is too large to make the price higher or even as the same as the commercial housing's makes the policy vacant. The price control requires the construction of indemnificatory apartment must be in strict and implemented by standards related to it. These standards involve area control, the scale of construction and procurement of materials and equipments. By controlling the upper limit of these standards the price control objective can be achieved.

Marketing and Sales. The main task of the phase is to certify and operate the purchase review process and determine the price and rent.

1. The purchase review process is a specific implementation of the access and exit mechanism. Large amount of the indemnificatory apartment construction, a big number of the applicants, non-perfect of the current housing management system, no special audit of institutions and full-time staff which make the

application and review process need pass through all levels of government administration, result in miscellaneous links, long cycle and complex review processes of the room's audit. In China, the reality is that the amount of indemnificatory houses in most regions is less than the applicants, so the quality of the managers and the rigorousness of the application review process must be paid attention to solve the problem and reflect fairness.

2. The determination of indemnificatory apartment price and rent is directly related to the construction costs of indemnificatory apartment. Affordable housing's determination of the sales price even needs to refer to the local commercial housing prices. For example, "The Management of Nanjing Indemnificatory Apartment Price Control" jointly formulate by the Nanjing Price Bureau, the Municipal Construction Committee and the Land Bureau proposes the political housing such as affordable housing, low-rent housing price's calculated basis and indicates the base price of the houses consists of the development costs, taxes and profits and describes the form of the fee of the development costs. Low-rent housing and public rental housing rents are determined by the costs and expenses of construction, depreciation, maintenance and operating, when the base price is determined the applicants should bear the appropriate proportion of the different costs according to the applicant's family income, that is to say, different family income charge different rents.

Facility Management. Facility management is directly related to the preservation and reuse of the indemnificatory apartment and low-income resident's quality life, and is an important component in follow-up management [5]. Different from the commercial housing facility management, it cannot rely entirely on the operation of market, must rely on the government's preferential policies to get its survival and development.

1. Dynamic management
   The indemnificatory apartment facility dynamic management refers to the regular publication of rents and operation of the exit mechanism. The rent of indemnificatory apartment will change in pace with the development of economic level, the rent condition of real estate markets and the affordability of single objects, so property management agencies should announce the rent formulated by the price administration department regularly to the pubic. The operation of the exit mechanism can ensure the reuse of the houses, expand the scope of protection, and safeguard the rights of low-income people. The dynamic model proposed above can continue to improve the management of the access and exit mechanism, and enhance the effectiveness of the indemnificatory apartment policies and the operational efforts.
2. Property cost management
   Indemnificatory apartment is facing a particular group—the low-income people, and the indemnificatory houses itself has its specific properties, so the cost charged to it should analyze specific issues. The points of this specific operational method can include: different economic levels get different charges; the property fees to special poor families can be exempted from by government

subsidies for concessions; different properties also have different management methods and fees. In China, indemnificatory apartment property rights are in various forms, such as no property of low-rent housing and public rental housing and limited property of affordable housing. Facility management increases the value of the houses to make the owner getting profits from it, so this part of the cost must be borne by owners.

3. Property subsidies
   The low-income group's affordability is vulnerable, so it can't imagine how difficult if completely rely on the operation of market to charge the property fees. Second, the profit margins of indemnificatory houses is much smaller than the commercial housing, making the property companies have no enthusiasm to manage, thus affecting the quality of property management. Moreover, for the purpose of the housing safeguard pubic policy, the financial subsidies and preferential policies are essential. In addition to financial subsidies conventional financial funds, the commercial shops operated on behalf of the property companies also serve as a source of funding [6].

58.5 Conclusions

The construction of indemnificatory apartment project is a hot social concern in recent years. Its success or failure will have a significant impact to the social security business and the quality of people's life. Compared with the general real estate projects, the implementation of indemnificatory apartment project has more needs to have a scientific management method to ensure it smoothly. The indemnificatory apartment project LCM is a comprehensive management throughout the construction process, guarantees the project's scientific and systematic, is indispensable to construction of indemnificatory apartment project.

Acknowledgments The research is supported by Jiangsu Planned Projects for Postdoctoral Research Funds (Grant No.1101154C) and partly by the General Project of Humanities and Social Sciences Research, Ministry of Education of China (Grant No.11YJCZH124).

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Chapter 59
The Benefits and Implied Costs of JIT Sourcing to Chinese Contractors: A Review of Literature

Peng Wu, Josua Pienaar, and Yingbin Feng

Abstract The just-in-time (JIT) concept originates from the Toyota Production System (TPS) and has been adopted in the construction industry for decades to improve logistics and performance. The concept has proven to be effective in reducing inventory level, improving information exchange and supply chain performance. Many new benefits of JIT sourcing have been identified in recent years, such as the improvement in environmental performance for contractors. However, these new benefits are challenged by many academics based on the rigorous criteria that should be followed when applying the JIT sourcing concept.

It is therefore necessary to re-evaluate the benefits and costs of JIT sourcing, especially to identify what the implied costs are in order to achieve the benefits. This paper aims to take the first step to re-evaluate JIT sourcing for Chinese contractors for better implementation. According to the research aim, this paper is split into two parts. The first section focuses on explaining the traditional and new benefits of JIT sourcing while the second section aims to investigate the implied costs of these benefits. By knowing the benefits and implied costs, the contractors can be fully prepared to apply JIT sourcing to improve their performance.

Keywords JIT sourcing • Contractors • Performance

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_59,

59.1 Introduction

The just-in-time (JIT) concept originates from the Toyota Production System (TPS) [1]. One of the two pillars that support the TPS is JIT, which means that the right parts needed in production reach the assembly line at the time they are needed and only in the amount needed in a flow process [1]. Sugimori et al. [2] firstly examined the JIT concept and stated that the JIT production is a method whereby the production lead time is greatly shortened by maintaining the conformity to changes by having "all processes produced the necessary parts at the necessary time and have on hand only the minimum stock necessary to hold the processes together" ([2], p.555). There are many interpretations about the techniques of JIT sourcing. However, the major ones include long-term contracts, single sourcing, total quality suppliers, dependable deliveries, small lot sizes, exchange of data and stable production schedules [3].

The advocates of JIT sourcing stated that JIT method is a better strategy for making sourcing decisions than traditional forms of purchasing [3]. There are many surveys and case studies which support such statement (e.g. [3–5]). On the other hand, the pragmatic ones stated that the concept can provide many benefits to the buyer, but will create many problems at the same time. The concept should be carefully examined before being applied to the supply chain system.

This paper therefore aims to examine the concept of JIT sourcing for Chinese contractors for better implementation to reduce sourcing costs and improve efficiency. The objectives of this paper include: a) examine the different techniques in JIT sourcing; b) identify the benefits of these techniques; and c) identify the implied costs of these techniques. While the benefits and implied costs of JIT sourcing are identified, contractors will be able to choose the techniques which suit them the most.

59.2 JIT Sourcing Techniques

The concept of JIT sourcing originates from the Toyota Production System. According to Fawcett and Birou [5], the success of the JIT concept in Toyota has led to a wide spread adoption among Fortune 500 manufacturing firms. The original JIT concept in the Toyota Production system aims to: "produce and deliver goods just in time to be sold, subassemblies just in time to be assembled into finished goods, fabricated parts just in time to go into subassemblies, and purchased materials just in time to be transformed into fabricated parts" [1]. The JIT sourcing has extended the concept into supply chain management and aims to requiring frequent deliveries of small order quantities directly to the area of the production floor where and when they are to be used [5].

There are many interpretations about the JIT sourcing techniques (e.g. [3,5,6]). However, the most commonly recognized JIT sourcing techniques include:

- Long-term contracts. The long term relationship between contractors and suppliers will enable the suppliers to cater for all needs of the contractor.

- Single sourcing. Single sourcing concentrates on reducing the supply base by using fewer but more capable suppliers, thereby ensuring that the buying company becomes an important customer to the supplier, reinforcing good buyer/supplier relationships [7].
- Small lot size delivery. The small lot size delivery is considered as a hallmark of JIT sourcing. The literature concentrates on the logistics of getting small frequent batches to the manufacturer at least cost [3].
- Just-in-time. The right parts needed in production reach the assembly line at the time they are needed and only in the amount needed in a flow process [1].

59.3 Long-Term Contracts

The JIT sourcing concept advocates a long-term relationship between contractors and suppliers. According to Schonberger and Ansari [8], the long-term relationship can encourage loyalty and reduce the risk of an interruption to supply. The long-term contracts will also eliminate the re-tendering costs and ensure that costs are reduced in the long-term through repetition [3].

However, there are some problems that can be caused by establishing a long-term relationship with suppliers. The most commonly recognized problem is the loss of price control. According to Ramsay and Wilson [9], single sourcing increases the risks of supply disruption and further leaves the buyer open to pay non-competitive price. Wu and Low [10] found that the price is one of the major considerations when selecting suppliers and is preventing the contractors from using long-term contracts. This is one of the reasons why many contractors are using a backup supplier.

Therefore, in order for long-term contracts to work, a mechanism to reflect price change in the market should be established between the contractors and the long-term suppliers. The role of price in the contracts should be re-examined. As Swift [11] has pointed out, the objective of the contractor is to find the optimal supplier, not necessarily the one who offers the lowest price, the quickest delivery, or the best service. In addition, the suppliers should offer dependable deliveries, i.e. the right amount needed by the contractors should be delivered to the construction site at the right time. Penalties to delivery disruptions caused by suppliers can be added to the long-term contracts.

59.4 Single Sourcing

Ideally, the number of suppliers for each material, or class of materials is one [12]. Single sourcing will help to eliminate waste and improve quality. More importantly, the exchange of data (e.g. change of construction schedule, change of required amount, delivery problems) between contractors and suppliers will be smoother upon the implementation of single sourcing. This will eventually help the contractor achieve better construction scheduling.

Although the objective of the firm is to find the optimal supplier, not necessarily the supplier who can offer the lowest price on the market [11], single sourcing can lead to the loss of price control if a mechanism to consider market price is not established between contractors and suppliers. It should be noted that single sourcing does not necessarily put the construction schedule to disruption. Contractor who will adopt single sourcing will conduct a quality audit of the supplier before such agreement is made. The quality audit is to make sure that the suppliers are competent to cope with the JIT sourcing activities.

59.5 Small Lot Size Delivery

Small lot size delivery is the hall mark of the whole JIT concept. The small lot nature of the delivery will ensure that the materials are used immediately when arrived, thus reducing inventory. The damages during inventory can therefore be reduced.

A consequence of small lot size delivery is the increased frequency of deliveries, which can lead to increased transportation costs. However, there some innovative delivery methods that can be adopted to balance the increased transportation costs, e.g. the Rim Delivery System (sometimes referred to as direct shipment with milk runs). The transportation costs under the milk runs can be reduced by having each delivery vehicle visit several customer locations, provided that the total quantity of goods to be delivered does not exceed the vehicle capacity [13]. The Rim Delivery System can significantly reduce the transportation costs by combining deliveries together, especially when a wide range of materials is required.

59.6 Just-in-Time

The most significant benefit of just-in-time is the reduced cycle time [14]. According to Koskela [14], the cycle time can be presented by the following equation:

$$\text{Cycle time} = \text{Processing time} + \text{inspection time} + \text{wait time} + \text{move time}$$

The just-in-time nature can help eliminate reduce time, wait time and move time, thus reducing the cycle time (construction duration). If the materials are used immediately when arrived at the construction site, inventory will not be needed at the construction site.

However, there are several important aspects that should be addressed before the just-in-time concept is applied to the supply chain. Ideally, the contractor needs to maintain a stable construction schedule. A stable and predictable construction schedule will make just-in-time easier to achieve. The supplier can produce and deliver based on the stable and predictable construction schedule. However, if unfortunately, a stable and predictable construction schedule cannot be achieved, for example, because of change of construction method, a smooth exchange of data (e.g. [15]) should be used to minimize the impact of such changes.

In addition, using the JIT concept in construction may also expose the construction process to disruptions. For example, unanticipated traffic congestion may cause the delay of the delivery, therefore disrupting the onsite construction process. Some actions should be taken to reduce the impact of such disruptions, e.g. by ordering regionally manufactured materials.

59.7 JIT Sourcing and Environmental Benefits

The JIT sourcing techniques are also found to have some environmental benefits, such as low carbon emissions and low wastage. According to Wu and Low [16], immediate use of building materials after arrival can significantly reduce transferring and singling out activities, thus reducing carbon emissions. Nahmens [17] found that by applying some of the JIT techniques to a production line, 9–6.5 people (labour waste), 12 % space (equipment waste) and 10 % wallboard (material waste) can be reduced.

However, some of the practices, especially the JIT delivery, were challenged by some academics. For example, Rothenberg et al. [18] stated that the survey results did not significantly support that hypothesis that JIT is greener, and it was only interview data that supported the relationship between JIT and environmental management practices.

As to JIT delivery, many academics argued that the small lot nature of just-in-time would actually increase the carbon emissions level in the transportation cycle. Venkat and Wakeland [19] stated that just-in-time supply chain did not necessarily reduce carbon emissions. When cold storage is not required for a particular product line, emissions depend largely on the transportation mode, and larger deliveries at less frequent intervals all along the supply chain generally lead to the lowest emissions. Some project managers interviewed have raised the same concern.

However, it should be noted that whether JIT sourcing techniques can help achieve some green benefits should be analyzed case by case, because:

- Just-in-time. The just-in-time nature was believed to have benefits in reducing carbon emissions by reducing unnecessary movement during construction.
- Small lot size delivery. Small lot sizes were considered as an important feature of JIT sourcing and were believed flexible enough to overcome the obstacles of higher delivery costs and loss of discount rates [20]. The small lot nature of JIT delivery can possibly increase the carbon emissions. However, the amount of carbon emissions should be assessed case by case before conclusions can be

made. The small lot nature of JIT delivery can reduce the inventory level. The benefits achieved by lower inventory level, e.g. lower carbon emissions in this case, should also be assessed.

- Long-term relationship. A long-term relationship between contractors, subcontractors and suppliers is essential to a JIT delivery system. It can help improve the information exchange between contractors, subcontractors and suppliers, thus supporting the JIT nature as discussed earlier.

It is therefore necessary for contractors to balance the JIT sourcing techniques, if environmental benefits are going to be pursued. Starting with just-in-time and long-term relationship can help the contractors achieve some green benefits, such as low carbon emissions.

59.8 Conclusions

JIT sourcing techniques originate from the Toyota Production System and have been applied in the construction industry to improve the supply chain. As can be seen from Table 59.1, the most commonly recognized benefits include improved quality, reduced inventory and damages, smoother exchange of data and reduced construction duration. However, it should be noted that not all JIT applications can achieve positive results. The implied costs of JIT sourcing techniques should not be overlooked. The most commonly recognized implied costs include loss of price control, supply disruptions, increased transportation costs and construction disruptions.

It is therefore proposed that the contractors should evaluate the construction projects first before applying the JIT sourcing techniques. The JIT sourcing techniques can be used as stand-alone applications. It means that the contractor can choose one or two techniques that can best serve the construction projects.

In recent years, better environmental performance has been identified as one the major benefits by applying JIT sourcing techniques. However, as can been seen

Table 59.1 Benefits and implied costs of JIT sourcing techniques

JIT sourcing techniques	Benefits	Implied costs
Long-term contracts	Low risk of interruption	Loss of price control
	Low re-tendering costs	Supply disruptions
Single sourcing	Improved quality	Loss of price control
	Smoother exchange of data	
	Better construction scheduling	
Small lot size delivery	Reduced inventory	Increased transportation costs
	Reduced damages	
Just-in-time	Reduced construction duration	A stable construction schedule
	Reduced inventory	Smooth exchange of data
		Construction disruptions

from this paper, all benefits come with implied costs. Knowing the implied costs of JIT sourcing techniques, appropriate actions can therefore be taken for further improvement.

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Chapter 60
Negotiation Scheme for a High-Speed Railway Station Redevelopment Project

Di Wu, ShouQing Wang, and Sheng-hua Ma

Abstract As "the twelfth 5-year-plan outline" is proposed to promote the healthy development of urbanization in China, many local governments' strategic focus of promoting the process of urbanization has been shifting from the traditional way of expanding new urban area, to the way of redeveloping and extending existing engineering projects to improve the population density of urban area. Public-Private Partnerships (PPP) modality has been widely used for this kind of redevelopment projects. However, the enterprise participating in the projects will face many kinds of risks, so the negotiation between the government and the investor is one of the most important business activities. Based on the real situation of a high-speed railway station redevelopment project in China, this paper first identifies and analyzes the key risks faced by the investor tendering the project with "binding PPP" model, then proposes the important factors and solutions to be considered for negotiation with the government. In accordance with the principle of fair risk allocation and aim of maximizing all stakeholders' satisfaction, a negotiation scheme is proposed for the investor. It is hoped that the scheme and relevant conclusions would be useful for enterprises that prepare to invest in this kind of redevelopment projects in China.

Keywords Public-Private Partnership (PPP) • Negotiation scheme • Project finance • Urban construction

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_60,

60.1 Introduction

As is pointed out in the Annual Report on World Cities 2012 by the Chinese Academy of Social Sciences, the proportion of urban population in China has reached 51.27 % in 2011, and urban population for the first time exceeds the rural population. However, in the process of urbanization, there have been some problems in urban development, such as low population density and decentralized development. At the high-level forum on the "12th Five-Year" development of urbanization in 2011, Mr. Yang Wei-min, the Secretary-General of the National Development and Reform Commission, said, "Since the beginning of this century domestic urban built-up area in China has expanded by 50 %, while the urban population increased by only 26 %." This means that the speed of urbanization of our land is nearly twice of that of the population. Therefore, for the sustainable development of the urbanization in China, "the twelfth 5-year-plan outline" proposed that, "determine the urban development boundary reasonably, and increase the population density of built-up area, and prevent the excessive expansion of the mega-cities". Reasonable use of land space has begun to draw more and more attention, and it has been an important way of promoting the process of urbanization for many local governments to redevelop and extend existing engineering projects.

Compared to the traditional expansion construction, urban redevelopment project has larger development scale and requires higher amount of investment, and more professional construction and operation team. Public-Private Partnerships (PPP) modality can solve the host government's problem of fiscal shortage, improve efficiency, create a market for enterprises, and then achieve a win-win. For enterprises participating in such projects, the negotiation with the government is one of the most important business activities in the whole life cycle of the project. Based on the real situation of a high-speed railway station redevelopment project in Southwestern China, this paper proposes the important factors according to the risks, and proposes a negotiation scheme with the local government for enterprises. The scheme has a certain universality, especially its ideas and principles. It can provide a reference for companies involved in similar projects investment. The research design is shown in Fig. 60.1.

60.2 Project Background

This high-speed railway station redevelopment project is located in Southwestern China. Taking the project as an opportunity, the local government would like to reposition the area around the station, so as to promote the process of urbanization. The entire redevelopment project can be divided into four subprojects. They are construction of a high-speed railway station site, the station zones, business district and green belt. The final investment and financing scheme is, the local government buys its shares by the land, and the project company uses the profits of the business

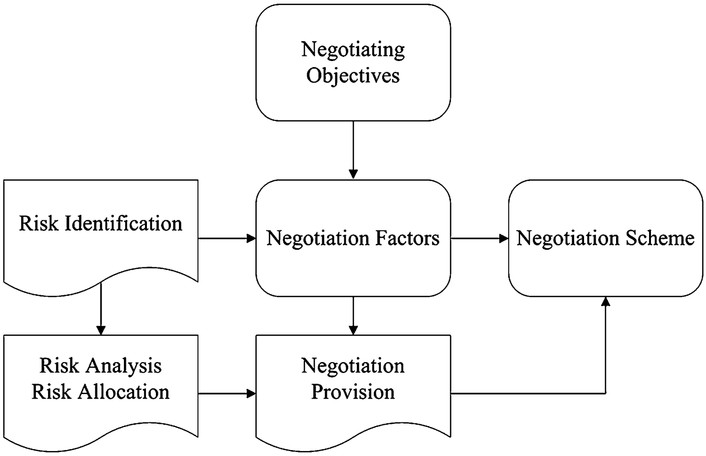

Fig. 60.1 The design ideas of the negotiation scheme

district development to compensate for the expenditure of other subprojects, which is called "binding PPP" model. Other detailed information of the project and the investment and financing scheme can be found in another paper [1].

60.3 Risk Identification and Analysis

60.3.1 Identification of the Main Risks

Wang et al. summarized the risk classification of PPP projects through the three stages: nation, market and project (Fig. 60.2), and found 51 risk factors according to the classification [2]. Combined with the actual characteristics of the environment of the nation, the market and the project, four important risk factors from the 51 above which has a major impact on the project are identified. They are redevelopment duration, government breach of contract, changes of taxes policies and changes in market demand. These risk factors will serve as an important basis to determine the negotiation factors, and the specific impact of the project will be discussed as follows.

60.3.2 Analysis of the Main Risks

60.3.2.1 Duration

The construction investment of this high-speed railway station contains 30 % from local government and 70 % from the Chinese Ministry of Railways. It would

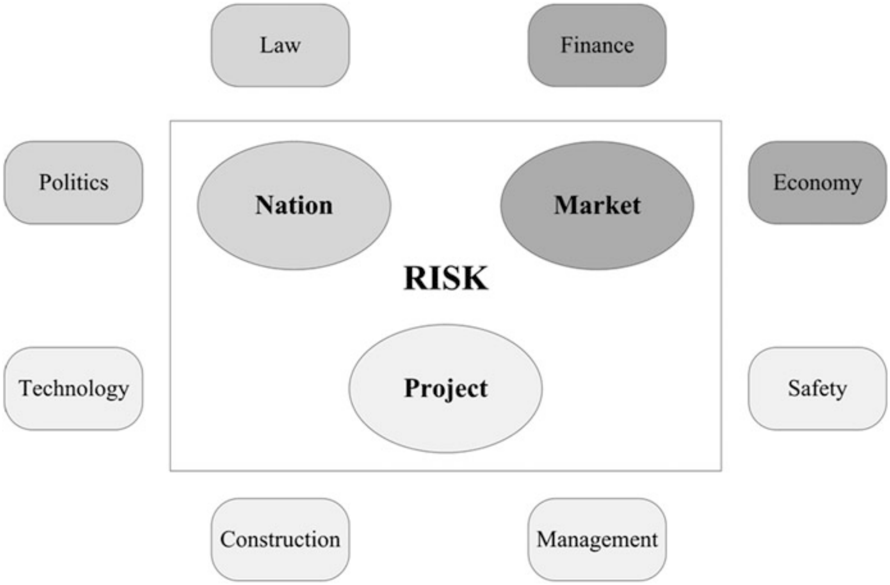

Fig. 60.2 Risk classification

Table 60.1 Impact of delay

Delay time (year)	IRR
0	19.41 %
1	10.85 %
2	2.67 %

influence the property around whether the high-speed rail could be open by the duration, and it must have a serious impact on the cash flow of the business district. It is estimated that at the operating period, the annual net cash flow of the project is 421,103,800 yuan. The project internal rate of return (IRR) once the high-speed rail delays is calculated according to the project's financial budget targets, as is shown in Table 60.1. Obviously, it exerts a tremendous influence whether it delays or not.

60.3.2.2 Government Breach of Contract

In this project government breach of contract refers to the change of the way of land transfer. The final investment and financing scheme is "binding PPP", which means the local government buys its shares by the land, and the project company obtains the land use rights. But the Article 12 of the People's Republic of China on Urban Real Estate Administration Law stipulates: "the use right of commerce, tourism, entertainment and luxury residential land, if possible, must be transferred by the way of auction or tender." So government may default on the land transfer.

Table 60.2 Impact of taxation

	Before taxation	After taxation
NPV(million yuan)	2,972.88	1,147.53
IRR	19.41 %	9.10 %
Dynamic recycling period(year)	7.66	8.45

Table 60.3 Impact of market

Amount of reduction of market demand	IRR (%)
10 %	13.90
20 %	8.30
30 %	2.60

Table 60.4 Risk allocation

Risk	Allocation
Duration	Government
Government breach of contract	Government
Taxes	Government and enterprise
Changes in market demand	Government and enterprise

60.3.2.3 Taxes

In the construction and operation period of the project, it will be a significant impact on the taxation of the project in the event of changes of government policy adjustments or in the macroeconomic environment. To measure the impact of taxes on the project, according to the project financial indicators, considering the turnover tax, land value increment tax and income tax, the project financial data before and after taxation is calculated, which is shown in Table 60.2. We can concluded that, taxation has a great impact on the project.

60.3.2.4 Changes in Market Demand

The city where the project is located in has a dual-core strategy of development. There are two alteration areas around the cores, and the project in the Southern District. Meanwhile, the traffic conditions around the project are very poor. The two reasons above might lead to reduction in market demand, resulting in the reduction of profits. The internal rate of return of the project company through sensitivity analysis is calculated, as is shown in Table 60.3. It is obvious that changes in market demand have a great impact on the project.

60.3.3 Reasonable Allocation of the Main Risks

PPP projects need a reasonable risk allocation between the government and the project company. Referring to the principle of risk allocation of PPP projects by Ke et al. [3], Table 60.4 lists the reasonable allocation of the four main risks of this project. This allocation will be important to determine the negotiation provision.

Table 60.5 Negotiation scheme

Negotiation factors	Levels	Scheme
(1)	Bottom line	Allowance 50 % of the cost of land transfer, about two billion (12 %)
	Basic scheme	Shares by the land (19 %)
(2)	Bottom line	Operating period delays
	Basic scheme	Allowance the rent according to the budget (government rents)
(3)	Bottom line	Allowance the part below 90 %
	Basic scheme	Allowance the part below 95 %
	Try if possible	Promise to limit competitiveness
(4)	Bottom line	Reduction and exemption of taxes

60.4 Negotiation Scheme Design

60.4.1 Negotiating Objectives

According to the profitability of the related enterprises, the project company negotiating objectives of this project are: capital of the internal rate of return is not less than 12 %; dynamic payback period is no longer than 15 years.

60.4.2 Negotiating Factors

Based on the risks above, the negotiations factors is summarized as follows:

(1) The form of compensation based on the value of the land;
(2) The sharing of damage caused by delay of high-speed rail;
(3) The lack of income caused by changes in market demand;
(4) Tax incentives.

60.4.3 Negotiation Scheme

From the perspective of the project company, negotiation scheme includes all their requests to the government on each factor. Each factor has a bottom line and a basic scheme to achieve the negotiating objectives. The project company should also fight for better scheme if possible.

According to the risk allocation in Table 60.4, for the risk which should be undertaken by the government, standard of the bottom line should be raised. Specific negotiation scheme is as follows.

60.5 Summary

This paper has identified several typical risks in a real project, summarizes the negotiation factors according to the risks. Based on the principle of reasonable risk allocation and the aim of all stakeholders' satisfaction, a negotiation scheme is designed. The negotiation enterprises can apply the design ideas of this project, in the negotiation process combined with the actual situation. At the same time, a variety of business negotiation skills need to be made comprehensive use of to obtain a satisfactory negotiation.

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Chapter 61
The Impact of Project Stakeholders' Relationships on Project Performance

Jingru Li and Lan Qiu

Abstract More and more researchers begin to study the impact of relationship between stakeholders on project performance. Base on the literature review, this paper summarizes the definition of stakeholders, the definition and classification of stakeholders' relationship. Then the two main perspectives of present research on relationship – supply chain management and social network are introduced and discussed. Based on the discussion, the study offers orientation for the future research, which should be from the social network perspective.

Keywords Stakeholders • Relationship • Project performance

61.1 Introduction

To improve the level of project management in engineering is a core problem, but in fact, poor performance occurs frequently, such as time delays, cost overruns and quality defects. So finding the key influencing factors on cost, quality and time – the iron triangle performance is helpful for project management. Recently, researchers pay more attention to the impact of stakeholders' relationship on project performance. Wood [1] regard partnering is one of the most significant means for improving project performance. Larson [2], Ankrah and Langford (2005), Chen [3] also show that stakeholders' relationship has a distinct effect to project performance. Chan et al.[4,5], Jha and Iyer [6,7] have studied the performance of success project and found that cooperation, commitment, communication, conflict and interaction between project participants are the key factors to influence project performance. Therefore, it is necessary to summarize and discuss how the relationship between stakeholders impacts on project performance.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_61,

61.2 Stakeholders' Relationships

61.2.1 Project Stakeholders

American economist Freeman [8] defines stakeholders as any group or individual who can affect or is affected by the achievement of the organization's objectives. Project Management Institute [9] defines project stakeholders as organizations and individuals who actively participate in projects, or the positive and negative stakeholders. According to the above definition, construction project in the entire process involves stakeholders such as investors, owners, designers, contractors, subcontractors, suppliers, supervisors, consultants, government, loan syndication, community, and other users. However, according to Lena et al. [10], most researches on supply chain concerned only about the relationship between owner and contractor, few studies on subcontractors and suppliers, and the rare studies on all stakeholders.

61.2.2 Relationships

Relationship literally means the interaction between things or the states or the nature of the links between people and people, people and things. In China, it is often understood as the interpersonal relationship, emphasizing contact between the individuals.

Relationship as academic terminology in relationship marketing is a link between two or more objectives, people and organizations, or social connection because of the basis for common interests, interests and resources [11]. It mainly focuses on the relations between individuals and organizations in the consumer market. But in the commercial market, IMP group considers the relationship as repetition of plot and emphasizes the company relationship. Hakansson and snehota [12] define the commercial market relationship as commitment of two companies which have mutual interaction between them.

In construction domain, conception of relationship has no uniform definition. Generally, the researches on relation are rarely defined this concept, and many literatures refer to the Construction Industry Institute's (CII) definition of partnering: "A long-term commitment by two or more organizations for the purpose of achieving specific business objectives to maximize the effectiveness of each participant's resources". Xu [13] in his doctoral thesis defines the relationship as the connection between the project participants who were driven by the complementary resources and common business interests based on project contract network. Liu [14] shows that the relationship between stakeholders in a project is an interdependent and mutual collaboration working partnership in the process of completing task. This relationship is dynamic, multivariate, role based on network relations, namely the project governance social network.

61.2.3 Relationship Classification

According to CII, construction projects relationship can be classified into traditional antagonistic relationship, partnership and strategic partnership. With the development of construction industry and the more intense competition, presently in the big city such as Shenzhen, the relationship of general project stakeholders is a partnership and the traditional opposite relationship slowly fade away.

Specially for project, there are three kinds of relationships, including the relationship between organization and organization, organization and personals, and between personals. Generally, we are concerned with the first kind of relationship.

61.3 The Impact of Project Stakeholders' Relationships on Project Performance

The project can not separate from the values, norms and environment of stakeholders' relationship, because project depends on different resources such as money, time, knowledge, reputation, trust, relationship through which to obtain information, knowledge and other resources [15]. Researchers have researched the impact of project stakeholders' relationships on project performance mainly from two perspectives: supply chain management and social network.

61.3.1 Partnership Based on the Supply Chain Management

The supply chain management has originated in manufacturing. Christopher [16] indicates that a supply chain is a network of organizations involved through upstream and downstream linkages in the different processes that deliver value in the form of products and services to end users. Christopher [17] defines supply chain management as the management process of the relationships between different customers and suppliers to deliver better value at less cost. Through the adoption of supply chain management, industry sectors have achieved significant improvement in performance.

Numerous researches have verified that the relationship between supply chain partners impact obviously on project performance. Ng et al. (2002) concludes that the lack of open communication is one of the major causes of poor project relationship. Chan et al. [5] believes that partners need to establish mutual trust relationship in order to make management more efficient. Lack of trust is a key barrier to collaborative relations [18]. Odeh and Battaineh [19] show that the contractual relationship has significant effect on poor performance. Owning common objective will promote project performance [20].

Meng [21] conducts a questionnaire survey to explore the impact of supply chain relationships on project performance in the UK construction industry. He concludes that the top ten supply chain relationship is common goals, sharing, trust, no-blame culture, teamwork, communication, problem solving, risk allocation, performance evaluation and improvement. The research shows that project stakeholders' relationships have various impacts on project performance. Of them, cost is significantly associated with communication, risk allocation, no-blame culture, performance measurement and problem solving, and slightly significant impacted by trust and common goals; defect is significantly associated with problem solving, and there are marginally significant associations with trust, joint working, common goals and communication; time is only significantly influence by joint working. It finds that supply chain relationship has more significant impact on cost.

Jin and Ling [22] categorize the relationships into 14 risk relationship and 16 tool relationships. The risk relationships include partner's incompetence, partner's exploitation, improper contractual agreement, unfairness in tendering, partner's project personnel lacking interpersonal skills, partner's distrust, insufficient communication, partner's short-term focus, excessive demands from partners, disputes with partners, over interference from partner, cultural conflict and change of partner's personnel; the tool relationships are seeking partner with good record of collaboration experience, establishment of good relationship with local partners, involving contractor in the project early, drafting a clear contract, gaining support of top management, adhere to mutual goals, specify clause to prevent corruption, maintaining efficient communication, appointing staff with interpersonal skills, seeking partner with similar culture, holding workshops for relationship building, solving problem jointly, adhere to defined responsibilities, implementation of a progress evaluation system, empowering staff with authority and cultivate learning atmosphere. The result shows that insufficient communication, over interference from partner, adhere to mutual goals, and empower staff with authority are the four critical relationship-based factors which significantly associate with performance metrics.

Although these meaningful research results have been achieved, there is still lack of systematic investigation on the influence of supply chain relationships on project performance.

61.3.2 Relationships Based on the Social Network Analysis

Social Network Analysis (SNA) originated from psychology and anthropology in the 1930s. Its research mainly covers two topics: position-orientation and relationship orientation [23]. The position-orientation studies the actor's position influences, including centrality, closeness, roles, and structure holes, etc.; the relationship orientation focuses on network relationship characters, including relationship strength, density, and contents, etc.

The SNA views a project as a system environment, which is joined by various relationships. In the project system, stakeholders are connected by anfractuous lines, which represent the relationships among them. The purpose of network analysis is examining how relationship structures impact behaviors, and this theory concerns with the "structure and patterning" of these relationships over time and seeks to identify both their causes and results [24–26].

Some researchers have achieved good results by SNA. Chinowsky et al. [27] constructs an initial social network model of construction project to analyze the project team performance. They find that the construction industry is based on network instability where project participants are regrouped with little regard to past network connections. This instability places the network in a scenario where minimum experience exists between the participants and thus forces the network to rebuild a significant portion of the trust relationship in each project. In addition, construction networks are often required to move from the formation stage to the collaboration stage very rapidly due to schedule constraints. This leaves little time for the participants to build trust prior to the execution of the project tasks. Third, the contractual relationships defined in a project context can serve as barriers to the free exchange of knowledge due to liability concerns. Based on these result, Chinowsky et al. [27] extends the model to illustrate the social networks of four full-service engineering companies. The results shows the relationship of the social network model and the high performance in the project teams.

Ding [28] undertake a quantitatively analysis on the project network evolution for a large construction project, considering the alliance of owners and supervisors and the alliance of contractors and supervisors respectively. The results indicate that stakeholders embedded network in different ways. Namely, supervision unit is an independent decision-making unit or alliance with owners or contractors that will affect the structure characteristic of network. Through SNA, the research analyse project stakeholder relations network evolution and behavior regulation capacity which can reduce the stakeholders' governance role risk and improve project performance.

Li and Le [29] builds up a complex network model to analyze organization role and compare with traditional formal organization structure model for a case of the 2010 Shanghai World Expo. It draws a conclusion that organization's role analysis can not only contribute to the study of the organization's position, function and relations, but also help to establish the project control method to improve project performance.

These researches all indicate that SNA is an important means for organization of construction project to achieve high performance of multi objective management.

61.4 Conclusions

Through summary the definition of stakeholders, the definition and classification of stakeholders' relationship, the relationships of construction project is fully understood. Then the two main perspectives of present research on relationship – supply chain management and social network are introduced and discussed.

In our view, social network methods is a promising research paradigm. First, project organization is a social network and has many stakeholders who embedded the network. Second, stakeholders' relationships are multiple relationships, and influent by structure of the network and other stakeholders' impact. Our future research will build up a social network model to examine the influence of relationship type and structure on project performance.

Acknowledgment The present study is part of the Humanities and Social Sciences research project entitled 'Construction project stakeholders' attitude and behavior toward construction waste minimization and transformation mechanism' (11YJAZH047) funded by the Ministry of Education of the people's Republic of China.

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Chapter 62
Stakeholders Management in Construction Project: A Case of Hydropower Station Project

Dong-bing Huang, Junfang Liu, and Chengjun Tang

Abstract In one construction project, different stakeholders have different objectives. The uncertainties among stakeholders always can bring the project risks and conflicts. This paper's research background is the Luojiaohe hydropower station's project management. The paper analyzes the roles of different stakeholders as well as the values and interests they want to gain. Through formulating the stakeholders' management strategy, people can manage and coordinate the construction project stakeholders.

Keywords Stakeholder • Construction project • Project management • Hydropower station

62.1 Introduction

In a construction project, different stakeholders have different expectations for the construction project, enjoy the different interests, play different roles, and have different purposes and pursuits. In order to ensure the management of construction project success, we must analyze the stakeholders' position, function, communication mode, and management characteristics in the management of construction project. We can see from research situation at home and abroad that stakeholder theory research mainly involves the foundation of stakeholder participating in management, as well as the definition and classification of stakeholders. They are all mainly on theoretical research. The empirical study support is less. In addition, research results' operability is not strong [1].

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_62, © Springer-Verlag Berlin Heidelberg 2014

Without the support of the construction project's stakeholders, construction project can not obtain the necessary resources and environmental conditions, and it is hard to succeed [2]. This paper combines relevant theoretical results, begins with and emphasizes stakeholder management.

62.2 Traditional Construction Project Management Mechanism

From our country's researches we can see that traditional construction project management mechanism usually adopts the way of design- tendering -construction-completion acceptance. That is to say, after construction project proprietors setting up the project, they determine the design organization and construction organization through the way of bidding, and then entrust supervising units to supervise project design, construction progress and quality. The traditional construction project management mechanism is the relationship of a series of separated contracts. But this relationship has many disadvantages. First, all the stakeholders only care about their duties within the scope of the contract, make decision from their own interests. Therefore it is easy to cause conflicts among stakeholders. Even it will bring out opposite relationship, influence the cooperation of all parties, and hinder mutual communication and understanding among the construction project stakeholders. Secondly, the management mode which is lacked of communication and is stepped by stepped makes construction project stakeholders have limited knowledge about project goals. The stakeholders have the tendency of maximizing its own interests. It is easy to have "local best and overall general" phenomenon. Thirdly, the construction project structure has many levels, and then management aspects and process aspects also increase. These lead to information's shortage, distortion and delay. Much information is isolated. It is difficult to control the construction project. We can see that traditional construction project management mechanism has many disadvantages in the changing construction project environment. Its effectiveness reduces greatly. It is urgent to research reengineering.

62.3 Construction Project Management Mechanism Based on the Stakeholder Theory

As market competition becomes increasingly fierce and business environment becomes persistently changing, project requirements turn into diversification and complication. The uncertainty of the project execution becomes higher. All kinds of advanced technology and management method are applied to stakeholders of construction project constantly. It only attaches importance to the enterprise internal resources development and utilization. The construction project management

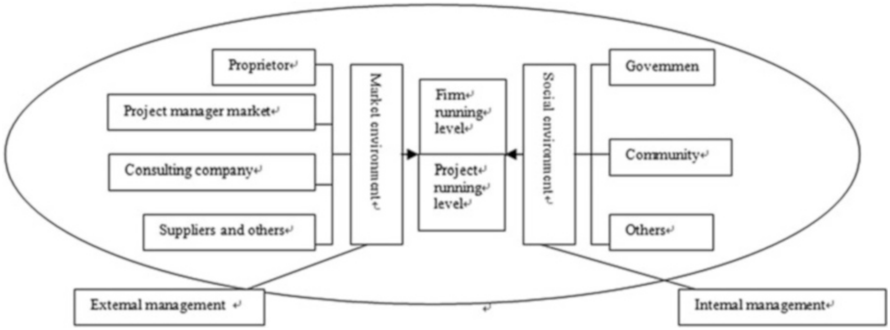

Fig. 62.1 Project stakeholders management structure

mechanism which stakeholders confront each other already can not adapt to the new project environment.

The construction project management mechanism based on the stakeholder theory is that each of construction project stakeholders included the proprietors, the contractor, the project management team, the suppliers, the consulting company, the supervision organization, the government, the relevant administrative department, the community and others establishes construction project management enterprise's supervision and coordination center, and consummates coordination and communication mechanism to realize sharing risk reasonably and solving contradiction friendly. Wang Yulin 2005 combines enterprise stakeholders' management with understanding for construction project management to study construction project stakeholder management structure [3]. Figure 62.1 gives the project stakeholder management structure.

According to the stakeholder theory, the construction project is regarded as a large collection of contracts. Each contract party can be regarded as the project stakeholder. In the whole process of the project implementation, each stockholder's interest should be protected practically [4]. However, the most important way to protect their interests is to let stakeholders participate in the construction project's management structure. The construction project management mechanism is based on the stakeholder theory whose carrier is construction project. Its coordination center is construction project enterprise. The construction project management mechanism considers the interests of all parties and its guidance is a plan which is synchronized, coordinated, integrated with construction project stakeholder. The construction project management mechanism's support is various technologies. It can reach project's best accomplished effect and make project stakeholders get a win-win result through designing, coordinating and optimization control to information flow, project flow and cash flow.

Compared with traditional construction project management mechanism, the construction project management mechanism based on the stakeholder theory overcomes traditional construction project management mechanism's some defects. It has distinct characteristics: firstly, the relationship among the stakeholders changes from traditional opposition into cooperation; secondly, when they select design organization, construction organization and suppliers etc., they emphasize price, quality and reliability standards, etc.; thirdly, it breaks the gap between different stakeholders, and it facilitates information flow and object flow in horizontal direction and vertical direction; fourthly, it pays attention to the whole project's implementation and result; finally, it emphasizes the use of information tools. They use automation and electronization to increase the efficiency of information flow.

62.4 Analysis on Construction Project Stakeholders

62.4.1 Project Profile

The Luojiaohe hydropower station was approved to build in 2004. Its total investment is 120 million RMB. The installed capacity is 2×10 MW. According to the installed capacity, we know that this project belongs to medium reservoir small (one) type power station. Its engineering level is third-class. The dam is level 3 building. Its factories and others are level 4 buildings. The Luojiaohe hydropower station consists of the dam, spillway, clamping, power generation tunnel and factories and other main buildings. The hydropower station project management began in October 2004 and ended in March 2007. And the hydropower station generated electricity on 28 September 2006. The hydropower station project management is a whole process management which includes revision preliminary design, construction drawing design, engineering construction, till to delivery operation.

62.4.2 Construction Project Stakeholders

The construction project stakeholders can be defined as groups or individuals who can influence the realization of the project or can be influenced by the project. The construction project stakeholders participate in the project directly or indirectly during the construction process. Each project has its particular stakeholder groups. According to the definition of construction project stakeholders, the stakeholders mainly include the Developer, construction unit, and design organization, the Contactor, suppliers, supervision unit, financial institutions, relevant governmental departments, community and users. Figure 62.2 shows the stakeholders of the Luojiaohe hydropower station in every stage.

In different stages of the construction project, the project stakeholders are also different. And the different construction project management mode will make each stage of the project stakeholders different. The stakeholders in the project concept

Project concept stage	Project planning stage	Project implementing stage	Project ending stage
• Construction Department	• Design unit	• Local people	• Financial institutions
• Development and reform department	• Construction department	• Design management unit	• Quality supervision unit
• Water conservation department	• Development and reform department	• Scientific research units	• Subcontracting unit
• Environmental protection department	• Governments at all levels	• Government's functional departments	• Government's functional
	• Governments at all levels	• Subcontracting unit	• Client
		• Supply unit	

Fig. 62.2 Stakeholders of the Luojiaohe hydropower station

stage mainly include construction department, development and reform department, water conservation department and environmental protection department. The stakeholders in the project planning stage mainly include construction department, design unit, governments at all levels and development and reform department. The stakeholders in the project implementation stage mainly include scientific research units, local people, government's functional departments, subcontracting unit and supply unit. The stakeholders in the project ending stage mainly include quality supervision unit, government's functional departments, subcontracting unit and client.

62.4.3 *The Hydropower Station Project Stakeholders' Expectation Analysis*

Engineering can't avoid having economic or noneconomic connection with various external organizations in the implementation. These stakeholders who are in order to seek for their maximized interests all expect to gain the unique value from the connection. This value may be visible economic interests, or may be invisible reputation, knowledge, technology, management, and other value. Figure 62.3 gives the stakeholders' expectations of the Luojiaohe hydropower station.

62.5 Construction Project Stakeholders Management

62.5.1 *Management Process*

In order to realize construction project stakeholder management, the hydropower station project management team applies the normative management program to deal with construction project stakeholders' relationship. The management steps

Serial number.	Categories.	Subclasses.	Expectation.
One.	Client.	The energy development Co., LTD.	● Making the first wholly -owned hydropower station to generate electricity soon. increasing the company's earning;. ● Ensuring the engineering's quality and days for construction;. ● Improving the project proprietors' industry image; .
two.	Support parties.	The government's functional departments.	● Contributing to the local economy's sustainable development ;. ● Constructing the harmonious society, constructing a new socialist countryside;.
		Residents around the hydropower station area .	● Increase employment opportunity.
three.	Contractors .	Construction project management Co., LTD.	● Completing the project goals according to the contract period;. ● Adopting the new technologies, reducing construction difficulties, Improving work efficiency;. ● Gaining the whole project management practice's successful case;. ● Exercise team, improve the company's brand;. ● Achieving project profits more than 30%;. ● Customer satisfaction rate above 90%;.
		The hydropower station project management team.	● Finishing the project goals smoothly;. ● Improving work skills. Getting promotion opportunities;. ● Forming a efficient and harmonious team;.
four.	Subcontractors.	The BJ water department.	● Expanding the company's influence;. ● Promoting the new technologies;.
		The second GD hydropower bureau.	● Finishing the project goals smoothly;. ● Adopting the new technologies;. ● Knowing more cooperative partners, improving the market competitiveness. Providing more market opportunities;.
		Guizhou PH company.	● Finishing the project goals smoothly;. ● Improving the company's brand;. ● Knowing more cooperative partners, improving the market competitiveness. Providing more market opportunities;.
		The supervision company.	● Ensuring the engineering's quality;.
		The GZ dam monitoring center.	● Finishing the project goals smoothly;. ● Ensuring the engineering's quality;.
five.	Other related parties.	The water quality monitoring station.	● Meeting the engineering's quality requirements;. ● Ensuring the engineering's quality;.
		The first DF Cement plant.	● Improving the company's brand;. ● Ensuring the engineering's quality;. ● Knowing more cooperative partners, improving the market competitiveness. Providing more market opportunities;.

Fig. 62.3 Luojiaohe hydropower station project stakeholders' expectation

are: (1) distinguishing construction project stakeholders and defining them, (2) confirming project stakeholders' requirements, (3) evaluating stakeholders' influence and the importance, and classifying stakeholders' requirements and distinguishing between primary and secondary requirements, (4) making different management strategies to different stakeholders, and (5) implementing the construction project stakeholders' management strategy, (6). Evaluating and improving the construction project stakeholders' management strategy continuously[5].

The hydropower station project management is a dynamic process. According to the feedback of the practice and the changed environment, we can adjust, supplement, and amend dynamically. In the different stages of construction project management's life cycle, different stakeholders have different influences and roles to the construction project. Therefore, this construction project stakeholders management has different management emphases and different management strategies in the different stages of the project management. Figure 62.4 shows the construction project stakeholders' management process.

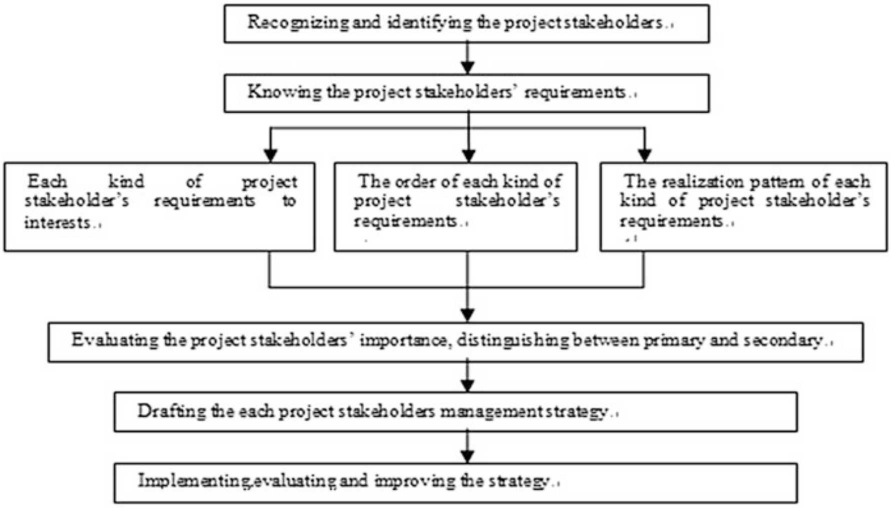

Fig. 62.4 The construction project stakeholders management processes

62.5.2 Management Measures

In order to implement construction project stakeholders management effectively, the hydropower station project team adopts a series of special measures.

- To promote and maintain good cooperation relationship, and establish the common goals. Project management goals are specific, measurable and facing results.
- To confirm all parties' duties and rights. The cooperative field, way, content, time limit, responsibilities, interest distribution way and contradiction processing method are formulated in the normative way of contract or agreement. People can use the forms of purchasing contract, supply contracts, franchise rights, guaranty contract, and performance bond and management agreement to share the construction project's core risks.
- To establish the perfect information communication network. After establishing the perfect information communication network people can find problems and solve them as soon as possible.
- To implement the coordinated and different management strategy. These main stakeholders who have a legal contract relationship with hydropower station are more likely to choose to support the project. They have natural cooperation relationship with construction project. So people should fully understand their benefits that they hope to get and then take the corresponding management strategy. People should absorb them to participate in project management as far as possible. However, those secondary stakeholders who do not involved in the project deals formally have a complicated relationship with construction project. They may adopt behaviors of collaboration and support or threat and

Serial number	The hydropower station stakeholders	Project management results	Conclusion
one	The energy development Co., LTD.	• The investment has been controlled within the contract price; • Two machine sets has generated electricity on 28 September 2006; • The project function and quality are very good.	Accomplishment
two	The government's functional departments	• The local residents' life has improved;	Accomplishment
three	Residents around the hydropower station area	• The living standard has improved;	Accomplishment
four	Construction project management Co., LTD.	• The company's benefits have increased; • It has improved all staff's work efficiency; • The company has gained highly acceptance from social sectors.	Accomplishment
five	The hydropower station project management team	• The average wage income has increased by 20%; • The work environment is good;	Accomplishment
six	The BJ water department	• The company's benefits have increased; • They have gained acceptance from contractor and relevant units.	Accomplishment
seven	The second GD hydropower bureau	• The company's benefits have increased; • They have gained acceptance from contractor and relevant units.	Accomplishment
eight	The PH company	• The company's benefits have increased; • They have gained acceptance from contractor and relevant units.	Accomplishment
nine	The supervision company	• The company's benefits have increased; • The project's quality is good.	Accomplishment
ten	The GZ dam monitoring center	• The company's benefits have increased; • The project's quality is good.	Accomplishment
eleven	The water quality monitoring station	• The project has been constructed safely; • The project's quality is good.	Accomplishment
twelve	The first DF Cement plant	• The company's benefits have increased.	Accomplishment

Fig. 62.5 Results of hydropower stakeholders management

limit in different situations. According to the different benefits of each stakeholder, people can adjust the specific management strategy to each stakeholder, at the same time notice to make overall plans and take all factors into consideration.

62.5.3 *Management Results*

Through the Luojiaohe hydropower station project management's stakeholders management practice, we can analyze the stakeholders and the benefit relationship among the stakeholders. Figure 62.5 lists the results of stakeholders management of the Luojiaohe hydropower station.

62.6 Conclusions

The success of Luojiaohe hydropower station construction project shows that if we use stakeholder theory to analyze construction project stakeholder systematically, it has great significance to improve the satisfaction of stakeholders, realize the overall benefit of project, and guarantee the project's smooth implementation.

The past construction project management practice experience proves that the construction project is hard to realize the project goals without stakeholders' support, without knowing stakeholders' roles and responsibilities and without cooperation among stakeholders. The construction project involves many stakeholders, and their relationship is complicated. The construction project is a synthesis of multi-stakeholders. The construction project stakeholders management is an important way to solve project's interests' conflicts, realize the maximization of the interests. Using scientific and reasonable project stakeholders management can promote construction project's success.

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Chapter 63
Agent Construction System on the Management of Government Investment Project

Yu Fan, Meng Wang, and Hong Zhang

Abstract By analyzing the currently problem existing in China Government investment project managements, the paper stresses the necessity of using the management model of ACS in China Government investment project managements, and then find the implementation problems in ACS. At the same time, the paper optimizes the development of the ACS. It is proposed that we should continue to prefect and advance the measures related to ACS in the policy, organization, the system establishment and market environment. There are also needed endeavors in accomplishment the ACS law and company qualification management, clearing the participators' functions in ACS, accomplishment the project guarantee system, unifying the ACS charge standard. The finial purpose of the paper is proposing some suggestion on the improving project management level for government.

Keywords Agent construction system (ACS) • Government investment project

Government investment project refers to the use of foreign government grants and national financial security for domestic and foreign financial organizations loans owned or joint venture to build fixed assets investment projects that is in order to

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_63,

adapt to and promote the national or regional economy development, satisfy the social culture, life needs, as well as political, national defense and other factors are taken into account, through finance by the government investment, issuance of bonds or financial bonds [1]. Along with the investment system reform in China continued to deepen, the old abuses of government investment project management pattern day by day, seriously hindered the reform and improve the efficiency of government investment. Under this background, in 2004 July, the State Council issued the "State Council's decision on the investment system" is presented in the paper to accelerate the non-business government investment project ACS management mode.

63.1 Problems Existing in Government Investment Project Management

For A long time, governments at all levels in our country imposed on the direct investment project management single mode of "financial investments, government managed". As the socialist market economic system is being gradually established and perfected, the government investment project management and construction system, mode, custom that under the planned economy system still plays an important role in the current government investment project management. The formation of government investment project of "investment, construction, supervision, use" multiple roles in a play model still exists. Although the model played a certain effect, but also has a lot of problems.

Some government departments are responsible for both investment approval, supervision of construction market, and direct projects construction that lead to integration of government administration with enterprise, responsibility is not clear and supervision ineffective. It is difficult to implement effective supervision and control, It is difficult to rectify the illegal problem in construction process, It is difficult to establish an effective system of responsibility, and even easy to lead corruption.

Government investment projects organized and implemented by temporary construction team which lack of engineering manager and technician required in the construction and project management expertise, and experience. That lead to the various phenomena of mismanagement such as decision-making is not mature enough, random adjustment program, long construction period; efficiency is not high and low investment benefit.

While, Infrastructure team disbanded at the end of the project, resulting in a waste of human, financial, material and information resources; Government investment project by construction company self-occupied, The user by itself interest drive, extremely easy caused contend project and funds. That led to some phenomenon such as "fishing" engineering, super scale, super standard construction, and super budget. Construction and supervision companies are the direct beneficiaries of "three super" thereby forming interest linkage body, aggravate the investment hunger. Monopoly phenomenon seriously in management of government investment projects, which cannot adapt to the needs of the market reform.

Therefore, it is necessary to imposed on the government investment project organization for institutional innovation and process reengineering, active exploration and practice of new modes of investment management.

63.2 ACS and Its Model

63.2.1 ACS

ACS was with the development of market economy, increasing specialization requirements for project implementation and technical content, and being widely used in engineering construction project management in the developed countries of the world. ACS means the project investment management company by means of bidding to select the professional project management company (agent construction company), to undertake the construction project organization and management of funds, and in accordance with the relevant country regulations and the requirements stipulated in the contract, after the completion of construction according to regulations delivery the project system of engineering construction.

Agent system based on the investment, construction, operation and supervision of "four separate", transformed the original building of administration management relations into contractual relationship. The principal-agent relations (as shown in Fig. 63.1) constitute the logic starting point and basis of ACS operation and management and can effectively inhibit the growth of corruption. It solves the last construction project principal issue of responsibility of project main body is unidentified and responsibility is not clear; so as to establish constraints and incentive mechanisms, impose strict controls on project targets. Agent mode is the summary of successful experience and promotion of all over the country on a

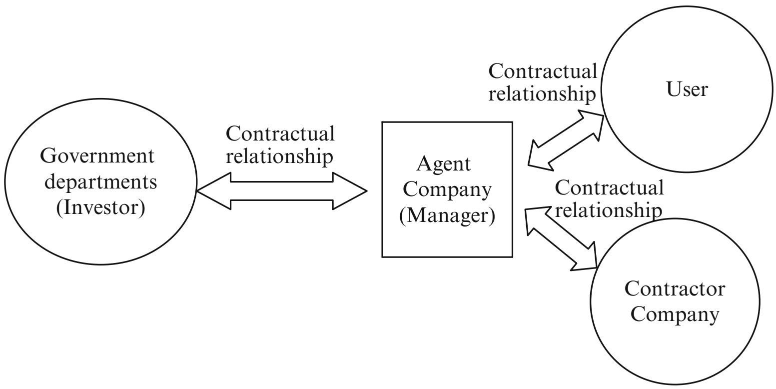

Fig. 63.1 Agent relationship in agent construction system

trial basis "agent" in recent years. As the construction main body, construction company's nature of work for the project construction management and consulting, and company property is a self-financing enterprise, competitive advantage is professional management level, profit model is the collection agency fees, consulting fees, and from the Save construction investment commission. Agent has the following three advantages: firstly, To give full play to the role of market competition (such as bidding), from the mechanism to prevent the "three super " acts. Secondly, to regulate the construction of government investment project management, enhanced user the sense of responsibility of the project. Third, help to accelerate the realization of the transformation of government functions, separate government functions from enterprise management.

63.2.2 Models of ACS in China

Now China has more than 20 provinces and cities begin the government invests project "ACS" trial implementation and promotion work, according to the different nature of the client and agent, ACS throughout the country is divided into the following several kinds of models [2].

63.2.2.1 Shenzhen Model

Earlier in the practice of "ACS" should be Shenzhen mode similar to the Hong Kong model. That is government contributors commissioned projects to government sector management that specifically set up. The specific approach is: after a project is established, government departments designated professional and technical personnel as the project leader and government departments (construction management center) signed the document of project management responsibility. Responsible for the contents include: Organization project proposal report editing, feasibility study report prepared, design and project budget, and invite public bidding, site management, completion acceptance, and settlement, full processes work. Other departments of construction management center to ensure technical scheme, total investment control, invite public bidding and contract, the disbursement of money and other monitoring, assist and service work.

63.2.2.2 Shanghai Model

Compared to Shenzhen model, shanghai model Pay more attention to "government indirectly" management principles. Government fosters the market, based on market mechanism and competitive mechanism to investment management and operation. The government investment company and the project management company through market competition by public bidding, determined by market selection. Government training a number of project management company through the market, formed the opening and the competition pattern.

63.2.2.3 Beijing Model

After the project proposals approval, the project examination and approval department of Beijing Municipal (Beijing development and Reform Commission) through public bidding, (also can be divided into early and implemented in two stages) signed a three party agent construction contract with agent construction company and project user The contract describes the client and agent rights, obligations and agreed on compensation related matters. The largest character of this model is government project decision-maker as investment main body participates in market. The advantage of this is that commissioned the main clear, investment intentions fully implemented. The biggest obstacle may be from the government legal identity as the main body of investment need to be recognized, the government as the main civil equality exists will confuse the government referee role and players' roles in market economy, and conflict with the present reform goal. In this model, the agent is a purely social intermediary organizations, agent is the legal person of project construction period and undertake the actual owner function.

63.3 The Main Problems in ACS Implementation

Although the ACS implementation in some areas have achieved success, however, as it is a new exploration, the lack of sufficient theoretical basis and practical experience, therefore it still exist some problems in the objective.

63.3.1 Lack of Legal Basis, Agent Construction Company Is Not Clear on the Legal Status

ACS is not a legal system. This makes construction parties and investor operation in fulfilling their functions only by experience, the actual operation process in different degree of confusion; legal status of project user and agent construction company is not clear, mutual relationship is not clear enough which is the main source of agent construction main body behavior was not standardized, owners ultra vires is overmuch, intervention construction main body. At present, there are certain contradictions between "ACS" as a legal person system design and the present legal environment. In the relevant national laws and regulations were identified in the basic construction procedure are not given agent construction company to the legal status. The approval procedures still need to project eventually of user name for handling, Such the meaning of an agent construction company as the project legal person to exist greatly weakened, actually become the organizer and coordinator of the construction project, and Unable to exercise all the rights in the process of project construction and assume the corresponding responsibility, Project user also cannot real detach from project construction program.

63.3.2 Qualification Management System of Agent Construction Company Is not Perfect

As the investment management mode of “ACS” to carry out ceaselessly, many problems of agent construction company begin to emerge. On one hand Most of the current agent construction company belonging to government departments, trade protectionism, and local protectionism phenomenon still exists. These phenomena are greatly hindered the Agent Construction Companies in market competition; on the other hand The scale of current agent construction company generally small, the overall level is not high, and lack of competitiveness. the amount of agent construction company that really have the strength of engaged in ACS in government investment projects is not much, so cannot achieve rapid development of ACS.

On the qualification of agent construction company, local files are different, and lack national standards. Local government general provisions of agent construction company should be with the corresponding qualification and ability to independently bear the liability of legal person. China has no special mechanism of agent construction company qualification management, and market access conditions about agent construction company are not standard, The qualification conditions about agent construction company required by some local government departments neglected country qualification requirement about the project preparatory work, and this will have a significant impact on the construction cost of the whole project. At the same time as the agent construction company’s qualification identification, grade classification, professional personnel, agent construction qualification management and so on are not clear on the basis of criteria. So not ensure investors to grasp the agent construction company comprehensive and reliable information, seriously affecting the project management quality and efficiency of investment.

63.3.3 Incomplete Guarantee System of Agent Project

At present China’s agent construction company are generally small and weak, their Assets up to tens of millions R.M.B. but As a consulting agency, its commitment to construction and management tasks often reach hundreds of millions, even billions R.M.B. In this case, once the project risks, agent company can not afford the economic compensations. For only a limited liability corporation, with its bankruptcy, the government investment will be difficult to recycle, finance capital investment benefits more impossible to guarantee.

63.3.4 The Standard of Agent Service Fee Is Low

At present, domestic on agent cost calculation, the main reference is construction management fee standards for ceiling for calculation but there are the larger differences between construction company management fees and agent service fee. Not including the agent construction company must be paid wages, taxes and should get reasonable profit, and other content, so the rate partial low, generally not more than 2 % of the project cost. If not the whole process agent, agent management fees lower. With FuJian province government investment project agent construction as an example, according to Min government [2007]11 article "FuJian province government provincial investment project agent management approach (for Trial Implementation)" provides that: If only assume construction phase agent, according to the whole process of agent fee 70 % to calculation ($2.0\,\% \times 70\,\% = 1.4\,\%$) [3]. Thus this pattern of charges is extremely unfavorable for agent construction enterprises to develop and grow.

63.4 Countermeasures for Perfect the ACS of Government Investment Project

The ACS of government investment project is still a relatively new project management model, Need to further enhance the understanding on the thought, make accelerate it as an important work of deepening the reform of the investment system, speed up the transformation of government functions. Improve the advance of supporting measures for ACS of government investment projects at the policy level, in the organizational structure, the system building and the market environment.

63.4.1 Improve the Relevant Laws and Regulations, Clearly the Parties' Functions in the ACS

In the project ACS, involves three parties: the investors, agent company and user. From the legal design requires a contract system can embody the principle of law and spirit, but also can balance the interests and efficiency of three parties, The author thinks ACS framework should be established as soon as possible, make the investors, agent company, user common sign normative agent construction contract, in the contract for three party rights, obligations and with assistance, and other provisions. In a unified contract under the premise, seek common ground while reserving differences, overcome information asymmetry brings disadvantages, with legal contracts, clearly the rights and obligations of the parties and strict implementation. It is suggested that the government departments issued legal documents about project ACS as soon as possible. Clearly what is a construction agent company, and in the national capital status, powers and duties, and in the program participation relationship between the parties, implementation of agent forms, scope of application, and so on. As a result of the implementation of ACS in the background and legal environment of various constraints, through the first provisional regulations or provisions of the pilot management, sum up experience and then gradually standardized and promotion.

63.4.2 Improvement Qualification Management of Agent Construction Company

Make clear provisions on the agent construction company qualification and market access conditions. At the same time, set a clear standard and basis on the qualification grade of agent construction company, Make The agent construction market to form a healthy market competition mechanism as soon as possible. Market mechanism makes agent company can benign competition, achieve the purpose of survival of the fittest, so that to reduce costs, improve quality, improve management, innovate actively, improve construction management level.

63.4.3 Establish and Perfect Engineering Guarantee System

Engineering guarantee is refers to the agent construction company entrusted third parties provide building owners with a certain amount of economic responsibility and guarantees, As the agent construction company is unable to perform the construction agent contract, the guarantee shall bear all the consequences arising therefore. Construction guarantee is a disciplinary mechanism in the construction industry, is also the inherent stability of the economy.

63.4.4 Unify the Agent Service Fee Standard

The standard of Agent service fee should according to the construction project investment quotas, characteristics, technical requirements, complexity, quality requirements and many other factors, the project will be different because of their own different characteristics so that the generation to build a service fee for the ratio is not the same. Different project has different characteristics so the ratio of agent service fee is different.

63.5 Conclusion

The agent construction mode is a new direction for government investment project management, although currently there are a number of problems, but in continuous exploration and practice agent mode will gradually improve, better play its advantages in the areas of government investment project management.

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Chapter 64
Discussion the Connection Between Trust and Relationship Characteristics of Construction Project Participants

Weiping Jiang, Qian Zhang, Yun Le, and Jian Fang

Abstract Lack of trust in construction projects is criticized by many scholars. Trust has the function of decreasing transaction cost and improving project performance. The characteristics of the relationship of the trustor and the trustee have important function on occurrence of trust. More specifically, communication, reciprocity and contract contribute to occurrence of trust.

Keywords Construction projects • Relationship of the trustor and the trustee • Trust

64.1 Introduction

There is a negative reputation in the relationship between project participants (such as the owner and the contractor) in construction industry. And this kind of negative relation has negative function on project schedule, quality, cost and long-term relationship among the participants [1]. One important reason for this negative relationship is the lack of trust, especially the trust between the owner and the contractor. It is emphasized by Wood and McDermott [2] that there should have trust between the owner and the contractor. Trust between the owner and the contractor favors the two parties to build up cooperation but competitive relationships [3]. What's more, trust also can decrease transaction cost [4–6] and opportunism action [7–10], improve cooperation performance [11–14].

Trust has so many good and important functions that research on how trust occurs and develops has well implication for construction projects practice. Trust involves the trustee and the trustor. In this paper, the relationship between the

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_64, © Springer-Verlag Berlin Heidelberg 2014

characteristics of the relationship of the trustor and the trustee and trust is discussed. From the literature review, the characteristics of the relationship of the trustor and the trustee relevant to trust contain the two parts' communication, reciprocity and contract.

64.2 The Relationship Between the Two Part's Communication and Trust

Anderson and Narus [15] believe that communication is an important variant of trust. What's more, there are more shared values and less opportunism behavior with more communication. Lander [16] found in project cases study that communication is an important mechanism for trust building.

Good communication involves correct information and in-time exchange. All these are important factors for project success. In communication, the owner and the contractor can understand their role and commitment, and execute project tasks. In communication, they can understand the other party's opinions and intentions, and put forward their own opinions, make themselves understood. All these are the foundations of trust.

Berkun [17] suggests that informal communication can set up enough trust more easily than formal communication. In fact, good communication and interpersonal contact skill are very important in setting up trust. Korsgaard et al.' [18] even put forward the mechanism of setting up trust based on communication. That is to set up trust by share of information and knowledge. If there aren't common expression and understanding about project items, trust can't occur easily. So "common language" is an important factor for trust [18]. This opinion is agreed with by Beslin and Reddin [19]. They also think communication is an effective tool for the setting up and holding of trust.

Vice versa, improper communication is inimical to the setting up and holding of trust. Wood and McDermott [20] found in interview research that once there is lie, trust will disappear. So communication must be proceeding sincerely. What's more, they also find that distrust may be caused from lack of share of information. In conclusion, good communication propel trust occurrence.

64.3 The Relationship Between the Two Parts' Reciprocity and Trust

1. Reciprocity involves that when one party makes sacrifice for the other, the other party should reciprocate and make benefit to the party who have make sacrifice. Reciprocity reflects fairness. In construction projects, the two parties in cooperation use each other's virtues to attain profits. The income of the two parties could be unequal, but it must be fair [20]. That's to say the two parties must benefit each other.

2. There are many researches on reciprocity in game theory. The basic opinion is that when one party make sacrifice for the other, the other would not necessarily return the benefit, but calculates and returns the benefit when this action benefits themselves [21]. There are also researches reflecting that people incline to reciprocate, even this action is contracted with their own benefits [22–24]. In Berg et al. [8]'s research, when a party who should reciprocate has the opportunity to make his benefit maximized, 20 % of people select not to reciprocate. So when one party in cooperation decides whether to trust the other party, he should concern reciprocity between them, whether the other party has the willing to reciprocate. Researches demonstrate that people incline to trust people willing to reciprocate.

In construction projects, it needs reciprocity between the client and the contractor. Owing to the existence of uncertainty in construction projects, cooperation parties should concern the other party's benefit in dealing with uncertainty [25–28]. For example, when the client supports the contractor facing financial problems, the contractor would help the client and speeds up construction, completes the project before the fixed date. All these actions are reciprocal. There are no conditions that one party sacrifices for the other without reasons. Once the party who has sacrificed doesn't get return, the trust he gives to the other party will decrease largely. Reciprocity is very important for the client and the contractor because of uncertainty in construction projects.

64.4 The Relationship Between the Trustee's Promise Keeping and Trust

In construction projects, traditional standard contract is criticized for fostering non-cooperative behavior, making the two parties of the contract selfish and hindering trust occurring and developing. What's more, the unequal risk allocation between the owner and the contractor also blocks trust occurrence [29].

Actually, there is a positive correlation between contract and trust. Sako [30] has put forward contractual trust. When the contract is precise, and contains provisions for kinds of uncertainty, the risk of the two parties would decrease to some extent. So, precise contract propels trust occurrence.

But Florian Herold [31] believes that precise contract is a demonstration of distrust, because it contains provisions for penalty and encouragement. At the same time, he thinks that in the condition of needing trust, the principal inclines to imperfect contract even it can cause risk, but it is a demonstration of trust. Bruce Lyons and Judith Mehta [32] have the same opinion that too detailed provisions hinder the occurrence of goodwill trust. There are three reasons. First, the provision may restrict the two parties' understanding of the contract, and this violates the original idea of the contract. Secondly, the provisions decrease the possibility of reciprocal behavior of the two parties facing with uncertainty in projects. Thirdly, concern of failure conditions in provisions makes the two parties suspect each other.

In conclusion, contract and trust have contradicted relationship with each other. On the one side, precise contract propels trust occurrence; on the other side, precise contract hinder trust occurrence. So contract should be made based on specific circumstance.

64.5 Conclusions

The characteristics of the relationship of the trustor and the trustee have important function for trust occurrence. More specifically, communication, reciprocity and contract contribute to trust occurrence. This paper analyses how the characteristics of the relationship of the trustor and the trustee function on trust and play which kind of role. It is hoped that this paper has instruction for building up trust in construction projects and be tested in practice.

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Chapter 65
Discussion on Mechanism Reconstruction of Construction Supervision Industry for Its Sustainable Development

Qian Zhang, Weiping Jiang, and Yun Le

Abstract Troubles existing in the industry of Construction Supervision in China are analyzed. The competition power of the industry is weakened due to the policy of long widely forced CS service procurement. Misapprehensions of the industry's liabilities extends the professional risks, making loss of excellent HR. Strategy for the improvement thru mechanism reconstruction are issued for the industry's sustainable development.

Keywords Construction supervision • Essentiality • Liability • Mechanism reconstruction

65.1 Introduction

The mechanism of Chinese construction supervision was built up following the typical project loaned by the World Bank. Construction supervision was promoted from 1986 to 1996 by Ministry of Construction of China. The aim of promoting project supervision was to improve project work efficiency, expand the work of project management and standardize project management in China. In the process, government promoting and market demand do both exist. The government has published administration regulations relevant to construction supervision. These regulations contain rules about qualifications of construction supervision companies, compulsion and feel scale of construction supervision.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_65, © Springer-Verlag Berlin Heidelberg 2014

Obviously, Chinese construction supervision is the outcome of government policy but not the market demand. Under this circumstance, people are hard to formalize correct recognition about construction supervision [1, 2]. Cases of project construction supervision bring debates and thinking.

65.2 Problems of Development of Construction Supervision in China

Though the mechanism of construction supervision is not the outcome of marketing, construction supervision should development under market rule. In project practice, people find operation of construction supervision is dominated by policy but not market demand. In practice, China's construction supervision is far from the original intention. The problems of construction supervision in China are as follow:

1. Construction supervision companies' scope of authority and responsibility are too narrow;
2. The influence of supervision companies in coordinating participants in project decreases;
3. Risks are shifting from contractors, the owner, the government to construction supervision companies;
4. The quality of construction supervision service is decreasing. In detail, construction supervision companies are in lack of conscientiousness, low level of professional competency, negative work attitude.

The problems in construction supervision have logical connections, just are shown in Fig. 65.1.

65.3 Relationships in Construction Supervision

1. **The Relationship Between Construction Supervision Company and Project Owner**

   Generally the project owner seeks personal construction supervision service according to his needs and shortcomings. The project owner authorizes construction supervision companies to make decision and take action. Construction supervision companies should take responsibility for their action. On one side, works of construction supervision is professional and indispensable. And on the other side, construction supervision companies service for the project owner. Of course, construction supervision service should not only meet the project owners' preference, or else, the value of construction supervision service doesn't exist.

   What's more, decisions of supervision companies are not always correct. If supervision decisions bring lost to contractors, contractors could claim for project owners. And the project owner could claim for the supervision company

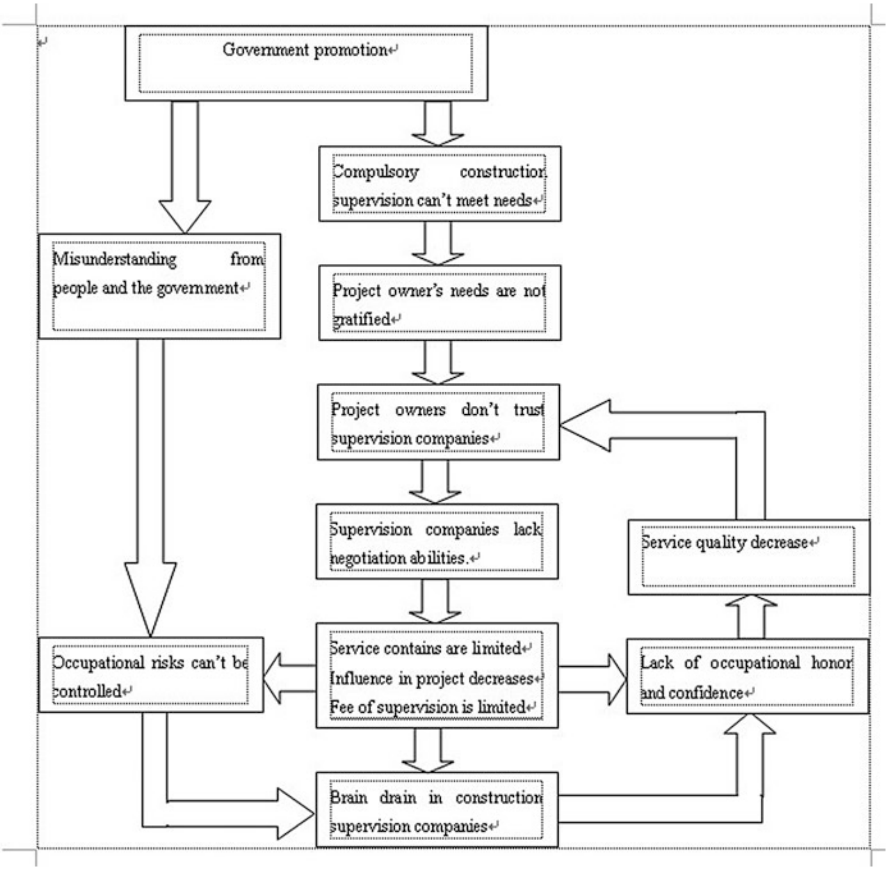

Fig. 65.1 Problems in construction supervision development

with his false decisions. But the two claims are not equal. The project owner can't transfer his responsibility and risk by purchasing supervision service. The truth of construction supervision service is one kind of professional judgment and suggestion.

2. **The Relationship Between Construction Supervision Company and Project Contractors**

   For the contractors, construction supervision companies are experts to execute the project owner's work. Contractors haven't the reason to struggle against this kind of work. If contractors need, they can also hire experts. In fact, the responsibility of the contractors shouldn't be reduced even with the existence of construction supervision companies.

3. **The Relationship Between the Government and Construction Supervision Companies**

   Whatever construction supervision companies exist or not, the responsibility of the government should not be transferred. Tough construction supervision companies monitor construction contractors. The responsibility of the supervision company is different to the government's. The government has the responsibility of administrative supervising. And the responsibility shouldn't be transferred to the construction supervision company.

65.4 Suggestion for Sustainable Development of Construction Supervision in China

In the beginning of construction supervision development, the government's law requires project owners' to purchase construction supervision service. This method propels the development of construction supervision. But in the long run, this method also becomes the obstacle of development of construction supervision. In this stage, compulsion can't propel the development of construction supervision. Just as analyzed above, cancelling compulsion makes construction supervision become market-oriented.

65.5 Conclusions

China's construction supervision has developed for more than 20 years. In the process of development, the government plays as an important role. But now the government's compulsion becomes a obstacle of development of construction supervision. Under the circumstance of compulsion, the project owner's demand is not demonstrated. Construction supervision companies either haven't developed core competence. Profession competency is decreased, talents flee. In this circumstance, the government should respect the market and support construction supervision companies sustainably develop.

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Chapter 66
The Use and Non-use of Time in New Construction of Residential Buildings: The Case of Sweden

Per-Erik Josephson and Chao Mao

Abstract There is a continuous debate on costs in construction. Customers are complaining on the high costs, while suppliers are focusing on cutting costs. Experiences from successful companies in other industries show another logical way for lowering costs. By prioritizing reduction of errors and other disturbances there is easier to foresee the processes as well as benchmarking processes in order to shorten lead-times. Shorter lead-times lead to lower costs. While costs, defects and delays are discussed among academics, the use of available time seems to be less covered in research papers. This paper aims to describe how time is used and not used in construction. Examples from Swedish construction are given. Some examples from Chinese construction projects are given as a benchmark. One perspective on how time is used concerns lead-times from briefing to final delivery. A second perspective concerns the fact that work is only going on 40 h a week. A third perspective concerns to what extent resources, here human resources and equipment, are used. The main argument is to focus more on the use and non-use of time as a way to improve construction.

Keywords Lead-times • Construction projects • Productivity • Non value adding activities

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_66,

66.1 Introduction

In construction, as a project-oriented business, there has for long been a tension between the short-term project focus and the long-term development on client-side as well as on contractor-side. As a way to improve, there has been a continuous debate on costs. Customers are complaining on the high costs, while suppliers are focusing on cutting costs.

Successful firms in other industries, e.g. automotive, space and transport, have another logic to develop a long-term cost effective business [1]. By prioritizing reduction of errors and other disturbances there is easier to foresee the processes as well as benchmarking processes in order to shorten lead-times. Less disturbances and shorter lead-times lead to lower costs, Fig. 66.1.

While costs, defects (e.g. [2–4]) and delays (e.g. [5–7]) are discussed among academics, the use of available time seems to be less covered in research papers. This paper aims to describe how time is used and not used in construction. Examples from Swedish construction are given. Some examples from Chinese construction projects are given as a benchmark. The first perspective on how time is used concerns lead-times from briefing to final delivery. The second perspective concerns the fact that work is only going on 40 h a week. The third perspective concerns to what extent resources, here human resources and equipment, are used. The main argument is to focus more on the use and non-use of time as a way to improve construction.

66.2 Value-Adding Time

For the case of the paper it is of interest to use the concept of value-adding and non-value-adding time.

Non value adding activities are defined by[8] as “anything that can be eliminated without detriment to the final product or service” and by[9] as “any losses produced by activities that generate direct or indirect costs but do not add any value to the product from the point of view of the client”. The concept of non value adding has certain similarities with how the term waste is used in the lean philosophy. A common definition ofwaste is “any activity, which absorbs resources but creates

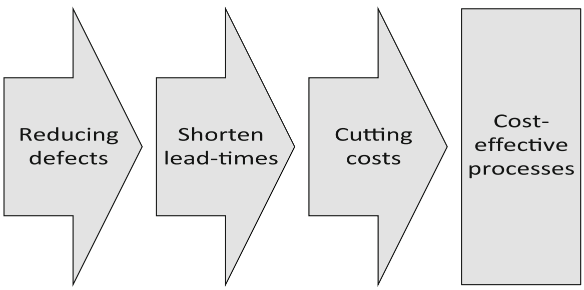

Fig. 66.1 Strategy for developing cost-effective processes

no value" (see e.g. [10]). The concept has also similarities with the concept of costs for poor quality.

In real situations activities can be viewed as value-adding by one actor but as non value adding by another. Of that reason it is generally argued that it should be a clear focus on the customer in order to determine what is not adding value, what is waste and what is costs for poor quality. A challenge is, however, to define who the customer really is. In this paper, the client organization is viewed as customer even if they have tenants using the building as their customers.

All types of activities can be described in terms of processes. Processes are usually divided into three categories. Operative processes are series of activities (work elements) that directly add value in the viewpoint of the customer. If an activity that is a part of the operative process is taken away, the product or service will be incomplete. Support processes are activities or series of activities that support the operative process. They do not themselves add value to the product or service but are necessary for the operative process to function. Management processes are activities or series of activities whose purpose is to determine the organisation's goals and strategies. Non value adding activities exists in all these categories of processes. In the operative process, the activities can perhaps be carried out in another order and in this way free up time or the activities may include corrections of defects. In support processes and management processes, there may be routines that added value at one time but have now lost their purpose.

Problems can arise in determining whether support and management processes should or should not be classified as non value adding. For this reason we divide work in value-adding work, indirect value-adding work and non value-adding work. Indirect value adding work refers to processes that are necessary for the value-adding work to be carried out.

66.3 Long Lead-Times

One aspect of time is lead-times from idea to delivery of the final product. Shorter lead-times involve lower costs and higher competiveness. In Sweden, these lead-times are considered to be long and also to be varying between projects to a large extent.

In order to check the real lead-times, data was gathered from five projects recently finished in Sweden. The projects were randomly chosen from a database including the majority of existing projects. As a benchmark, same data was gathered from three Chinese projects. In each project, the project manager was asked about dates for start and end of briefing phase, design phase, procurement phase and production phase. They were also asked about date for when remarks from final inspection were approved by the client. The total floor area for the Swedish projects was in the range of 2,000–5,000 m^2, while the Chinese projects was in the range of 22,000–45,000 m^2.

Tables 66.1 and 66.2 show several things of interest

Table 66.1 Lead-times (number of days, accumulated) for processes beginning at start of briefing phase for Swedish and Chinese residential building projects

Project no	Size (m^2)	Start brie-fing	Start de-sign	Start procurement	Start production	End production	Remarks corrected
Sweden							
Case 1	2,418	0	152	228	366	792	913
Case 2	2,936	0	169	291	411	1019	1050
Case 3	9,318	0	71	395	467	789	789
Case 4	3,667	0	245	350	397	1035	1158
Case 5	1,100	0	35	86	133	498	590
China							
Case 6	45,000	0	45	321	347	825	886
Case 7	22,000	0	118	177	241	831	844
Case 8	22,000	0	0	31	81	721	745

Table 66.2 Lead-times (number of days) for processes in new construction of residential buildings, averages for the five case projects in Sweden and the three case projects in China

Process	Swedish projects	Chinese projects
Start briefing phaseto start design phase	134	54
Start design phase to start procurement phase	136	122
Start procurement phaseto start production phase	85	47
Start production phase to end production phase	472	569
End production phase to approved	73	33

- The total time from start of briefing phaseuntilremarksarecorrectedis longer for Swedish projectsthan for Chineseprojects, despitethat the Chineseprojectsarer-oughlyten timeslarger
- The total projecttimevaryto a largeextentbetween the Swedish projects, while it is less variation among the Chineseprojects
- The productionphase is shorter for the Swedish projects, while all previouspha-sesarelongerthan for the Chineseprojects

There are two conditions that delay Swedish projects during the early stages. The first condition is related to the local authorities' work on preparing the detailed development plans and giving buildingpermits. The detailed development plan explainswhat kind of buildings are allowed to be built and what kind of businesses are allowed to take place on certain areas. Every citizen is allowed to formally complain at threestages (for the plan as well as the permit) if they have reasons against the plan. The first stage is handled by the local authority, the second by the County Administrative Board and the third by the central government.

This process is often delayed since the public organisations take long time to handle complains. As an example, Fig. 66.2 shows the average time for County Administrative Board to approve the detailed development plan and also the average time for giving building permits in Sweden 2007–2011. A comparisonbetween

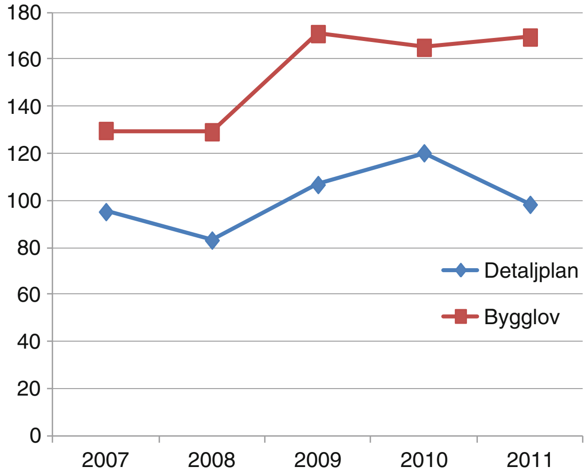

Fig. 66.2 Average time for administer detail plans (Detaljplan) and building permits(Bygglov) at County Administrative Board 2007–2011 (Data received from the Swedish Association of Local Authorities and Regions)

the 12 County Administrative Board shows that the average time to administer the detailed development plan varies between 30 and 250 days, and that the average time for administer building permits varies between 50 and 380 days.

The second condition is the procurement process, in which the client choses a contractor. Public clientshavetouse an open invitation for bids. Competition leads to lower bids and following this an increased demand for the winners to be resource efficient during production work. Still, it takes time for the client to prepare tender documents, for the contractors to prepare their bids and then for the client to evaluate the bids. The last few years it has been more common for contractors not winning the contracts to appeal, which further delays the process with 2–4 months.

66.4 Is a Week 40 or 168 Hours?

Another aspect of how time is used or rather how time is not used, is the fact that work – on most Swedish construction projects -is going on 8 h a day 5 days a week, excluding breaks for holidays. That means that, despite the large investments, only approximately 20 % of the theoretical available time is used. The rest of the time, the sites are empty. This is illustrated in Fig. 66.3.

In other projects, such as renovation of road tunnels, all work is done from Friday evening until Monday morning, i.e. when the traffic is low. During these periods the work is going on every hour. For housing, material is sometimes delivered to site and handled on site after regular working hours. Figure 66.4 shows how five excavators are doing work on a Chinese construction site night-time.

Fig. 66.3 Two weeks showing when work is going on at construction sites (*black*) and not (*white*)

Fig. 66.4 Five excavators working during night at a construction site in Beijing

66.5 Use of Capacity

A third aspect of time is to what extent resources are used for value-adding and non-value-adding time, i.e. use of capacity. The ideal situation is of course that resources are used 100 % of the time. That means that human resources, in the Swedish case, can be used 8 h a day, 5 days a week, while machines can be used 24 h a day, 7 days a week.

Studies by one of the authors indicate that contractor's workers and sub-contractors' workers spend 15–20 % on their time on value-adding activities and more than one-third on non-value-adding activities, see Table 66.3. Strandberg and Josephson [11] found that 17.5 % of the construction workers time on new construction of residential buildings was value adding, 45 % indirect value adding and 37.5 % not value adding. Josephson et al. [12] found that roughly 15 % of the plumbing and ventilation workers' time was value adding, 50 % indirect value

Table 66.3 How time is used by construction workers and heating and plumbing workers (percentage of working time) (After [11] and [12])

Activity	Construction workers (After[11])	Heating and plumbing.workers (After [12])
Value-adding work (assembling)	17.5	13.3
Direct assembling	17.3	9.4
Pre fabrication	0.2	3.8
Indirect vakue adding work	45.4	51.9
Indirect assembling work	25.5	26.4
Transporting material on site	13.9	8.8
Work planning	6.0	16.7
Waste (timelosses)	37.1	34.8
Rework	2.0	3.1
Unused time	10.4	10.1
Disruption/waiting	23.0	21.6
Other	1.7	21.6
Total	100.0	100.0

adding and 35 % not value adding. Comparing the twogroupsofworkers is not relevant, since the last group for examplespendmoretime on managerialactivi-tiessuch as work planning.

Similar studies of managers and equipment in production of other products indicate that neither these resources are used fully.

66.6 Discussion and Conclusions

This paper highlights three perspectives on how time is used and not used in construction. Examples from Swedish construction are given. For two of the perspectives, examples from China are given as a benchmark. It should however be noted that it is not relevant to strictly benchmark data for the two countries. Among the reasons are that different standards are used, different traditions and the fact that the Chinese projects are much larger than the Swedish projects used as cases in the paper.

The main argument in the paper is that actors, clients as well as contractors, must focus more on how they can use the time available as a way to improve construction. So far, time has mainly been discussed concerning meeting deadlines. An exception is Skanska, which had an improvement program during the 1990s in which they focused on reducing the lead-time for the production phase (see e.g. [13]). As seen in this paper, the lead-time for the production phase is quite similar in all projects presented here. Instead, it is the lead-times for processes before start of production and the process for correcting defects found during final inspection that varies and hence should have higher focus in the improvement programs.

Shorterlead-timeswouldsignificantlychange the conditions for projects from an investorperspective. An investment decision madeduringdepressions (with a certain budget) mayneed a far higher budget if the economyraisesuntil the productionphase starts, since the pricesarehigher for material and services. On the other hand, projects-decidedduringbooms get conderablebettereconomyifproduction is carriedthrough under depression.

From an environmental perspective, there are several reasons for shorter lead-times. Less disturbances on traffic and existing business is just two examples.

Among implications are:

- The processes for handling appeals should be shortened
- The clients (and contractors) should, if possible, keep the organization for more than one project in order to avoid long procurement processes
- All actors should find ways to keep the projects running for more than 8 h per day
- All actors should consider that increasing productivity is not only about investing in new technology, but also improving the way of working in order to use the full potential of the existing technology

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Chapter 67
Meta-network Based Fitness Measurement of Projects Organization and Tasks Assignment

Yong-kui Li, Li-li Qian, Qing-hua He, and Yun-feng Duan

Abstract Meta-network is the core base of computational organization theory and dynamic network analysis. As an extend version of Social Network Analysis, meta-network is the representation of a group of networks, it extends the scope of the construction project organizational structure from only personnel to knowledge, tasks and other entities as well as people. In this paper, knowledge is considered as the people's abilities to complete the tasks of projects. Combine with these entities and relationships among them, this paper build the meta-networks framework model of Projects Organization and Tasks assignment. Six index definition and formula: Congruence of Org Agent Knowledge Needs_(C_{OAK}),Congruence of Org Task Knowledge Needs_(C_{OTK}), Congruence of Agent Knowledge Needs_(C_{AK}), Congruence of Task Knowledge Needs_(C_{TK}), Task Completion of Knowledge based_(TC_K), Actual Workload of Knowledge_(AW_K).

Shanghai General Motors Buick 4S centers network, as a program, has the characteristics of numerous participants and complex relationship, was elected as a case. The conclusion indicates that a well-operation project organization have a high fit between projects organization and tasks assignment. Through the simulation analysis visually expressed how an organization will behave and change after considering a sequence of strategic interventions or personnel loss by way of agent removal.

Keywords Meta-network • Construction project organization • Tasks • Fitness

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_67,

67.1 Introduction

In the engineering and construction industry, a project is usually broken into multiple manageable tasks to accomplish project goals [1]. At the same time, researchers in construction project management have achieved a relative consensus on the importance of human factors (people) for successful project outcomes [2], and organization is the core for project goals [3]. Thus reasonable organizational and work design is absolutely crucial to improve project performance, without proper task coordination and team organization, communication and cooperation among a large number of dependent or interdependent tasks and team members could seriously delay project completion [4].

Most large and complex construction projects, are characterized by having dispersed geographical locations, long construction duration and a great deal of participants [5]. Thus project network may include project participant network, task network, resource network and knowledge network etc. and it comprise different entities as well as different relationships [6]. Construction engineering and management researchers have utilized network analysis in many diverse and distinct domains. For instance, Li et al. used social network analysis approaches to evaluate organizational power [7–9], the social network concepts of centrality, density and distances are applied to measure person's (organization's) position and power in a organizations. Di Marco et al. examined the emergence of cultural boundary spanners in global engineering services networks [10], and Chinowsky et al. used SNA to examine the structure and relationships within project organizations [4]. However, these existing organization network approaches seldom analyze the relationship between the organization and tasks; they mainly focus on an independent network.

Yang et al. proposed an organization-task interdependent network for large-scale engineering project systems [11], which overcome the shortage of treating the organizations and tasks separately in the research of project management, but only focus on single relationship. These analyses have neglected the coordination of knowledge exchanges and fitness across the project organizational network.

Krackhardt and Carley proposed a meta-network model, an extended version of SNA, and that can analyze construction project organizational structure from only personnel to knowledge, resources, tasks and other entities as well as people [12, 13]. This method has combined merits of traditional Social Network Analysis (SNA), Link Analysis (LA) and multi-agent systems (MAS) [9]. They employ Organization Risk Analyzer (ORA), software developed by CMU. With this tool, a large variety of networks can be assessed including, but not limited to, social networks, activity networks, task networks, knowledge networks, supply chains, and communication networks [14].

67.2 Model and Methodology

67.2.1 Concept Model of Organization and Tasks Assignment Meta-network

67.2.1.1 Basic Components of Meta-Network

A network N comprises two sets of entities, called U and V, and a relationship set $E \subset U \times V$. For i ∈ U and $j \in V$, an element $e = (i, j)$ in E indicates there exists a relationship between entities. These entities and their relationships are represented by a collection of networks called the meta-network. Meta-network extends the scope of the construction project organizational structure from only personnel to knowledge, tasks and other entities as well as people. The following networks defined on these entity sets are most common networks [14, 15], see Table 67.1.

67.2.1.2 Formulation of the Concept Model for This Research

The design structure of an organization comprises the relationships among its personnel, knowledge, resources, tasks, and other entities. People assigned different work according to their abilities or resources they have, here knowledge is considered as the people's (or organization's) discipline skills (or abilities) to complete the tasks of projects. As time passes, we have different tasks and the organization may evolve, too. Based on the meta-network theory, build the Meta-networks framework model of Projects Organization and Tasks assignment, see Fig. 67.1.

Table 67.1 Most common networks

	Entity sets		
Symbol	U	V	Network name
AA	Agent	Agent	Communication Network
AK	Agent	Knowledge	Knowledge Network
AR	Agent	Resource	Capabilities Network
AT	Agent	Task	Assignment Network
KK	Knowledge	Knowledge	Information Network
KR	Knowledge	Resource	Training Network
KT	Knowledge	Task	Knowledge/Ability Requirement Network
RR	Resource	Resource	Resource Substitute Network
RT	Resource	Task	Resource Requirement Network
TT	Task	Task	Precedence Network

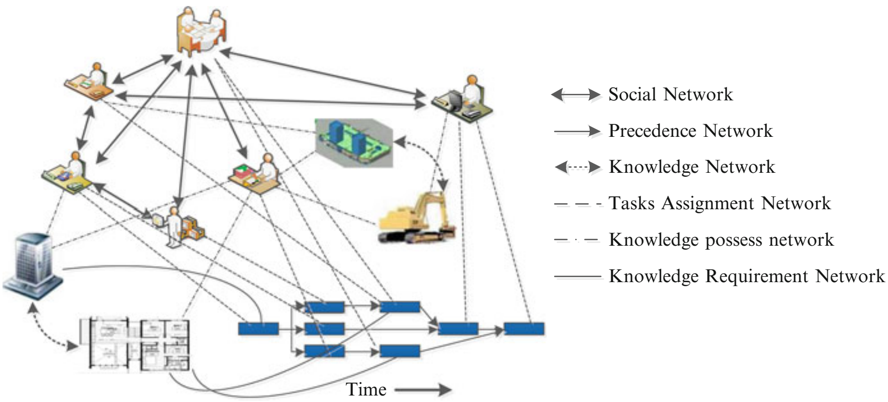

Fig. 67.1 Concept model for projects organization and tasks assignment based on meta-network

67.2.2 Quantitative Measures

In the organization, people's (task's) importance and complexity can be measured by the degree centrality of a agent (task) in a organization (tasks) network [7–9]. Besides, we measure organization and task assignment fitness, considering the assigned agents and the required resources and expertise, the following indicators should be used [14, 15].

Congruence, Org Agent Knowledge Needs, C_{OAK}: Across all agents, the knowledge that agents lack to do their assigned tasks expressed as a percentage of the total knowledge needed by all agents [16]. It can be calculated by the following (67.1): $st.N = AT * KT'$

$$C_{OAK} = \frac{\sum_{i=1}^{|A|} \sum_{j=1}^{|K|} N_{i,j} * \left(\sim AK_{i,j}\right)}{\mathrm{sum}(N)} \tag{67.1}$$

Congruence, Org Task Knowledge Needs, C_{OTK}: Across all tasks, the knowledge that tasks lack expressed as a percentage of the total knowledge needed by all tasks [16]. An organization needs many skills to meet it's organizational objectives. However, not all of the skills are present within the organizational network. This measure computes a value for this lack of skills as it is distributed across the organization as a whole. It can be calculated by the following (67.2): $st.S = AT' * AK$

$$C_{OTK} = \frac{\sum_{i=1}^{|T|} \sum_{j=1}^{|K|} KT_{i,j} * \left(S_{i,j} = 0\right)}{\mathrm{sum}(KT)} \tag{67.2}$$

Congruence, Agent Knowledge Needs, C_{AK}: The number of knowledge that an agent lacks to complete its assigned tasks expressed as a percentage of the total knowledge required for the assigned tasks [15]. It can be calculated by the following (67.3): $st.N = AT * KT'$, for agent i

$$C_{AK} = \frac{\sum_{j=1}^{|K|} N_{i,j} * \left(\sim AK_{i,j}\right)}{\sum_{j=1}^{|K|} N_{i,j}} \tag{67.3}$$

Congruence, Task Knowledge Needs, C_{TK}: The number of knowledge that an task lacks expressed as a percentage of the total knowledge required for the task [15]. It can be calculated by the following (67.4): st.$S = AT' * AK$

$$C_{TK} = \frac{\sum_{j=1}^{|K|} KT_{i,j} * \left(S_{i,j} = 0\right)}{\sum_{j=1}^{|K|} (KT)} \tag{67.4}$$

Task Completion, Knowledge Based, TC_K: The percentage of tasks that can be completed by the agents assigned to them, based solely on whether the agents have the requisite knowledge to do the tasks [15]. Find the tasks that cannot be completed because the agents assigned to the tasks lack necessary knowledge: let $\mathrm{Need} = (AT' * AK) - KT'$

$$\text{let } S = \{i|1 \leq i \leq |T|, \exists j : \mathrm{Need}(i,j) < 0)\}$$

then, Knowledge Based Task Completion is the percentage of tasks that could be completed,

$$TC_K = (|T| - |S|/|T|) \tag{67.5}$$

Actual Workload, Knowledge, AW_K: The knowledge an agent uses to perform the tasks to which it is assigned [17]. Actual Workload for agent i is defined as following (67.6):

$$AW_K = (AK^* KT^* AT')(i,j)/\mathrm{sum}(KT) \tag{67.6}$$

When defining these measures, a network can be represented as an adjacency matrix. The following adjacency matrices and notation are used to explain formulas list above, see Table 67.2.

The indicators above should be used flexibly in practice according to different organization types and research objectives, since they are related to each others.

67.3 Case Study: SGM Buick 4S Shop Construction Program Project

The Automotive industry of our country develops very fast, especially the passenger car is being in the "golden period". The manufacturers speed up the development of franchise distribution network in order to win the market share. Automobile 4S shop are the most popular type of commercial networks both for the manufacturers and the consumers because of its normative, exclusive features [18]. According to statistics,

Table 67.2 The notation be used to explain index formulas

Adjacency matrix	A: element (i,j) is the degree to which agent i communicates with agent j
	AK: element (i,j) is the degree to which agent i knows knowledge j
	AT: element (i,j) is the degree to which agent i is assigned to task j
	K: element (i,j) is the degree to which knowledge i can be substituted for knowledge j
	KT: element (i,j) is the degree to which knowledge i is needed to do task j
	T: element (i,j) is the degree to which task i must be done before task j
Matrix notation	|Matrix| = dimension of a square Matrix(i.e. **A** has dimension r x r, then |**A**| = r)
	$Matrix_{i,j}$ = Matrix(i,j) = the element in the ith row and jth column of Matrix
	Sum(Matrix) = sum of the elements in Matrix (also, Matrix can be a row or column vector of Matrix)
	Matrix' = the transpose of Matrix
	~Matrix = for binary Matrix, ~$Matrix_{i,j}$ = 1 iff $Matrix_{i,j}$ = 0

Note: Here the matrices **A**,**K**,**R**,**T** are square networks, which is short for AA,KK,RR,TT; the others are rectangular networks. For each index,usually the Input Data Type is binary,Output: R ∈ [0,1] here, R denotes a real number

there totally are 6~7,000 4S store in China, and about 405 in Beijing, with a 1.5 % annual growth.

As a program, the 4S Shop construction network is characterized by having dispersed geographical locations, long life cycle and numerous participants. It is meaningful to provide significant implications to construction professional in improving organizational and work design.

67.3.1 Case Background

Shanghai General Motors (SGM) Buick 4S Shop network, projects are scattered throughout the country with over 70 new projects with their own owners (local dealer) annually increased (data from: *Summary Report for Buick Brand Network Facilities Management*, *2011*). The organization characters can be briefly introduced as follows,

Strategic level: SGM sets up Buick Dealer Network Development Department representing manufacturer. SGM authorized dealer (Dealer), according to the build stores contract, to build up 4S store based on its standard.

Controlling level: Project Management Company (PMC) provide design management and project management service, make on-site inspections and controlling. Project manager provide Buick brand dealer facilities theme design and project management services, provide dealer timely, accurate and comprehensive project management services and decision support for the construction of infrastructure projects. Project manager will provide technical and work support to ensure the implementation and enforcement of the brand standards.

Implementation level: As owners of specific projects, Dealers have overall responsibility for the implementation of projects. They have to Commission a local

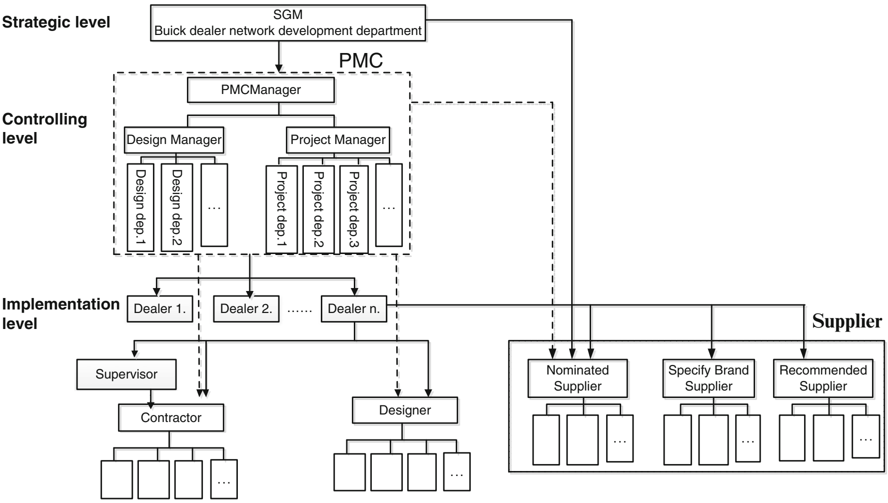

Fig. 67.2 Buick 4S shop construction program project organization structure (brief)

design unit for the deepening of the design and organize a construction contractor to build up the store.

By mainly dividing suppliers into three categories, including SGM nominated suppliers, specify brand suppliers and recommended suppliers, it can ensure that materials and equipment would satisfy the requirements of Corporate Identity standard.

The structure can be briefly described as the flowing Fig. 67.2.

In general, the facilities construction period of SGM Buick's 4S is 175 days, including the whole process from the foundation construction to the fit-out works, FF&E installation, outdoor overall and hardscape and landscape. Basis for the total flow chart of the project construction and the process of procurement and project management, there are 64 tasks in the facilities construction. Therefore, on this basis, we can ensure that the individual project will be completed on time and quality, and achieve the project management goals.

67.3.2 Building Model

67.3.2.1 Information Collection

According to the concept model described in Fig. 67.1, the paper collect data needed considering information's accessibility, validity and sufficiency. By working in the project management team of PMC, we did an investigation of the managerial system, organization structure and so on. Table 67.3 lists the available meta-network component networks and information collection source.

Table 67.3 The available meta-network component networks and information collection source

	Agent	Knowledge	Task
Agent	AA: Communication network	AK: Knowledge possess network	AT: Task assignment network
	Who talks to, works with and reports to whom	Who has what expertise	Who is assigned to which task, who does what
	From: Project weekly report, inspection itinerary, contract and documents analysis	From: HR information and functional division	From: Task division and responsibility matrix
Knowledge		KK: Knowledge network	KT: Knowledge requirement network
		Connections among types of knowledge, substitutions	What type of knowledge is needed for that task
		From: Professional capability analysis based on ominiclass	From: expertise requirements analysis
Task			TT: Precedence network
			Which tasks are related to which
			From: Overall project work flow chat, project weekly report

Note: Most of the original information is available in < Project Management Manual for SGM Buick Autohaus Construction Program>, <SGM DMES II > User Manual for Dealer and Project weekly reports

67.3.2.2 Information Processing

The meta-network involving different entities and complex relationships, especially for some sub-organizations located in the latter controlling level and implementation level, to ensure the content sufficiency and data scalability, a coding system was set to classify entities as the following Fig. 67.3.

In this model, a dealer project is selected, the organization have four sub-organizations: SGM Buick dealer Development Department (SGM for short), Project Management Company (PMC), Dealer and Supplier which include 11 main agents, then 15 discipline knowledge and 64 tasks are definited. Most of the coding up to level 2, some extending as necessary.

67.3.2.3 Model Establishment

After achieving the overall information of project, the model is established according to the relationship network described in Table 67.3. To simplify the

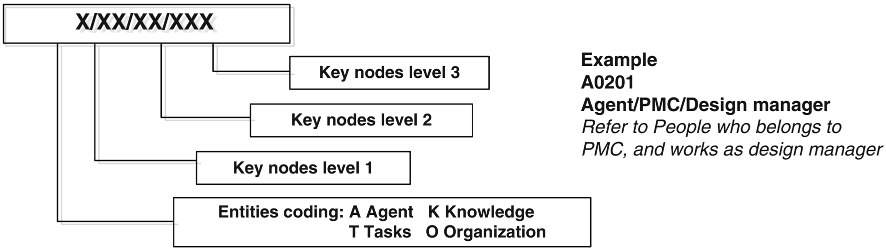

Fig. 67.3 Coding system for entities

model, the paper assume that if two entities have any kind of relationship stated above, then this relationship is set to "1"; otherwise it equals to"0". Each note in the network refers to one entity, including agents, tasks, knowledge, and organizations. We selects the these entities, analyzes their relationship though ORA software, and plots them into meta-network model as following Fig. 67.4a–g.

67.3.3 Data Analysis

According to meta-network model and algorithm, measures can be calculated as the following Table 67.4.

Generally, the whole organization's Task Completion $TC_K = 60.9\ \%$, and Congruence of Task Knowledge Needs $C_{OTK} = 38\ \%$, Congruence of Org Agent Knowledge Needs $C_{OAK} = 49.1\ \%$.

Besides, some conclusions can be drawn from above calculations,

On average, Congruence of Agent Knowledge Needs 39.5 % is approximately equal to Congruence of Task Knowledge Needs 37 %, which indicates that tasks and people have consistent need for knowledge.

In social network, A04, the Dealer, holds the highest power, and in the task assignment network, A04 also took many tasks. Which accords with reality because the Dealer is the main participant of project's implementation, it benefits project construction implementing.

In precedence network, T0203,T0205,T0202 holds very high Centrality and betweenness Centrality, for T0205 are milestone tasks for the project construction, while T0203 and T0202 not the key task, but the main work for PMC making supervisory control and connecting SGM with Dealer.

A04 holds higher $C_{AK} = 0.826$, Dealer is in desperate need of knowledge,but without directly expertises, in order to complete assigned task, A04 get knowledge indirect from other participants, which is also visually expressed in knowledge possess network.

A0202, the project manager, holds highest AW_K, whose expertise worked reasonably and the task assignment is fitness.

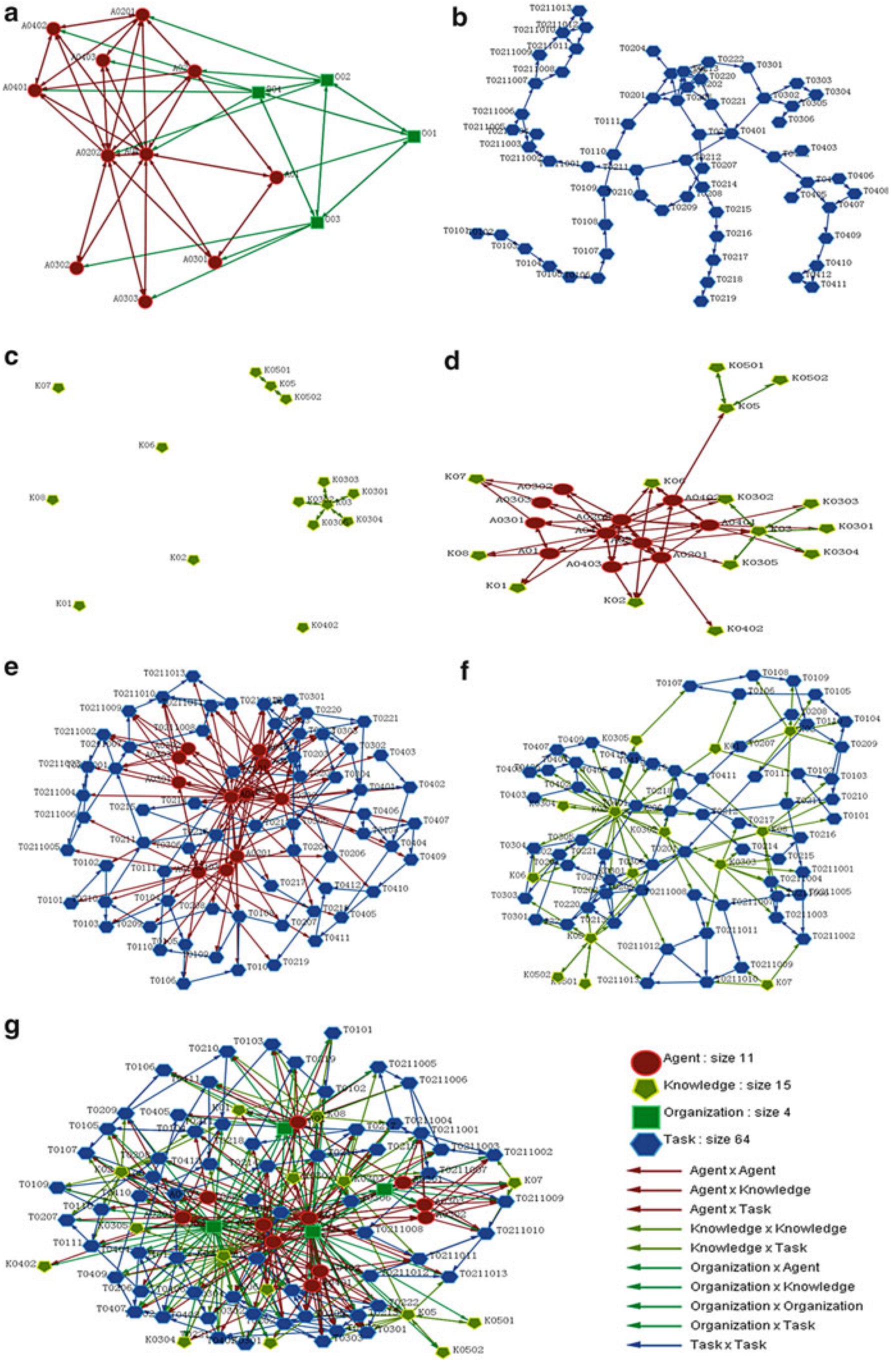

Fig. 67.4 (**a**) Communication network. (**b**) Precedence network. (**c**) Knowledge network. (**d**) Knowledge possess network. (**e**) Task assignment network. (**f**) Knowledge requirement network. (**g**) General chat for meta-network

Table 67.4 Measures for meta-network model

Measure	Avg	Stddev	Min/Max	Min/Max Nodes
C_{OAK}	0.491			
C_{OTK}	0.380			
TC_K	0.609			
AW_K	0.069	0.047	**0.014**	**A0401**
			0.197	A0202
C_{AK}	0.395	0.258	0	A0403
			0.875	**A0401**
C_{TK}	0.370	0.471	0	39 nodes (60 %) have this value
			1	22 nodes (34 %) have this value

A0401, the Supervisor, holds lowest $C_{AK} = 0.875$,and $AW_K = 0.014$,indicates that it is have lowest knowledge an agent uses to perform the tasks to which it is assigned. We should deleted the position or we keep it, what happens if we remove A0401?Using ORA simulation tool that allows for the removal of nodes from a given organizational structure to evaluate how the organization will likely perform as a result. Deleted A0401 at different time, analyze the links among these entities, and input to the ORA software. The result is shown as Fig. 67.5.

It can be seen that the removal of Supervisor have negative impact on project, and earlier it be deleted, the worse the influence it was. Then we change tasks A0401 was assigned, deleted its T0211012 about purchasing, and added construction management work T0202, T0204 to Supervisor. The result show that the whole organization's Task Completion $T_{CK} = 60.9$ %, and Congruence of Task Knowledge Needs $C_{OTK} = 36.6$ %, Congruence of Org Agent Knowledge Needs $C_{OAK} = 48.6$ %, while Actual workload improved to 0.072, with lowest value 0.042. the result indicated this tasks assignment is more reasonable.

67.4 Summary

Meta-network is the core base of computational organization theory and dynamic network analysis. Besides the Social Network Analysis,the paper extends the scope of the construction project organizational structure from only personnel to knowledge, tasks and other entities as well as people. The model provide in this study can enrich previous studies on project network analysis and have significant implications for improving organizational and work design.

The index provide quantitative methods to evaluating the fitness of projects organization and tasks assignment. The model is important to reasonable organization structure design, adequately perform people's abilities and complete project effectiveness.

The case study was used to retrospectively validate the meta-network approach. Through the simulation analysis visually expressed how an organization will

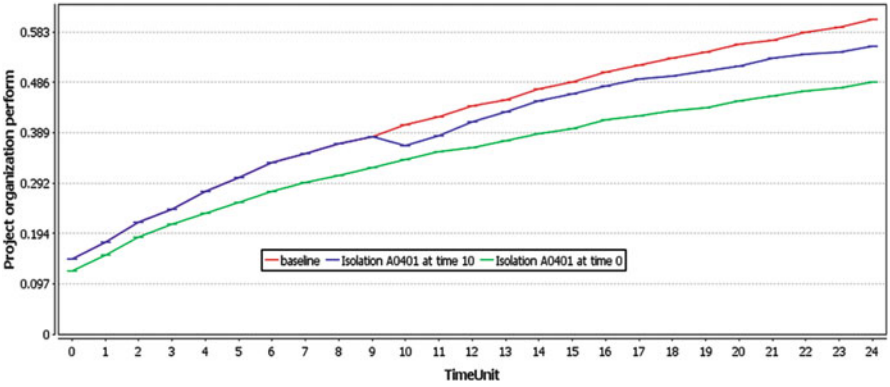

Fig. 67.5 The project organization perform before and after A0401was deleted

behave and change after considering a sequence of strategic interventions or personnel loss by way of agent removal.

The approach also has several limitations that should be addressed in future research. First we didn't consider the weight of relationship, such as the same task might be assigned several agents. Another limitation is that we haven't list resource entities. Additional research is required, however the model is a valuable approach to understand and improve project organization design.

Acknowledgement This research was supported by the National Youth Natural Science Foundation of China (Grant No. 70902045) and the Humanity and Social Science foundation of Ministry of Education (Grant No. 09YJAZH067).

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Chapter 68
Documentation Quality in Construction Projects: A Qualitative Inquiry

George Zillante, Marek Mikucki, Jian Zuo, and Xiao-Hua Jin

Abstract Documentation quality is of high importance for any procurement method, however for a managing contract type procurement it is particularly important as there is limited time to issue and fine tune the finalised drawings for tender without the potential to halt concurrent works. It is the quality of the finalised documentation during this construction phase that generally dictates the final outcomes of a project. This research adopted a qualitative approach to investigate documentation quality issues in construction projects. Selected industry professionals in South Australia were interviewed, followed by a case study. The results showed that choosing an appropriate procurement approach plays a critical role to improve the documentation quality. In particular, the risks associated with management contracting in terms of documentation quality are highlighted.

Keywords Documentation quality • Procurement • Risks • South Australia

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_68,

68.1 Introduction

The managing contract style of procurement is generally adopted due to the relatively good time-saving potential for the overall project due to the overlapping of the design and construction processes as stated by [1]. It particularly appeals to clients who are inexperienced as they appoint "…a design team with the responsibilities as in the traditional method whose expertise and advice is available throughout the design development and procurement processes" [2].

Common issues underlying managing contract projects are that documentation is not finalised at the commencement of the project, meaning the budget of the project and the financial risks of the project are really unknown. The main issue from a constructability point of view is that once finalised documentation is issued it is expected that the documents are immediately issued for tender and that works can continue without being halted. However, if this documentation is poor, a large multitude of problems can occur which may determine the overall success of the project.

As it stands, it is perceived to be a common occurrence that finalised documentation for managing contract projects are of poor quality. The aim of the research is to investigate documentation quality issues in managing contract projects.

68.2 Documentation and Documentation Quality

In the construction industry context, documents provide the explanation of an operation required, a particular process and or a requirement for the building project. Documentation is required to present a design concept so as it can be understood and constructed by others [3]. In particular within the construction industry, documentation is an essential tool required to convey information that is contractual or legally binding for building projects. This is reinforced by Hipel et al. [4] who states that documentation can be used as a form of evidence in the court of law, if litigation or arbitration dispute arises between parties on a building project. Throughout the construction life cycle there are various different forms of documentation with varying purposes, the most common of these shared between project teams and industry professionals. These include: Architectural Drawings, Engineers Drawings, Shop Drawings, Specifications, Contracts and Subcontracts, Purchase Orders, Instructions, Transmittals, Requests for Information (RFI's), and Operation and Maintenance Manuals [5–8]. Additionally, to these main forms of documentation listed there is still a vast array of other procedural and administrative styles of documentation that is evident within building projects and the industry. To refine the research and for the purposes of this project documentation quality analysed will be limited to Architectural and Engineering drawings as well as their coinciding specifications. The other examples of documentation listed are outside of the desired scope of the project objectives and aims.

According to Sun and Meng [9], many construction projects experience frequent changes that result in negative impacts such as delays, cost overruns and defects. There are various impacts and intricate scenario's based on the impacts of design quality both positive and negative in a construction project. The main impacts of poor design include: program delays, cost overruns and building re-work [10, 11]. The higher complexity and extent of the project design will inturn demand an increased effort from designers to provide a quality documentation standard for the project.

A significant factor in the overall success of documentation quality particularly in managing contract building projects is the correlation between specifications and drawings. Rosen and Regener [12] argued that it as essential that the development of the specifications go hand in hand with the preparation of the drawings and that at the outset of creating documentation a member if the design team for each discipline e.g. the Architect and Engineers establish and keep a project checklist. Rosen and Regener [12] further emphasised that the project checklist should contain a schedule of what is to appear on the drawings, what is required within the specifications and also what is to be listed and itemized on the various schedule appendices. It is interesting to note, with regards to the designers checklists and in particular the 3D modelling undertaken by designers, Gal et al. [7] stressed that design checklists should accompany the listings of decisions made by the designers and detailers regarding action items to be developed or resolved within the documentation.

68.3 Semi-structured Interviews

All personnel that participated in the research project interviews were selected on their experience in the commercial building sector within the construction industry in Adelaide. Other selection attributes included their availability, level of experience and position within their respective companies as well as their relevant experience to the research topic. The profiles of interviewees are shown in Table 68.1.

Table 68.1 Interviewee profile

Interviewee	Working organization	Position	Professional experience (years)
1	Construction company	General manager	30
2	Architectural design firm	Director	20
3	Engineering consultancy	Partner	20
4	Electrical subcontractor	Manager	20
5	Construction company	Senior construction manager	18
6	Engineering consultancy	Associate	19
7	Architectural design firm	Associate	20
8	Construction company	State manager	15

68.3.1 Documentation Quality in Managing Contract Projects

All interviewees commented that the managing contracted projects tend to lack detail as opposed to the other procurement methods. Interviewee 1 elaborates this statement in further detail by explaining that often documentation is 'deliberately' lacking in detail as to collaborate with the builder to provide advice for cost effective solutions. However from a different point of view interviewee 2, commented that the reasons behind documentation issues on managing contracted projects are heavily attributed to the changes that are allowed to be made during the construction phase of the project by the client which results in issues and a higher level of coordination as well as the time restraints that are usually attributed with fast tracking construction with managing contract procured projects.

Interviewee 5 denoted that the main issues that they had to overcome was trying to commit the designers to provide documentation in time as to not dramatically halt construction and incur unnecessary delay costs effecting the profitability of the project. Interviewee 8 referred to the issue of time restraints to produce quality documentation. This linked with interviewee 1's, response as he noted that documentation was required to be partially completed to appease the builders needs to continue, but still required finalisation. As a result errors occurred and re-work to the project required. This is a clear common link which can be connected to the project as analysed within the case study. Linking this further, Interviewee's 3 and 4, described re-work as the main issues attributed to poor documentation in managing contracted projects. Interviewee 4 noted that although costs could be re-cooperated it meant extra time and energy was required to finish the works and this outcome is never desired as it slows down job and work turnover.

68.3.2 Systems or Procedures to Improve Documentation Quality

Interviewee 5 emphasized that all designers should define to all parties involved the realistic timelines to produce documentation, or, if the documentation is staggered such the case in a managing contract procured building method than they should define what stages are complete, incomplete, and which are to be revised.

Interviewee 7 stated that from a designer's point of view there are various checklists and measures that are adopted to oversee the production of documentation and to assess its quality. The limitations with this are that these checklists are not provided to any other project party who may find this information beneficial, in particular the engineering designers. Interviewee 6 provided similar information regarding the quality checklists, however mentioned that in a managing contracted project, there can often be some conjecture between the engineering and architectural plans, as they have to make various assumptions, which all bear a certain level of risk, due to the fact that the architectural documentation is not 100 % complete.

Interviewee 4 provided a totally different and extreme point of view by mentioning that an external body, similarly to a building certifier should be developed within the industry and engaged to crosscheck documentation and certify that ‘it all works’, in lieu of relying on the builder and sub-contractors to pick up errors, and relying on them to provide requests for information which can be quite time consuming.

68.3.3 Attributes of Documentation Quality

Interviewees 4 & 5 both noted that clarity and design intent were the main factors in documentation quality, as it can at least provide the bare minimum requirements to price up and build which is a vital part of their individual sectors within the construction industry.

Interviewees 2 & 3 differed in opinion by noting conformity, compliance, and the build ability of the design and documentation were the most important factors. Interviewee 2, in particular noted that subsidiary to these key attributes, a clear definition of material allocation on documentation was an important factor for them as architectural designers to get right. If this is incorrectly denoted throughout drawings, heavy variation penalties or re-work to rectify the issues could be experienced on site, and in turn parties could apply and claim for latent condition compensation or litigation.

68.4 Case Study

Interviews for the case study were undertaken with the three main parties involved within the building project. Subsequently these included the project manager and site manager representing the builder, lead architect who provided information from a design perspective, the client, the Service Engineering consultants and the Electrical Sub-Contractor.

68.4.1 Background

This project was built for a private college in Adelaide’s inner eastern suburbs. The building was a large double storey, purpose built music, media, and middle school building required to facilitate the ever growing and current needs of the school. The building itself was close to 2,350 m^2 with a price per square metre of roughly $3,944 including all external works. Upon completion of the building and finalisation of all variations and other associated costs the building's finalised figure was only a couple hundred thousand under the ten million dollar mark.

The builder was awarded the project in October 2008. As is the structure of the managing contract, the tender was based upon a submission of a builder's management fee which outlined all the builder's overhead costs as well as anticipated completion dates as required to manage the project. This management fee was submitted to the superintendent of the project who also happened to be the Architect. Being a managing contracted project, naturally, the works could commence soon after the project was awarded. Subsequently works commenced demolition of an existing building in December 2008, and was overall the project was completed by January 2010. According to the builder, the project presented many challenges and adversities due to the structure of the projects procurement method. These factors will be outlined in greater detail throughout the case study.

Access to the site was limited due to the presence of low power lines on the Southern side of the site. Two access points on the western side of the site were able to be utilized. Pre contract meetings were held on site with the critical trades by the builder to identify any issues as a result of access via one side of the site and what remedies could be put in place to overcome them.

68.4.2 Design and Construction Requirements

When interviewing the builder it was revealed that contrary to commencing works on December 2008, the original scheduled site commencement was initially tabled for February 2009. This was the builder's intention based on the scheduled completion of design documents and allowance to tender the trade packages, however due to the managing contract freedom to construct without finalised drawings, it was advised by the client and superintendant that construction should commence even whilst the project design documentation was only 25 % complete.

The school had expressed a desire to have the building completed by the end of January 2010 in time for the start of the 2010 school year. Based on a start date of February 2009 this was not going to be feasible. Upon being awarded the project the builder took charge of weekly design meetings and 'fast tracked' the design phase identifying key trade packages which needed to be procured in order for them to be able to meet a January 2010 completion.

In order to be able to meet this completion date works needed to commence no later than the first week of January 2009.

As revealed in interviews with architectural and engineering design consultants involved in the project, there was a consensus that this period of time was only sufficient to produce preliminary level drawings to commence construction. Subsequently, there would need to be updates, modifications or revisions to the design and documentation to achieve a final construction level of documentation midway through the construction. This system as also revealed within the literature review and surveys bears an extreme risk to the quality of construction and the cost control of the project.

By early 2009 the project was well into its civil and structural phase, however it appeared that the documentation had not kept pace with the construction program and requirements. To keep the project moving the builder had to progress with overlapping the design phase with construction. To the detriment of the project and the project team this continued throughout the whole building phase of the project. As a result constructability became increasingly difficult for the builder and for the design teams, including consultants. Time restraints made it increasingly difficult to produce good quality documentation that was particularly concise and conforming with the other documentation provided by other project design parties. All parties interviewed agreed that the method of building in the managing contract with the 'fast tracked' intent was a major contributing factor to these issues.

The issues and important quality measures were highlighted by all project parties involved as noted by the Architect. Weekly site meetings were carried out to ensure that the correct means of communication were developed between with the Superintendent/Architects, Project Managers, Site Supervisor, Client and Consultants.

After interviewing the client regarding the value of the site meetings an interesting response revealed that, from their perspective, the meetings were an opportunity to discuss budget and project progress//programme review. The level of influence in discussing design issues, site requirements, and OH & S updates was minimal and often left to sort out between the builder, superintendant and consultants. This information provides a clear link to Davis et al. [13]'s findings that an attractive factor for clients in adapting a managing contracted project are that roles, risks, and responsibilities of project parties are clear from the onset prior to commencing a project.

68.4.3 Project Issues and Consequences

Latent conditions were minor on the project, however, the presence of bored piers underneath the demolished building and proposed new building area caused a minor delay. The builder investigated the possibility of retaining these piers, however upon inspection the engineer deemed the piers to be unstable and as a result were required to be removed. Apart from these initial unforseen delays, the balance of delays to the project where as a result of majority design related issues. To justify this point further the builder indicated that there was a total of 340 Requests for Information issued to the design teams required for design and documentation clarification. According to the builder this is an unprecedented amount for a project valuing just under $10 million. As discussed within the literature an abundance of RFI's can be a contributing factor to poor documentation quality.

These RFI's where often quite lengthy and specialised. As a result they often required a few days each to be resolved by the Architects and consultants.

According to a select few sub-contractors that where interviewed, some of the RFI's took weeks for a response and even when the response was provided it meant that a change of works was needed meaning variations to the contract and administration nightmares. The sub-contractors associate these problems with poor coordination and incomplete documentation.

Variations were another contributing factor to the poor quality of documentation induced by the managing contract method of building this particular project. The Architect mentioned that there were a total of 240 variations and architect instruction and change notices provided to the builder during the projects construction phase. These variation changes where a multitude of items varying from structural, build ability, aesthetic and fit-out changes. These changes all contradicted the drawings previously provided, and as a result, constant revisions of the documentation were often made on a weekly basis. These constant revisions in documentation also had an influence in causing inadvertent administration and communication errors occurring between the builder and subcontractors.

As well as the build ability and administrative issues caused by the variation changes to the documentation there was also cost implications which had to be absolved by the client. Of the 238 variation changes to the contract and documentation, the builder notes that it ended up equating to just under $1 million dollars worth of changes. This equates to over 10 % of the overall budget figure. All parties involved within the project believe that this was a cost 'blow out' and can be directly related to trying to fast track construction associated with the managing contract procurement method for this project.

There were many specific documentation issues experienced throughout the project as described by both the Builder and Architect in their respective interviews. Below provides a list, and a brief summary, of the poor documentation quality issues experienced, which can be linked to the managing contract procurement method utilized for this project;

68.4.4 Clashes with Revised Documentation

Particularly mechanical and electrical service drawings were not crosschecked properly once architectural and structural changes were made to revised documentation. These errors were high risk as they were identified and addressed during the construction phase of the project. This inturn meant that there were many service revisions required made to rectify the issues and in most cases this was done quite hastily considering the time restraints as to not halt construction. Service layout design had to be totally revised to accommodate certain areas within the building. As a result these changes equated to roughly 60 % of the total of variation expenses for the project.

68.4.5 Client Changes

Due to the nature of the contract, client changes could be made progressively throughout the construction phase of the project. This proved to be costly and difficult to manage in an administrative sense for all parties involved. Due to the specific functions of the building being a music and media centre there was a lot of changes made to the design as per the request of the schools music and media departments. Various inclusions had to be accommodated for as per the client's request. This often occurred midway through construction which as a result ended in high cost variations, issues with constructability and in some cases re-work to finished items. Examples of these included, ensuring rooms where all acoustically rated not previously documented, additional AV feeds and outlets not previously documented, room layout changes, and specific product changes.

68.5 Conclusions

Documentation quality is of high importance for any procurement method, however for a managing contract type procurement it is particularly important as there is limited time to issue and fine tune the finalised drawings for tender without the potential to halt concurrent works. It is the quality of the finalised documentation during this construction phase that generally dictates the final outcomes of a project. This research investigated the documentation quality issues in managing contract projects through semi-structured interviews and a case study. Results showed that time restraints on the project design to accelerate construction, clientele changes, lack of cohesion between different project parties and difficulty to manage costs attributed to poor documentation quality, subsequently bourn from the managing contract style of building and its restrictive attributes for the design team.

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Chapter 69
Precautions for Project Managers in Public Tendering

Yuen F. Tony Ma

Abstract A major component in project planning is the compilation of procurement documents and the setting of criteria for tender assessment. Project managers are commonly engaged by owners to provide project management services, and therefore during the tendering stage they would have obligations and liabilities to their owners. Evidence suggests that many so-called project managers enter the industry by accidents without suitable training or qualifications. The legal position of the owners of a project may be complicated by the delegation of their power to manage contracts to specialist project managers. In a decided case, the court held that the consulting engineers owed a duty of care for misleading tender documentation to the tenderers. The scope of a project manager's liability might be significantly widened if this reasoning were to be adopted. This paper aims to review the extent of engagement of project managers and attempts to suggest precautions especially for their involvement in public tendering. Thirty in-depth interviews were conducted and the results indicated that project managers should have relevant updates of legal cases in tendering, and in order to elevate the status of project management profession, there is no doubt that the standards of professional training and competence must be increased.

Keywords Project managers • Public tendering • Precautions

69.1 Introduction

Information collected from literature [1, 2] demonstrates that a successful project requires leadership skills by a competent project manager with necessary authority and commitment to push the project forward. For the above reasons, Crawford [3]

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_69,

indicated that there is a growing international interest in project management competency. Burke [4] stated that there is a trend away from the knowledge examinations, which assess a person's knowledge, towards competence-based assessments which assess a person's ability to perform. Crawford [5] highlighted that there are two de facto global international standards: the PMBOK (1996) [23] Guide is indicates what project managers are expected to **know**; and the Australian National Competency Standards for Project Management (NCSPM 1996) [21] provides the first generic description of what project managers should be able to **do**.

Using construction as an example, project managers are a relatively new profession and there is no recognised definition of a project manager and the best indication of the nature of the tasks commonly performed can be found in the service contracts. As with all professionals, the primary obligations which they owe to their clients are to be found in the express or implied terms of their contracts. Most contracts set out the range of services which the project manager has to perform and also indicate the requisite standards of skill, care and performance. Since there is not yet recognition of a distinct profession of project management it is likely that when ascertaining the relevant duties of skill and care courts would look into the profession from which the project manager comes. That is to say, if the project manager were to be, say, a professional engineer, then the standard expected of him when performing the project management role would be equivalent to that of an engineer. In *Pacific Associates Inc v Baxter* [*1990*] *1 QB 993 at 1023* Purchas LJ described the role of an engineer as follows:

> *The engineer remains under the contractual obligations to the employer, which give rise to a duty to exercise skill and care and in appropriate circumstances to act fairly between the employer and the contractor. If the engineer is in breach of this duty they are* [*sic*] *liable to the employer for economic loss directly flowing from the breach.* (cited by [6], p. 75)

The Project Management Agreement (PM2 August 1990) stipulates that the project manager shall provide the following project management services for tendering:

1. *In consultation with the Principal, prepare lists of renderers,*
2. *In consultation with the Principal, prepare all tender documents,*
3. *Invite tenders for the works,*
4. *Analyse the tenders and advise the Principal as to the suitability and expertise of contractors submitting tenders,*
5. *Provide the Principal with all tender received, and*
6. *Recommend to the Principal which tenderer should be awarded a contract.*

In public tender procurement, the role of project manager is described. In the Selective Tendering Guideline by the NSW Department of Commerce, project managers are required to comply with the department's tendering manual (PWM-0633) for the management of a tender process, including the initial establishment of the Request For Tender (RFT) number. Therefore it is important that project managers should be aware of the current issues of tendering. With the increasing legal disputes in tender validity period, acceptance of non-conforming tender, undisclosed evaluation criteria, procedural unfairness impacting upon public tendering, it is reasonable to suggest that the courts may increasingly look on project managers as full professionals, and the scope of a project manager's liability might be significantly widened if this were to be adopted.

This paper attempts to review the extent of engagement of project managers in practice and attempts to suggest precautions for their involvement in public tendering.

69.2 Project Management Development: From Accidental Engagement to Certification

It is not surprising to see that the increasing demand for competent project managers in various industries is creating pressure on the project management profession. Project managers are seeking university training and recognition as a means of increasing their professionalism, and at the same time many organisations are still appointing individuals capable of assuming the role of project manager, thus creating a secondary stream of 'accidental' project managers. As cited by Bourne [7], Pinto and Kharbanda[8]) have defined the concept of 'accidental' project manager by exploring the difference between the accidental project manager and the career project manager. The accidental project manager usually has a technical background, such as engineering or programming, or is a person with expertise in the field of the project. By contrast, the career project manager will normally have to seek project management education and have experience in management as well as organisational skills. The career project manager may also have some knowledge relating to the features, or industry, of the project deliverables. A survey was carried out by Baccarini and Darrell [9]) and found out that project managers are assigned to manage projects because they possess the relevant technical background and experience, not because they have any project management knowledge and skills. Shum [10] conducted a similar survey in Adelaide but pointed out that majority of respondents replied that the training they received was a project management subject in an undergraduate program or in-house training.

From the literature [11, 12], it is evident that many so-called project managers enter the profession unprepared, and if required to provide procurement advice in tendering processes it is likely that they may not possess the skills to fulfil the work.

Though it might be debatable whether project management is a distinctive profession [13], currently there are project management institutes which promote the roles of project managers. The Project Management Institute (PMI), and the Australian Institute of Project Management (AIPM) are good examples. In 1984, PMI held its first PMP (Project Management Professional) certification exam, resulting in 43 passes out of 55 applicants. As of 31 July 2010, there were 393,413 active PMP certified individuals worldwide and the rigorous, examination-based certification process (that holds an ISO 9001 quality standard) has become a highly-valued project management credential (Wikipedia PMP viewed on 2012). On the other hand, AIPM has also developed a certification program (RegPM) which involves an individually-designed competency-based workplace assessment based on the new AIPM

Professional Competency Standards for Project Management. They were formally released on 7th July 2008. Depending on qualifications and experience, the certification programs have three categories namely,

1. Certified Practising Project Director (CPPD)
2. Certified Practising Project Manager (CPPM)
3. Certified Practising Project Practitioner (CPPP) (AIPM Website) [22]

Since the role of project manager is concerned mainly with supervision and coordination, most professional negligence action against project managers may involve allegations that the project manager failed to control the timing, cost, and quality of the project. It is relevant to note that in the case of *Chesham Properties Ltd v Bucknall Austin Project Management Services Ltd* [*1996*] *82 BLR 92*, the claimant sued both the architect and the project manager in respect of the excessive extensions of time together with the loss and expenses awarded to the contractor. The court held that a reasonably competent project manager has an obligation to inform the claimant accordingly when the architect is not performing his duty. Similarly in the case of *Pride Valley Foods Ltd v Hall* & *Partners*(*Contract Management*) (unreported, Toulmin QC, Technology and Construction Court, QBD), a fire destroyed Pride Valley's bakery as a result of the use of highly combustible expanded polystyrene panels installed close to the baking ovens. The project manager was held liable under a contractual duty to advise the employer in relation to the suitability of materials being used. In this case, the court specifically indicated that there is not yet a recognised profession of project managers and that their role and conduct are not outlined by any chartered or professional institution. It highlighted that the role of a project manager is not set and will vary greatly according to the project delivery structure adopted ([14], ACLN – Issue #74, Clayton Utz, Sydney).

69.3 Risks of Discrepancies of Tender Documentation in Tendering

According to Kirchner and Wood [15], quality assurance was being described as simply '*getting it right first time*, *every time*' with the help of document systems. Experience has shown that often, not enough attention is put into quality planning to ensure that sufficient controls were regularly used to meet client and government requirements and professional responsibilities. It has been a general practice that tender documents, specifications and drawings are prepared for tendering purpose. These documents are usually prepared by professionals and/or government procurement managers, however, discrepancies do occur. When such discrepancies occur and are not detected at tender stage, the problems will be carried forward to construction stage. Once it is detected, this will lead to implications like variations, delays, additional cost and even disputes.

In Skinner & Edwards (Builders) Pty. Ltd. -v- Australian Telecommunications. Corporation [1992] 27 NSWLR 567 at 571, the architect engaged a consulting engineer to prepare some of the drawings but the scale was 1:100 instead of the correct scale of 1:200. The architect then reproduced the drawings without checking and gave them to client, the Telecom. Telecom also had a building consultant and they checked the drawings but did not discover the error. After the work commenced, the subcontractor claimed against the builder the extra cost involved in carrying out the work as shown on the tender drawings. The builder accepted the claims and sought to pass on the extra cost to Telecom. Telecom refused to accept the liabilities and resulted in court proceedings. The court held that the architect, the engineer and Telecom all owed a duty of care to the party to whom they gave the drawings [16].

The following case (cited in [17], p. 232) also reinforced the importance of getting the document right the first time. In a Canadian Supreme court case of *Edgeworth Construction Ltd v. F. Lea & Associate [1993] 3 SCR 206*, the consulting engineers prepared the tender invitation documents for a government road-building authority. The documents misled the contractor. The court also held that the consulting engineers owed a duty of care to tenderers when preparing the documentation. They were providing with information and they knew that the tenderers would rely on the information. They failed that duty and thereby causing economic loss to the contractor.

Based on the similar situations above, the project manager may also be held responsible for his professional advice during the tender procurement process. It is recommended that public agencies should either provide in-house project management training or outsource to qualified project managers (e.g. RegPM) to handle major projects from inception till completion.

69.4 Precautions to Protect Project Managers in the Administration of Tendering Process

In order to understand more about how project managers are engaged in public tendering, 30 in-depth interviews were conducted in Adelaide of South Australia. All interviewees were very knowledgeable of the tender procurement process. Of the 30 participants, 17 represented public owners and clients organisations, and 13 represented general building contractors eligible to tender for public works. Three major questions were asked and the analyses are summarised below:

(a) Do public clients usually engage an external project manager to manage tender procurement processes for major capital projects?

    Project management is a growing profession, but so far there have been no government-mandated requirements that project managers must be registered or that they should qualified members of professional institutes, such as the Australian Institute of Project Management. But since project managers are

Table 69.1 External project managers engaged for procurement of capital projects

	Very often	Only at times for major projects	Usually not	Don't know	Total
Public Owners	0	5	12	0	17
%	0 %	29 %	71 %	0 %	100 %
Contractors	3	5	4	1	13
%	23 %	38 %	31 %	8 %	100 %
Overall (%)	3(10 %)	10(33 %)	16(54 %)	1(3 %)	30(100 %)

frequently involved in the procurement processes for public capital projects it was relevant to seek the views of the participants regarding the employment of qualified people as managers.

From the data shown in Table 69.1 it can be seen that 71 % (12/17) of public owners reported that it was not common for public owners to engage external project managers. The main reason is that most public agencies already have their own procurement units and/or contracting staff. For example, the Building Management and Project Services section of Department of Planning, Transport and Infrastructure (DPTI) provides asset, risk, project, procurement, and management advice to the South Australian Government and its agencies, and it facilities the interface between government and the building industry. Government policy requires agencies to refer all building projects valued over $150,000 to DPTI for advice and risk management services.

On the other hand, 43 % (13/30) of participants reported that project managers were engaged for major capital projects. When questioned further they said that Defence, Public utility, and Commonwealth Government agencies are outsourcing more of their projects to external project management consultants.

(b) There is a need to regulate the employment of a qualified project manager for his involvement in the tendering process (e.g. from the client's perspective, should an AIPM registered project manager be employed to manage the tendering process?)

Table 69.2 showed that 73 % (22/30) agreed that there is a need to regulate the employment of qualified project managers for their involvement in the project procurement process. As described in the literature review, it is reasonable to suggest that the courts may increasingly look upon project managers as full professionals with the result that the scope of a project manager's liability might be significantly widened. For the benefit of the public owner, it would be prudent to establish clear guidelines when project managers are engaged.

(c) Are there any precautions that project managers should be aware of in the tender procurement process?

Table 69.3 below indicates some of the precautions which project managers should take in the tender procurement process:

Table 69.2 Opinions on the statement (1 strongly disagree to 5 strongly agree)

	1	2	3	4	5	Total
Public Owners	0	1	3	4	9	17
Contractors	2	0	2	3	6	13
Total	2	1	5	7	15	30
Percentage	7 %	3 %	17 %	23 %	50 %	100 %

Table 69.3 Precautions for Project managers in tender procurement process

		Frequency counts	
No.	Precautions for Project managers in tender procurement	Public owners	Contractors
1	Update of legal cases in tendering	6 (0.353)	2 (0.154)
2	Understand government tendering procedures, guidelines & code of practices	9 (0.529)	9 (0.692)
3	Adhere to code of ethics and observe standards	5 (0.294)	2 (0.154)
4	Quality of tender documentation	2 (0.118)	4 (0.308)
5	Knowledge & due diligence in tender assessment	5 (0.294)	3 (0.231)
	Total no. of counts	27 (1.588)	20 (1.539)

Note: The figure in brackets denotes a ‘response rate per interviewee’. The frequency counts were divided by the respective no. of interviewees

Based on the contents of the conditions of tendering prepared by government procurement managers, it can be reported that the wording in many documents are drafted as a result of legal cases in tendering. Concern about possible legal ramifications is the reason that project managers need to take precautions, such as awareness of legal cases in tendering, and the ability to fully understand government tendering procedures, implementation guidelines, and codes of practice. Two interview participants (public owners) provided a succinct summary:

I don't think that the responsibilities/requirements differ from those which would apply to an internal PM appointment – need to be aware of market trends, supply and demand factors, current legal position, evolving forms of engagement, performance measurement, arrangement etc.

Assessment and evaluation must be based on due diligence. They should be able to identify the risk when calling for tender. Documents must be clear and precise – able to produce a high quality of conditions of tendering.

69.5 Conclusions

Evidence suggests that many so-called project managers enter the construction industry by accident. However, in the absence of suitable training or qualifications, ill-informed advice or poor management by that individual might leave him/her open to claims of professional negligence. According to Jones and Young [13], practitioners are currently liable for ordinary negligence claims against them, but if project management were to become an accepted profession then higher levels of professional negligence would apply.

Based on the answers to the interview questions, it is clear that the employment of external project managers for capital projects is not a common practice in the public sector. However, 43 % (13/30) of participants reported that project managers were now engaged for major capital works because large organisations, such as public utilities and Commonwealth government agencies, are increasingly outsourcing their projects to external project management consultants.

So far there has been very little judicial consideration of the application of negligence to a pre-award (tendering) relationship. Even in the case of the case of *Blackpool and Flyde Aero Club Ltd v Blackpool Borough Council* [*1991*], an argument raised by the club was that the council owed the club a duty to take reasonable care in its handling of the tender process. However, both Judges Bingham and Stocker declined to decide on this point [18–20]. As a result, it is unclear whether an Australian court would find that there is sufficient relationship between the parties to give rise to a duty of care, especially in the case of a project manager who acts on behalf of a client when dealing with tenders. If the project manager rejects a tender, and if the client relies on his professional judgment, then he may be liable for professional negligence if an unsuccessful tenderer claimed for damages because of unfair treatment. For that reason, 73 % of participants agreed that there was a need to regulate the employment of project managers. A thorough understanding of government tendering procedures, guidelines, and codes of practice would help project managers to perform their duties appropriately. As abstracted from Table 69.3, participants suggested a number of ways in which project managers could ensure that they are performing their duties in a legally-accepted manner. Finally, in order to elevate the status of the project management profession, there is no doubt that the standards of professional training and competence must be increased. Since there is an increasing trend for governments to outsource their projects to external consultants, precautions for project managers involved in tender procurement should be a high priority.

Recognising this need, in 2007 the Australian Council of Built Environment Design Professions (BEDP) successfully applied to partner the Australian Government to develop a long-term plan for all the built environment design professions including project management, architecture, engineering, quantity surveying, landscape architecture, and planning. This is evidence that the work of project managers is now acknowledged as being of great importance, and it shows that high levels of expertise, knowledge, and due-diligence are expected when service is provided to project owners.

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Chapter 70
An Analysis of International Case Law for Process Contract in Public

Yuen F. Tony Ma

Abstract Traditionally, an 'invitation to tender' is no more than an invitation to treat which means that it is not an offer to make a contract with any person or organization which might act on the invitation. In other words, the owner is free to accept or reject any offer and no legal relationship is entered between tender parties during the tender pre-award period. However, developments in commonwealth jurisdiction since the 1980s have significantly changed the principle of offer and acceptance. The changes suggest that the traditional view of invitation to tender should not be regarded with complacency. This paper describes the major international court cases relating to tendering which would have significant impacts on the day-to-day running of public tendering processes. The aim of these legal case studies is to evaluate the legal implications when public tenders are invited. The analysis of ten selected court cases since the 1980s shows that process contract has become widely accepted as the legal basis of tendering. Furthermore, decisions by courts have also highlighted the principles of fairness and integrity within the tendering system, and these principles must be observed by all parties to the tendering system.

Keywords Public tendering • Commonwealth jurisdiction • Process contract

70.1 Introduction

A tendering arrangement is basically a contractor selection process, usually through competition by means of open invitation to selected or pre-qualified tenderers. Tendering is the traditional way of obtaining a competitive price for a one-off

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_70, © Springer-Verlag Berlin Heidelberg 2014

project. Cooke [3] stated that a tender is submitted by a contractor in response to an invitation by an owner to submit an offer for the execution of work described in tender documents issued by the owner. The tendering process, and the tender documentation and its effects on the contract formation, are regulated by contract law and by some other legislation. Under the principles of law of contract, a simple contract is a legally-binding agreement between two or more parties and is supported by consideration. Unless and until an offer is properly accepted by way of conduct or written confirmation, there will not be any contract between the parties. Accordingly, the tendering process has been regarded as no more than 'an invitation to treat'. Owners can reject or accept tenders as they please, or they can negotiate with one or more tenderers to produce a satisfactory deal. The seminal case on offer and acceptance in the tendering situation was *Spencer v Harding (1870) LR5 CP 561* ([4], p. 186) which laid down the general principle that the invitation to tender was not an offer, but merely an invitation to treat. The vendor was not obliged to accept any tender. Therefore, traditionally, the owner was unrestricted in how tenders were assessed and how the subsequent contract was awarded. In fact, many conditions of tendering do not really contain any information about the tender assessment criteria.

This traditional position has been changed by decisions and rulings made in several international court cases since 1981. It is now held that a 'Process (Tendering) Contract' exists between the tenderer and the owner upon the submission of a tender. Under this relationship the owner has a general duty to treat all tenderers equally and fairly in the selection process. In his book on Procurement Law, Craig ([4], p. 221) defined a 'process contract' as "...a contract brought into being automatically upon the submission of a responsive tender." This specific duty may be breached when an owner accepts an alternative tender which does not conform to the tender conditions. The principle behind the so called 'process contract' is that if the owner accepts an alternative tender which contains proposals which do not adhere to the original project stipulated in the tender documents, then it would be unfair to tenderers who only make submissions which conform to the tender requirements. Any departure from the conditions of tender by the owner risks allegation of unfairness to the tenderer(s), so bids that do not comply with the tender call should be rejected. Typically, procurement codes or conditions of tendering do not provide for an independent innovative solution from any one bidder in response to the tender call. However, the owner's obligation to be fair to all tenderers should not be compromised by bad project management. If the owner does accept an alternative tender that was non-conforming, he/she may be liable in damages to the lowest conforming bidder.

This principle of fairness also extends to the dealing of tender validity period. It is usual for owners to state their requirements in their tender documentation regarding the length of time for which any tender received shall remain open for acceptance. Historic cases such as *Routledge v Grant (1828) 4 Bing 653* set the principle that a tenderer was free to withdraw his offer at any time before acceptance despite the existence of any period stipulated for the offer to remain open. Relying on such precedent, some tenderers find it expedient to submit bids first and check their accuracy later, especially when the tender period is short. However, this practice has been criticised by owners as being too opportunistic in tendering. The landmark case was the Supreme Court of Canada in *The Queen in Right of Ontario et al. v. Ron Engineering & Construction Eastern Ltd (1981) SCR 111.* The contractor (Ron) submitted a tender and made the deposit as per the conditions. The contractor's tender was the lowest, but soon after the opening of tenders the tenderers discovered a pricing error by omitted work and therefore requested in writing to withdraw the tender without penalty. The withdrawal was denied and Ron also refused to sign the contract for acceptance. The contract went to another tenderer and the deposit was not returned. Ron commenced proceedings to recover the deposit but the owner made a counter-claim on the contractor's refusal to carry out the terms of the tender. One of the conditions of tender was that the offer could not be withdrawn for 60 days after the opening of tenders. The point in question related to whether the submission of a tender in this situation would create a contractual obligation for both parties so that the contractor's revocation of offer would be a breach of contract and thus entitle the owner to damages. In the end, the owner successfully argued that the submission by the contractor of a tender created a contractual obligation so that the contractor must perform the tender conditions. As a result the deposit was not refunded.

The aim of this paper is to review and evaluate the implications of commonwealth case law upon the procurement processes when public tenders are invited. It is anticipated that sources of disputes in relation to tender-selection can be identified. Both owners and tenderers have to take extra care in tendering.

70.2 Summary of International Case Law for Process Contract

The implications of the 'process contract' have created some confusion as to when it actually occurs or when there is procedural unfairness during the process. The reason is that the detailed legal principles behind those judgements have yet to be fully investigated, developed and understood. In the case of *Cubic Transportation Systems Inc & Anor v State of New South Wales & 2 ors [2002] NSWSC 656,* the Judge did not conclude that there would always be a preliminary process contract in every government tender. Whether there is a pre-award contract depends on the conditions stipulated in the tender documents. It is not possible to describe all the relevant cases in details and the Table 70.1 [1, 2, 5–15] below comprises a summary of 10 court cases where process contract has been established.

The writer would like to stipulate that the legal cases examined in this enquiry came from Australia, New Zealand, Canada, Hong Kong, and the United Kingdom because each of these Commonwealth jurisdictions follows the common law system.

Table 70.1 Summary of 10 international court cases. Source: Various online legal websites and Australian Construction Law Newsletters

Court cases	Issues/disputes in tendering process	Decision	Implications
1. *The Queen in the Right of Ontario et al. v. Ron Engineering & Construction Eastern Ltd. [1981] 1 SCR 111*	Due to pricing error, Ron withdrew its tender and revoked its offer after opening of tenders	It was decided that the contract was brought into being automatically upon the submission of a tender	Tender conditions must be observed by both parties
	The owner successfully argued that the submission of a tender by the contractor created a contractual obligation so that the contractor must perform the tender conditions	The contract created by the submission of the tenderers is now known as Contract A; Contract A is now known as a Tendering Contract or a Process Contract	
2. *Calgary (City of) v. Northern Construction Co [1987] 2 SCR 757*	This appeal raises the question of whether the appellant, a general contractor (Northern Construction) who made a tender, expressly agreed to be irrevocable for a stated period or until the acceptance of another tender, was entitled to refuse performance of the contract because of honest error in its preparation resulting in a lower price than intended	It was held that the appeal was dismissed with cost	Pricing mistake was irrelevant in this case
		The owner (the City of Calgary) successfully claimed damages equal to the difference between the erroneous tender and the next lowest tender	This case could not be distinguished in any significant respect from the *Ron Engineering* case

(continued)

Table 70.1 (continued)

Court cases	Issues/disputes in tendering process	Decision	Implications
3. *Health Care Developers Inc and Others v. The Queen in Right of Newfoundland (The Crown) [1996] 136 DLR (4th) 609*	The invitation asked for irrevocable proposals to design and build, and lease the required facilities to the government. Health Care was the preferred bidder but the government awarded the contract to a tenderer who provided a preferred design solution	The defendant (government) was held in breach of tendering contract. There was an obligation placed upon the owner to act fairly towards all tenderers	The court referred to "the emerging obligation of contracting parties to perform in *good faith*". Failing to reject non-conforming tenders or awarding Contract B based on undisclosed criteria are examples of the owner not acting in good faith
	The tender evaluation criteria were not stipulated in the conditions of tendering. Usual owner's privilege clause was included	Health Care was only entitled to loss of profits on those projects. Claims of tendering cost were rejected. Each party had to bear its own costs in the appeal	
4. *M.J.B. Enterprises Ltd. v. Defence Construction (1951) Ltd. [1999], 1 SCR 619*	The Supreme Court of Canada was to decide whether the inclusion of a 'privilege clause' in the tender documents allowed the respondent (Defence Construction) to disregard the lowest bid in favour of any other tender, including a non-compliant one	It was held that the appeal was allowed with cost	A privilege clause allows the owner to award Contract B to any tenderer if it is a complying tender. The owner has no absolute and unfettered discretion in awarding the contract
	The appellant (MJB), the second lowest tenderer, brought an action for breach of contract claiming that the winning tender should have been disqualified	Contract A was brought into being automatically upon the submission of a tender It was held that the note offered by the winning bid was a qualification and should be disqualified	Irrespective of the privilege clause, the owner has an obligation to award the tender to a tenderer that best meets the criteria stated in the tender documents

(continued)

Table 70.1 (continued)

Court cases	Issues/disputes in tendering process	Decision	Implications
5. *Blackpool & Flyde Aero Club Ltd v. Blackpool Borough Council [1990] 3 All ER 25*	The club claimed damages in respect of the council's failure to consider a tender received in accordance with its standing orders The council argued that "the Council does not bind themselves to accept all or any part of any tender"	The Court held that the council was under an implied term to consider the conforming or complying tender submitted by the club	The Court would not accept that an owner could invite tenders but at the same time ignored the stipulations detailed in the conditions of tender
6. *City University of Hong Kong v. Blue Cross (Asia-Pacific) Insurance Ltd [2001] HKCFI 218; HCA No. A10750 of 1993*	The main issue was whether a mistake as to the terms of a contract, if known to the other party, might void the process contract. Blue Cross withdrew its tender within the tender validity period due to a pricing mistake	The earlier trial indicated that Blue Cross (the defendant) was in breach of the implied contract and City University (the plaintiff) was entitled to seek damages. Blue Cross appealed	This case highlighted the importance of the contracting parties to observe the stipulations in the conditions of tender
		It was decided that Blue Cross could void the contract because the plaintiff failed to exercise its right given in the Clause 8 of the conditions of tender relating to pricing errors	It reminds the owners that they must be careful to follow the said conditions and the failure of which will allow the tenderer to withdraw its tender without recourse
7. *Pratt Contractor Ltd v. Palmerston North City Council [1995] 1 NZLR 469*	Pratt submitted the lowest conforming tender and, on the basis of the tender requirements, expected to be awarded the contract. One tenderer submitted an alternative tender and was accepted	The court held that Pratt can successfully sue for breach of contract as there was a contractual relationship between the council and individual tenderer who submitted a conforming tender. Pratt was entitled to cost of tendering and loss of profit	Unless it is stipulated, the alternative tender is a non-conforming tender and cannot be accepted within the confines of the tendering contract The first case that the cost of tendering was compensated

(continued)

Table 70.1 (continued)

Court cases	Issues/disputes in tendering process	Decision	Implications
8. *Hughes Aircraft Systems International v. Air Services Australia [1997] 146 ALR 1*	Hughes was the unsuccessful tenderer in a two-party bid for a project for Air Services Australia. Thomson was the successful tenderer on the basis of "its significant commitments to work with Australian industry". Subsequently Thomson also submitted a price reduction and an upgrade export commitment. Hughes argued for being treated unfairly in evaluation	The court held that Air Services had breached the process contract as follows: It did not evaluate the tender according to the priorities of the evaluation criteria It disclosed information to parties which were outside the scope of their evaluation role, i.e. information regarding price was released to the department undertaking the industry evaluation	Process contract was first recognised in Australia in the 1997 decision of Hughes case Fair dealing was of particular importance in tender process The judge asserted that "the integrity of the bidding system" must be protected.
9. *Cubic Transportation Systems Inc & Anor v State of New South Wales & 2 ors [2002] NSWSC 656*	Both Cubic and ITSL lodged detailed proposals for an integrated ticketing system. ITSL was the preferred and recommended proponent	Relying on the clause that "the Principal reserves its right to cancel, vary, supplement or supersede this Call" the court held that no unfairness or breach of any obligations owed by the government to Cubic with regard to the tender process was established	A clearly drafted request for tender stating the actual undertakings and legal obligations will more likely avoid the consequence of the expensive litigation
	Cubic commenced proceedings and sought injunctive relief restraining the government from entering into a contract for the supply of the integrated ticketing system by ITSL on the basis that the tender evaluation process was unfair	The judge highlighted the fact that Cubic had engaged in reprehensible conduct during the course of the tender through breaches of confidentiality	There is a growing recognition that all commercial players must also act in *good faith* (not just the governments) in their commercial dealings

(continued)

Table 70.1 (continued)

Court cases	Issues/disputes in tendering process	Decision	Implications
10 *State Transit Authority (NSW) v Australian Jockey Club [2003] NSWSC 726*	State Transit initiated a tender process for the sale of the busway for vehicles servicing Randwick race-course. The case involved an unsuccessful tender by Australian Jockey Club (AJC) which claimed that the process contract had been breached and its tender had not been fairly considered because of various conditions imposed upon it	The court held that in the light of clauses 6.2, 6.5 and 6.6 State Transit, was entitled to deal with individual tenderers differently and was under no obligation to follow any particular process. The call for tender was merely an invitation to treat	This case reinforces the principle that analysis of the terms of the invitation to tender is the starting point to see whether a request for tenders gives rise to a process contract

70.3 Implications of Court Cases on Tender Procurement

Contracts for public capital works projects are generally procured through a tendering process. The documents issued usually comprise information necessary for the preparation of the bids. The information in the Conditions of Tender often includes a clause stating that "*the Owner is not bound to accept the lowest or any tender it may receive*". It is this privilege clause that many owners rely on as a defence if they reject the lowest tender or any tender they receive. However, recent development in common law relating to tendering indicate that circumstances may arise where the owner is liable to the unsuccessful tenderers as a result of failing to comply with the stipulations prescribed in the tender documents. Failure to adhere to the stated assessment evaluation criteria, the acceptance of a non-conforming tender, and the assessment of tenders not in good faith are all issues which may give rise to legal liabilities. Moreover, owners should be aware of the implications of the judgements arising from the 10 cases cited here. The lessons learned from these cases include the following:

1. Tender conditions must be observed by both parties.
2. In nearly all cases in which a bid contract expressly or impliedly imports a term making the tender irrevocable for a stipulated period, a tenderer will be unable to withdraw its tender.

3. The general purpose of the so-called ‘privilege clause’ is to prevent the creation of any owner’s duty to award a contract to the lowest tenderer, or to award any contract at all. It is not designed to negate the owner’s duty of fairness to all tenderers.
4. The owner cannot award Contract on the basis of undisclosed criteria.
5. Courts would not accept that an owner could invite tenders but at the same time ignore those stipulations detailed in the conditions of tender.
6. The compensation might include the cost of tendering and loss of profit.
7. There is a need for all government departments to arrange and conduct procurement codes with maximum care and supervision.
8. There is a growing recognition that all commercial players (and not just governments) must also act in good faith in their commercial dealings.

70.4 Conclusions

It is evident from the literature review and, the examination of relevant legal cases that the tendering system for public works needs to be open and transparent. Government agencies must maintain the integrity of the tendering system and ensure that it is conducted with probity and fairness. Not only is this good practice, but it will avoid exposing the project owner to any form of litigation. As the *Hughes Aircraft* case showed, agencies must make sure that tender processes, particularly tender evaluations, are consistent with the stipulations contained in the tender documents, and that the basis of the evaluation is clearly stated in the tender documents. The owner is obliged to assess the tender according to the specified evaluation criteria, and failure to do so puts the owner at risk of breaching the process (tendering) contract.

The over-riding principle to which the owner must adhere is that all tenders must be treated equally and fairly, and all conforming tenders must be considered. On the other hand, tenderers should also comply with tender requirements as to the validity period of their bids. Breach of tendering contract entitles the injured party to the normal remedy of damages.

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Chapter 71
Building an Effective Interfirm Networks for Enhancing Contractors' Project Competitiveness

Calvin C.W. Keung and Li-Yin Shen

Abstract Competitiveness is an important concept to contactors due to fierce competition in the construction industry. In order to outperform their competitors in the market, contractors are keen to realize their competitiveness by measuring it for benchmarking and improvement purposes. That is the reason why competitiveness for construction has been an active research topic. Yet, little has been done in addressing the methods to improve competitiveness in the construction field. Previous studies have proved that networking is an effective tool for gaining competitive advantage over competitors. It is therefore important to gain a clearer understanding of the effect of contractors' networking to their competitiveness in the construction industry. This paper focuses on the ways of enhancing contractors' competitiveness in the networking perspective. A research model was developed in this study and the relationships between contractors' network performance and their success of competitiveness were examined by the use of multiple regression analyses. The findings show that contractors' networking techniques are related to certain outcomes which in turn stimulate the level of competitiveness. In particular, the techniques of supporting information exchange and organizing project communication stood out to be the highly significant predictors of competitiveness attributes.

Keywords Competitiveness • Interfirm network • Networking techniques • Networking outcomes

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_71, © Springer-Verlag Berlin Heidelberg 2014

71.1 Introduction

Competitiveness is paramount for business firms to outperform their competitors in the market and its importance has attracted an enormous amount of scholars and practitioners to study the related topic area. In the construction industry, contractors need to take competitive strategy for positioning themselves in the market and standing out from their competitors [1]. Construction business is competitive particularly during the period of economic recession as contractors strive to maintain workload and cashflow for survival. Due to the importance of competitiveness, contractors are desirous to measure and benchmark their competitiveness with their competitors [2]. However, the ultimate goal for measuring competitiveness is to enhance and improve its performance based on the understanding of competitiveness performance indicators. Notwithstanding, little previous research exists about improving competitiveness, especially for competitiveness at the construction project level which enables contracting firms to win the construction contract and then undertake the project successfully [3].

Previous studies in the business field explored the effect of networking to competitiveness and the results indicated that networking is an effective tool for a firm to gain competitive advantage over competitors. Networking study is a well-defined research topic in the fields of sociology, anthropology, etc. and this approach is used to examine the relationships among a group of people or organizations, which particularly emphasizes on building and sustaining these relationships [4]. Especially, effective interfirm networks enhance a firm's competitiveness [5, 6]. Evidence is also found that networking is a tool for gaining competitive advantages [6, 7]. According to Rollyson [8], the use of networks will give firms significant competitive advantage over competitors. It is therefore necessary to gain a clearer understanding of how effective networking help contractors to improve their competitiveness, in particular at construction project level that significantly affects their construction business. In this regard, the objectives of this study are to investigate the relationships between contractors' network performance and their success of project competitiveness, and to propose recommendations for contractors to manage their interfirm networks strategically in order to enhance the level of competitiveness. To achieve this, the study is divided into four steps: (i) develop a conceptual framework of network performance and success of competitiveness from literatures; (ii) collect data from local contractor firms by using the questionnaire; (iii) develop taxonomies for the networking techniques and competitiveness attributes; and (iv) investigate the relationships between the networking techniques and competitiveness attributes.

71.2 Literature Review

Competitiveness is a controversial topic which has generated a great number of studies during the past decade. The substantial research effort of competitiveness shows its importance to firms in the fields of economics, business management, construction, etc. However, traditional approaches of competitiveness research have little applicability for practitioners who want to stimulate competitiveness and provide little practical guidance because they emphasize unchanging characteristics such as personality and socio-cultural heritage. The major weakness of these efforts lies in the absence of consideration of firm relationship about the construction process. Every construction project involves a series of relationships among different firms such as client, consultants, main contractor, specialist sub-contractors and suppliers. Involvement of multi-disciplinary professions in a single project causes differentiation in project roles and leads to adversarial relationships between project participants [9]. In addition, sub-contractors and suppliers play an important role in implementing construction projects through the application of extensive sub-contracting systems [10]. Eccles [11] stated that coordination of these sub-contractors and suppliers during the construction period is a complicated task for the main contractor due to the increased complexity of these organizational relationships. Thus, the construction industry is often described as fragmented [12] and this fragmentation jeopardizes contractor's performance in communication and cooperation [13]. The moribund nature of traditional competitiveness research in construction is due to the absence of consideration in firm relationships. In addition, traditional approaches to understanding competitiveness provide little guidance for contractors to improve competitiveness so make them little application in the industry. Not surprisingly, these traditional approaches have also been criticized and various competitiveness theories come from empirical evidence should be operationally and firmly tested in the construction context [3]. Thus, traditional approaches have little value for contemporary needs and they are too theoretical and impractical. New approach to study competitiveness is necessary to be explored.

In the fields of business, marketing and manufacturing, various research contributions are found to use alternative approach to study competitiveness. This alternative approach considers the relationships within the established networks. According to Langford and Male [1], establishing relationships in networks allow a firm to create asset to gain competitive advantages and effective interfirm networks can enhance a firm's competitiveness [5, 6]. Evidence has also been found that networking is a tool for gaining competitive advantages [6, 7]. According to Rollyson [8], the use of social networks will give firms a significant competitive advantage over competitors. Further, Anklam [14] observed that networking creates the value of firm's competitiveness. In the construction industry the effect of networking on competitiveness improvement was rarely supported by empirical evidences and few studies have provided empirical support on such relationship. In the context of construction competitiveness research, Fellows [15] stated that this alternative approach reinforces the concept of co-operation and is a preferable long term strategy to competition. Thus, it is anticipated that establishment of networking in construction project can improve the performance of contractors and their competitiveness in the market. In fact, the significance of measuring the network performance has previously been addressed in many literatures [16] and research on critical success factors has identified various factors as key elements in producing competitiveness [17]. In order to corroborate and extend current efforts of competitiveness research in a networking perspective, this paper attempts to explore the critical networking techniques and their relationships to the networking outcomes which in turn make contribution to the success of competitiveness. Building on previous

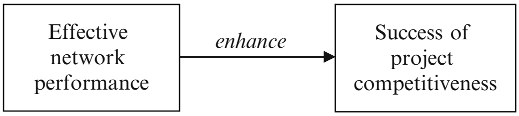

Fig. 71.1 Conceptual model of contractors' network performance and their project competitiveness

work, conceptual model predicting the relationships between contractors' network performance and success of competitiveness was developed and empirically tested. The conceptual model of this study is given in Fig. 71.1.

71.3 Data Analysis

A questionnaire survey was used to collect data for analysis. The questionnaire consists of two groups of variables, they are networking techniques and outcomes under the interfirm networks of contractor firms. The comprehensive literature review led to the development of the variables in this study. For the first group of data, a seven-point scale was used to measure the degree of significance to the networking techniques in term of their support to the contractor's network performance. A high score represents a greater preference of the respondent. As for the second data, the respondents were asked to assess the degree of significance with respect to the contribution of the networking outcomes to the contractor's project competitiveness on the same seven-point scale. A total 250 questionnaires were sent to the contractors under the government's list of approved contractors. Finally 119 respondents returned the questionnaire and the response rate was 47.6 %.

It was found that all networking techniques and outcomes with mean value exceeding four. To this extent, based on the consensus of the respondents, networking techniques are significantly to support effective networking performance, and networking outcomes become competitiveness attributes which significantly contribute contractor's project competitiveness. Then, by using the principal component analysis (PCA), five networking techniques (supporting information exchange, organizing project communication, sharing knowledge for collaboration, promoting culture of networking and creating learning capacity) and seven competitiveness attributes (project management, organizational resources, technological advancement, organizational structure, sustainable relationship, bidding performance and competitive strategy) were identified. The relationships between networking techniques and competitiveness attributes were explored by the use of multiple regression analysis (MRA), a statistical technique that can be used to analyze the relationship between a single variable and several independent variables [18]. In this study, for each of the regression models, the dependent variable is one of the competitiveness attributes and the independent variables are the networking techniques. Based on the factors identified by the PCA described before, factor scales were calculated for the purpose of the multiple regressions. These scales are the composite measure created for each observation on each factor extracted in the PCA [18]. Therefore, new sets of variables

Table 71.1 Overall results of MRA (for contractors' capacity to undertake the construction project successfully)

Dependent variables	Independent variables	R^2	Unstandardized coefficients (B)	(Std. error)	Standardized coefficients (Beta)	*t*-value	
CA1	(Constant)	0.541	5.374	0.514		10.241	**
	NT1		1.512	0.173	0.337	3.841	**
	NT2		0.431	0.138	0.244	2.733	**
	NT3		0.171	0.043	0.236	2.654	*
	NT4		−0.044	0.135	−0.092	−1.046	
	NT5		−0.053	0.014	−0.129	−1.532	*
CA2	(Constant)	0.599	5.541	0.542		10.354	**
	NT1		0.732	0.254	0.523	5.867	**
	NT2		0.224	0.077	0.374	4.203	**
	NT3		−0.092	0.112	−0.184	−2.071	*
	NT4		−0.101	0.020	−0.112	−1.262	
	NT5		0.253	0.081	0.125	1.415	*
CA4	(Constant)	0.505	4.462	0.397		9.856	**
	NT1		0.625	0.217	0.411	4.623	**
	NT2		0.145	0.054	0.296	3.335	**
	NT3		−0.087	0.134	−0.175	1.977	*
	NT4		−0.143	0.036	−0.084	−0.983	
	NT5		−0.168	0.043	−0.112	1.301	*
CA6	(Constant)	0.395	6.231	0.541		11.243	**
	NT1		0.453	0.139	0.304	3.431	**
	NT2		0.287	0.142	0.221	2.464	**
	NT3		1.386	0.225	0.198	2.207	*
	NT4		−0.025	0.011	−0.105	−1.178	
	NT5		−0.064	0.124	−0.170	−1.933	*
CA7	(Constant)	0.453	5.443	0.647		10.145	**
	NT1		2.556	1.021	0.346	3.942	**
	NT2		0.147	0.017	0.250	2.845	**
	NT3		−0.113	0.026	−0.229	−2.614	*
	NT4		−0.181	0.142	−0.088	−1.017	
	NT5		0.044	0.153	0.123	1.411	*

*$p < 0.05$; **$p < 0.01$

for each competitive attribute were calculated for the multiple regression analysis. In summation, the equation of the multiple regressions is in the following form:

$$O = a_0 + a_1S_1 + a_2S_2 + a_3S_3 + a_4S_4 + a_5S_5 + \varepsilon \tag{71.1}$$

where O = dependent variable (competitiveness attributes) and S_i = independent variable (networking techniques).

As described in the literature review, competitiveness at project level refers to the contractor's capability to win a construction contract and then to undertake the construction project successfully. For ease of discussion, the statistical results of these two groups of competitiveness attributes are presented in Tables 71.1 and 71.2

Table 71.2 Overall results of MRA (for contractors' capacity to win a construction contract)

Dependent variables	Independent variables	R^2	Unstandardized coefficients (B)	Unstandardized coefficients (Std. error)	Standardized coefficients (Beta)	t-value	
CA3	(Constant)	0.484	5.987	0.741		12.445	**
	NT1		0.587	0.146	0.407	4.601	**
	NT2		1.144	0.335	0.271	3.163	**
	NT3		−0.036	0.021	−0.015	−0.166	
	NT4		−0.068	0.117	−0.127	−1.490	*
	NT5		0.125	0.034	0.264	3.095	**
CA5	(Constant)	0.513	5.642	0.664		10.549	**
	NT1		0.454	0.151	0.306	3.577	**
	NT2		0.348	0.314	0.222	2.545	**
	NT3		−0.021	0.012	−0.045	−0.523	
	NT4		−0.247	0.237	−0.114	−1.324	*
	NT5		0.326	0.139	0.213	2.469	**

*$p < 0.05$; **$p < 0.01$

respectively. The relative contribution of the networking techniques toward the competitiveness attributes can be compared by the coefficients of the regression equation. The higher the standardized coefficient, the greater its contribution toward the prediction of the attributes.

71.4 Discussion of Research Findings

Generally contractors are recommended to support information exchange in inter-firm networks for the success of competitiveness. As shown from the results obtained by MRA in Tables 71.1 and 71.2, this technique was significantly correlated to the competitiveness attributes. This result provides evidence that information exchange is beneficial to the contractors for the development of their organizations and practicing management techniques in construction projects, with positive contributions to technological advancement and interfirm relationships. These observations are in line with findings in previous studies [19–22]. Moreover, the support of information exchange appears significantly correlated to both competitiveness attributes for winning construction contract and undertaking construction project successfully. This result indicates that effective management of information exchange does not only increase the chance of contractor to win a contract during tendering stage but also lead to project success at the post-contract period. This was supported by Froese [19], who suggested that management of project information is treated as a critical function within the overall project management process. According to the results of MRA, the technique of organizing project communication is also regarded as highly significant to various

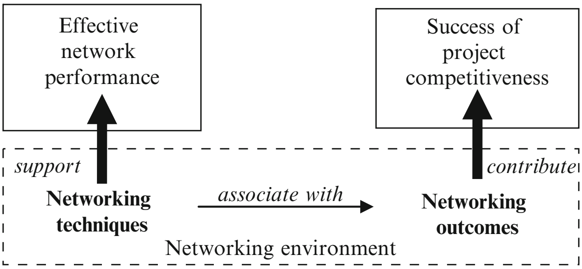

Fig. 71.2 Finalized model of contractors' network performance and their project competitiveness

competitiveness attributes. Under the inter-organizational settings, as-built communication channel can connect all project members together for the construction alliance, whereas under intra-organizational communication it preserves all kinds of management activities within individual organizations

The technique of creating learning capacity of contractor firms had a significant relationship to the attributes of their bidding performance and competitive strategy. The findings are in line with the previous studies about the effects of learning to bidding and competitive advantage. Extensive research has documented the positive implications of organizational learning on competitive advantages [23, 24]. Incidentally, the use of interfirm network does contribute to inter-organizational learning where networks for a group of firms are formed for collective learning. In this regard, the result has provided evidence that networking environment tended to lead to positive attitudes towards organizational learning which supports contractors to achieve successful bidding and gain competitive advantages. Overall, the results suggest that the critical networking techniques of contractors contribute to different competitiveness attributes which in turn affect different aspects of their project competitiveness and this finding developed the finalized model as shown in Fig. 71.2.

71.5 Concluding Remarks

The construction industry is perceived to be adversarial and fragmented and there is a pressing need for contractors to explore the ways to enhance their competitive edge by adopting more practical approach. In this context, the aim of the present research is to investigate the effect of contractors' networking to their competitiveness under the built interfirm networks in the construction project. Based on these results, the relationships between those networking techniques and competitiveness attributes were explored by conducting MRA. It was found that the networking techniques of supporting information exchange and organizing project communication were highly significant predictors for the competitiveness attributes. Likewise, the networking technique of creating learning capacity was positively associated with contractors' bidding performance and their competitive strategy. The research findings coincide with the empirical evidence from previous studies. Based on the conceptual model constructed in the research, networking techniques support effective network performance and associate with certain outcomes which contribute significantly to the success of project competitiveness. This study recalibrates our understanding of contractors' competitiveness at project level, as well as how to improve it most effectively by managing networking techniques strategically.

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Chapter 72
Spatial Econometric Analysis of the Energy Efficiency of the Chinese Regional Construction Industry

Bingsheng Liu, Xueqing Wang, and Tengfei Huo

Abstract With the acceleration of industrialization and urbanization, the energy consumption is rapidly increasing, therefore improving provincial energy efficiency is of great realistic importance and urgency under the background of implementing scientific concept of development and constructing a harmonious society. This paper aims to identify the provincial energy distribution, and to develop further recommendations and research directions. By using the input-oriented super-efficiency DEA model with constant returns to scale, this paper measures the regional energy efficiency of building industry in mainland China (except Tibet) from 2005 to 2009, and then does the space clustering analysis of regional architecture industry energy efficiency by *GeoDA095i*. The results indicate that energy efficiencies of building industry in provinces differ substantially, which of most provinces almost stay constant in the 5 years while those of only a few violate.

Keywords Building industry • Regional energy efficiencies • DEA model • Spatial econometric analysis

72.1 Introduction

Energy is the material basis and the resource guarantee for human survival and economic development. With world energy demand growth, the increase in energy consumption brought about many problems to the economic and ecological environment, such as changes in energy prices and economic instability and environmental

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_72,

degradation. Therefore, the efficient use of energy become the focus of the world's attention. There are two main features of World Energy situation: First, developed countries economic development has entered the stage of industrialization, and the economic trend of low-power, high-yield industrial structure, and energy-intensive manufacturing have gradually shifted to developing countries; second, developing countries ignore the energy efficiency for the pursuit of economic growth [1]. For developing countries like China, improving energy efficiency, promoting sustainable energy development is very important. It has become a national security issue and cannot be ignored.

For measurement methods of energy efficiency academia has been a lot of useful exploration. Mainly concentrated on two levels: First, the estimates of the single-factor energy efficiency; Second, the estimates of total factor energy efficiency. Single-factor energy efficiency calculation method is relatively simple, without considering the links between the elements and substitution relationship and other implications, with the one-sidedness. Single-factor measure of energy efficiency perspective, is to start from the macroscopic energy efficiency, energy kind efficiency, energy physical efficiency, energy value efficiency, and measure energy efficiency from the different aspects; However, total factor energy efficiency that is proposed on the basis of the correlation between the elements mainly use of data envelopment analysis (DEA) and stochastic frontier analysis (SFA). These two methods are focused on the technical level. At the same time, with the new perspective based on energy efficiency, energy efficiency of the state space must be analyzed. The existence of the spatial differences of China's energy resource utilization objectively requires that the analysis of energy efficiency need to take into account the factors of space. Therefore, it is necessary to learn the theory of spatial measurement, and explore the objective status of China's energy efficiency.

Overall, energy efficiency improvements is important for the sustainable development of the energy. Energy efficiency assessment methods and influencing factors need to continue to explore, in order to provide theoretical support for energy efficiency improvements. However, there are still many inadequacies of the existing literature on regional energy efficiency. This paper attempts to use spatial econometric theory and methods describe and analyze the factors affecting the regional energy efficiency in China's construction industry, to compensate for the lack of our industry-regional energy efficiency.

72.2 Determination of the Chinese Regional Construction Industry Energy Efficiency Based on DEA

72.2.1 Establishment of Index System

Selection and measurement of input factors and output results are key parts of the indicator system. In order to more systematically select the input factors and output results, this article selected part of the papers of the research and energy efficiency, and summarized the input indicators and output indicators and combine the characteristics of the construction industry to select the appropriate input–output indicators. Through reading and collation of existing energy efficiency literature, draw the efficiency measure based on DEA model in Table 72.1.

From Table 72.1 shows, the input indicators of the energy is concentrated in the coal and oil consumption, while the object of this thesis is focused on the construction industry. On energy consumption data, select a variable measure, including the construction industry energy consumption (million tons of coal). In this study, using the construction of total energy consumption to measure the region's energy usage. The contrary, the input indicators in the construction industry are more extensive, involving the construction of assets, the construction industry practitioners over the years, the total wage and Machinery and Equipment Owned total power. This paper more attention to energy efficiency in the construction industry, it is to select only the variable measure of the relevance, such as construction employees (persons), construction industry total assets (million), its own construction machinery and equipment at the end of total power (000 kW) and construction materials. The output indicators are the Gross Output Value (million) and construction enterprises total profits and taxes (million).

72.2.2 DEA Model Theory

DEA is abbreviation for Data Envelopment analysis, is created by the well-known operations research home A. Charnes. WW Cooper and E Rhodes and other scholars in 1978. It is also a new cross-cutting areas of mathematics, operations research, mathematical economics and management science. The DEA model is in the paper 'Empirical Research on Efficiency of Construction Industry with Three-Stage DEA Model in China' [10].

This is the three important Formula:

$$\begin{cases} Min\ \theta \\ s.t. \sum_{j=1}^{n} \lambda_j\, x_j \leq \theta\, x_0 \\ \sum_{j=1}^{n} \lambda_j y_j \geq y_0 \\ \lambda_j \geq 0, \qquad j = 1, 2, \cdots, n \end{cases} \tag{72.1}$$

$$\begin{cases} \min \left[\theta - \varepsilon \left(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_\gamma^+ \right) \right] \\ s.t. \sum_{j=1}^{n} x_{ij}\, \lambda_j + s_i^- = \theta x_0, \qquad i = 1, 2, \cdots, m \\ \sum_{j=1}^{n} y_{\gamma j}\, \lambda_j - s_\gamma^+ = y_0 \\ \lambda_j \geq 0, j = 1, 2, \cdots n, s_\gamma^+ \geq 0, s_i^- \geq 0 \end{cases} \tag{72.2}$$

Table 72.1 The efficiency measure based on DEA model

Input indicators	Output indicators	Paper	Author
Consumption of coal and oil	GDP and industrial waste gas emissions	Study on energy consumption efficiency of China's various regions based on super-efficiency DEA [2]	Xiao-chun Cai, Xiao-ai Xiao
Annual average balance of net fixed assets in construction industry	All provinces' value added of construction	Empirical Research on the Growth of Total Factor Productivity of Chinese Construction Industry in 1993–2003 [3]	Xiu-song Shi, Kang-ning Xu
Construction of assets (Fixed assets and total current assets) the construction industry practitioners number of each year	Output value of construction	An empirical study on the migration of total factor productivity of the Chinese construction industry in 1996~2005 [4]	Zhong-fu Li, Xin-yong Zou, Guo-liang Li
Fossil-fuel energy and electrical energy	Carbon dioxide emissions	Analysis of energy efficiency and energy-saving and emission-reduction potential of steel industry in various regions of China based on super-efficiency DEA model [5]	Yi-jie Han, Xiu-li Liu
Energy, human and capital	Economic output	Evaluation model of energy efficiency based on super-efficiency-DEA [6]	Chun-you Wu, Qi Wu
Number of employees of construction by region, total wages of construction workers, total assets of the construction industry, machinery and equipment owned total power	Output value of construction, settlement profit of value-added projects	Total factor productivity for Chinese construction industry and its convergence trend [7]	Yong-an Dai, Cai Chen, Mao Zhang
EQE Staff (managers, associates, and coordinators), held orders	Issued plans, processed requests	Knowledge worker performance analysis using DEA: an application to engineering design teams at bell Canada [8]	Joseph C. Paradi, Sandra (Rehm) Smith, and Claire Schaffnit-Chatterjee
Capital stock, labor employment, energy consumption in accordance with the appropriate conversion ratio, granted patent amount	GDP	Total-factor energy efficiency of Jiangsu province based on DEA [9]	Ma Hailiang, Huang Dechun

$$\begin{cases} \min\left[\theta - \varepsilon\left(\sum_{i=1}^{m} s_i^- + \sum_{\gamma=1}^{s} s_\gamma^+\right)\right] \\ s.t. \sum_{j=1, j\neq k}^{n} x_{ij}\,\lambda_j + s_i^- = \theta x_0, \quad i = 1, 2, \cdots, m \\ \sum_{j=1, j\neq k}^{n} y_{\gamma j}\,\lambda_j - s_\gamma^+ = y_0, \quad \gamma = 1, 2, \cdots, s \\ \lambda_j \geq 0, j = 1, 2, \cdots n, s_\gamma^+ \geq 0, s_i^- \geq 0. \end{cases} \tag{72.3}$$

72.2.3 Determination of Energy Efficiency of China's Regional Construction Industry

Construction enterprises in total assets, its own construction machinery and equipment at the end of the total power and the construction industry output value of the raw data from the *China Statistical Yearbook*. Construction energy consumption, employed persons of construction and construction industry construction enterprises total profits and taxes of the raw data from *China Construction Industry Statistical Yearbook*. The construction materials range, select the main materials (steel, wood, cement, glass and aluminum) to calculate the principal component scores of construction materials, as input indicators. Material consumption data also are from *China Construction Industry Statistical Yearbook*. To exclude the effects of inflation, the 2005 prices as the benchmark price, all year nominal GDP revision for the corresponding actual GDP.

On the basis of the existing literature, total factor productivity framework, consider the relationship between China's construction energy consumption as well as changes in economic development. Selected input indicators are various provinces (Tibet does not include the number of samples) in the construction industry practitioners x1, total assets of the construction enterprises x2, construction energy consumption x3, machinery and equipment owned total power x4, principal component scores of construction materials x5; Output indicators are various provinces (Tibet is not included in the sample) the construction industry output value y1, construction industry construction enterprises total profits and taxes y2. According to the formula (72.1)–(72.2) to calculate the 2005–2009, China's construction industry total factor energy efficiency, shown in Table 72.2.

This section is based on the DEA model, and using DEAP Version 2.1 software to obtain the 2005–2009 region of China building industry total factor energy efficiency, provide effective data for further analysis.

Table 72.2 China's regional construction industry total factor energy efficiency 2005–2009

Region	2005	2006	2007	2008	2009	Average value
Beijing	1.000	1.000	1.000	1.000	1.000	1.000
Tianjin	0.724	0.699	0.718	0.732	0.685	0.712
Hebei	0.717	0.693	0.696	0.717	0.667	0.698
Shanxi	0.880	0.889	0.882	0.889	0.805	0.869
Inner Mongolia	0.714	0.722	0.821	0.841	0.880	0.796
Liaoning	0.682	0.697	0.688	0.723	0.705	0.699
Jilin	0.967	0.984	1.000	0.964	1.000	0.983
Heilongjiang	1.000	1.000	1.000	1.000	1.000	1.000
Shanghai	1.000	1.000	1.000	1.000	1.000	1.000
Jiangsu	0.910	0.932	0.941	0.929	0.848	0.912
Zhejiang	1.000	1.000	1.000	1.000	1.000	1.000
Anhui	0.941	0.977	0.964	1.000	0.968	0.970
Fujian	0.878	0.880	0.939	1.000	1.000	0.939
Jiangxi	1.000	1.000	1.000	1.000	1.000	1.000
Shandong	0.961	0.929	0.940	0.866	0.819	0.903
Henan	1.000	1.000	1.000	1.000	1.000	1.000
Hubei	0.762	0.755	0.754	0.778	0.736	0.757
Hunan	0.822	0.816	0.780	0.789	0.723	0.786
Guangdong	0.917	0.899	0.892	0.900	0.894	0.900
Guangxi	0.982	0.963	0.954	0.947	0.923	0.954
Hainan	0.880	0.944	0.950	0.992	1.000	0.953
Chongqing	1.000	1.000	1.000	1.000	1.000	1.000
Sichuan	1.000	1.000	1.000	1.000	1.000	1.000
Guizhou	1.000	1.000	1.000	1.000	1.000	1.000
Yunnan	1.000	1.000	1.000	1.000	1.000	1.000
Shaanxi	0.791	0.770	0.790	0.844	0.857	0.810
Gansu	1.000	1.000	1.000	0.977	0.965	0.988
Qinghai	1.000	1.000	1.000	1.000	1.000	1.000
Ningxia	0.995	0.995	0.995	0.995	0.995	0.995
Xinjiang	0.832	0.818	0.822	0.814	0.810	0.819

Source: DEAP Version 2.1 calculation results

72.3 Spatial Econometric Analysis of Energy Efficiency of Chinese Regional Construction Industry

72.3.1 Spatial Clustering Model

Spatial statistical analysis, which is also called geological statistics, is a science, which is based on the theory of regionalized variables as the basis, and the variation function as the basic tool to study natural phenomena, that is distributed in space and presents certain random and structural. As a research direction of spatial analysis, spatial clustering separates the spatial data object into class of similar objects. Similar objects have higher similarity, but different kinds of objects are in

Table 72.3 The regional distribution of provinces based on the time dimension changes

Region	2005	2006	2007	2008	2009	Trend
Beijing	5th	5th	5th	5th	5th	→
Tianjin	1st	1st	1st	1st	1st	→
Hebei	1st	1st	1st	1st	1st	→
Shanxi	2nd	2nd	2nd	2nd	2nd	→
Inner Mongolia	1st	1st	2nd	2nd	2nd	↑
Liaoning	1st	1st	1st	1st	1st	→
Jilin	3rd	3rd	5th	3rd	5th	↑
Heilongjiang	5th	5th	5th	5th	5th	→
Shanghai	5th	5th	5th	5th	5th	→
Jiangsu	3rd	3rd	3rd	3rd	2nd	↓
Zhejiang	5th	5th	5th	5th	5th	→
Anhui	3rd	3rd	3rd	5th	3rd	↑ ↓
Fujian	2nd	2nd	2nd	5th	5th	↑
Jiangxi	5th	5th	5th	5th	5th	→
Shandong	3rd	3rd	2nd	2nd	2nd	↓
Henan	5th	5th	5th	5th	5th	→
Hubei	1st	1st	1st	1st	1st	→
Hunan	2nd	2nd	1st	1st	1st	↓
Guangdong	3rd	2nd	2nd	2nd	3rd	↓ ↑
Guangxi	3rd	3rd	3rd	3rd	3rd	→
Hainan	2nd	3rd	3rd	3rd	5th	↑
Chongqing	5th	5th	5th	5th	5th	→
Sichuan	5th	5th	5th	5th	5th	→
Guizhou	5th	5th	5th	5th	5th	→
Yunnan	5th	5th	5th	5th	5th	→
Shaanxi	2nd	2nd	2nd	2nd	2nd	→
Gansu	5th	5th	5th	5th	5th	→
Qinghai	5th	5th	5th	5th	5th	→
Ningxia	4th	4th	3rd	3rd	3rd	↓
Xinjiang	2nd	2nd	2nd	2nd	2nd	→

the differences. The principal means of five categories: partition clustering algorithm, hierarchical clustering, density-based methods, grid-based methods and model-based clustering method.

(1) The basic idea of partition clustering algorithm: given a collection of n objects or data, the data set is divided into k subsets, each subset represents a cluster ($k \leq n$), the division method first creates an initial divided, and then use the recycled positioning technology, or move in a different division of the object to change the division of content. (2) Hierarchical clustering algorithm clusters by the data organization for several groups and the formation of a corresponding tree clustering, hierarchical clustering methods can be divided into a top-down splitting and bottom-up cohesion algorithm. (3) When neighborhood density (objects or the number of data points) exceeds a certain threshold, the method based on the density continue to cluster, such an approach can filter the "noise" data and found the class of arbitrary shape. To overcome the disadvantage of distance-based approach can

only be found in a round cluster. (4) The main idea of the grid method is that the region of space is divided a number of rectangular element of the hierarchy, different levels of unit corresponds to a different resolution grid, all the data in the data set is mapped to a different unit grid, all processing of algorithm is a single element mesh for the object, its processing speed is much higher than tuple processing efficiency of the object. (5) Model-based method assumes each cluster as a model, then to find a perfect fit for the data sets of this model. Commonly used model in two ways: one is a statistical method, the representative algorithm is COBWEB algorithm; the other is a neural network approach, the representation of the algorithm is competitive learning algorithm [11, 12].

72.3.2 Energy Efficiency Cluster Analysis of Chinese Regional Construction Industry

Thirty provinces (including autonomous regions and municipalities) in the construction industry energy use of industrial energy efficiency status, and then the provinces between the building levels of efficiency evaluation value of the order in the past 5 year, which can be clearly seen from Table 72.2. In order to vividly expressed energy efficiency levels and spatial distribution analysis of all provinces building industrial, and analysis whether the energy efficiency of the construction industry is related to China's provinces spatial location and economic development, this paper uses GeoDA095i software selected from 2005 to 2009 the 5-year average of total factor energy efficiency of the regional construction industry to make a fifth of the evaluation value of the level of China's regional construction industry energy use bitmap, as shown in Fig. 72.1.

It can be seen from Table 72.2, the continent has been divided into five categories. From low to high, they turn on behalf of the gradual increase of energy efficiency, 1st–5th range followed by the low utilization, low utilization, general availability, high utilization and high utilization. The 1st range [5]: Liaoning, Hebei, Hubei, Hunan, Tianjin; 2nd range [6]: Inner Mongolia, Xinjiang, Shaanxi, Shanxi, Shandong, Guangdong; 3rd range [6]: Jilin, Jiangsu, Anhui, Fujian, Guangxi, Hainan; 4th range [2]: Gansu, Ningxia; 5th range [11]: Heilongjiang, Beijing, Qinghai, Sichuan, Chongqing, Yunnan, Guizhou, Jiangxi, Henan, Zhejiang, Shanghai.

Throughout the fifth of the bitmap, construction industry more energy-efficient region is relatively concentrated in the southwest, east, northeast and some areas of its surrounding, in addition to the capital city of Beijing. However, the construction industry of provinces and cities surrounding Beijing, energy efficiency is relatively low, the status of low energy utilization is also found in central and eastern areas bordering. To better understand the fluctuations of the provinces building industrial energy efficiency changes over time, this paper uses GeoDA095i software make China's regional construction industry energy use level evaluation of the value-fifth of the bitmap, as shown in Fig. 72.2.

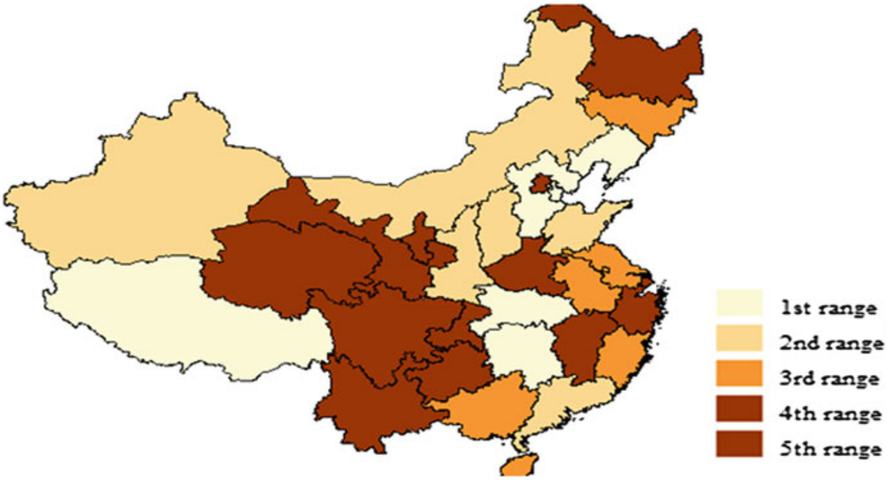

Fig. 72.1 Energy level evaluation of the value of one-fifth bitmap of Chinese regional construction industry

To can visually see the change in status of the provinces building industrial energy efficiency over time, according to the dimension of time, this paper statistics each province in the regional distribution of changes, as shown in Table 72.1.

From Fig. 72.2 and Table 72.1, we can clearly find that the construction industry energy efficiency in a considerable number of provinces remained relatively stable from year 2005 to 2009. In Liaoning, Hebei, Hubei, and Tianjin, has been in the 1st range; Xinjiang, Shaanxi, Shanxi has been in the 2nd range; Guangxi has been in the 3rd range; Heilongjiang, Beijing, Qinghai, Sichuan, Chongqing, Yunnan, Guizhou, Jiangxi, Zhejiang, Henan and Shanghai, has been in the 5th range; and only in Ningxia in the 4th range. In addition, Fujian, Hainan and Jilin's energy efficiency is at a status of enhance. But in Hunan, Jiangsu and Shandong, energy efficiency is decreased. Meanwhile, Guangdong is in a fluctuating state.

72.3.3 Analysis Conclusion

We can learn from Table 72.2: the construction industry of Beijing, southwest, east, northeast and the surrounding parts is more energy-efficient. However, the construction industry energy efficiency of the provinces and cities around Beijing is relatively low status. Low energy utilization is also found in central and eastern areas bordering. For the detailed analysis of energy efficient space distribution changes of the 2005–2009 regional construction industry, the paper in accordance with the regional dimension, counts the annual data including changes of the provinces in each region per year, the statistics shown in Table 72.2.

Table 72.4 Provinces change based on the regional dimension

Range	1st	2nd	3rd	4th	5th
2005	Liaoning, Hebei, Hubei, Tianjin, Inner Mongolia	Xinjiang, Shaanxi, Shanxi, Hunan, Fujian, Hainan	Guangxi, Jilin, Jiangsu, Anhui, Guangdong, Shandong	Ningxia	Heilongjiang, Beijing, Gansu, Qinghai, Sichuan, Chongqing, Yunnan, Guizhou, Jiangxi, Zhejiang, Henan, Shanghai
2006	Liaoning, Hebei, Hubei, Tianjin, Inner Mongolia	Xinjiang, Shaanxi, Shanxi, Guangdong, Fujian, Hunan	Guangxi, Jilin, Jiangsu, Anhui, Hainan, Shandong	Ningxia	Heilongjiang, Beijing, Gansu, Qinghai, Sichuan, Chongqing, Yunnan, Guizhou, Jiangxi, Zhejiang, Henan, Shanghai
2007	Liaoning, Hebei, Hubei, Tianjin, Hunan	Liaoning, Hebei, Hubei, Tianjin, Hunan	Guangxi, Jiangsu, Anhui, Hainan, Shandong, Ningxia		Heilongjiang, Beijing, Gansu, Qinghai, Sichuan, Chongqing, Yunnan, Guizhou, Jiangxi, Zhejiang, Henan, Shanghai, Jilin
2008	Liaoning, Hebei, Hubei, Tianjin, Hunan	Xinjiang, Shaanxi, Shanxi, Inner Mongolia, Shandong, Guangdong	Guangxi, Jilin, Jiangsu, Hainan, Gansu, Ningxia		Heilongjiang, Beijing, Qinghai, Sichuan, Chongqing, Yunnan, Guizhou, Jiangxi, Zhejiang, Henan, Shanghai, Anhui, Fujian
2009	Liaoning, Hebei, Hubei, Tianjin, Hunan	Xinjiang, Shaanxi, Shanxi, Inner Mongolia, Shandong, Jiangsu	Guangxi, Anhui, Gansu, Ningxia, Guangdong		Heilongjiang, Beijing, Qinghai, Sichuan, Chongqing, Yunnan, Guizhou, Jiangxi, Zhejiang, Henan, Shanghai, Fujian, Hainan, Jilin

Tables 72.1 and 72.2 shows, energy efficiency of Heilongjiang, Beijing, Qinghai, Sichuan, Chongqing, Yunnan, Guizhou, Jiangxi, Zhejiang, Henan, Shanghai and other building industry has been high at the highest stage. Liaoning, Hebei, Hubei, and Tianjin has been very stable, but lower energy efficiency. The results show that the energy efficiency of the construction industry in the provinces there is a big difference. To identify the factors that cause such a difference was of decisive importance to develop improvements.

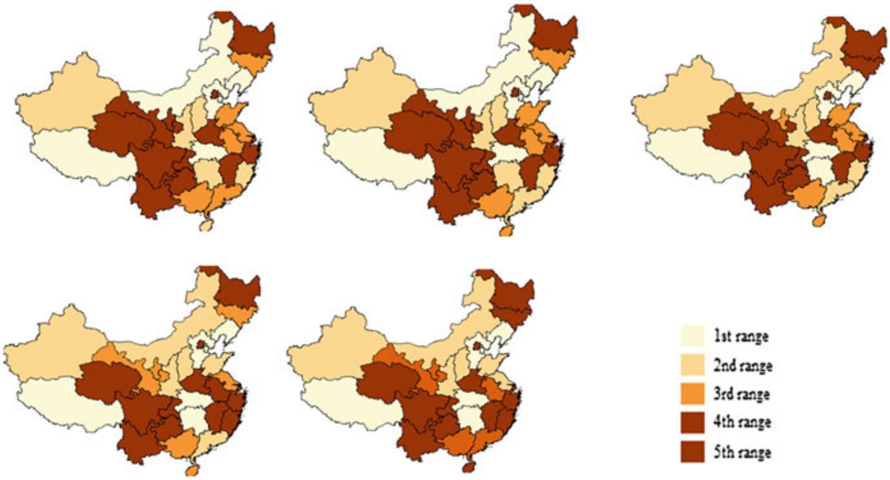

Fig. 72.2 Fifth of bitmap of evaluation of the value of energy use level of China's regional construction industry

72.4 Conclusion and Prospect

This paper chooses energy efficiency of the regional construction industry as the research object. The study uses spatial econometric analysis methods to find that there is a big difference in the inter-provincial construction industry energy efficiency which is relatively stable in most provinces, and only few provinces fluctuations within 5 years. Studies have shown that improve of energy efficiency dependent on total factor productivity. To analyze the factors affecting the construction industry energy efficiency. Next we will explore the factors affecting the construction industry energy efficiency from aspects of the energy consumption structure, technological level, the characteristics of industrial organization and industrial development level [13].

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Chapter 73
Experience of the Post-Disaster Housing Rehabilitation and Reconstruction in Wudu District, Longnan City

Leitao Liu and Jian Liu

Abstract The post-disaster housing rehabilitation and reconstruction work is a very concerned and sensitive topic in China. Because it is directly related to the survival, life and vital interests of the affected people. This study analyzes the problems in the implementation process of the post-disaster housing rehabilitation and reconstruction in Wudu District, Longnan City, Gansu Province. Some measures were put forth to provide a reference for management and decision-making of governmental departments in the post-disaster reconstruction.

Keywords Wudu district • Post-disaster reconstruction • Problems • Measures

73.1 Introduction

On May 12, 2008, an 8 Richter-scale earthquake took place in Wenchuan County, Sichuan Province, which was the largest earthquake since the founding of the People's Republic of China. This earthquake affected the many regions of Sichuan, Gansu, and Shanxi Provinces. A number of cities and villages suffered serious damage in the three provinces. Wenchuan Earthquake had caused 69,227 fatalities, 374,643 injuries and 17,923 missing as of September 25, 2008 [1]. Wudu District is the administrative and business center of Longnan City, Gansu Province, and it is one of the worst-hit areas. After the quake, the housing recovery and reconstruction became the urgent desire of the people in disaster areas. How to reconstruct

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_73,

scientifically, quickly, and effectively has become a major challenge for the governmental policy-makers. How to complete the reconstruction work scientifically and rationally has also been the focus of attention of many experts and scholars [2]. In order to ensure a powerful and orderly recovery and reconstruction, the central and local governments issued a series of policies and measures. However these policies and measures only provided a macroscopic guidance for the reconstruction, they could not solve the problems in the specific implementation and management. The first author took part in the housing reconstruction in Wudu District from September 2011 to June 2011, and found many problems such as waste of fund and resources, lack of construction materials and labors and poor project quality. It is necessary to study how to implement the housing reconstruction scientifically and effectively, how to solve the problems which problems appeared during the implementation process, and how to protect and use the reconstruction results. This study analyzes the problems of the housing recovery and reconstruction in Wudu District by means of field survey, data analysis and expert interview, and some measures are put forth.

73.2 Main Problems of the Housing Rehabilitation and Reconstruction

The main problems during the process of the post-disaster housing rehabilitation and reconstruction in Wudu District can be listed as follows [3].

1. Building material shortage and price rising

   According to 3 years plan of the housing rehabilitation and reconstruction in Wudu District, 1.9 billion pieces of bricks and over 0.7 million tons cements are needed to construct 71,000 houses. However, local companies only provide 400 billion bricks and 0.1 million cements per year [4]. The gap between supply and demand is very large. Almost all kinds of materials are in short supply, and price increase rate had risen by an average of 60–100 %.
2. Lack of professionals and technicians

   Ninety percent of the residents in Wudu District are farmers without good education, therefore, they could not be trained into the professionals and technicians necessary for reconstruction in short time. Lack of the professionals and technicians affected the project quality and reconstruction progress.
3. Lack of reconstruction fund

   5.1 billion yuan is necessary to complete the housing rehabilitation and reconstruction in Wudu District. However only 3.7 billion yuan had been raised by the end of 2009 and 1.4 billion yuan should still be raised [5].
4. Poor project management

   Project planning, reconnaissance and design are hysteretic and unreasonable. Some projects did not do the engineering investigation. The problems seriously

Table 73.1 Planed and actual progresses of town housing recovery

Time	Reinforcement and maintenance plan	Actual schedule	Reconstruction plan	Actual schedule
End of 2009	100 %	27.7 %	50 %	9.2 %
June 2010	–	76.0 %	88 %	12.9 %
End of 2010	–	–	100 %	–
May 2011	–	100 %	–	80.1 %

affected the structural safety and quality of rebuilt houses. Most of construction materials are without quality testing, and some materials brands are not real ones. The construction teams have no required qualification. Excessive foundation settlement, basement or beams cracks and housing tilt impacted the housing quality, safety and seismic performance.

5. Poor quality supervision and management

   A lot of projects were implemented without tendering method. The owners and managers lack professional knowledge and abilities, and they are not familiar with the construction procedures and construction quality management. The supervision work was largely invisible, which made the project quality and progress out of control almost.

6. Serious lagging of project schedule

   According to the housing recovery and reconstruction implementation plan of Wudu District, the rural housing recovery and reconstruction task plan should be completed in November of 2009. 66,940 of 71,890 planned houses had been completed until November of 2009 [6]. Table 73.1 gives the planning and actual schedules of the town housing recovery and reconstruction projects. The reinforcement and maintenance projects were planned to complete by the end of 2009, and only 27.7 % of the projects were finished at that time, all the projects were actually completed in May 2011. Similarly, the reconstruction projects were planned to complete at the end of 2010, and actually only 80.1 % of the projects had been done by May 2011. The schedule lagging progress are caused by insufficient material supply, poor coordination, poor project quality and lacking of technicians.

7. Lack of effective communication mechanism

   The communication between the governmental departments is not positive, not active and not in time. The work efficiency is very lower. Once something happened, the departments shuffled mutually and the collaborative capacity was low. The communication between the government and the sufferers was poor. The rights and duties of the government and the sufferers were not clear. Only the governmental departments were busy during the whole reconstruction process, the sufferers did not participate in the work. The governmental departments didn't understand public opinion, and the citizens did not experience the governmental kindness. The policies and measures didn't fully consider the willing of the citizens, so its implementation process was often blocked.

73.3 Countermeasures

In order to better implement the restoration and reconstruction, the following countermeasures were put forth [3]:

1. To strengthen the governmental regulation and control to the building materials production and supply

   Scientific reconstruction planning and demand planning should be drawn up, and the reconstructions should be implemented in phases to avoid shortage of the building materials excess demand. The building materials production should be speeded, and energy consumption and building materials production cost should be reduced. New building materials should be developed actively. Inspection of the materials quality should be strengthened and the product supply should be ensured.
2. To innovate the mechanism of cultivating professionals

   Sufficient human resources and technical force was the important guarantee to realize scientific and quick reconstruction for the disaster area [7]. In order to solve the shortage of professionals in Wudu District, the professional training should be strengthened. The support of superior departments and the assistance from partner provinces and cities should be actively sought. In particular, the volunteers in the planning, design and management fields should be asked to the partner provinces and cities.
3. To raise funds through multiple channels

   The local government should raise reconstruction funds by means of multiple channels. The local government should actively strive for the superior government political and financial support. Different construction methods such as self-build, joint build, build-transfer, build-operation-transfer should be taken to save investment. According to economy and price level of the affected areas, the government should appropriately adjust the capital subsidy standards. The loan policies such as extending the repayment period, free interest and subsidy interest should be adjusted.
4. To intensify the construction management

   The bidding system, construction supervision, contract management, quality guarantee system and accountability system should be implemented. The project construction sequence of investigation, design and construction should be strictly implemented. Various construction management modes should be introduced.
5. To strengthen the effective monitoring and supervision of the project quality

   The housing recovery and reconstruction projects constructed by the concentrated reconstruction mode or dispersed self-building management mode should be taken into the quality supervision and management program. For the scattered town household or rural housing reconstruction, the supervision fee could be free. For the other reconstruction projects, the government could reduce and cancel the supervision fee, according to the reconstruction policies and measures. The construction administrative department and the quality supervision institution should strengthen supervision and law enforcement efforts, to ensure the reconstruction project quality. The projects without acceptance could not be put into use.

6. To perfect the organization and policy guarantee measures

   To complete the housing recovery and reconstruction projects on schedule, elaborate planning and arrangement should be done through the perfect organization and policy guarantee measures.

7. Paying attention to coordination and communication

   The coordination and cooperation between governmental departments should be strengthened. A special reconstruction organization composed by the relevant departments should be established, and it could finish the daily decision-making, review and approval, coordination and supervision to strengthen the communication and interaction between the officers and the citizens, the communications channels should be unimpeded.

73.4 Conclusions

In this study, the existing problems of the post-disaster housing rehabilitation and reconstruction in Wudu District, Longnan City, Gansu Province were analyzed by means of literature review and field survey. The main problems of the housing recovery and reconstruction in Wudu District include: (1) shortage of building materials and rising prices, (2) lack of human resources and weak technology, (3) difficult management of large amount housing reconstruction funds, (4) an attention to the planning, surveying and design being not paid and these work being not standardized, (5) poor quality of the construction, (6) bad supervision and management of the project quality, (7) slow progress of recovery and reconstruction, and (8) lack of an effective communication mechanism.

Some measures were put forth to provide guidance for the post-disaster recovery and reconstruction work. These measures to solve the existing problems include: (1) strengthening governmental regulation and policy support for the production and supply of the building materials, (2) developing the mechanisms of innovative professionals and technicians, (3) raising funds through multiple channels, and clutching the rational use and regulatory of reconstruction funds, (4) strengthening the housing construction and management of recovery and reconstruction, (5) strengthening the effective monitoring and supervision of the project quality, (6) perfecting the organizational and policy safeguards to speed up the reconstruction progress, and (7) paying an attention to coordination and communication, and collaboration of officials and the public work together to promote the reconstruction work.

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Chapter 74
The Causes of Delays in the Delivery of Construction Projects: A Review of Literature

X. Shivambu and Wellington Didibhuku Thwala

Abstract This paper investigate on why there are many delays in the delivery of public construction projects by the main contractors on construction sites and how the mitigation of delays can play a role in addressing this challenge. The study has been conducted through the use of secondary data in form of literature review only. The findings from the literature survey revealed that the major causes of delays in government projects being contractor's improper planning, contractor's poor site management, inadequate contractor experience, inadequate client's finance and payments for completed work, problems with subcontractors, shortage in material, labor supply, equipment availability and failure, lack of communication between parties, and mistakes during the construction stage. A competent persons need to be involved in the project to improve the planning, site management and to reduce lot of mistakes during construction.

Keywords Construction delay • Mitigating delays eradication

74.1 Introduction

In the last 15 years, the Gauteng Provincial Department of Local Government and Housing has delivered more than 500,000 units to poor households. However, this delivery has not been sufficient to meet increasing demand for housing in the province. Inevitably, a deficit of 600,000 households continue to live in housing conditions that do not meet acceptable minimum requirements for residential quality (Human

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_74,

Settlements Review 2010). The Department of Housing has to meet its objective of having a nation free of slums by 2014, eradication of informal settlement and it is a deadline it intends to meet.

74.2 Objectives of the Study

The aim of this paper can be highlighted as follows:

- To identify the causes of the delays in the construction
- To find out how the delays can be minimized on sites

74.3 Literature Review

The delay is a relative term in construction, where construction delay is defined as the time overruns either beyond the completion date specified in a contract, or beyond the date that the parties agreed upon for the delivery of a project [12]. In the simplified term, Zack (2003) defined delay as an act or event that extends required time to perform or complete work of the contract manifest itself as additional days of work. Delay time is an added duration to the project estimated time. The construction process can be divided into project conception, project design, project construction and final hand over. Project conception is the initiation of the need that can be satisfied by a physical structure. The project design phase translates the primary concept into an expression of a spatial form that will satisfy the client's requirements in an optimum economic manner. Construction operations are the action phase, where the design is implemented on the ground. The final hand over that is where the project finalized and handed back to the client as the product. They create the physical form that satisfies the conception and allows realization of the design (Nabeemeeah 1996). From the above mentioned, construction delays are likely to occur in those phases and construction delays are for the most part costly and completing projects on the stipulated time is beneficial to all project parties. Therefore, it is essential to identify the actual causes of delay in order to minimize and avoid the delays and their corresponding expenses [1].

Time delay is the most widely held cause for construction disputes. In the past it was accepted to have delays in construction projects completion time. However, today, with a client tight budget, delays became a very important cost item. Consequently these delays often end up as construction claims [2]. Time performance of a project is usually a particularly important consideration for the owner and the contractor. Often, the most difficult construction disputes involve delay and failure to complete the work in the specified time frame. The delivery time of a project is a key factor to the owner in terms of cost, as well as it is for the contractor (Assaf and Al-Heijji 2006).

74.4 Causes of Delays in Construction

Many studies have been done internationally on construction delays especially on the developing and developed countries. Malaysia is one of the developing countries that also suffer from construction delays. Delays give rise to disruption of work and loss of productivity, late completion of project, increased time related costs, and third party claims and abandonment or termination of contract. It is important that general management keep track of project progress to reduce the possibility of delay occurrence or identify it at early stages (Martin 1976). The Government in Malaysia plays a very important role in providing major infrastructures in meeting the socio-economic needs of the nation and uplifting the quality of life and standard of living in the country. Therefore, it is essential to identify the actual causes of delay in order to minimize and avoid the delays and their corresponding expenses (Abd El-Razek et al. [1]).

On the study undertaken by Sambasivan and Soon [13], on Malaysian construction industry has identified the following ten most important causes of delay from the list of 28 different causes: contractor's improper planning, contractor's,poor site management, inadequate contractor experience, inadequate client's finance and payments for completed work, problems with subcontractors, shortage in material, labor supply, equipment availability and failure, lack of communication between parties, and mistakes during the construction stage. Othman et al. (2006), has reviewed the construction time performance of the public projects in Malaysia where it was found to be affected more by variables related to excusable delays than project characteristic variables. They further indicated that In Malaysia that is where most of the delays were caused by excusable factors, the construction time of public sector civil engineering projects can be improved if the occurrence of excusable delays can be minimized. Both excusable and non-excusable delays, according to Chalabi and Camp [14] affect the project in a negative way. Majid (2006) has identified that some of these factors were the top ten most important factors that contributed to the causes of delays includes: insufficient numbers of equipment; inaccurate time estimate; monthly payment difficulties; changes orders; inaccurate cost estimate; poor site management and 80 supervision; inadequate modern equipment; shortage of construction materials; incompetent project team; improper project planning and scheduling; and contractor's financial difficulties. The factors were grouped into eight groups of causes of delays. Group of contractor-related delays was ranked the most significant groups that cause delays, followed by group of equipment-related delay, client-related delays, material-related delays, finance-related delays, consultant-related delays, external-related delays, and labor-related delays.

Alaghbari et al. [3], has studied the significant factors causing delay of building construction projects in Malaysia where the results were analyzed to rank the causes of delay and further classify the types of delay. The main finding of the study was that the financial factor is the most influencing factor in causing delay in construction projects in Malaysia. Coordination problems are considered the second important factor causing delay in construction projects, followed by materials problems. Further examination of factors causing delay in construction projects in Malaysia based on four categories: contractor, consultant, owner, and external factors; the study shows that on the contractor's side, financial problems are the major factor in delaying construction projects. Poor site management and, as a consequence, construction mistakes, delay in the delivery of materials to the site, and coordination problem were the subsequent factors causing delay in construction projects in Malaysia. The next most important factors causing delay in construction projects in Malaysia come from the labour side, and finally the contractor's side, summarized by "lack of subcontractor's skills" and "lack of site contractor's staff".

Abdullah-Razaki et al. [4], have studied the Causes of Delay in MARA Management Procurement Construction Projects in Malaysia where the results analysis revealed that the significant delay causes were cash flow and financial difficulties faced by contractors, contractors' poor site management and ineffective planning and scheduling by contractors. Several steps are proposed in order to avoid delay for MARA future project. Al-Moumani [15] had identified the causes of delays on Public Construction Projects in Oman which they compared with the cause of delays on Malaysian construction industry identified by Sambasivan and Soon (2006), where they found that there are Owner instructs additional works, Owner instructs modification to design, Non-availability of construction manuals and procedures for project construction in Oman, Non-availability of engineering licensing for engineers in Oman to maintain the quality of consultancy services and Poor communication between relevant governmental units and the owner. However Sambasivan and Soon (2006), has identified 16 causes of delays on Malaysian construction industry where the ten most important causes of delays are; contractor's improper planning, contractor's poor site management, inadequate contractor experience, inadequate client's finance and payments for completed work, problems with subcontractors, shortage in material, labor supply, equipment availability and failure, lack of communication between parties, and mistakes during the construction stage.

74.5 Discussion of the Findings

Many studies have been done in relation to the delays in construction and the effects of these delays into the project. To a project owner who counted on the revenue from the project commencing from a specific date in order to comply with the schedule for repayment of the project finance, delay of even a week is not only an embarrassment, but also a serious risk of financial failure of the whole enterprise. As protection against the risk, project owners invariably state in their contracts with their contractor the amount that will be payable in the event of delayed completion from a cause for which the contractor is responsible [16]. On the contractor's side, delay in completion entails increased overheads over those budgeted for (example, cost of supervisory personnel and site infrastructure required over the extended duration) and loss of the opportunity of taking on other profit-earning projects with the resources tied down on the delayed project. Where the cause of the delay is the responsibility of the owner, the contractor would be entitled to compensation against these losses. The large sums usually involved and the multiplicity of cause of delay that may occur simultaneously often make the determination of each party's responsibility a matter of the greatest difficulty and this often results in many disputes that will require resolution through arbitration or other forms of dispute resolution forums [5].

74.6 Conclusion

This study investigated the causes of delays in the construction, to find out how the delays can be minimized on sites, to find out how the principal parties can play a role in promoting improvements in the service delivery set by the state government. The findings from the literature survey revealed that the major causes of delays in government projects being contractor's improper planning, contractor's poor site management, inadequate contractor experience, inadequate client's finance and payments for completed work, problems with subcontractors, shortage in material, labor supply, equipment availability and failure, lack of communication between parties, and mistakes during the construction stage.

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Chapter 75
Compensation Approaches for Early Termination of PPP Projects

Wei Xiong and Xueqing Zhang

Abstract Even though a lot of successes had been achieved since the PPP model was applied to deliver public works, many projects were terminated earlier before the expiry date due to the complexity of the nonrecourse financing method and a variety of risks and uncertainties related to project finance. In early termination, fair, effective and operational compensation approaches were required to relieve both parties from the rights and obligations within the concession agreement. This paper introduced two popularly applied compensation approaches including Compensation based on Financial Statement (FS) and Compensation based on Discounted Value of Future Cash Flow (DVFCF). Those approaches were analyzed through four simple cases and their characteristics were various by different allocation strategies of long-term risks. Finally, this paper provided implications for how to choose the most suitable compensation approach in different scenarios.

Keywords Public-private partnerships • Early termination • Compensation

75.1 Introduction

Presently, most of the PPP projects have fixed concession period and the concessionaire contract was supposed to run its full course and terminate on the expiry date which was specified in the concessionaire agreement [1]. However, many projects were terminated before the expiry date due to a lot of reasons. Evidence of this can be seen in the Private Participation in Infrastructure (PPI) Database of World Bank that shows 334 out of 4,874 PPP projects in developing countries were terminated earlier [2].

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_75,

PPPs are more risky than traditional procurement approaches because project finance has higher debt ratio than cooperate finance. The equity invested by private sector partners are their long-term commitment to project lenders and the higher it is, the lower the risk level is. But for most of PPP projects, the debt ratio is higher than 50 % [3]. For example, power projects tend to have a debt level of 70–90 % [4]. As a consequence, PPP projects are sensitive to a lot of risks and some serious risks could cause early termination.

When serious risks occur and cause great difficulties to the project, most of the governments prefer to renegotiate rather than terminate the concession contract earlier. such cases could be easily found when the governments were dealing with the financial problems of PPP projects in regressions. For example, the UK government injected £21.5 billion into new PFI hospitals, schools and roads during the global economic crisis in 2008 because private funding had dried up in the recession. In order to encourage private sector investment in infrastructures, many governments provide guarantees to compensate the investors in case of bankruptcy, so the early termination may be very costly for governments. For example, the Spanish concession law establishes that if the contract was terminated earlier, even though the reason was bankruptcy of the concessionaire, the government had to pay compensation to the concessionaire for the works that had built and were not yet depreciated. This compensation should be equal to the capital cost declared by the concessionaire in its financial plan, minus the depreciation of the assets calculated according to the accounting norms of Spain [5].

Nonetheless, a large number of PPP projects have been terminated earlier around the world. On early termination, the concessionaire contract must deal comprehensively with the consequences including compensation and transfer of the remaining project assets [1]. Focusing on the compensation, many approaches have been taken by contracts, and this paper summarizes the most widely used approaches and categorizes them into two typical compensation approaches. After that this paper introduces four early terminated PPP projects for illustration and then comparative analysis is conducted.

75.2 Early Termination and Compensation

In practice, PPP agreements have to include pre-agreed compensation clauses specifying the parties' rights and obligations under the early termination scenarios even though most of them may not be terminated earlier. The compensation model is the core of those clauses and it is extremely important for both parties to secure their interests once the PPP project comes to the early termination. Hence, the compensation model is supposed to be designed at operational level and consider every potential scenario. It is impossible to set up a fixed compensation amount for future early termination because when and how the early termination will occur is unknown at the planning phase, therefore a predictable model

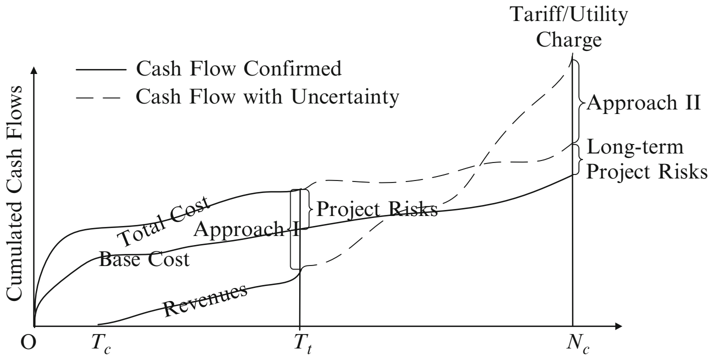

Fig. 75.1 Approaches of compensation on early termination of PPP Projects

with suitable flexibility is necessary to be pre-agreed in the contract to tackle with the uncertainties of the compensation amount.

In perspective of the contractor, the early termination of a concession is ending the engagement to the long-term project risks and the revenue stream generated over the long-term operation period [4]. Assuming that the construction period is T_c years, the concession period is N_c years, and the project is terminated at the T_t year, the cumulated cash flows of costs and revenues for a typical PPP project are shown in Fig. 75.1. Base Cost is the planned cost when the project is progressing as planned and all risks are well controlled and cause no extra cost, therefore Base Cost at any time point of concession period is confirmed. Total Cost is the actual cost that occurs in construction and maintenance and operation. Total Cost before the termination date is recorded in project's financial statement, but that in the remaining concession can only be estimated. Depending on risk scenarios and capability of the contractor, Total Cost after T_t could be either higher or lower than Base Cost and the gap represents value of the long-term project risks. Another important issue is Revenues of the project, based on either tariff charge or utility charge. Revenues after T_t are also depending on a lot of uncertainties, including performance of the concessionaire and market situation.

Therefore, if a PPP project was terminated earlier, the compensation could be calculated mainly through two approaches. In Approach I, the compensation equals Cumulated Cost at year T_t minus Cumulated Revenue at year T_t. Apparently, all of the information needed in Approach I is available in financial statement of the project. Therefore, this paper named this approach as Compensation based on Financial Statement. In Approach II, the compensation equals estimated Cumulated Revenue at year N_c minus estimated Cumulated Cost at year N_c. Estimations are conducted at the base of historical data before year T_t, through cash flow analysis technique. Moreover, the compensation has to be discounted to year T_t. So Approach II was defined as Compensation Based on Discounted Value of Future Cash Flow.

75.3 Approach I: Compensation Based on Financial Statement

As shown in Fig. 75.1, this approach calculates the compensation based on project's financial statement. No matter how much the project will lose or gain in the future, the compensation equals unreimbursed cost (plus reasonable profits in some occasions) at the termination date T_t. Theoretically, Cumulated Cost used in the calculation should range between Base Cost and Total Cost, and negotiation has to be conducted to decide final Cumulated Cost. In this way, project risks and demand uncertainty before T_t are shared between the public authority and the contractor. However, long-term project risks and demand uncertainties are retained by the public authority because Costs and Revenues after T_t will not be considered. The following cases illustrate this approach.

75.3.1 Case I

The National Physical Laboratory (NPL) redevelopment project was procured by the Department of Trade and Industry UK (the Department) through a 25 year Private Finance Initiative (PFI) contract in July 1998, and the contractor was Laser, a special purpose company jointly owned by Serco Group plc and John Laing plc. The planned cost of the project was £96 million and the Department would pay a service charge of £11.5 million per year after the Commence on Operation. The redevelopment works involved the construction of over 400 laboratories, many of which had to meet exacting environmental requirements, such as for temperature and sub-audible noise control. However, the contractor underestimated the design risk and found that it had exhausted the funds available to it to complete the building by mid-2004. On 7 July 2004, it proposed to the Department that the PFI contract should either be revised and refinanced, or terminated [6].

This case is a typical early termination caused by the contractor's default. According to their agreement, the termination sum was the lesser of the lender's liabilities, initially assessed at £93 million, and Laser's construction costs, adjusted for the projected cost to the Department of completing the project and any unpaid damages owed by the company, initially assessed at £54 million. As negotiations progressed, the Department estimated that a more realistic assessment would be between £86 million and £73 million; the agreed termination sum was near the lower boundary of this range [6]. The PFI contract was terminated in December 2004 and the Department paid Laser £75 million for its interest in the new buildings.

75.3.2 Case II

The Build, Operate and Transfer (BOT) Water Concession Agreement between METRONIC GLOBAL BERHAD (MGB) and Lai An County Water Utility Board ("Water Utility Board"), Anhui Province in the People's Republic of China was terminated earlier in 16 August 2010. This project started from 2 February 2009 and the planned concession period was 33 years. Upon termination of the BOT Water Concession Agreement, MGB shall return the concession rights to the Water Utility Board and handover all construction works completed up to the date of Termination (inclusive of office building, water supply pump station, chlorine and additive treatment plant, water tank, perimeter wall etc.) and related documents, materials and files to the Water Utility Board. The termination was in line with MGB's direction to streamline its resources to focus on core business and to divest its non-core businesses.

Pursuant to the early termination, the Water Utility Board agreed to compensate MGB for all construction works completed up to the date of the termination amounted to RMB 5,123,484. It was mutually agreed that part of the compensation amount of RMB 1,219,181 shall be paid directly by the Water Utility Board to one of the subcontractor of concession works, for the balance amount owing on construction costs of the water treatment plant, and the remaining amount of RMB 3,904,303 shall be paid to MGB's wholly owned special purpose company, namely Anhui Lai'An Metronic Water Supply Co Ltd. upon the Water Utility Board entering into a new BOT concession agreement with a third party who shall become the successor of MGB to pursue/take-over the concession rights and related works. The total cost of investment of MGB in the entire concession project up until the date of the termination amounted to RMB 6,856,323. So the MGB suffered a loss of RMB 1,732,839 [7].

Based on the abovementioned two cases, several findings are made as follows:

- This approach is more popular in evaluating project without market value but has utility charge set out in the contract. For example, prison, hospital, school, and sewerage treatment plant. At early termination, the only way for the contractor to get compensated is from the public authority. That means the contractor has no alternative ways such as selling the asset on open market. In case I, the buildings for laboratory are project with special purpose which cannot be sold by market price. In order to guarantee the interests of the contractor in this situation, a fair value should be estimated by pre-agreed formula [1]. Utility charge comprises two elements: the availability charge, which pays the contractor for the facilities; and the service charge, which pays the contractor for the service they provided [8]. Usually, the former part should be compensated because the project asset will be transferred to the public authority, but the latter part should not be repaid because the service is not delivered yet. Sometimes, the loss of potential profit with the service should be compensated as well. In case I, the loss of potential profit was not compensated because the early termination was caused by the contractor's default.

- This approach is also well applied in the compensation of those projects where the construction works are not completed when the early termination occurs. The main reason is that without a clear picture of total construction cost, the project is very difficult to be sold out by its real value. The potential substitute concessionaires pretend to offer much lower price for uncompleted projects to cover construction risk. Another reason is that without the historical data of the performance and demand volume of the project, it is impossible to make a precise prediction for the future revenues. In case II, the compensation was decided by negotiation between MGB and Water Utility Board through the FS approach, instead of selling it directly to the substitute Concessionaire. That's because the Water Utility Board was more likely to act neutrally and offer a fair price than substitute concessionaires.

The main feature of this approach is that Total Cost, Base Cost and Revenues are confirmed, so there is no uncertainty with this approach. That enables the contract defines all the compensation rules at the very beginning. The negotiation focusing on Cumulated Cost is consistent with the risk allocation between the contractor and the public authority. Usually, this approach is fast in procedures and convenient in transferring the asset to the substitute concessionaire.

75.4 Approach II: Compensation Based on Discounted Value of Future Cash Flow

As shown in Fig. 75.1, this approach compensates the contractor estimated value of the remaining concession, which is in terms of NPV of future cash flows. There is great uncertainty with estimated value of the remaining concession. Demand volume is one of the biggest sources of uncertainty, while overestimates of demand have caused many PPP projects failed especially for transportation infrastructure projects [5]. Besides, the Maintenance and Operation Cost also fluctuates a lot. Compared to the FS Approach, This approach takes different strategy in dealing with long-term project risks and demand uncertainty. The following early terminated projects were compensated through this approach.

75.4.1 Case III

The South Bay Expressway is a 35-year Build-Transfer-Operate franchise between California Transportation Ventures, Inc. and the State of California, which allows developer to set market rate tolls. After 8 years operation, Private investors and lenders had put up around $1,000 million, but disappointing traffic revenue and serious cost overrun caused the project company bankrupted. Then the South Bay Expressway was officially sold to the San Diego Association of Governments

(SANDAG) by $341.5 million. The compensation was significantly more than the road's assessed value of $287 million during the bankruptcy which was based on the financial statement. However, if the future revenue which would be generated by the increasing traffic demand is considered, this is a good deal for the Government. Moreover, SANDAG plans to lower tolls to attract increased traffic and about $200 million will be saved by canceling previously planned additions to capacity-extra lanes on another state-owned road (parallel I-805) [9].

75.4.2 Case IV

The 91 Express Lanes were originally built in the early 1990s at a cost of $134 Million USD and operated on a Build Transfer Operation (BTO) basis by the concessionaire – the California Private Transportation Company (CPTC). The operator reported net profits by 1998. In 2002 the Government purchased CPTC's interest (the remaining 27 years of operating and receiving tolls out of its original 35 years term) in the franchise agreement for a sum of $207.5 Million USD. The purpose of the purchase was to eliminate a "non-compete" agreement with CPTC, the prior franchised private consortium, that prevented improvements to a nearby freeway [10].

The compensation paid to the contractor was much more than the initial investment and a great amount of public funding was used to buyout the franchise. As well, since the project had stable revenue and traffic demand was likely to keep increasing in the future, in a market economy it is not possible to force the franchisees to sell at a price they see as anything less than being very attractive [10]. Through costly early termination, a clean break with CPTC enabled the government to carry out essential improvements to the road network and have a freer hand in adjusting tolls, unencumbered by the franchise agreement. It is therefore a two-edged tool.

From Case III and Case IV, several facts can be draw as follows:

- The DVFCF approach is properly used in the compensation of PPP projects which have substantial tariff revenues, such as traffic project, water supply plant, and power plant. As soon as the completion of construction, the project can be operated and generate revenues, which can be used to repay the lenders. Even if the early termination (except caused Force Majeure) occurs, revenues generated from daily operation are not affected. So there is alternative choice for the contractor to sell it in open market, instead of selling it to the public authority. If the public authority want to buyout the concession, such as occurred in case IV, they have to offer a market price for the deal. With alternative choice, the contractor's ability to bargain with the public authority also increases in the negotiation of early termination. In Case III, the compensation paid by the public authority was higher than the assessed value.

- The compensation made by the DVFCF approach is more representative for the real value of the project. When the remaining concession is sold in open market, the tenders are buying a real option which is collecting revenues in the remaining concession, instead of the project facilities. Therefore, Cumulated Cost the contractor has spent in the project can't reflect the real value of the project. In case III and IV, the compensation amounts have huge discrepancies to the original investment.

Compared to the FS approach, the DVFCF approach is more risky for the contractor. In this approach, the contractor has to take all long-term risks because when calculating the cash flows, both O&M costs and revenues are forecasted based on its performance before termination and the market prediction made by then. So if the contractor didn't perform well in construction or operation, or made severe error in demand forecast, the early termination can't end its long-term engagement to project risks and demand depression without paying the risk pain in terms of low compensation from the public authority. In case III, the poor performance of the contractor and disappointing traffic demand caused the early termination, therefore the compensation was far less than the initial investment. But on the other hand, if the contractor behaved very well and the market was also good before the termination, the public authority had to pay a great amount of risk premium to the concessionaire in early termination. In case IV, the termination was caused by the public authority and there was no default for the contractor, so the public authority had to pay compensation which was much more than the investment.

75.5 Conclusion

In this paper, two compensation approaches for the early termination of PPP projects were introduced. These two approaches took different strategies in dealing with the long-term project risks and demand uncertainty, therefore they have different characteristics: (1) The FS approach calculates the compensation based on the Cumulated Cost and Revenues before the termination date, which are stated in the financial statement. The public authority retains the long-term project risks and demand uncertainty. This approach is suitable for utility charge based projects and uncompleted projects; (2) the DVFCF approach calculates the compensation through estimating the cash flows of the remaining concession, which are with high uncertainty. All of the long-term project risks and demand risks are taken by the contractor. This approach is suitable for those tariff based projects while their revenues are not influenced by the early termination. This paper clarified the principles and applications of two most widely used compensation approaches for early termination of PPP projects, and that could facilitate the design of early termination clauses in PPP agreement.

Acknowledgement This study is financially supported by the Research Grant Council of the Government of Hong Kong Special Administrative Region (Public Policy Research, HKUST6002-PPR-11).

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Part V
Safety, Risk and Value Management in Construction

Chapter 76
Safety Investments and Safety Climate in Construction Sites

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Abstract Problem: Safety climate refers to the degree to which employees believe true priority is given to organizational safety performance. It is considered to be a reflection of actual safety culture. Safety investments refer to the expenses for all kinds of accident prevention activities. However, the links between safety investments and safety climate remain unclear. It is not known which components of safety investments are effective to construct a positive safety climate in construction environment. Objective: This study aims to examine the actual links between safety investments and safety climate in the context of building construction in Singapore. Method: face-to-face interview with a questionnaire was used to collect data for this study. Results: The results of this study show that different components of safety investments have different effects on safety climate of building projects. Implications: The findings are important because they may provide the basis for contractors to formulate the strategies for constructing a positive safety climate of their construction sites.

Keywords Construction • Safety • Safety climate • Safety investments

76.1 Introduction

Efforts to prevent accidents are likely to be shaped by the root causes of accidents. Accident causation theories (e.g., [1–3]) suggest that lack of management control is the root cause of accidents and thus the accidents could be somewhat prevented

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_76,

through management efforts. The management efforts could be in the form of physical input such as the investments in safety personnel, safety facilities and equipments, safety training, and other safety related activities, and cultural input such as the cultivation of safety culture or positive safety climate in construction sites [4]. Safety investments are costs paid for pursuing people's health, the security of life, and living safeguard [5]. It is aimed at protecting the health and physical integrity of workers and the material assets of a contractor [6]. Safety climate was first defined by Zohar [7] safety climate as a summary of '*perceptions that employees share about their work environment*' (p. 96). More recently, Zohar [8] suggested, '*safety climate relates to shared perceptions with regard to safety policies, procedures and practices*' (p. 125). Although both safety investments and safety climate are believed to have positive impacts on safety performance of construction projects (e.g., [6, 9, 10]), it seems that no research has been conducted to examine the relationship between safety investments and safety climate in construction environment. It is still unclear what aspects of safety climate may be impacted by increasing the level of safety investments. It is also unknown which components of safety investments are more effective in constructing a positive safety climate in construction sites. These aspects were addressed in this study, which aims to investigate the relationship between investments in workplace safety and safety climate in the construction environment.

76.2 Literature Review

76.2.1 Dimensions of Safety Climate

Various previous studies [11–13] have defined measuring of health and safety climate as taking the "health and safety temperature" of an organization. Dimensions are the major features or levels of a health and safety climate [14]. In the construction industry, many researchers have attempted to find the common dimensions of health and safety climate. Although there are various factors to measure a health and safety climate, the dimensions in several of the latest research studies demonstrates strong similarities [11, 15–17]. Teo and Fang [17] compared the health and safety climate framework in Singapore and Hong Kong and found that there is very little difference between the two countries. Mohamed's [11] factor structure could be deemed as representative since the dimensions were derived from an extensive literature review rather than through the factor analysis method. Thus, Mohamed's [11] ten-factor safety climate structure was used to assess safety climate of building projects in this study. The ten dimensions of safety climate are: (1) management commitment (D_1); (2) communication and feedback (D_2); (3) supervisory environment (D_3); (4) supportive environment (D_4); (5) safety rules and procedures (D_5); (6) training and competence (D_6); (7) workers' involvement (D_7); (8) personal risk appreciation (D_8); (9) appraisal of work hazards (D_9); and (10) work pressure (D_{10}).

76.2.2 Components of Safety Investments

The components of safety investments have been discussed in some previous studies (e.g., [5, 6, 10, 18]). Accident prevention cost comprises expenses for safety planning, acquisition of equipment and protective installations, personnel training, salaries for safety staff, safety measurement and accident investigations [18]. Brody et al. [10] classified safety investments into three types: (1) Fixed prevention costs (FPCs); (2) Variable prevention costs (VPCs); and (3) Unexpected prevention costs (UPCs).

In an attempt to optimize construction safety cost, Tang et al. [6] collected the data on the investments in safety of building projects in Hong Kong. The information on safety investments was divided into three major investments components, namely: (1) safety administration personnel; (2) safety equipment; and (3) safety training and promotion. Investments in safety administration personnel comprise the salaries of these personnel, such as safety officers, safety supervisors, or safety managers in some large companies, and their supporting staff such as clerks and typists. Investments in safety equipment include the expenditure on personal protection equipment and other equipment that involve the provision of safety on building sites. Expenditures on safety training and promotion are also part of safety investments.

Hinze [5] discussed the most salient components of a safety program for the construction industry while numerous experts were consulted about the costs of the various components of a safety program primarily associated with the petrochemical and industrial sectors. These safety program elements include: (1) substance abuse testing; (2) staffing; (3) training; (4) personal protective equipment; (5) safety committees; (6) investigations; (7) preparation and implementation of safety program; and (8) safety incentives.

76.3 Methods

A questionnaire was developed by defining and operationalizing the research variables. The questionnaire was divided into the following four sections: (1) Project and contractor information; (2) Safety investments; (3) Safety climate of the project; and (4) Personal information.

76.3.1 Measurement of Safety Climate

Ten dimensions and their respective attributes for assessing safety climate were listed in the questionnaire. The overall level of safety climate was measured by a dimensionless quantity, Safety Climate Index (SCI), which is derived by the following formula:

$$SCI = \frac{1}{10} \bullet \sum_{i=1}^{10} D_i, D_i = \frac{1}{n_i} \bullet \sum_{j=1}^{n_i} A_{ij}$$

where D_i = Score of *i*th dimension of safety climate ($i = 1, 2, \ldots, 10$); n_i = number of attributes for *i*th dimension; A_{ij} = *j*th attribute score of *i*th dimension.

76.3.2 Measurement of Safety Investments

Based on the literature review, safety investments are the sum of the following components: (1) Staffing costs (C_1); (2) Safety equipments and facilities costs (C_2); (3) Compulsory training costs (C_3); (4) In-house safety training costs (C_4); (5) Safety inspections and meetings costs (C_5); (6) Safety incentives and promotions costs (C_6); and (7) Safety Innovation costs (C_7). Close examination of these components could reveal that some components are determined by external industry or government regulations and some are determined by internal company or project OSH policy. Thus, safety investments could further be classified into two types, namely basic safety investments and voluntary safety investments.

- *Basic safety investments* (*BSI*) are required by industry or government regulations and construction process on minimal safety standards. As a compulsory part of safety investments for any individual building projects in Singapore, BSI consists of those costs incurred by safety personnel, safety equipments and facilities, and compulsory safety training courses.
- *Voluntary safety investments* (*VSI*) are generally determined by individual companies or projects. This type of safety investments is incurred by the voluntary safety prevention activities such as in-house safety training and orientation, safety inspections and meetings, safety incentives and promotions, and innovative technologies, methods and tools designed for safety (4 "I" activities).

A dimensionless quantity, the Total Safety Investments Ratio (TSIR) was used to enable the comparison of the level of safety investments among projects of different sizes. TSIR is therefore defined as follows:

$$TSIR = \frac{Total\ Safety\ Investments}{Contract\ Sum} \times 100\,\%$$

where Total Safety Investments = $\sum_{i=1}^{7} C_i$, where C_i is the *i*th safety investment component.

Similarly, two dimensionless quantities, Basic Safety Investments Ratio (BSIR) and Voluntary Safety Investments Ratio (VSIR) were used to enable the comparison of the level of BSI and VSI among projects of different sizes respectively.

76.3.3 Data Collection

Personal interviews with a questionnaire were used to collect data for this study. The population consists of all building contractors in Singapore. The sampling frame is a list of 234 large and medium general building contractors (A1, A2, B1, and B2) who were registered with the Building Construction Authority (BCA) of Singapore. The reason why small general building contractors (C1, C2, and C3) are excluded from the sampling frame of this study is that, according to practices of Singapore construction industry, small general building contractors (C1, C2, and C3) usually perform as sub-contractors of building projects and it is not possible to acquire complete information about the whole building project from sub-contractors. The building contractors from the sampling frame were contacted via Email or telephone to request them to participate in this study. The contact person (project managers or safety officers) were then interviewed with the questionnaire after he or she agrees to accept the interview. The interviewees were requested to provide information for their project/s that has/have been completed within the past 3 years. The project managers of these projects were required to review the historical records about the cost information of safety related activities of the projects that they had managed. For a single project, three members of site management staff comprising project managers, construction managers, site engineers, safety officers, and safety supervisors were requested to complete the safety culture assessment form, which is the fourth part of the interview questionnaire. The average of SCI value derived from the three questionnaires was used to gauge the project safety climate level.

The 23 contractors provided information of 47 completed building projects. The types of the projects comprise commercial building (10.6 %), residential building (63.8 %), office building (12.8 %) and industrial building (12.8 %). The contract sum of most projects (83 %) ranges from SGD ten million to SGD 100 million. 83 % of the projects are from private sector, and 17 % percent are from public sector. The sample projects are evenly distributed among the four BCA grades. The profile of the projects suggests that the data were collected from a wide range of building projects with a focus on residential (63.8 %), middle-size (83 %) and private building projects (83 %). The interviewees consist of 42 project managers and 5 safety officers. Each of the interviewees provided the information of one completed building projects. The 47 interviewees came from the 23 sample contractors. Out of the 23 contractors, 5 provided 1 interviewee; 12 provided 2 interviewees; and 6 provided 3 interviewees. Most of the interviewees were project managers, and had more than 10 years of experience in construction industry. The average working experience of the interviewees was 13 years, and the minimum working experience was 7 years.

76.4 Results

Before inferential statistical analyses were carried out, the characteristics of data collected were illustrated through descriptive statistics. The total safety investments of sample projects account for 1.62~3.00 % of total contract sum with a mean percentage of 2.05 % and a standard deviation of 0.27 %. The basic safety investments of sample projects account for 1.20~2.22 % of total contract sum with a mean percentage of 1.59 % and a standard deviation of 0.20 %. The voluntary safety investments of sample projects account for 030~0.78 % of total contract sum with a mean percentage of 0.46 % and a standard deviation of 0.11 %. The SCI of sample projects ranges from 3.25 to 4.02 with a mean value of 3.58 and standard deviation of 0.18.

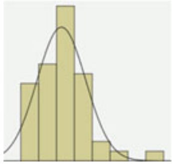
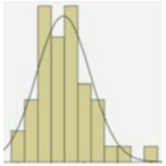
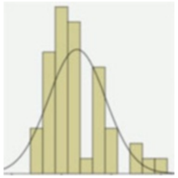
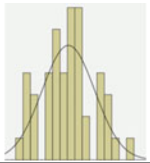
Bivariate correlation analysis was used to test the associations between different types of safety investments (i.e., BSI and VSI) and the level of safety climate in construction sites. Table 76.1 presents the bivariate correlation coefficients, distributions of variables, and scatter plot which may indicate some relationships between variables. Table 76.1 shows that SCI is significantly ($p < 0.05$) correlated with TSIR ($r = 0.316$) and VSIR ($r = 0.347$); whilst there is no significant correlation between SCI and BSIR ($r = 0.230$, $p \geq 0.05$).

76.5 Discussions and Conclusions

The results suggest that different types of safety investments have different impacts on safety climate of a construction project. An increase in voluntary safety investments contributes to the cultivation of a positive safety climate in construction sites. However, an increase in basic safety investments does not significantly contribute to the cultivation of a positive safety climate. Based on the definition of basic safety investments, the investments in basic safety measures (e.g., employment of safety professionals, provision of safety equipments, and enforcement of formal safety training courses) are largely determined by industry and government regulations and construction process to maintain minimal safety standard. One possible reason for the relatively weaker effect of basic safety investments on safety climate could be that the contractors have to invest in certain basic safety prevention activities even if some of these activities could be ineffective or inefficient for their projects. In comparison with the enforcement nature of basic safety measures, the investments in voluntary safety measures (e.g., accident investigation, safety inspections, safety committee, safety promotion and incentives and in-house safety training and orientation) are the result of contractors' voluntary selection and therefore reflect the willingness of contractors to improve safety standard of their projects.

Some kinds of safety investments like the time invested in accident prevention activities (e.g., the time invested in participation in safety training and orientation,

Table 76.1 Correlations and scatterplot matrix

	TSIR	BSIR	VSIR	SCI
TSIR				
BSIR	0.925**			
VSIR	0.749**	0.442**		
SCI	0.316*	0.230	0.347*	

*$p < 0.05$ (2-tailed); ** $p < 0.01$ (2-tailed).

the time invested in emergency response drills, the time invested in safety meetings and inspections, and the time invested in accident investigations and other activities) do not produce a direct impact on safety performance, while they contribute to the cultivation of safety climate and then indirectly influence safety performance through the effect of safety climate. The positive impact of voluntary safety investments on safety climate reflects the importance of voluntary efforts in constructing positive safety climate of construction projects. This result supports Teo and Fang's [17] finding that a good safety culture is the result of a concerted effort, and requires investments in training and safe work procedures. This finding also supports Fang et al.'s [16] study, which investigated the safety climate in the Hong Kong construction environment and highlighted the importance of providing enough safety resources in constructing a positive safety climate.

The findings of this study suggest that the investments (including dollars and time spent on the accident prevention activities) in the following activities deserve sufficient considerations: (1) in-house safety training; (2) safety inspection and meetings; (3) safety incentives and promotions; and (4) safety innovation. A limitation of this research concerns the use of indexes (i.e., SCI) to measure the level of safety climate. It is acknowledged that it is not likely to have an absolute measure of safety climate. The SCI can only provide relative measures of safety climate. To minimise the potential threats of this limitation to the validity of the findings, this study adopted the following strategies: (1) proactively identifying potential threats of bias and carrying out precautions to mitigate them; and (2) interpreting the statistical inferences in the context of literature.

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Chapter 77
An Assessment on Critical Risk Factors for Chinese Engineering Firms in Ghana

Martin Henry Asare and Yousong Wang

Abstract Construction is one of the main strongholds for development in every country. Its risk assessment is very vital and of prime priority. It is a procedure of fixed assets formation for the economy and an effective construction project determines and expresses economic power and social influence at the national and international front. The objective of the research is basically to identify and establish the most critical aspects of risk factors that influences many of these Chinese engineering firms in Africa. It explores general risks that Chinese engineering firms normally face and have to deal with when embarking on projects in Africa. It also gives a case study on Ghana and subsequently identifies and adopts risk assessment methods to ameliorate and improve safety at various construction sites. By the adoption of questionnaire surveys and statistical analyses in Ghana, being the country used as a case study, risks encountered by Chinese Engineering Firms (CEF) in Africa were identified, assessed and ranked. The study revealed that loss incurred due to political changes, loss due to rise in fuel prices and poor communications between clients were among the highly ranked risks. Among the average risks were increase of material price, cost increase and material shortage. The least encountered risks were breach of contract by project partner and loss due to fluctuation of interest rate. The research findings help to enlighten and outline various risk factors to the Chinese firms who are making their way into Africa for developmental projects and gives pragmatic steps to reduce these risks and ameliorate safety in Construction by the Chinese Engineering Firms (CEF) and other stakeholders. It was found that the critical risk factors for Chinese construction companies in Ghana are technical, political, market and language risks. These findings may also be useful to other firms in Asia and those from different continents since some of the risk factors examined are more general in nature.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_77, © Springer-Verlag Berlin Heidelberg 2014

Keywords Risk assessment • Construction • Engineering firms • China • Africa • Ghana

77.1 Introduction

Risk assessment is one of the major components in risk management procedure. Risk is defined as exposure to the consequences of uncertainty. In a project context, it is the chance of something happening that will have harmful impact upon set objectives. It includes the possibility of loss or gain, or variation from a desired or planned outcome, as a consequence of the uncertainty associated with adopting a particular course of action [1].

Methods for assessment of risk may differ between industries and whether it pertains to general financial decisions or environmental, ecological, or public health risk assessment [2].

As many countries in Africa seek to rise to par with other nations of the world, there has been a great need to focus on its industrial and construction sector and bring about the change required.

77.2 Research Methodology

The general research methodology for this project comprised basically of a survey questionnaire which was issued out to eight interviewers at various locations and centers by postage and emails. They in turn went to the various construction firms in Ghana to conduct the study. It also consists of a statistical analysis of the data obtained.

The questionnaire is made up of two parts. The risk factors section and the personal details which sought for general personal data about the respondents. The first section consisting of various risk factors are each categorized.

77.2.1 Approach and Data Analysis Method

To assess the relative significance among risks, previous literatures study suggests establishing a risk significance index by calculating a significance score for each risk. The method for calculating the significance score is to multiply the probability of occurrence by the degree of impact. Thus, the significance score for each risk assessed by each respondent can be obtained through the model where

$$S_j^i = \alpha_j^i \beta_j^i \tag{77.1}$$

Where: S_i = significance score assessed by respondent j; for risk i; α_j = probability of occurrence of risk i, assessed by respondent j; β_i = degree of impact of risk i, assessed by respondent j.

By averaging scores from all the responses, it is possible to get an average significance score for each risk, and this average score is called the *Risk Index Score* or Risk Significance as was previously defined. This is used to rank all categories of risks factors. The model for the calculation of *Risk Index Score* can be written as:

$$RS^i = \frac{\sum_j^T =_1 S_j^i}{T} \tag{77.2}$$

Where: RS^i = index score for risk I or expected value of risk; S^i = Significance score assessed by respondent j for risk i from Equation (77.2) and T = Total number of responses.

To calculate S^i, the five point scales for α and β was converted into numerical (Likert scale) scales. A Likert scale is a type of psychometric response scale often used in questionnaires, and is the most widely used scale in survey research. When responding to a Likert questionnaire item, respondents specify their level of agreement to a statement. The scale is named after Rensis Likert, who published a report describing its use (Likert 1932). Respondents were asked to review and indicate the probability of occurrence of risks using the Likert scale as: very small, small, normal, large, and very large. The degree of impact if the risk occurs using Likert scale was interpreted as: very low, low, medium high and very high [3].

77.3 General Analysis

The data for this study was obtained through questionnaire administered to the various companies and results received through email, Skype, phone calls and postage. After the data were obtained they were input in Microsoft Excel 2010 version and analyzed using the installed function of the Excel Pivot Table. This was used to pivot the data in a PivotTable analyzer and PivotChart by changing the field layout of the data. The critical risks shown in this study are market, policy and political, technical, and language and social risk.

77.3.1 Market Risk

Increase of resettlement cost had a high probability level of occurrence of 3.58 and a high degree of impact of 3.17. This means the nature of the project required relocation of local settlements and the impact of these resettlements may have harmful repercussions on the on-going project. These harmful effects come from

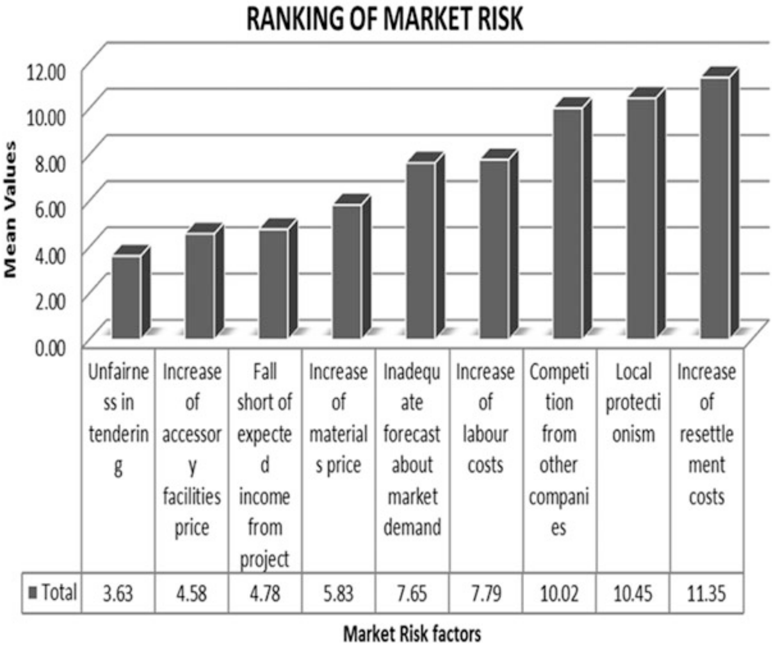

Fig. 77.1 Rank of market from the lowest to highest risk factors

the locals who may be dissatisfied with the compensation given to them to resettle in another location who respond in an unsatisfactory demeanour.

The highest ranking from the market risk is the increasing cost for resettlement with a risk value of 11.35 from Fig. 77.1 which is about 17 % of the total market risk. It is considered as a high risk and must be given immediate attention and prompt action taken. Local protectionism was also rated with a value of 10.45 being 16 % of the total market risk because it's now gaining grounds in Ghana as the government seeks to protect locally manufactured products even though many industries have already closed down as a result of vast importation of goods from China. Competition from other companies is considered as a high risk of about 15 % of the market risk distribution.

Many companies from Europe and America who were already embarking on various projects before the Chinese companies came in are still working competitively to maintain their position. Some are resorting to using locally produced constructions materials for their projects in order to politically, economically and legally gain an upper-hand over their Chinese competitors.

Increase of labour costs (12 %), Inadequate forecast about market demand (12 %), and increase of material price (9 %) like cement price has also been a major concern for many of the Chinese Engineering Firms (CEF).

Table 77.1 Showing policy and political risk mean values

Policy and political risk	Probability level of occurrence	Degree of impact	Expected value of risk
Cost increase due to changes of govt. policies	1.92	3.00	5.75
Loss incurred due to corruption and bribery	2.83	2.50	7.08
Loss incurred due to political changes	3.75	3.92	14.69
Loss due to bureaucracy for late approvals	2.50	2.50	6.25

77.3.2 Policy and Political Risk

From the study 43 % of the political risks was actually due to political changes as can be seen from Table 77.1. This is a high risk and must be quickly addressed. One way to deal with this situation is to ensure that there are national policies that support various major projects instead of them being politically driven. As long as they're woven into a national policy program, they must be independent of any political interference and changes. The CEF can verify all these procedures before beginning any project so that they're ensured of a smooth flow of work.

The medium political risk from the study are loss incurred due to corruption and bribery (21 %), loss due to bureaucracy for late approvals (19 %) and cost increase due to changes of government policies (17 %). These are risks that must be addressed with emergency. Chinese firms must stay up to date with general news in the country especially with issues concerning government policies.

77.3.3 Technical Risk

Improper planning and budgeting, improper feasibility studies, no past experience in similar projects are some technical risk faced by the companies. Shortage in power supply was recorded to have the highest degree of impact of 4.33, which means that most of the equipment used by the firms are powered by fuel or electricity. The highest probability level of the risk occurrence is industrial disputes which is 6 % of the total distribution of probability occurrence. Figure 77.2 shows that shortage in power supply has a high degree of impact (4.33) on the work of the firms even though it does not record a relatively high probability of occurrence (2.75). Most of the firms depend on equipment that are powered by diesel or gas and are equipped with generators to supply electricity during construction. The shortage of these fuels will pose as a serious threat to their project. Unknown site physical conditions though has a high degree of occurrence records a low degree of impact. It's the same scenario with handling of surplus materials. Many firms see it as less harmful to their project because they're cheap and easily accessible from China [10].

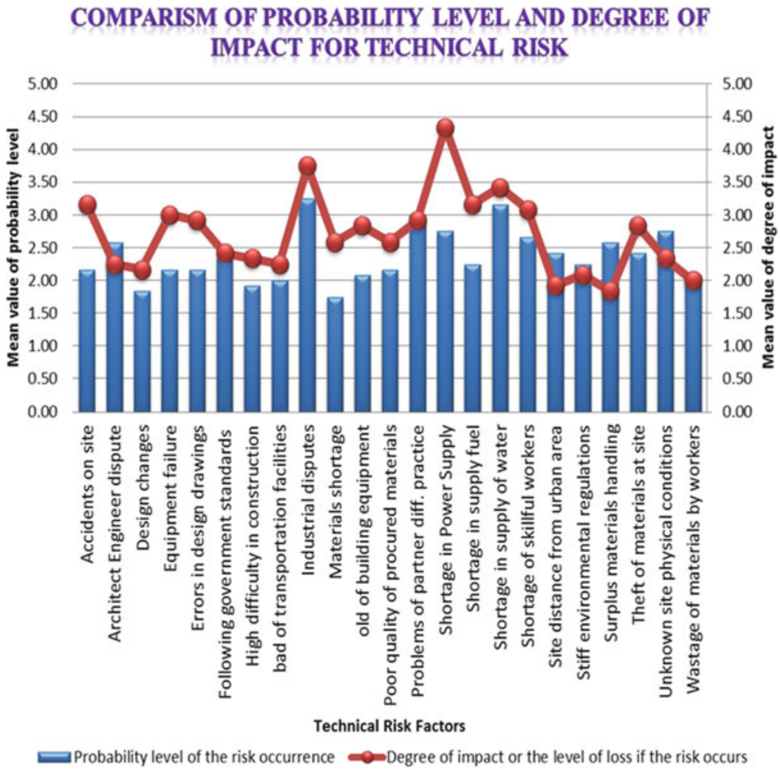

Fig. 77.2 Bar and line chart comparing probability level and degree of

77.3.4 Language and Social Risk

Language and social risk here refers to the communication skills, culture and practices of the Ghanaians that are different from the Chinese workers. This may pose as a form of risk to any project at hand. The highest probability level of risk occurrence of 3.5 is difficulty of communication with workers. This obviously leads to less support from the local people because of lack of understanding and mutual concession. Local people support for the project had a medium risk projection of 8.36 which measures about 17 % of the total risk distribution. Support of the people is an important factor if the project is going to be successful and achieve its aim [7]. Since every project that is undertaken especially in rural areas has direct implication and ties with traditional rulers of the community, it's recommended that Chinese engineers always seek their cooperation and support whenever they embark on any project in such areas [11]. The acknowledgement of the chiefs and rulers of the villages and other localities paves the way for immense support from the community for projects to go on successfully (Fig. 77.3).

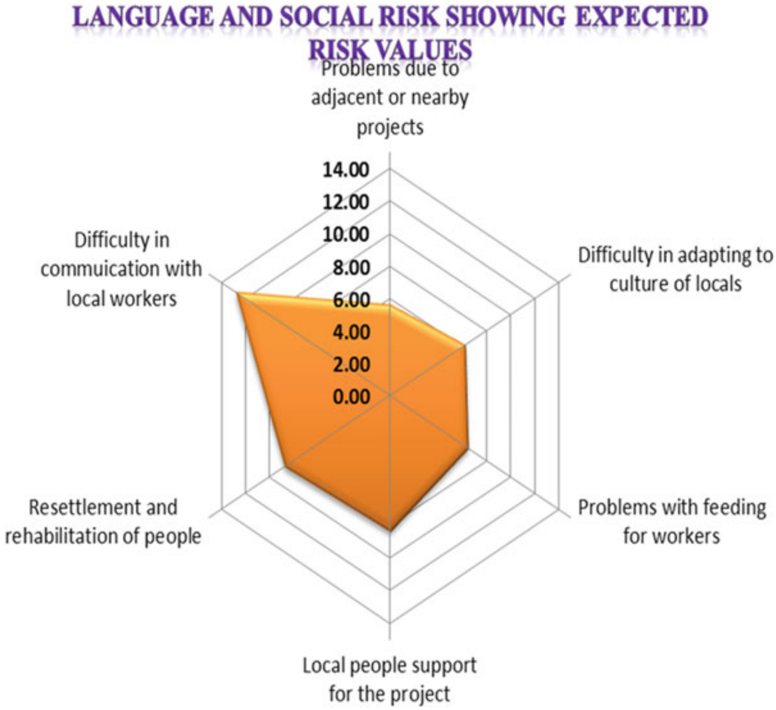

Fig. 77.3 Radar chart displaying expected risk values for language and social

77.4 Case Study: Ghana's Bui Dam Construction

The construction of the Bui Dam is one of the major projects of Chinese construction in Ghana after the construction of the Ghana National Theatre in Accra [18]. The Bui dam will be the third major dam in the country after the Akosombo Dam and the Kpong Dam [4, 5].

77.4.1 Environmental and Social Impact Assessment

An Environmental and Social Impact Assessment (ESIA) for the dam was completed in January 2007 by the US consulting firm Environmental Resources Management (ERM). During its preparation hearings were held in Accra and in five localities near the project area, such as Bamboi. However, no hearings were conducted in the project area itself. Once completed, an independent panel appointed by the Environmental Protection Agency (EPA) of Ghana reviewed the ESIA [15]. The latter was revised in the important aspects, including the following: "compensation" had to be provided for the inundated area of Bui National Park, a "rescue plan" for the hippos was required and it had to be specified how resettlement would be carried out. When the EPA issued the environmental permit for the dam, it required the Bui Power Authority to present within 18 months an Environmental Management Plan based on the revised ESIA. Construction and resettlement began in 2008, but no environmental management plan had been submitted as of July 2010 [16].

77.4.2 Environmental Impact

The Bui National Park will be significantly affected by the Bui Dam. Twenty one percent of the park will be submerged. This will affect the only two populations of black hippopotamus in Ghana, whose population is estimated at between 250 and 350 in the park. It is unclear if hippos can be relocated and if there is any suitable habitat near the area to be inundated. Even if there were such a "safe haven", it is not clear if the country's game and wildlife department has the means to rescue the animals. The Environmental and Social Impact Assessment states that hippos will be vulnerable to hunting during the filling period of the reservoir. It also claims that they would ultimately "benefit from the increased area of littoral habitat provided by the reservoir" [23].

The dam could also have other serious environmental impacts, such as changing the flow regime of the river which could harm downstream habitats. A survey by the University of Aberdeen has revealed that the Black Volta River abounds with 46 species of fish from 17 families. None of these species is endangered. Nevertheless, these fish communities could be severely impacted by changes to water temperature, turbidity and the blocking of their migration [17]. Waterborne disease could also occur [9]. Schistosomiasis in particular could become established in the reservoir, with severe health risks for local people [8].

77.4.3 Environmental Risk Factor

The risk involved here for the Chinese firms embarking on the project is the fact that the community is having a negative perspective on their endeavours as being inconsiderate of environmental hazards. This has led to less cooperation between community members and construction workers. Periodic education on the importance of the project and measures being taken to address them will help curtail this risk.

77.4.4 Social Impact

The Bui dam project requires the forced relocation of 1,216 people, of which 217 have been resettled as of June 2010. In order not to slow down the construction of the dam, the Bui Power Authority has opted for a quick resettlement process.

It neglected the recommendations of a study, the “Resettlement Planning Framework”, that it had contracted itself. In theory, all affected people are expected to be moved to a new locality called Bui City. However, as of 2010 the city does not exist and there is not even a schedule for its construction. Instead, the first 217 relocated people have been moved to a temporary settlement called Gyama Resettlement Township, which has dilapidated infrastructure. Fishers were resettled on dry land and lost their livelihoods [22].

77.4.5 Social Risk Factor

Although the study had recommended the establishment of an independent body to monitor the resettlement, no such body has been set up [6]. Constant dispute and tension between residents and the Chinese construction workers has been an on-going issue and a risk factor for the Chinese firms. This can also be dealt with by having regular educative seminars on the importance of the dam in the community and the nation and speeding up resettlement and compensation procedures [20, 21].

77.4.6 SWOT Analysis

The SWOT is centered on examining its Strengths; Weaknesses; Opportunities and Threats of the Chinese firms. This allows for development of strategies in order to exploit its competitive advantages or defend against its internal weaknesses or provide possible remedial measures. In the SWOT Analysis matrix, Strengths and Weaknesses involve identifying the firm’s internal capabilities and/ or disadvantages against its competitors, while Opportunities and Threats involve identifying external factors such as government policies, forces from competition, emergence of new technology, governmental intervention and/or domestic and international economic trends that influence the financial performance and business operations of an organization (Table 77.2).

77.5 Conclusion

The assessment of risk is always an important part of effective construction for any on-going project. In this study different aspect of risks being faced by Chinese Engineering Firms have been detailed and analysed to show the critical risk factors. These assessments are envisaged to help with applicable and easy mitigation procedures for tackling the various threats. The following are the conclusions drawn from this thesis:

- Political changes are the major risk being faced by most of the Chinese firms. Change of government always tends to stunt the progress of on-going projects.

Table 77.2 Showing SWOT matrix

Strengths	Weaknesses
Increasing knowledge of African culture	Poor communication
Easy adaptation to harsh weather conditions	Low working conditions
Low labour costs	Low wages of workers
Quick construction	Low quality of imported materials
Easy access to cheap resources	Do not encourage the purchase of locally produced materials.
Continuous and rotational shift system of workers	Low level of team work with locals
Low bidding rates	Lack of knowledge of arbitration
Hands-on management style	Low enforcement of labour rights
High degree of organization	
General aptitude for hard work	
Easy access to funds	

Opportunities	Threats
Market developments	Local protectionism
More access to resources and raw materials	Political changes
Expansion of economy	Climatic changes
Increasing knowledge of foreign culture	Fluctuation of fuel prices
Better opportunities with other African nations	Shortage of gas and petrol
Increased tourist attraction	Disputes with community
Exposure of Chinese culture to foreigners	Health hazards
Contribution to the development of other nations	Uncertainty of court of justice
Macro-economic stability	Breach of contract by project partner
Increased influence on the international front	Fluctuation of inflation rates
Increased export opportunities	Intense competition from other companies
Niche creation	
Technological development and innovation	

- Shortage of skillful workers is also major risk faced by almost all the companies. This is because; the skilled workers are migrating between companies very often due to the high demand in the market. And also huge vacuum is created by the workers who move to other companies where they are offered very high packages.
- The study reveal that fuel prices is a major concern for the Chinese construction firms as they depend solely on gas and diesel to operate their equipment for various construction projects.
- Poor communication between clients and subcontractor related problems are major factors for concern. Many Chinese firms prefer working with only Chinese nationals but since the labour law of the country does not allow that they have to employ locals as well to create a fair and balance working force.
- Increase of resettlement cost was a major issue to be considered and addressed. The construction of the Bui dam has led to the relocation of several homes. Compensation has not been quick and many are still waiting to be compensated.

- Local protectionism was rated as one of the high market risk because it's now gaining grounds in Ghana as the government seeks to protect locally manufactured products.
- Increase of labour costs inadequate forecast about market demand, and increase of material price like cement price is a major market risk for the Chinese Engineering Firms (CEF).
- Industrial disputes continues to rise and depicts the level of miscommunication and misunderstanding at various project sites.
- China's weaknesses in the sector of construction in Africa include, poor communication low working conditions, low wages of workers, low quality of imported materials, low level of team work with locals, lack of knowledge of arbitration and low enforcement of labour rights.

This study has created a list of risk and its impact on the construction industry using a detailed survey. It's beneficial to all Chinese engineering firms embarking on various construction projects in Africa. Other foreign firms embarking on international projects will also find it very useful. It's also beneficial for national project planning and making judicious management decisions to safeguard the lives of construction workers, road users and building occupants.

77.5.1 Recommendation and Mitigation Measures

Risk assessment and risk management must be a major tool adopted by all Chinese firms and other international companies embarking on various project in Africa. During the planning stage itself a full-fledged risk assessment about the project should be made as an effective measure to curb risks [12].

1. One of the measures to control loss due to risk in fuel prices is to factor in and consider the high possibility of fuel prices during the budgeting of the project so that it does hamper construction progress. Just as fuel prices should be considered during budgeting of the projects inflation rate must also be seriously considered [19].
2. In order to curb the situation of poor communication and reduce risk, Chinese workers should be given a period of technical language courses prior to the start of project and during the project. They may also hire translators with background in construction to help them on site especially with critical technical work. Ghanaian Civil Engineers should also begin to take some Mandarin courses to enhance and improve their relation with their Chinese counterparts and Chinese schools and institutions be established in Ghana as is being done all over the world [13].
3. To address the issue of resettlement, the compensation plan and terms of resettlement and whether the Chinese companies or government of Ghana is responsible for resettlement should all be spelt out clearly in the tendering agreements before starting the projects. It must be ensured that these conditions are strictly adhered to in order to avoid undesirable response from the locals

during construction. Chinese companies must also be encouraged to begin using locally produced materials instead of always importing their materials. They must also be encouraged to establish industries of the materials they need for large projects in Ghana through local agents.

4. Political changes cause a lot of instability for on-going projects. One way to deal with this situation is to ensure that there are national policies that support various major projects instead of them being politically driven. As long as they're woven into a national policy program, they must be independent of any political interference, manipulations and mainline development [14]. The CEF can verify all these procedures before beginning any project so that they're ensured of a smooth flow of work.

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Chapter 78
Tools to Prevent Waste in Material Flow in Housing Projects

Tobias Karlsson and Per-Erik Josephson

Abstract There is a lack of apartments in major Scandinavian cities. At the same time, there is a general opinion in media that the costs for housing production are too high. Studies indicate that waste, in the lean perspective, is in the range of 30–35 % of the project cost, excluding costs for land. Among initiatives for reducing waste are tools to prevent waste in material flows. This paper presents a case study in which a logistics company, a medium-sized contractor and a material supplier collaborated to develop tools for improving the material flow on the construction site. Initially, nine tools used for preventing waste in material flow is presented; logistic analysis, demand profile, process map, specifications for building hoist, delivery plan, responsibility during material handling, location in apartments, quantification of materials and control of deliveries. Then, each tool is evaluated concerning what kind of waste is reduced. Examples from a residential building project with 163 apartments are given. The costs associated with enhanced material logistics in this specific project were approximately SEK 130 per m^2, which is equal to RMB 115 per m^2. This covers the enhanced handling of 80 % of the materials. It's expected within the case project that enhanced logistics with support by the nine tools has a potential of giving a 2–5 times return on the investment. The conclusion is that material logistics requires good planning and structure in order to be effective and succeed in minimizing waste.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_78,

78.1 Introduction

Public debates in Sweden about construction have in the past years concerned issues related to the high production costs for new buildings. At the same time, the construction industry struggles with low profit margins. Thus, there are external as well as internal reasons to reduce costs by improved efficiency.

Recent statistics show that the Swedish factor price index – which is the cost for all material, workers' wages, machines, transportation, energy and contractor expenditure constructor costs – have increased by 21.5 % for construction of new residential buildings the last 5 years. Material costs alone increased by 30.8 % [1]. The cost distribution for newly produced apartment-block houses can be seen in Table 78.1. Construction costs stands for 61 % of total production costs and last year's factor price index increase encourages construction companies to start looking for potential savings by reducing waste [2].

According to an empirical study by Josephson and Saukkoriipi [3], waste is in the size of 30–35 % of the total production cost. They argue that waste reduction should be one of the highest priorities in construction.

This paper focuses on material logistics and especially material handling. It's based on a case in which a contractor and a third part logistics company collaborate in finding ways to reduce waste by developing tools that improve material flows to the construction site and on the site. This paper is however limited to the process from the point the materials arrive to site until the materials is ready to be assembled by the workers in the apartments. The purpose of this paper is to present nine such tools and then evaluate what kinds of waste that is reduced. In this paper it is assumed that all work and resources can be coordinated by schedules and that inability to perform to schedule is rare or evidence of lack of commitment.

78.2 Material Handling and Waste in Lean Perspective

Deliveries of materials to the construction site are seldom scheduled and manufacturers and wholesale dealers report that express delivery is by far the most commonly used form of delivery when counted by number of orders [4]. Materials

Table 78.1 Cost distribution for new residential buildings [2]

Cost element	Proportion of the production cost (%)	
Value added tax	17	
Future proprietor costs, including land acquisition and municipal fees	22	
Construction cost	61	
Transport, machinery, operating expenses		12
Material		28
Wage cost – non-manual workers		5
Wage cost – craftsmen of sub-contractors		5
Wage cost – construction workers		11
Total	100	

delivery to site is a critical activity in the building process [5]. It affects productivity and needs a system for monitoring as early as possible in order to control the material flow. The supply of building materials to site without suitable planning is fraught with obstacles (Ibid). For example the need for unloading equipment interrupts other activities in production and requires storage of material, which takes space that could be used to make other production activities run more smoothly. Material handling becomes a supply bottle-neck.

Waste is often related to Toyota and the lean philosophy. Lean production, either in the construction or car industry, consists of many ideas including continuous improvement through standardization, flattened organizational structures, teamwork, elimination of waste, efficient use of resources and co-operative supply chain management [6]. The primary goal of lean production is, however, the elimination of waste [7]. Waste is generally defined as "an activity that absorbs resources but creates no value". With a construction perspective [8], define waste as "the loss of any kind of resources – materials, time (labor and equipment), and capital – produced by activities that generate direct or indirect costs but do not add value to the final product from the point of view of the client".

Vrijhoef and Koskela [9] concisely conclude three things about waste in relation to material logistics: "Firstly, even in normal situations the construction supply chain has a large quantity of waste and problems. Secondly, most of these are caused in another stage of the construction supply chain than when detected. Thirdly, waste and problems are largely caused by obsolete, myopic control of the construction supply chain". For material handling works that add value are assembly, finishing and packaging. Thus wasteful activities are those such as moving, storing, counting, sorting and scheduling [10].

Liker [7] identifies eight different waste areas from his study of Toyota: (1) overproduction, (2) waiting, (3) unnecessary transport or conveyance, (4) over processing or incorrect processing, (5) excess inventory, (6) unnecessary movement, (7) defects, and (8) unused employee creativity. Number 2, 6 and 8 are linked to work by people while the other five are linked to the flow of materials.

78.3 The Case Study: New Construction of Residential Buildings

This paper presents a case study in which a third party logistics company, a medium-sized contractor and a material supplier collaborated to develop tools for improving material logistics. For each new project they registered ideas on how the processes related to the material logistics could be improved followed by a joint meeting for deciding what improvement ideas to work on in next project. The paper focuses on the material flow on construction sites, which the logistics company and the contractor were responsible for. The case study, which concerns a new construction of residential buildings, was the third project the two companies collaborated in. One of the authors, who works for the logistics company, and the contractor's project manager were responsible for developing, implementing and evaluating the tools.

The case project was built on a turnkey contract with a public client. The site is located in Gothenburg, Sweden, at a site, which belonged to the shipping industry until the late 1970s. The project includes the construction of 163 apartments and two other facilities. The apartments are shared between four separate buildings, which range from four to eight stories each. As part of the project, a basement and parking garage will be built beneath the construction site. One of four buildings must meet the regulations for passive houses. The project includes a total of 10,111 m^2 finished gross area, excluding parking garage area, and 9,825 m^2 finished living at an estimated construction cost of SEK 173 million (RMB 150 million), excluding land acquisition and piling work. The project was initiated in March 2008 and completed in December 2011.

The study presented in this paper focuses on material handling in the frame complement phase, which was divided into four processes. The first process concerns the façade, which is a mix of plate and plaster. The second process concerns outer walls, which were built with the base materials timber, insulation and windows. The third process concerns inner walls, which were built of the basic materials timber, steel bars, insulation and gypsum boards. Bathroom walls were, however, built with gypsum boards and a board called Jackon. Ceilings, which are classified as inner walls, are built with gypsum boards. The fourth process concerns wardrobes and kitchen cabinets. These components are delivered assembled. The last three processes were chosen for the study since they cover 80 % of the materials handled on site in this phase. All assembly work was done by the contractor's own workers.

78.4 Method

Data was gathered through individual interviews and direct observations during a 2-month period. In total, 18 open-ended and semi-structured interviews were performed. The interviews were performed with individuals who had responsibility for the achievement of project targets and also worked with the chosen materials on a day-to-day basis. The interviews were held with nine individuals from the construction company: one site manager, four foremen, two worker representatives, one calculation engineer, and the CEO. Interviews were further performed with five managers at the third part building logistics company and four interviews were held with personnel from a construction material supplier. Further questions were asked in person, by e-mail or via phone. The purpose of these interviews was to get the practitioners' opinions about obstacles relating to the handling of materials.

The construction work on site was further observed during a 2-month period. Observation was undertaken as a known, non-active observer, and lasted between 1 and 3 h for each occasion and coincided with the delivery of selected materials.

A total of 20 deliveries were selected and observed arriving during the frame complement phase. The purpose of the observations was to find techniques and obstacles related to the handling of the chosen materials from site delivery until the workers are ready to assemble the material. During the observations bottle-necks that interrupted the material flow were documented. Examples of such bottle-necks are too small width of door openings, too low height between balconies, too small size of indoor elevator. Also, kitchen cabinets and wardrobes that were delivered assembled and not in packages, were larger than expected.

78.5 Example of Interruptions in a Delivery of Gypsum Board

Each material's flow on the construction site was studied, starting from the time the material arrived to the site and ending when the craftsmen assembled it. Every material's flow was interrupted of several reasons.

The following example considers a delivery of gypsum boards. Gypsum board is among the most frequently transported materials in the frame complement process. A gypsum board package is in many cases also the package, which encounters bottlenecks due to the size and weight of the package.

> *The gypsum board delivery arrived late to the site and no one was ready to guide the lorry to the correct location for being unloaded. Next, a fork lift truck was located to unload the lorry. However, after the arrival of the fork lift truck the craftsmen discovered that the temporary material store was not cleared. A new interruption occurred due to vague markings on the package which should indicate the boards' dimensions and which apartment the package should be transported to. These unclear markings created extra work since the craftsman could not guide the fork truck driver to unload the material in the right sequence for the next step, which is transportation into the house.*

The lorry was unloaded so that the material could be transported into the appropriate building (according to which apartment it goes in). The activity started with interruption because the hydraulic material transport wagon, which was used to transport the gypsum package was not correctly equipped. The wagon itself did not have distances high enough that the fork truck could take the forks away after loaded the package on the wagon.

Next time the transport was interrupted was by the building hoist. The hoist had engines, which were built in into the area used for transportation available to transport. The craftsmen needed to cut the wrapping and take away three layers so that the transport wagon with its package could fit under the engine in the building hoist. When the building hoist reached the correct level and the gypsum package was ready to be transported into the apartments, the hoist was not aligned with the door, which forced the craftsmen to scratch half of the package. Scratching could be avoided by carrying every single gypsum board by hand. Finally, inside the first door the rest of the passages were wide enough so that the hydraulic transportation wagon could be driven to the correct apartment. The passages were done wide enough in this case, since a previous logistic analysis identified that the original width was too small.

Other factors discovered that interrupted the flow of materials were weather conditions, coffee breaks, lunch breaks, height of building hoist, material garbage, blocking by other activities and craftsmen's motivation.

78.6 Tools to Prevent Waste in Material Flow

Factors that were identified as interrupting the material flow were recorded in the documents: logistic analysis, demand profile, process map, building hoist specification, delivery plan, responsibility areas, location plan in apartment for each material, quantification guide and arrival control. These are all created to ensure the correct flow of material from manufacturer to the worker's final assembly.

Logistic analysis (*1*). When the craftsmen were ready to use the gypsum board no one thought about where to put the package of boards in order to make the assembling process more efficient. The logistic analysis of construction projects is offered to construction companies on a consultancy basis by a third party logistics company. The analysis is based on internal and external material flow. The purpose of the analysis is to find critical activities that constrain the material handling. This provides internal and external transport plans, placement suggestions for tower cranes and construction elevators and production sequence (see Fig. 78.1). The process is based on a close collaboration between the consultants and the clients.

Demand profile (*2*). Each material is specified in the demand profile which has details about wrapping, packaging size, quantity etc. The contractor demands that material supplier and third party logistic companies consider the demand profile in order to avoid waste and to secure uninterrupted material handling (see Fig. 78.2).

Process map (*3*). The process map indicates how to handle material deliveries. It includes descriptions on where to unload, where to temporary store material, the route that should be used to the building hoists, where to store material if it is to be handled by crane etc. It was concluded that the deliveries should arrive between 1:00–2:00 PM and that the material should be temporarily stored at a marked position until the ordinary craftsmen finished the day at 4:00 PM. The materials were best suited to be transported to site after 4:00 PM to ensure that the transport neither interrupts nor is interrupted by work activities.

Specifications for building hoist (*4*). The building hoist specification described where the building hoist should be located and the size of the packages that will be handled. Restrictions are detailed, such as that no engine may be put inside the loading space. Weight and height demands are also specifications that need to be considered when renting a hoist. The specifications also include a checklist, which clarifies in what order work on site has to be done in advance to accomplish a successful building hoist assembly.

Delivery plan (*5*). The delivery plan describes exactly when the material deliveries take place. Craftsmen and team leaders then take the plan into account so they can

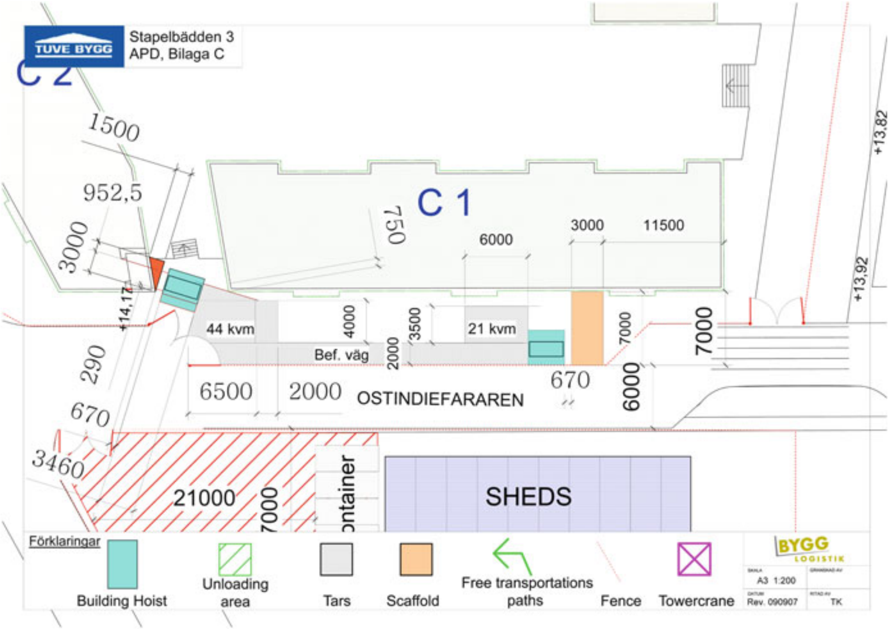

Fig. 78.1 Logistic analysis

Material	Timber
Dimension	45x195
Package curiosa	Distance under each package, not in between the bars Cut end should be oiled
Dimension package	Max Width: 900 mm Max Height: 500 mm Max Length: 3100 mm see quantification guide
Delivery time controlled	Yes between 13:00-14:00
Wrapping	Weather protected
Package quantity	See quantification guide for each apartment
Bandage	Minimum 3 pieces
Technical tool for transportation at site	Hydraulic material transportation wagon
Heap on other package	Not in apartments
Mark on package	Apartment number, Quantity
Acceptable quantity damaged	0 % Damaged, 5% Scratched
Humidity level	Maximum 18%

Fig. 78.2 Demand profile for the material timber and one of its dimensions

Delivery Number	Type of material	House	Staircase	Level	Week	Day	Time
1	Windows/Insulation /Timber	C3	C34	7-2	937	Tue,Wed	13:00-14:00
2	Windows/Insulation /Timber	C3	C33	7-2	941	Tue,Wed	13:00-14:00
3	Windows/Insulation /Timber	C3	C32	7-2	944	Tue,Wed	13:00-14:00
4	Windows/Insulation /Timber	C3	C31	7-2	947	Tue,Wed	13:00-14:00
5	Gypsum boards/steel bars/ Jackon boards	C3	C34	7-5	947	Tue	13:00-14:00
6	Gypsum boards/steel bars/ Jackon boards	C3	C34	4-2	949	Tue	13:00-14:00

Fig. 78.3 Part of delivery plan

proceed without interruptions. In a total of 52 delivery weeks, 62 delivery days were planned for the chosen materials (see Fig. 78.3). Some deliveries were delivered over 2 days because of the strict regulations from the environmental and health authority that forbids noise from machines after 8:00 PM in that area. This creates a bottle-neck that was taken into account during analysis.

Responsibility during material handling (*6*). The responsibility area document is designed to guarantee responsibility for damages that occur during handling of the materials. The project accepts no defects and a very small amount of scratches. If damage occurs, the document clearly states responsibilities for compensation and within which period of time it should be made. The document clearly stated responsibility for waste due to, for example, careless handling. One fork-lift truck driver supported the idea with the document:

> *…with clear definitions, now I know that my mistakes cost money and that I will be responsible to pay for all damages I cause. I will be more careful from now on.*

Location in apartments (*7*). A location plan is structured by demands from craftsmen and team leaders in order to secure most efficient handling of the materials but at the same time ensure healthy handling that prevents injuries. Craftsmen and team leaders asked for less carrying and unnecessary moving of material. The whole handling chain from the moment that the craftsman takes the material until he assembles it is considered. Each chosen material has its own unique spot in each apartment. Figure 78.4 shows the location for the materials used in the inner wall for apartment number 437. One of the contractor's team leaders was surprised over the effect:

> *Why haven't we thought about this before? Now we save a lot of time and make the craftsmen happier and more efficient.*

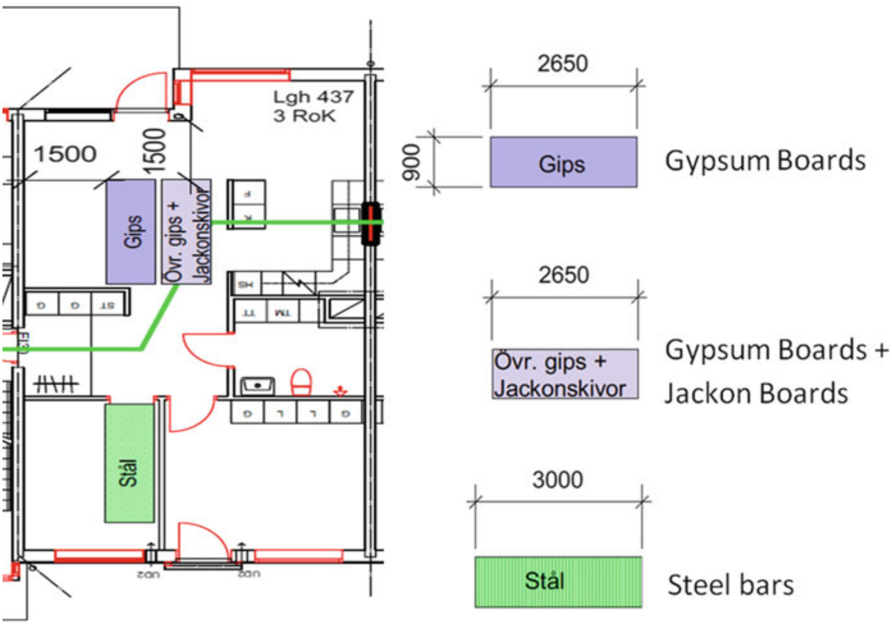

Fig. 78.4 Location plan apartment 437, inner walls material

Quantification of materials (*8*). The quantification guide shows the quantity of materials required. It is broken down to packages for each apartment. The purpose is to show those responsible for the transportation so materials are not transported needlessly, thus reducing waste. The required distributions of special steel bar systems for door opening and pre-cut gypsum boards above door openings are also taken into account in order to increase the efficiency of the craftsman. Figure 78.5 shows an example for apartment number 437 and 438.

Controlling deliveries (*9*). The arrival control is a checklist for quality controls that are supposed to be done during unloading. Each material has its own checklist points. As an example, the gypsum board controls include checking the board dimensions are correct, checking the correct quantity in both delivery and each package, checking packaging protects against bad weather and checking wrapping, defects and scratches. The controls will secure an uninterrupted material flow and no defects built in to the building.

78.7 Discussion and Conclusion

The purpose of this paper has been to present tools for reducing waste in materials handling on construction sites, i.e. from the point the materials arrive to site until the materials is ready to be assembled by the construction workers, and to evaluate

Staircase C13							
Level	**Apartment number**	**Steel bars**		**Gypsum Boards**		**Jackonboard thickness 12 mm**	
		Package quantity	Number of package	Package quantity	Number of package	Package quantity	Number of package
Level 2	**437**	32 bars	1	42 pieces	2	10 boards	1
	438	32 bars	1	42 pieces	2	10 boards	1
		Jackonboard thickness 6 mm		**Door systems and cut gypsum boards**		**Timber 45x45**	
		Package quantity	Number of package	Package quantity	Number of package	Package quantity	Number of package
		6 boards	1	6 systems	1	35 pieces	1
		6 boards	1	6 systems	1	35 pieces	1

Fig. 78.5 Quantification guide inner wall, apartment 437 and 438

Table 78.2 To what extent tools reduced various types of waste related to material handling. (*** = major influence, ** = some influence, * = minor influence, "–"= no influence)

Tool	Overproduction	Unnecessary transport	Over processing	Excess inventory	Defects
1 Logistic analysis	–	***	**	***	**
2 Demand profile	***	*	–	**	***
3 Process map	–	**	**	**	**
4 Specification for building hoist	–	***	*	**	**
5 Delivery plan	*	***	**	**	–
6 Responsibility during material handling	*	–	***	*	**
7 Location in apartments	–	***	**	*	**
8 Quantifications of material	***	*	**	*	–
9 Control of deliveries	–	*	*	**	***

what kinds of waste that is reduced by applying each of these tools. It must be noted here that it is not the tools that reduce waste, rather the appropriate use of the tools. Further, the tools have been developed in collaboration with a third party logistics company, a contractor and a material supplier.

The idea behind the tools has been to find ways to prevent all kind of interruptions in material flows. All three firms have experienced that most interruptions cause not only breaks in the flow, but also "hidden" consequences such as demotivation and needs of modifying the production plans.

In order to evaluate the tools, one of the authors used the five of Liker's [7] eight wastes that has to do with material handling on site. Based on interviews and direct observations he used a four-point scale in which three meant major influence and zero meant no influence on waste reduction, see Table 78.2. Then he found that each tool had some influence or major influence on at least two types. Further, all five types of waste were influenced by at least four of the tools. It must, however, be noted that the tools have been developed in such a way that they are aimed to work together, not as single tools.

Table 78.3 Cost for material handling, excluding parking garage (1 SEK = 0.85 RMB)

Cost item	Cost (SEK)	Cost/m^2 (SEK)
Third part logistics company	1,043,000	103
Preparing tender and selecting suppliers	222,400	22
Logistic analysis	50,000	5
Total	1,315,400	130

The case organization also experienced that the health and safety improved significantly. The work environment in the case project was considered better than in previous projects. Further, the sick-leave among managers and workers on-site was significantly lower than in previous projects. The interviews confirm that the focus on improved material handling is one reason for this improvement.

The additional activities in material handling in the case project were activities performed by the third party logistics company. Before the contractor was awarded the contract the logistics company made a logistics analysis and took active part in preparing the contractor's tender to the client. After the contractor was awarded the contract the logistics company took active part in selecting material suppliers and also transported 80 % of the material from the unloading place to the place for assemble. The majority of this transportation was done after 4 PM, i.e. after the construction work finished for the day. The cost of these additional activities corresponded to 130 SEK/m^2, see Table 78.3. The case organization perceived that the cost savings were 2–5 times higher than the investment.

The study presented in this paper indicates that there is a general lack of focus on material logistics in construction and that large costs associated with material handling are being ignored. The paper also shows that enhanced logistic capability can be achieved by early logistics planning. This helps to eliminate waste by identifying bottlenecks and restrictions to material package dimensions.

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Chapter 79
Construction Project Cost Management Under the Mode of Bill of Quantities

Qingli Li and Zhifang Tian

Abstract This article analyze characteristic of the bill of quantities valuation. According to the management system reform of current construction cost and the characteristic of bill of quantities evaluation, This article make simple introduction about the method and procedure of cost estimate, the content and the step of the cost plan. The cost control's main factor and method.

Keywords Cost management • Cost predict • The cost control • The bill of quantities

79.1 Introduction

79.1.1 Topics Raised

With the rapid development of globalization, the project needs a new, better adapted to the development of market economy, is more conducive to the construction project through market competition reasonable pricing to determine its construction prices. For this purpose, the competent department of the government implements the bill of quantities to accommodate the objectives of the reform of market pricing. In this pricing mode, the bill of quantities is given by the tenderer, tender complete the unit price, the unit price solely on the basis of the overall strength of enterprise technology and management level. Give full play to the initiative and dynamism of the subject of the construction market, is a market economy project valuation. Under price in bill of quantities, how to make cost management simple, and more realistic, more scientific, this is the original intention of this project.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_79, © Springer-Verlag Berlin Heidelberg 2014

79.1.2 List Pricing Features

Judging from the nature of the content, volume and price in one, that is: the level of consumption of artificial, material, mechanical elements is uniform, as reflected in the social average level of consumption. At the same time, artificial, material, mechanical unit price are static command prices, rates of various fees also carry certain mandatory. From the form of expression, the calculation of the amount of each sub-unit project is based on construction plans and multiplied by the corresponding labor, materials, mechanical unit price. Then get the sum of the unit project labor costs, material costs, and machinery usage fees; plus other direct costs according to the rules of procedure and guiding rate, site funding, indirect costs, plan profits and taxes will form a unit project quotation.

79.2 The Construction Project Cost Prediction Analysis

79.2.1 The Basic Principles of Bill of Quantities

The basic process of bill of quantities can be described as: on the basis of the uniform rules of the engineering calculation, according to specific engineering construction drawings calculates the quantities of each list item, according to the engineering cost information and experience data calculate engineering cost. The basic calculation process is shown in Fig. 79.1.

79.2.2 Predicted Program of the Cost of Construction Projects

Cost projections, means based on historical cost data and economic information, on the basis of a careful analysis of current economic conditions, the external environment changes and the management measures, made a quantitative description of the future cost levels and their development trends and logical deduction. Construction project cost prediction is the starting point of the cost management and is also the key to cost control in advance. Scientific and accurate cost projections must follow reasonable procedures. Cost forecast work procedure is shown in Fig. 79.2

1. *Development of cost forecast plans*
   Development of cost forecast plans is the basis to ensure the smooth progress of cost forecasting. The cost forecast plan including the identification of predictable targets and goals, organizational leadership and work layout, cooperation provided by the relevant departments, schedule, and scope to collect material.

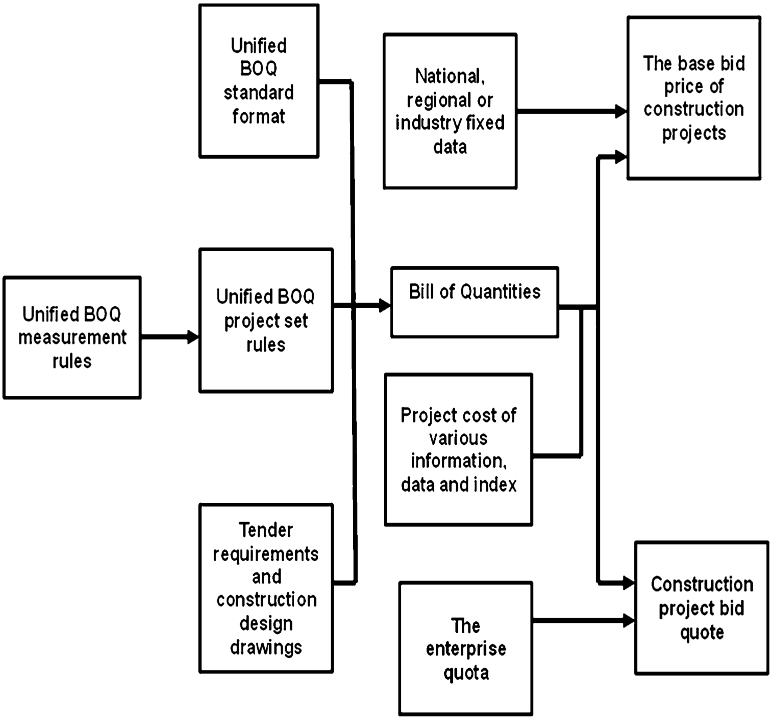
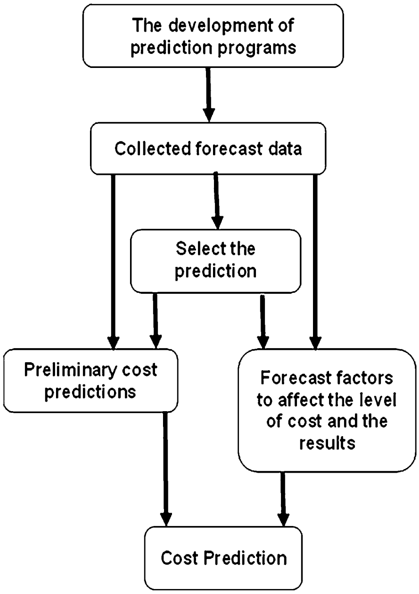


Fig. 79.1 The cost of BOQ pricing process schematic

Fig. 79.2 Schematic diagram of working procedure cost forecast



If in the process of cost prediction the emergence of new circumstances or discovery of the problems of cost prediction scheme cost forecast plan should be timely revised. We do that in order to ensure the smooth development of cost prediction and obtain good prediction quality [1].

2. *Environmental Investigation*
   Environmental survey from three aspects:

   (a) *Market research*
   The main purpose is to understand the development of the national economy, the scale of investment, orientation and layout of the country or region and the nature and structure of the major projects, competition in the marketplace, etc.
   (b) *Cost-level survey*
   Understand the cost levels of various types of project, project cost level and the target profit in various localities and types successful projects of the enterprises, building materials, labor availability and market prices and their trends.
   (c) *Technical Development Survey*
   Understand domestic and abroad new technologies, new designs, new processes, the possibility of new materials and the cost implications.

3. *Collecting and collating the cost forecast data.*
   Collecting the cost prediction according to cost prediction program is an important condition for cost prediction. In the process of prediction to extensively collect cost information related to decision problems. Costs related information generally can be divided into two categories: one is longitudinal data, such as the consumption of various categories of materials and dynamic data of unit price of the calendar year, etc. The other is the horizontal data, such as cost information of similar construction project in a period of time [2].

   Cost forecast information mainly includes:

   (a) *Cost-related indicators issued by the corporate headquarters.*
   (b) *The cost information of the similar project in history.*
   (c) *The level of the cost of the project site.*
   (d) *Other predictive information related to cost in the project. Such as labor, materials, mechanical stage working hours consumption*
   (e) *Other cost-related information, such as project technical features, such as the use of new materials, new processes and new equipment, transportation, energy supply.*

4. *Establishment of predictive model*
   In order to make cost projections more standardized and scientific forecast model should be based on data through analysis, on the basis of cost variation. In the experiment, for the short-term cost forecast can use relatively simple prediction model, factors to be considered can also be correspondingly less. For the cost of a longer period of forecast should use more complex prediction model and a variety of forecasting methods, factors to be considered should also be more.

5. *Select the forecasting methods of cost*
   Cost forecasting methods are generally include two types: qualitative forecasting methods and quantitative forecasting methods, qualitative prediction use the personal experience, subjective judgment and analysis capabilities, to predict the future status, mainly include the Delphi method, subjective probability method and expert meetings and other methods. Quantitative prediction method is based on the history and current status data create a relevant mathematical model, make quantitative predictions of the future development of the things and use a mathematical model to express the rules of development. Commonly used quantitative prediction methods include regression analysis, moving average method, exponential smoothing method, gray prediction method, etc.
   When choosing the forecasting methods, generally consider the following aspects:
   (a) *Time*. Different forecasting methods applied to different projection periods. Qualitative prediction is generally used for long-term forecast (usually more than 10 years), quantitative prediction for the medium range forecast (usually 5 years) and short-term prediction (usually within 2 years).
   (b) *Data*. Different forecasting methods have different data requirements, should be based on the characteristics of the data, select the appropriate data model. If there is a full month cost data, may be applied time series analysis to predict. If there is similar project output and cost data can use regression analysis and forecasting.
   (c) *Accuracy*. The forecasting methods should be able to obtain sufficiently accurate predictions, only proven effective model, can be used for the actual prediction.
6. *Cost forecasting*
   First of all, according to the method of cost prediction and the quantitative forecast of horizontal cost data, preliminary estimate of the cost of construction projects. Its predictions tend to be rough. Factors affecting the cost of construction projects such as price changes, labor productivity, materials consumption, and indirect costs need to be further detailed forecasts, in order to according market conditions, the situation of the subcontractors and other recent projects implementation, etc. Speculate about the future factors affecting the level of construction project cost and how its effects. Last, according to the results of the initial cost predictions and predictions on the impact of factors determine the forecast cost of the construction project.
7. *The analysis of the results of prediction, evaluation and put forward the report of prediction*
   A prerequisite for using the model to predict is the law of development of the prediction object will be different, because of the different conditions. Then make the predicted results deviate from the actual results. Therefore in order to check and modify the forecasting result the results of prediction using the model need to be analyzed and evaluated. Based on the conclusions of the predictive analysis, ultimately determine the predict results, on this basis put forward the

report of forecast to determine the target cost, as the basis for the preparation of cost plans and cost control.

8. *Analyse forecast error*
   The results of costs predict often differ from the actual costs incurred after the implementation, resulting prediction error. The size of the prediction error reflects the degree of accuracy of cost prediction. For analysis of this error, help to improve the quality of the work of the future cost prediction.

79.2.3 The Method of Construction Project Cost Prediction

The method of construction project cost prediction combine quantitative calculation and qualitative analysis. Qualitative and quantitative forecasting methods commonly used are shown in Fig. 79.3 [3].

The construction project cost forecasting methods can be grouped into two categories: The first category is the approximate prediction method, that is based on the similar projects in the past to predict the current cost of construction projects such methods include time series and exponential regression method. The second category is detailed prediction method that is based on the cost of similar projects in the near future, by adjusting the differences between structure and architectural, correcting the direct costs and indirect costs, such as artificial cost, material cost to measure the cost of the construction project:

1. *Approximate prediction method*

   (a) *Linear regression method*
   The method is suitable for the cost predictions within the period of small price volatility but for the greater price fluctuations should make price caliber conversion, the specific methods are as follows:

   - Collect information on the cost of recent similar projects.
   - The annual cost of the project will be converted into forecasted cost level.

   As the cost levels are determined mainly by the price of materials, therefore, it can be calculated according to building materials prices coefficient.

   - Establishment of regression forecasting model.

   (b) *Time series analysis and forecasting*
   A construction enterprise is generally within the same year there will be several projects in the same type are completed. Unilateral cost of construction projects can't be consistent. In addition, many projects are multi-year construction, if 1 year in a forecast period its cost is actually not only reflect the cost level in the current year.

2. *Detailed prediction method*
   This prediction method usually analyze the factors affect the cost changes during the planed period of construction project, according to the cost of recent

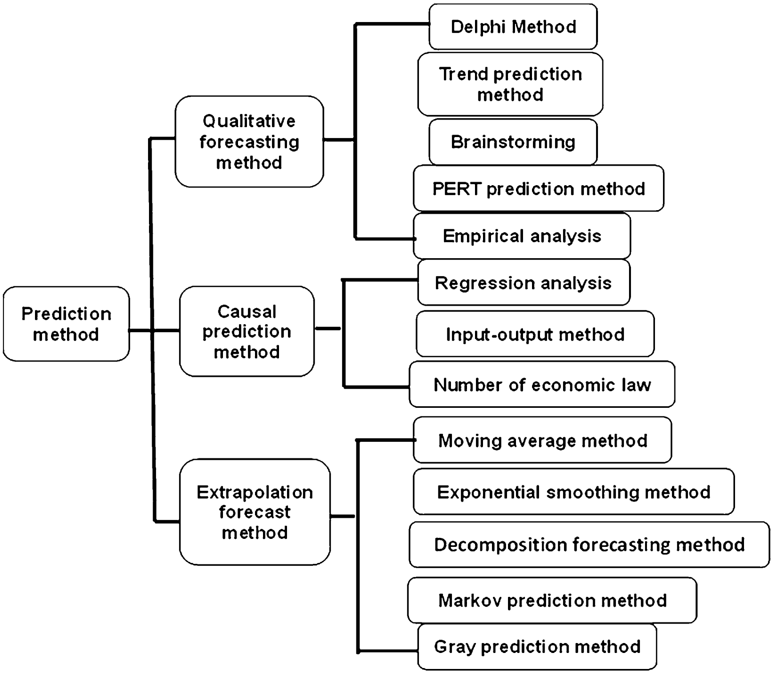


Fig. 79.3 Qualitative and quantitative forecasting methods

completed or will be completed construction projects (the cost of per unit area or unit volume cost), predict the degree of influence of these factors on the cost of the project in the project (cost items). Then calculated using the proportion method predicts the unit cost or total cost of the project.

This method first to calculate the cost of the recent similar construction projects has been completed or nearly to be completed (hereinafter referred to as reference works), including the amount of cost items; second step will be to analyze the impact of cost factors, and predict the factors that affect the cost; the third step is calculate according to proportion method. Predict the costs of the current construction project (hereinafter referred to as the object project).

79.3 The Cost Plan of Construction Project

79.3.1 Content of Construction Project Cost Plan

1. The composition of the cost plan of construction project
   The cost plans of the construction project are generally composed of lowering the direct cost plans and indirect cost plans of the construction projects. If the

project has a subsidiary production unit (such as the processing plant, precast plant, machinery and power station and vehicle fleet) the cost of the scheme also includes the cost of the product planning and operating cost of the scheme.

(a) The plan to reduce the direct cost of construction project
Construction project to reduce the direct cost of the scheme reflect the cost of the project's estimated value, the amount plans to cut and the rate plans to lower. Generally include the following aspects: general principles, objectives and accounting principles, total table of reduce the cost of the scheme or total control program, description of the estimates process on the number of planned expenditure in the cost plan of the construction project, source analysis of plans to reduce the cost.
(b) Indirect cost plan
Indirect cost plan mainly reflect the number of plans for construction site management costs, the number of budget revenues, and the amount of reduction. Indirect cost plan should be based on the accounting period of the project based on the project management fee of total revenue, develop the cost of revenue and expenditure plans of departments, after the summary for the project cost management plan.

2. Construction project cost schedule
After the preparation of a cost plan also need through various kinds of cost schedule implement cost reduction task on the whole process of construction project and in the project implementation process to achieve cost control. Cost schedule usually consists of cost planning task table, technical measures of organization form and the cost reduction plan table. Indirect cost plan can use construction site management fee schedule to control.
3. The calculation of the result of measures to reduce the cost
After the identification of the technical and organizational measures to reduce the cost then calculate the expected economic effect after using it. This is actually a prediction to lower the degree of ensure the cost targets.

(a) The cost reduced because labor productivity increased more than the average wage growth.
(b) The cost reduced because of the consumption of material and fuel is lowered.
(c) Due to the additional task of the completed works, so that reduced the fixed costs and the costs.
(d) The reduction of the cost as a result of saving management cost.
(e) The proportion due to the reduction of waste, rework losses and to reduce the cost.

Mechanical royalties and other direct costs savings can also be calculated according to the measures to be adopted. Sum the above cost reduction rates, able to measure the total cost reduction.

79.3.2 Steps of the Construction Project Cost Planning

Cost planning of the construction project not only just a few preparation of schedules, more important is the decision-making process of the project cost management. That is, selected the program which is technically feasible, economically optimal to reduce the cost. The basic procedures for the preparation of cost plans are as follows:

1. Collecting and collating data.
2. Estimate the planed cost, namely to determine the target cost.
   When financial sector mastering a wealth of information, then analyzed, on the basis of the analysis of the completion of basic period cost scheme, according to the plans of design and construction and according to the supplies, materials, labor, machinery, energy and a variety of facilities which should be put into the project. Combined with the changes of a variety of factors planning period and the yield-saving measures prepared to take, repeated estimates, amendment, equilibrium, to estimate the total level of production expenses and then put forward the whole project cost planning control index, ultimately determine the target cost [3].
3. Preparation of cost plan draft.
   For medium and large projects, after the indicators of the cost scheme approved by the project manager department issued, every functional departments should fully mobilize the masses to discuss, on the basis of the summary of completion of the cost scheme, combined with the current plan targets to identify favorable and unfavorable factors in the completion of the current plan, proposed specific measures to tap potential and overcome the unfavorable factors. In order to ensure the completion of planned tasks.
4. Overall balance, the preparation of a formal cost plan
   After the functional departments report the departmental cost plans and cost budget, the project manager should first combine various technical and economic measures check the plans and cost estimates are reasonable and feasible or not. And the overall balance, enable the departmental plans coordinate with the cost estimates; secondly, from the overall situation, in the situation of ensuring cost reduction task assigned by enterprises and the cost of the project objectives to achieve. The analysis of the mutual coordination equilibrium of cost of planning and production planning, labor man-hours plan, material costs and material supply plan, wage costs and wage fund plan, capital plan.

79.4 Cost Control of Construction Project

79.4.1 The Control of the Elements of the Project Cost Under the List Pricing

Management emphasis of BOQ project cost elements is how to control costs under the premise of the established income.

1. Effective control of the employment quantity.
   Labor expenses accounted for about 17 % of the cost of building products and changing with the market price fluctuations. To make realistic predictions on the unit price of labor throughout the construction period is a prerequisite to control labor expenses.
2. Control of the cost of materials.
   Material expenses accounted for about 63 % of the cost of building products, is the focus of cost elements control.
3. Mechanical cost control.
   Mechanical fee expenses accounted for about 7 % of the cost of building products, the control parameters mainly based on the BOQ calculated the number of mechanical stage.
4. Control of the fee of water and electricity in the construction process.
5. Management of design changes and engineering visa.
6. Management of other cost elements.
   Cost elements there are administrative expenses, profit, taxes, insurance except those in the quantity price method.

79.4.2 The Methods of Construction Project Cost Control

Construction enterprises in order to get the advantage of the lower cost to seize market share and realize the expansion in the current market economy, especially the implementation of the BOQ. In terms of cost control cost control model should be established for the enterprise.

1. *Evaluation method of cost plan*
   Network planning technique first developed in the United States. This approach is built on a network model which mainly used for planning and control, it is known as network planning technique.

   In the daily cost control, the cost control combined with the network plan, has its unique, can give full play to the advantages of network planning method. Application of cost plan evaluation and review technique the comparison of each process's schedule and actual progress and the comparison of planned cost and actual cost can clearly be seen from the network diagram. The direction of cost control and progress control can also clearly be seen.

   The cost of program evaluation and review technique is to mark the planned cost and schedule for each process on the network plan, shown in Fig. 79.4. Figures below the arrow are the time limits for a project, figures above the arrow are the costs. The letter c represents costs, the following figures for the amount of planned cost [4].

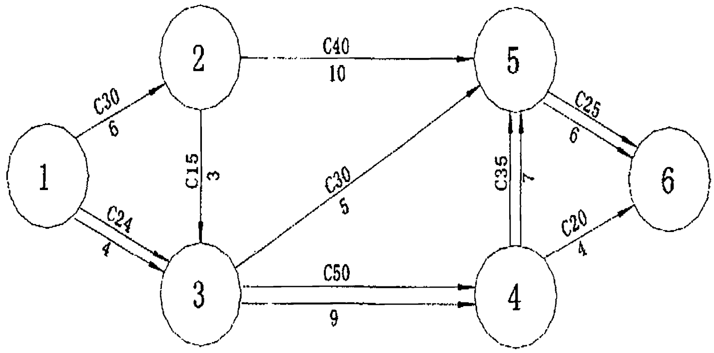


Fig. 79.4 Network plan

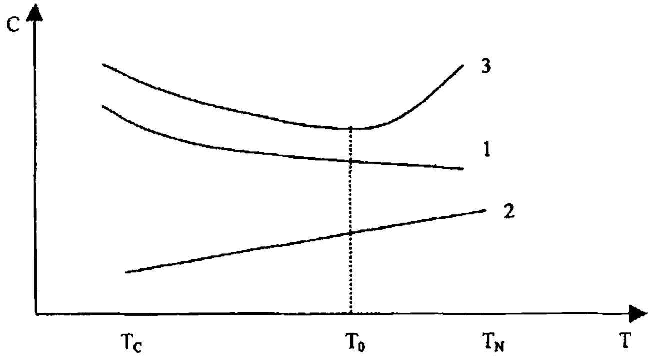


Fig. 79.5 Duration – cost curve

2. *Time cost optimization*

   Time cost optimization method, also known as cost-optimization method, it is the shortest time arrangement when seeking the lowest cost or according to the requirements of time limits for a project to seek the lowest cost.

   The total cost of the construction project consists of the direct and indirect costs. The direct costs increase with the shortening of the duration and indirect costs are reduced with the shorter duration. So, there must be a least total cost of the project. This is the target which the time cost optimization method to search for. The above is in Fig. 79.5

79.5 Conclusion

This thesis studies the management of construction project cost in the mode of bill of quantities, however, due to time constraints and difficulty of research, it should be noted that the contents of this paper is preliminary, there are many problems need to be further deepen and research.

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Chapter 80
Design of Safety Exit Route of Public Buildings

Fuliang Guo, Gui Fu, Chanlong Luo, and Yan Gao

Abstract Fire disaster will lead to heavy property loss and casualties. The safety exit routes shall be arranged rationally. A lot of the exit routes in the Chinese public and residence buildings are not reasonable, which would cause the increase of casualties. In this study, the feasible design theory and principles of the safety exit routes in the public buildings were discussed, and numerical simulation on a university office building in Beijing was performed. Some suggestions were put forth to scientifically design the exit routes.

Keywords Design • Exit route • Fire accident • Simulation

80.1 Introduction

In case of fire accident, selecting proper exit routes is very important to avoid heavy casualty. In 2008, Wenchuan Earthquake caused 69,227 fatalities, 374,643 injuries and 17,923 missing [1]. Although the Sangzao Middle School is near to Wenchuan

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_80,

County, there is no casualty in this school. All of 2,200 students and 100 teachers of the school were safely evacuated to the playground from different office buildings and classrooms, The escaping time just spent 196 s. This is beneficial to emergent evacuation rehearsal done every semester since 2005.

In high-rise public buildings such as office and classroom, their functions are diversified and traffic routes complicated. In case of fire, the consequence is beyond imagination. Due the particularity of high-rise buildings, the design of safety evacuation is very important.

In China, the design of the exit routes is done generally according to the shortest distance principle. A lot of evacuation models based on application features, people behavior and physical space have developed [2, 3]. In this study, the design principles for exit routes are addressed, and numerical simulation to determine suitable evacuation routes for an office building of a university in Beijing are introduced.

80.2 Design Principles of Exit Routes

For high rise public buildings, the design of exit routes shall be performed in accordance with the following principles:

1. In consideration of the peoples lacking the ability to think about evacuation methods and time limit in emergent evacuation, exit routes should be concise and easy to distinguish. Also, clear and eye-catching evacuation marks should be installed;
2. Exit routes generally consist of four stages: (1) from the fire-catching room to the gate, (2) the public passage, (3) evacuation in the staircases, and (4) evacuation from the staircases to safety places. The four stages shall be safe in each stage and avoid reverse flow.
3. In emergency, the people get used to pass their familiar routes, the location of evacuation staircase shall be arranged close to the elevator hoist way frequently used, making the frequently used routes perfectly combine with the evacuation routes. In addition, obvious marks should be employed to guide the peoples to the exit routes;
4. The exit routes and rescue routes shall not cross each other to avoid mutual interference. It is inappropriate for the evacuation staircase to share the anteroom with fire elevator, because such sharing will cause collision of evacuated people with the rescue personnel, and hinder safe evacuation and fire rescue;
5. Evacuation path should not be arranged in “S” or “U” shape, that is not unblocked, nor is plane with variable width available. Above the path there should be no projecting objects impeding safe evacuation, and on the bottom there should be no steps that suddenly change the ground altitude;
6. At any place within a building, it is better to have two or more evacuation directions at the same time. The bag shape evacuation path shall be avoided,

because such shape path has only one evacuation direction. Once the evacuation exit is blocked by smoke and fire, the people in the evacuation path are hard to escape safely;

7. Various safety evacuation facilities shall be reasonably set up, and the quantity, location and type shall be determined properly. Their fire partition, staircase width and other structures should meet the requirements in the relevant criteria, so that their roles are well played in case of fire, and the safety of the evacuated people is guaranteed [4].
8. Generally, the available safe evacuation time shall be longer than the required safe evacuation time comprising detection time, preparation time for movement and movement time.

80.3 Numerical Simulation of Exit Routes

Presently, the software for simulating exit routes includes STEPS, Building exodus, and Simulex. Compared with other software, Simulex can simulate the complicated buildings with geometrical shape, multiple stories and staircases, and it can read the files generated by CAD [5]. The architectural diagrams of the building are input to Simulex, and it will depict the exit route for each room.

In this study, Simulex was selected to simulate the exit routes of the office building of a university in Beijing. The 18 stories office building has complicated structures as shown on Fig. 80.1. If the persons in the building are unfamiliar with the exit routes, they would encounter obstacles in case of fire.

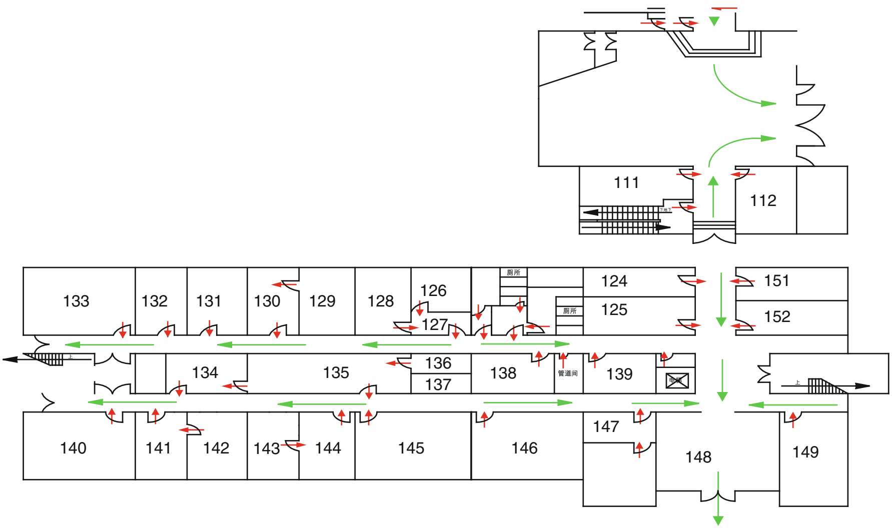

Fig. 80.1 Part of the exit routes on first floor of the office building at a university in Beijing

The simulation is stored in standard 2D DXF file format for the plan of each floor of the office building pre-drawn by CAD. Before the DXF files are transferred to the simulation software, the information other than the transferred information on the building walls must be deleted. In the original CAD building plan, the rotation lines like doors, text contents and other lines irrelevant with the simulation were deleted beforehand. Otherwise, Simulex will not execute the operation program. After the graphics are input, click “adds Exit” in “building” option, relevant parameters for Exit are set, and the Exit is added on the corresponding location according to the location of a real floor. Before evacuation simulation, the parameters are set, including the number of persons in each room of the building and individual attributes, etc. Then click for simulation. At this time, small guys composed of three circles will exactly simulate the actual escape process. The guys will choose and run towards the nearest exit. The direction of their running to the exit is just the direction we need to determine. Simulex simulated some psychological aspects, including the time of the peoples’ exit selection and alarm response.

The results simulated by Simulex can be only used to determine a relatively reasonable evacuation route. In order to design more scientific exit routes, further improvement is needed by means of site evacuation tests and statistical analysis on the basis of simulation results.

All the persons in the building should conduct rehearsal according to the predetermined rehearsal plan. The evacuation staircases are the second safe areas in the safe evacuation system. In order to guarantee rapid and safe evacuation in case of fire, the sundries on the evacuation staircases at different evacuation directions should be cleaned up. In the design of exit routes, consideration should be given to avoid confusion due to mass congestion in case of fire. The people flow should be evenly scattered, letting them escape from many exits. Four exits are available in the building, and each exit is provided with a staircase. In the rehearsal, escape must be done according to the predetermined routes. Try to be quick but in order, making them run to the designated exit and arrive at the gathering place.

People evacuation can be quantitatively represented as three basic attributes: density, flow and speed. Density means the number of peoples on a unit path area, also represented by per capita occupancy area, 0.5 m^2/person; speed only simply means the walking speed in unit time, for example, 1.0 m/s; flow means the number of peoples passing a given point, for example, 2.0 persons/s, generally used in the scenario where speed or movement has been determined. The flow can be represented as the product of density, speed and the path width.

When the building is constructed, the width of each staircase will be designed consistently. Therefore, the flow on the staircase depends on the people density and movement speed. Suitable exit route allows the people at all exits to escape almost at the same time during the rehearsal. Full-time persons are appointed to make records at the four exits for the time and the number of passing peoples during the rehearsal.

Figure 80.2 shows the relationship of the flow with time for same staircase width. It can be seen from Fig. 80.2 that, the people flow at the first exit is obviously more than that at other exits. Since all the staircase widths are same, this

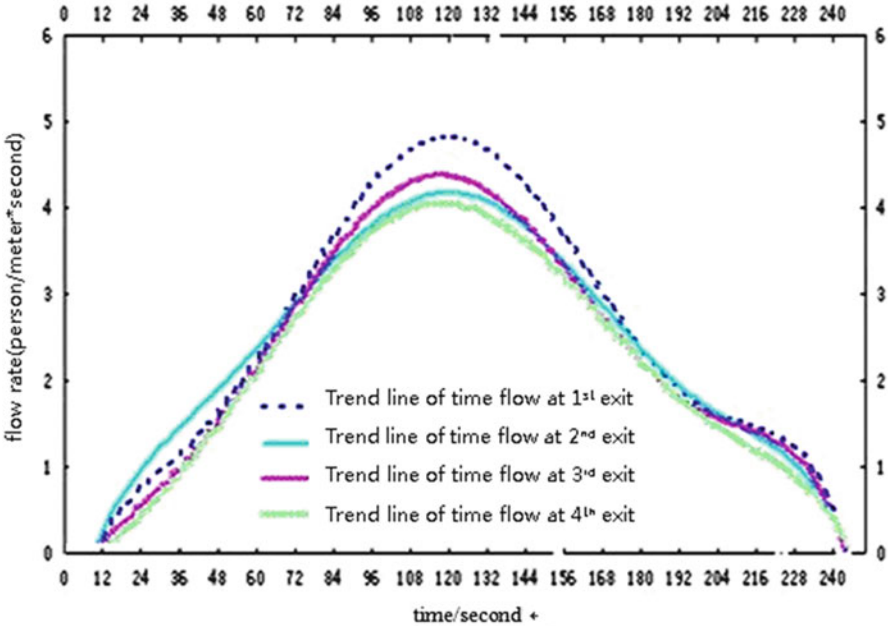

Fig. 80.2 Trend line of people flow with time at each exit on first floor

phenomenon may result from more peoples being evacuated to the first exit, and leading to larger density, or may be because of different movement speeds resulting from the differences in their physical constitution. Therefore, the evacuation routes should be further improved by re-marking the exit routes of some rooms. While frequent rehearsals and continuous improvement of exit routes are made, the exit routes in the building will be more scientific, safe and perfect. In case of an emergency, the peoples will escape according to the predetermined exit routes. Thus, the peoples in the building can run to the safe place before the fire threatens the people's safety and casualty and property loss can be diminished.

80.4 Conclusions

This design principles of the exit routes are discussed, and evacuation model with evacuation rehearsal are used to simulate the exit routes of a office building at an university in Beijing. In such designs, the influence of smoke flow, temperature and concentration on the people evacuation is not taken into consideration, the peoples will not escape strictly according to the designed routes in case of faster flame spread, and so the designed routes are the shortest routes, instead of the optimized routes. In the event of fire, if unexpected circumstance happens when indoor persons are escaping according to the designed routes, they have to escape by adhering to the site commander or specific conditions. The peoples can pay attention to evacuation marks and exits during the evacuation, and escape according to the predetermined routes. They can survive quickly but in order in case of emergency, and run to the exit and the designated gathering place. And the routes are improved through regular rehearsal. The design targets at the places where indoor peoples are unchanged, such as the office building of school, enterprise or institution.

In a word, the design of the exit routes in a building is a complicated system project. When safety design is made for it, both subjective factors and objective environmental conditions should be taken into account.

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Chapter 81
Construction Safety Management Related Dominant Issues in the Construction Sector of Pakistan

M. Haseeb, Xinhai Lu, and Aneesa Bibi

Abstract Around 67 % population of Pakistan is in rural areas, where almost all houses and buildings are constructed without safety codes and regulations. There are legislative codes and safety regulations regarding construction of buildings, but these codes and regulations are not implemented or negligibly implemented. All related parties are involved in the safety management, but the contractor plays most important role in construction safety. Incentive factors, personnel factors, policy factors, and construction site are affected by the process safety factors and dealing with these factors is very important. Safety performance is determined by organizational environment, safety management and safety conditions of the construction site. Safety culture refers to the human behavior, perceptions, attitudes and practices regarding safety at the construction workplace. The construction safety is also linked to safety planning, designing and decision making. We mentioned some principles and guidelines for building design, construction management and safety management. Safety management system is developed to ensure the site safety and to control risks. Some requirements regarding the building structural elements and construction materials ensure the safety, durability and stability of the building structures. The safety of the site is ensured by better safety performance, effective safety management and quality assurance system.

Keywords Construction safety • Safety culture • Safety regulations • Human behavior • Safety standards • Foundation • Wall • Mortar • Joint

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_81,

81.1 Introduction

Pakistan is a country having around 67 % population living in rural areas, but recently urban population is increasing due to development and modern trends. In rural areas, most of the buildings and house are non-engineered or negligibly engineered. The buildings and their situation on the ground do not show the existence of building controlling authorities, civil authorities, organizations and regulatory authorities. The negligible existence of these authorities leaded to the informal construction practices, procurement of materials and standardization of low standards Ali [1]. Contractor's role is more important in safety management practices and they need to implement an adequate safety system to counter risks Niskanen [2]. Working environment can be controlled by the successful safety management system implementation and to lessen or eliminate the fatalities like injuries, deaths, damages etc Levitt and Samelson [3]. Safety culture includes the human behavior, attitudes, perception and practices Dedobbeleer and Beland [4]. The safety management system and safety planning ensure the construction site safety and building safety.

81.2 Literature Review

In developing world, less and incomplete statistics are available on the intensity and level or fatalities and risks, but it is assumed from the legislations, regulations and hazard awareness that there are many safety issues and problems in developing world Koehn et al. [5]. There is limited legislation regarding safety issues in some countries of developing world and there are rare or less provisions about safety conditions and environment at construction work places Mattila et al. [6]. In many countries of developing world, the legislation and provisions regarding safety issues exist but the regulatory authorities are non-existent or poor in implementing the safety regulations on construction sites and projects Lee and Halpin [7].

Mostly the hazards and risks are not well perceived Larcher and Sohail [8]. The selection of subcontractors with good safety record and better history of safety performance is also important for the success and safety concerns of the construction project Sikes et al. [9] and Bertagnoli [10]. It is the responsibility of prime contractor for selection and performance of subcontractors to ensure overall safety of the project and to ensure uniform and consistent safety policies and procedures implemented.

The checking of safety performance is required for faster improvement Krause et al. [11]. An integrated approached involving collection of information, problem identification, preventive actions, safety efforts and making improvements is useful Krause et al. [11].

The safety policies and regulations affects the safety level of construction site and these regulations and policies make up a framework to regulate and control the safety issues Salminen et al. [12]. The lack of effective safety policies leads to poor safety performance and also the lack of proper effective enforcement of these safety policies and regulations affects the construction safety Bishop [13]. The construction firms should recognize and ensure the requirements of safety assessment scheme (OHSAS) and occupational health. OHSAS leads to safety awareness, improvement in safety standards and promotion of safe construction practices Bishop [13]. Process factors refer to the safety related concerns of constructions works carried out by working personnel. The effectiveness of management and control over's diversified activities by different subcontractors and working personnel Mohamed Sherif [14]. Different safety standards and procedures are needed for different construction phases and methods.

81.2.1 Safety Culture

The safety related values are reflected by the safety culture, perceptions and attitudes of workers and staff and safety culture also describes the safety management Mearns et al. [15]. Organizational environment, safety management and safety conditions are linked in a presented model Thompson et al. [24]. Safety performance model and safety behavior model are presented Maloney and Smith [16]. The organizational culture affects workers behavior and attitude towards safety and safety performance Mohamed [17] Selection and evaluation of measures management, operations, and learning and customer perspectives in construction environments leads to the improvements in safety performance Mohamed [17]. The actions towards risks and their prevention are guided by experiences and interpretations of safety and work Richter and Koch [18]. Safety culture is described as the combination of safety values, attitudes and practices which make up the safety climate. The description of safety culture elements such as reporting, teamwork, commitment, responsibility, involvement and communications is shown below in the Fig. 81.1.

81.2.2 Safety Regulations and Construction Management

Health and safety regulations are present in legal law framework and building construction codes. But these regulations and codes are less or negligibly implemented on the field or construction sites Ali [1]. The fundamental principles of building design and construction management are shown in the Fig. 81.2 below.

The building design and construction management regulations and codes incorporate the safety and safety management measures in the design of buildings and planning of construction work. Not just the contractor, all parties have the responsibility for safety measures and management of and during the construction work Hinze and Rabound [19].

Fig. 81.1 Safety culture element

Fig. 81.2 Fundamental principles of construction management and building design

Fig. 81.3 Safety management stages

81.2.3 Safety Planning and Safety Management System

Safety advisors mostly provide formatted or generic risk assessments focusing on duties of contractors according to the building and construction regulations and codes. A safety management system should be developed for controlling risk Jannadi and Almishari [20]. The safety system should be at all levels and there should be understanding for the better safety performance. A better safety system is developed from various informal and formal communication, information and experiences Loosemore et al. [21]. The stages of safety management process in organization are shown above in Fig. 81.3.

The safety, stability and durability of the buildings are ensured by taking into account some requirements which are as follows:

81.3 Foundation

The foundation should be adequate and according to the safety standards. The foundation should be around 2–3 ft wide and around 4–5 ft deep. In foundation, iron sheet and rods are used in addition to stones/bricks with cement mortar. Large metal bolts embedded in the outside perimeter of concrete foundations of building structures are known as anchor bolts of foundation European foundation for the improvement of living and working conditions [22]. The depressions in the outside perimeter of building structure at the brick locations are known as brick ledges of foundation. The steel rods in grade beams and footings of concrete in foundation are referred to as rebar of foundation. The process of back filling is used for providing support to the wall or form Armstrong [23]. Pre-bent rebar pieces are used to bind regular rebar for forming specific shape are called stirrups. The floor drains are used in wet or possible wet areas and metal grate cover is used to cover floor drains to control water drain. Soil moisture is very important factor in determination of compaction rate.

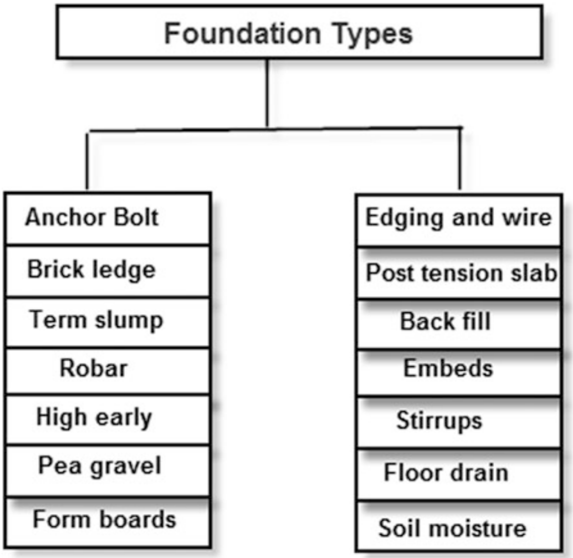

Fig. 81.4 Different type of foundation

Concrete and concrete slabs are most common materials for foundation. Footing is the lowest part of the building located below frost line at depth of 12 in. or more and is wider than the foundation wall and upper parts. The footing prevents the movement or settling of the building by distributing the weight of the building. There are three types of concrete foundation known as concrete blocks, poured concrete and concrete piers. Concrete blocks are used in construction of standard foundation wall and they are supported by concrete footings reinforced with steel rods and blocks filled with grout. A raised perimeter, flat slabs or combination of these two is referred to as poured concrete foundation (Fig. 81.4).

81.3.1 Bricks/Stones

It is recommended that the bricks/stone walls should have more strength and should be more resistant. A thick full brick/stone construction performs much better than the thick half brick/stone construction. The stone/bricks should be well joined with each other. There are two types of clay bricks: wire cut bricks and pressed bricks. Wire cut brick's 25 % of the volume is constituted of 3–4 holes or some preformatted wire cut bricks have many smaller holes constituting 25 % of the total volume. Pressed bricks have a shallow frog in one bedding surface and have a deep frog in other bedding surface. The wire cut and pressed bricks are used in three ways

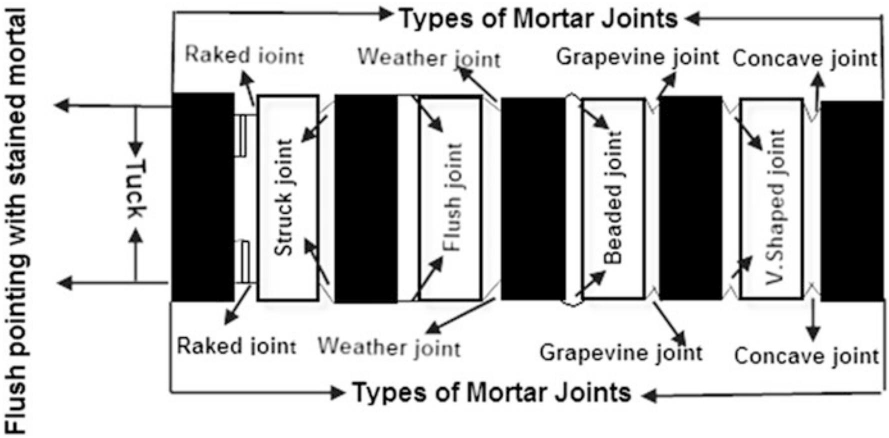

Fig. 81.5 Mortar joints usage and types

81.3.2 Mortar

Mortar is also very important as it joins together the bricks/stones in the walls and it is also exposed like bricks/stones. Mortar is a mixture made up of cement, sand, lime and some other mixing materials mixed with adequate water. Mortar provides various architectural appearances and weather resistance. Tooled mortar joints perform better than mortar joint ledges for exterior applications controlling moisture.

Mortar between bricks is called pointing. The pointing should be well resistant to different weather conditions like sun, rain and frost. V-shaped and concave mortar joints show good performance against water penetration (Fig. 81.5).

81.3.3 Damp Proof Course DPCs

To avoid the water and moisture, there are some barriers used which are known as DPCs. DPCs particularly high bond bitumen polymer have the ability to adhere with the mortar. The causes, effects and prevention of dampness through using damp proof courses (DPCs) are shown below Fig. 81.6.

81.3.4 Fillers

By little pressure between thumb and finger, the fillers are needed to be compressible and when released these fillers must change back to their original shape and thickness. The best fillers are the cellular polyurethane and polyethylene because they compress easily and expand back to normal shape and thickness when released.

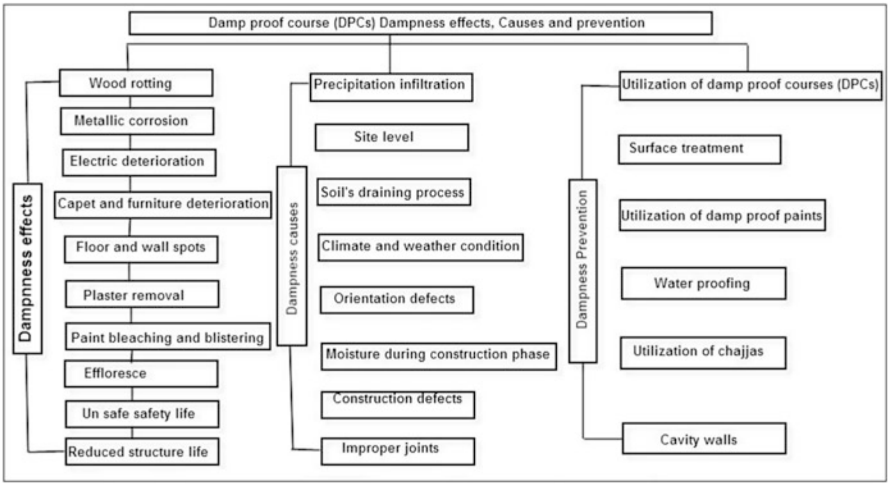

Fig. 81.6 Causes, effects and prevention of dampness through damp proof

10 × 10 mm space is needed for sealant which is provided by the installed fillers with brickwork/stonework with a space of 10 mm in between. Polysulfide is better sealant to be used.

81.3.5 Piers

Piers are required to be incorporated at the endings of walls to ensure the long term stability and safety. One case of higher walls of more than 1.5 m height, stiffening piers are required along the length of the walls.

81.3.6 Joints

Due to moisture and temperature changes, the buildings materials and parts can move. Expansion or movement joints are required in the walls at 6 m spacing maximum and 3 m spacing maximum from direction change or from corner. These joints are required to start from foundation level and continue through. The adequate width of this joint is approximately 10 mm. There are three types of joints know as construction joints, isolation joints and control joints, which are as follows:

Construction Joints

Construction joints are made where structural element is placed against concrete and at the end of concrete operations. Dowels or keys are used in these joints to allow the transfer of load from structural element to other structural element. Construction joints extend through entire concrete element or structure. The different types and usage of construction joints is shown below Fig. 81.7.

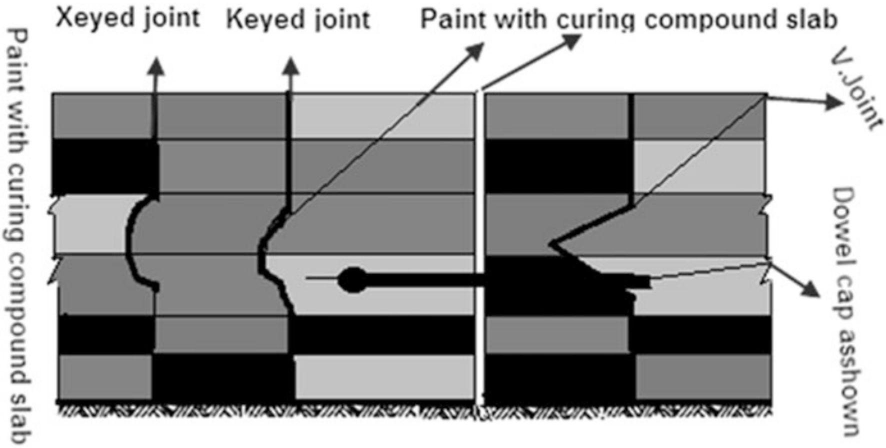

Fig. 81.7 Construction joints

Isolation Joints

Isolation joints are used for separation of adjacent structural members. Differential movements are allowed by these joints, so they are also known as expansion joints or contraction joints. These isolation joints extend entirely through structural members. The isolation joints and their usage in structural members are shown below.

Control Joints

Control joints are made into concrete slabs for creating a weak plane to force cracking to happen at designated places instead at random places. These joints run at right angles and in both directions. Control joints are filled with joint filler and they are one fourth or one third of the slab thickness. The control joints used in the walls are show below.

81.4 Conclusion

Safety management and other safety concerns are very important in construction industry. There are legislative codes and regulations regarding safety issues in construction sector, which are still not well implemented in developing world. The construction site safety is affected by the factors such as policy factors, personnel factors, incentive factors and process factors. Safety related values, attitudes, perceptions and practices of workers and other working staff reflects the safety culture and describes the safety management also. The field or construction site safety is also very important and safer construction needs better skilled field workers, supervisors and professionals. The safety, stability and durability of the buildings is ensured by constructing according to the safety standards. Foundations, walls, brickwork, mortar, DPCs, construction joints etc are the important parts of the construction sector and they need to be according to building codes and safety regulations.

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Chapter 82
Identification of Major Duration Delay Risks in Infrastructure Projects: Viewpoints from Different Stakeholders

Jiayuan Wang and Hongping Yuan

Abstract Effective risk management is regarded as a key factor to ensure the successful implementation of infrastructure projects. However, previous literature shows that how various stakeholders perceive duration risks in infrastructure projects in China is lacking. Thus, this study aims to identify major duration risks in infrastructure projects and make a comparison of various stakeholders' views toward these risks. With the aid of literature review and questionnaire survey, 15 major duration risks are identified and analyzed. The results demonstrates that contractors shall take main initiative in managing duration risks. Further, there is a consensus among different stakeholders that major duration risks include "F04 Construction change by clients", "F05 Late monthly payment", "F15 Unreasonable schedule plan", and "F12 Design changes". These findings would be useful for deepening the understanding of duration risks in Chinese infrastructure projects.

Keywords Duration delay • Risk management • Infrastructure project • Project stakeholder

82.1 Introduction

Construction projects are comprised of a series of one-off construction activities. Besides, the long period construction process generally involves different project stakeholders and can encounter numerous uncertainties. All these factors have been regarded as significant for causing the construction projects being exposed to

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_82, © Springer-Verlag Berlin Heidelberg 2014

various risks. Once happening, project risks will affect major objectives of construction projects, including project duration, cost, quality and safety, in a number of ways. Thus there is a pressing need to reduce, control, transfer and manage project risks so that the regular construction activities can be implemented as they are planed [1, 2]. The effective management of risks can be even more important for infrastructure projects considering that infrastructure projects would involve more participants and generally have lager investments than normal construction projects [3].

Since the 1950s, a set of risk management techniques and tools have been developed in the construction management discipline with an ultimate aim to create added value to the industry through enhancing the overall efficiency of construction activities. For example, Akintoye and Macleod [1], Shen [4], Kangari [5], Lyons and Skitmore [6], Skorupka [7] investigated the status-quo risk management practices and research in the UK, Hong Kong, USA, Australia, and Poland, respectively. Their studies concern issues including how major project stakeholders perceive project risks, as well as how different risk management techniques and tools have been effectively utilized in their specific regions. However, up-to-date literature determined that an investigation into the duration delay risks associated with infrastructure projects in China are not well conducted; particularly studies focusing on a comparison of viewpoints about duration delay risks of different project stakeholders in infrastructure projects is lacking. In this regard, this article aims to identify major duration delay risks by considering the viewpoints of different project stakeholders mainly including designers, engineers, clients and contractors.

82.2 Research Methodology

A hybrid research methodology is applied in this study to collect research data. Firstly, a thorough review of related literature is carried out to form a list of potential risks that can affect infrastructure project duration. Secondly, the potential risk list is modified based on a further review of studies concentrating on construction project risk management in China. The reviewed literature includes Sun [8] identifying the safety risks in Beijing Olympics projects, Wang [9] analyzing the risks facing joint ventures when undertaking international construction projects, and Yuan et al. [10] examining the critical major risks when implementing public-private partnership projects in China. This research activity results in 47 risks been identified, encompassing eight risks associated with project clients, four risks related to designers, 23 risks related to contractors, three risks associated with sub-contractors, four risks associated with the local government, and the other five risks in relation to the external environment. Thirdly, a questionnaire is developed in line with the above 47 risks identified. The questionnaire is divided into two major section. The first section collects the general background of the respondents such as their working experience, education level and their specific roles in the projects. In the second section, each respondent is requested to justify the possibility of occurrence of the risk and its influence on the project duration. Both the possibility of occurrence of each risk and its influence on the project duration are measured by a three Likert scale. Specifically, when measuring the possibility of occurrence of each risk, one means low possibility of occurrence while three means high possibility of occurrence. Similarly, when quantifying the influence of a specific risk on project duration, one indicates a low influence while three indicates a high influence.

Based on the survey results, a Risk Importance Index (RII) is calculated for each risk under study. The RII is computed in line with the following formula:

$$S_{ij} = \alpha_{ij}\beta_{ij} \tag{82.1}$$

Where S_{ij} is the perceived importance of risk i's influence on the project duration provided by respondent j; α_{ij} means the perceived possibility of occurrence of risk i provided by respondent j; β_{ij} indicates the perceived risk influence on project duration when risk i happens provided by respondent j. By following the above rules, the RII for each project risk identified can be quantified and analyzed.

82.3 Results Analysis and Discussions

The questionnaire is administrated randomly among clients, contractors, designers, engineers and related government staff and all respondents selected shall have eminent experience and good understanding about the potential risks when undertaking infrastructure projects in China. A total of 60 questionnaires are sent out and 32 valid responses are obtained, reflecting a valid rate of 53 %. Among the respondents, approximate 91 % of them have more than 5-year working experience in participating in construction engineering project management and evaluation. Table 82.1 tabulates the 15 most important risks as perceived by major stakeholders involved in infrastructure projects in China. The identified risks are ranked under two main categories, with one group been evaluated by consultant (i.e. designers and engineers) while the other been judged by contractors.

It is evident from Table 82.1 that among the 15 most critical project duration risks, risks associated with constructors (including sub-contractors) account for the majority (53 % and 47 %, respectively) as regarded by the two stakeholder groups. This is because the contractor is the primary stakeholder who are in charge of the implementation of construction activities and thereby participating in the longest process of infrastructure construction as compared with other stakeholders. Along with the project proceeds, the occurrence of any uncertainties or changes in the internal and external environment would affect the project duration and the contractor have to respond to such uncertainties or changes. Therefore, the contractor-related risks are

Table 82.1 The RIIs for the 15 most important risks affecting infrastructure project duration

Risks perceived by consultants (designers and engineers)	RII	Risks perceived by contractors	RII
F04 Construction change by clients	0.591	F12 Design changes	0.500
F05 Late monthly payment	0.584	F15 Unreasonable schedule plan	0.495
F15 Unreasonable schedule plan	0.540	F19 Difficult claimant for contractors from the clients	0.398
F12 Design changes	0.538	F05 Late monthly payment	0.391
F19 Difficult claimant for contractors from the clients	0.534	F04 Construction change by clients	0.372
F07 Over-tight project schedule	0.473	F36 Breaking or low compliance with the contract	0.328
F24 Poor project management	0.464	F41 Complicated governmental examine-approve procedure	0.326
F45 Unexpected rise of material fee	0.426	F10 Inaccurate site investigation information	0.321
F41 Complicated governmental examine-approve procedure	0.419	F47 Unpredicted condition of engineering geology	0.313
F23 Lack of skillful labor force	0.413	F16 Change in construction scheme	0.295
F17 Imperfect site construction conditions	0.398	F22 Low efficiency of labor force	0.287
F27 Lack of professional or management staff	0.395	F37 Poor management capacity of sub-contractors	0.287
F38 Delay in material supply	0.395	F08 Poor communications among different parties	0.285
F39 Government bureaucracy	0.360	F23 Lack of skillful labor force	0.285
F36 Breaking or low compliance with the contract	0.350	F20 Dispute due to conflicting contract items	0.276

significant for affecting the overall project duration according to viewpoints from major stakeholders.

It can also be observed from the Table that when being requested to evaluate the same duration risk, the RII value by the contractor is generally lower than that given by the consultant. This can be attributable to various reasons but a notable one is that many Chinese contractors do not have a serious attitude toward risk identification and management in their projects. In most circumstances, the contractor grows up gradually from small labor contractors or sub-contractors which are equipped with poorer capacities in handling project risks. Additionally, although various project risk prevention and management techniques and tools have been developed in the past decade, how to apply these techniques and tools effectively in construction management practices is still an issue awaiting further investigation, and thereby a mature system for project risk management has yet been formulated.

The two project risks including “F04 Construction change by clients” and “F05 Late monthly payment” are regarded as critical by both the consultant and contractor, demonstrating their significance to the project duration. Further analyses show that if the two risks happen at the same time, the negative effects caused by the risks can be reinforced and eventually the project duration delay will be amplified.

Particularly, when the client encounters a lack of cash for payment, the planned project tasks will be delayed due to the late monthly payment. If the client proposes any project change at this point, the project scope or tasks will be widened. In such a circumstance, the widened project task will amplify the duration delay.

"F12 Design changes" is perceived as a key risk by the contractor. The occurrence of any design change might affect the successful implementation of construction work along the critical path. In this regard, sufficient and effective communication between the client and designer is critical for bettering satisfying the client's requirements and preventing design changes. Another risk, "F15 Unreasonable schedule plan" might also cause duration delay because under this situation, the contractor will not have the power to adjust the schedule plan to meet the project duration as planned. Furthermore, "F19 Difficult claimant for contractors from the clients" would lead to various conflicts among the client, the contractor and even the supervisory engineer, which affect the regular construction works of the contractors and delay the infrastructure project eventually.

"F41 Complicated governmental examine-approve procedure" has long been perceived as an important risk which not only affect project duration but can also influence other project objectives including cost, quality and safety in China. This duration risk is related to the specific societal context of China and the drawbacks associated with the construction industry mechanism. For several years the Chinese government department has special power in implementing (especially in evaluating and approving) an infrastructure project. Given that either the client or contractor has very little control on such a risk, it is suggested on one hand that the local government should take a leading role to cultivate an improved internal and external environment for public investment, and on the other hand that the client need to well prepare the essential documents for project evaluation and approval at the early stage to avoid any vetting delay.

82.4 Conclusions

Managing infrastructure project risks effectively has been of vital importance to ensure the overall success of the projects. However, the literature shows that research in duration risk of infrastructure projects in China is lacking. This study thus aims to fill the research gap by investigating the major duration risks when implementing infrastructure projects in China, with a particular focus on comparing the viewpoints of different stakeholders toward how different duration risks should be perceived.

The duration risks in this study are identified by using literature review and questionnaire survey with major project stakeholders. Results show that contractors shall take main role in managing duration risks as all surveyed stakeholders believed that the majority of duration risks are related to contractors. Four risks, i.e., "F04 Construction change by clients", "F05 Late monthly payment", "F15

Unreasonable schedule plan", and "F12 Design changes", have been perceived as the most important affecting infrastructure project duration.

These findings can be informative for both industry participants and the local government when they are conceiving of effective measures for dealing with duration risks while implementing infrastructure projects.

Acknowledgments This study was supported by the National Natural Science Foundation of China (71272088).

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Part VI
Construction Innovation and Knowledge Management

Chapter 83
A Study on a New Method for Training Building Work Process Supervisors Through Internships in Japan

Hitoshi Mihara, Takuro Yoshida, and Masato Urae

Abstract The objective of this study is to (1) clarify the current training of building work process supervisors (on-site construction supervisors) at universities and other educational institutions that offer a degree in architecture in Japan, (2) assess the extent to which internship-based training has proliferated among educational institutions and companies such as general contractors, subcontractors, contractors, and home builders that participate in the training by studying the contents and effects of training, (3) gauge how such training has improved the image of the construction industry among the youths who have yet to be employed by a company or become an apprentice, and (4) propose a new internship-based training method and its contents on the basis of the results of the study. The present study was conducted as follows. First, we conducted a survey of educational institutions and companies to determine the extent to which internships at educational institutions, general contractors, subcontractors, contractors, and home builders foster skills applicable to construction sites and help companies develop their human resources in the field. Building on the knowledge gained on the current state of internships, we then analyzed mainly the comments portion of the questionnaire, as well as the contents of the interviews. Based on the results, we then proposed a new internship-based training method and its contents.

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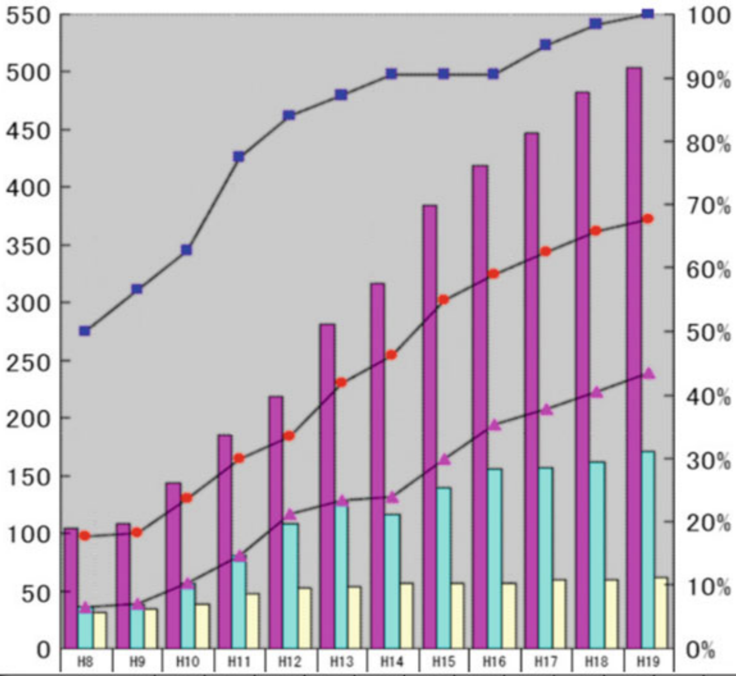
J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_83, © Springer-Verlag Berlin Heidelberg 2014

Keywords Internship • Training of building work process supervisors • General contractors • Subcontractors • Contractors • Home builders

83.1 Introduction

Since the 1996 academic year, the Ministry of Education, Culture, Sports, Science and Technology has been conducting a yearly survey on internships that have been integrated into university curriculums. As of the 2007 academic year, approximately 68 % of universities in Japan offered internships, and that number is increasing (Fig. 83.1).

Furthermore, the academic year in which students participate in internships, the dates, and the durations of those internships are comparable to what had been reported in the previous year, shown as follows (excerpts from "Implementation of Internship Programs at Universities and Other Institutions in 2007") (December 1, 2010). Internships are defined as on-site professional training conducted at companies and



	H8	H9	H10	H11	H12	H13	H14	H15	H16	H17	H18	H19
Universities	104	107	143	186	218	281	317	384	418	447	482	504
Jr. colleges	36	39	57	81	108	127	117	139	155	157	162	170
Tech. colleges	31	35	39	48	52	54	57	57	57	60	60	61
Universities(%)	17.7%	18.3%	23.7%	29.9%	33.5%	41.9%	46.3%	55.0%	59.0%	62.5%	65.8%	67.7%
Jr. colleges(%)	6.4%	7.0%	10.3%	14.7%	21.1%	23.4%	23.9%	29.9%	35.3%	37.8%	40.6%	43.6%
Tech. colleges(%)	50.0%	56.5%	62.9%	77.4%	83.9%	87.1%	90.5%	90.5%	90.5%	95.2%	98.4%	100%

Fig. 83.1 Changes in the percentage of universities, implementing internship programs in 2007

other locations, during which students participate in activities relevant to their majors and career interests. When compiling the data for this research, internships related to qualifications for educational, medical, and nursing licenses were omitted. As discussed above, universities and other institutions that require students to receive credit for professional training are on the rise. However, no investigation has yet been conducted to determine how students who expect to work as construction work process supervisors and architectural professionals exploited internship opportunities, or into the kinds of training and career guidance that are provided by companies accepting student interns. For these reasons, in order to promote future internship programs, it was considered imperative to present the results of surveys and analysis on internships offered by universities with architecture departments and study programs related to four major construction industries (general contractors, subcontractors, home builders, and contractors).

83.2 Survey and Research: Objectives

The objective of this survey and research was to gain a better understanding of the implementation of internship programs at universities with architecture departments, and at companies that are active in the field of architecture. Based on our desire to foster construction work process supervisors and architectural professionals, and to promote the development of the construction industry, this research was conducted to present a set of fundamental documents that would help further promote future internship programs.

1. Subjects of the Survey
   Educational institutions: 229 architecture departments at national, public, and private universities with architecture departments.
   Companies: Four major types of construction industries (general contractors, subcontractors, home builders, and contractors). (Hereafter referred to as "construction industry types"): 723 companies (Table 83.1) and 37 organizations.
2. Method of sampling
   General contractors: Total of 145 member companies of the Japan Federation of Construction Contractors.
   Subcontractors: Total of 370 member companies and 37 member organizations of the Association of Construction Industry Specialists. Subcontractors were chosen by unions and other organizations by asking them to select ten corporations arbitrarily.

Table 83.1 Four major types of construction industries

General contractors	145 companies
Subcontractors	370 companies
Home Builders	188 companies
Contractors	20 companies
Total	723 companies

Contractors: Ranking by prefecture of newly built housing by Nikkei Home Builder's "2011 National Survey of Home Builders". Total of 188 companies ranking in the top four in each of the 47 prefectures

Home builders: Total of 20 major, semi-major, and medium-sized homebuilders

3. Research items

   Names of the faculties, graduate schools, and departments at national, public, and private universities with architecture departments; the names of the majors; the class titles; the academic years in which students participated in internship programs and the numbers of students participating; the internship dates; the internship periods; the types of internship dates, periods, and laboratory affiliations; the employment statuses; the relationships between internships and employment; the statuses upon acceptance of interns by companies, etc.

4. Questionnaire

   Questionnaires: Refer to "Appendices" at the end of the volume.

5. Answer formats

   Multiple-choice and free-answer questions

6. Survey period

   January 20, 2012 to May 10, 2012

   - The date the questionnaires were mailed to universities with architecture departments (first round): January 20, 2012
   - Deadline for the above questionnaires: April 27, 2012
   - The date the letter of request for responses to the questionnaires was sent to universities with architecture departments (second round): April 20, 2012
   - The deadline for the above questionnaires: May 10, 2012
   - The date the questionnaires were mailed to companies (major four construction industries); March 20, 2012
   - Deadline for the above questionnaires: April 27, 2012

7. Survey year

   April 1, 2011 to March 31, 2012

8. Method of distributing and collecting the questionnaires

   The questionnaires were sent by postal mail to the universities and companies. Responses were returned to the Mihara Lab of the Institute of Technologists via postal mail and via online methods (e.g. e-mail). Subcontractors were chosen by unions and other organizations from among the construction industries. Ten subcontractors were chosen arbitrarily, and the questionnaires were distributed through each professional organization.

9. Number of responses (Tables 83.2 and 83.3)
10. Response profiles

    Whether internship programs are in place (Fig. 83.2).

11. Summary of companies that responded

    (a) Type of construction industry (Table 83.4)
    (b) Composition of subcontractors (specialized construction services) (Table 83.5)

Table 83.2 The number of universities with architecture departments that responded and the collection rate

	univ.	responded	collection rate
univ. with architecture departments	229	61	26.60%

Table 83.3 The number of companies from the four major construction industries that responded and the collection rate

Typs	companies	responded	collection rate
General contractors	145	25	17.3%
Subcontractors	370	97	26.2%
Home Builders	188	11	7.5%
Contractors	20	4	20.0%
Total	723	137	18.9%

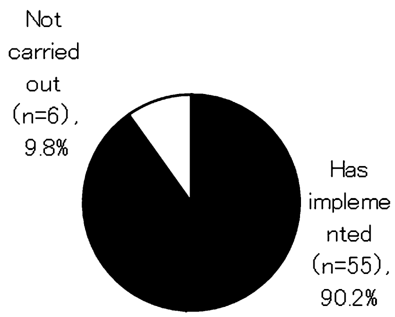


Fig. 83.2 The availability of internship programs

Table 83.4 The number of companies that responded based on the type of construction industry and the ratio

Category	Number	%
General contractors	25	17.9
Subcontractors	97	69.3
Home Builders	14	10.0
Contractors	4	2.9
Total	140	100

Table 83.5 The number of companies that responded according to the type of the specialized construction services and the breakdown

Industry type	Number
Scaffolding and earthwork	5
Plumbing	11
Metal fittings	2
Steel structures	8
Plastering	13
Gardening	24
Reinforcement placing	7
Electronics	1
Carpentry (shuttering carpentry)	14
Waterproofing	7
Special concrete	5
Number of companies responded	97

83.3 The Responses Corresponding to the Question of the Survey

83.3.1 The Academic Year in Which Students Participated in the Internship Programs

Among the universities overall, most students participated in internships during their third year of the undergraduate program (70.9 %), followed by the first (65.5 %) and second (47.3 %) years of the master's program. There were only a few students who participated during the third year of their doctorate program (Fig. 83.3).

83.3.2 The Number of Working Days at an Internship

As shown on Fig. 83.4, over half of the students worked "Approximately between 8–14 days" (60.0 %), followed by "Approximately 4–7 days" (27.3 %) and "15–21 days" (27.3 %). Many students worked somewhere from a week to less than a month. The summary of the "Number of hours" (18.5 %) indicates that the average is 161.8 h.

83.3.3 The Objectives of Participating in Internships

Figure 83.5 shows the objectives of participating in internships. In terms of the objectives of participating in internships, the highest number of universities

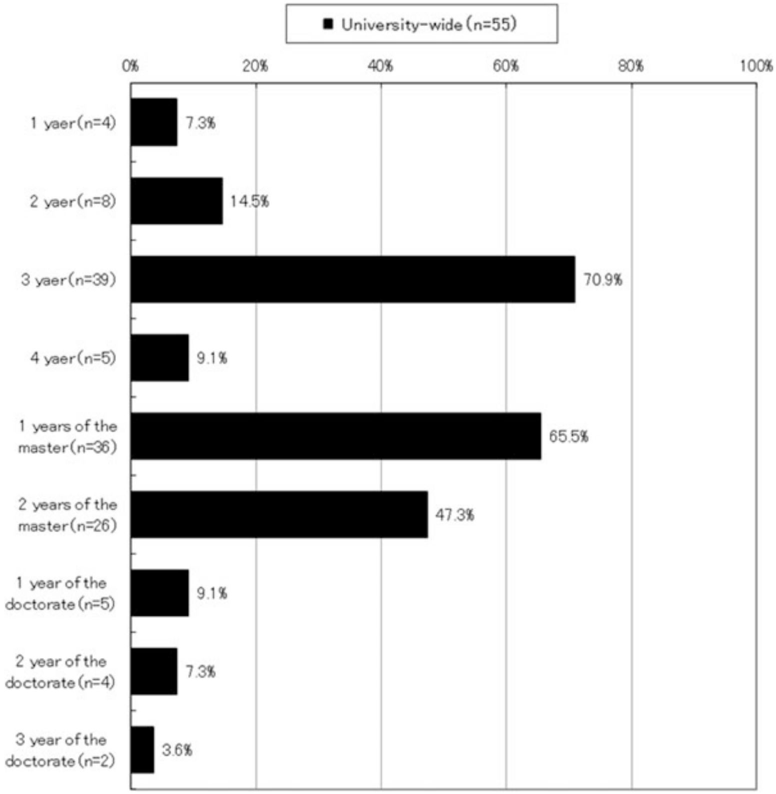


Fig. 83.3 The academic year in which students participated in internships

responded that they sought to allow the students to "Gain experience that cannot be achieved in the classroom" (65.4 %), followed by those that wished to help students "Identify [their] aptitude" (61.5 %), "Build a career opportunity" (55.8 %), and "Understand the realities of today's construction industries" (55.8 %). Many of those that responded "Other" (25.0 %) said the students would gain the professional experience required to qualify for taking the architectural license examination.

83.3.4 Academic Credit Approval for Completing Internships

In terms of approving academic credit for completing internships, most universities (92.5 %) "Approved internships for academic credit." For approval, the number of required working days was 15.0 days on average, for an average of 3.1 credits.

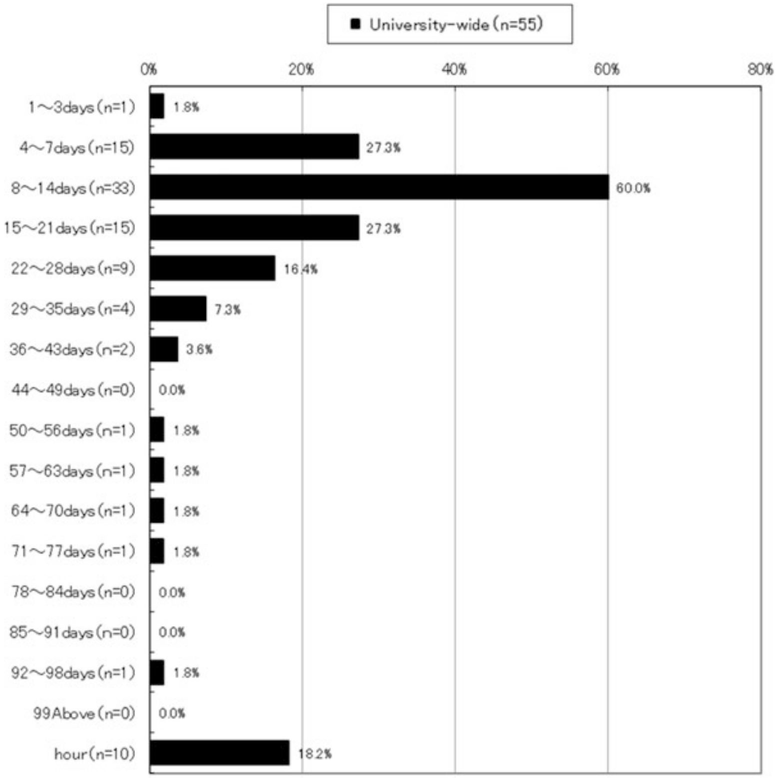


Fig. 83.4 The number of working days at an internship

There were only a few universities that stated they “Did not approve.” Moreover, internships were rarely “Required for graduation,” but “Designated as electives” (79.2 %) (Figs. 83.6, 83.7 and 83.8).

83.3.5 The Employers of Graduates

Figure 83.9 shows in terms of the graduate employment, most were hired in the “Housing industry” (88.0 %), followed by “Design firms” (84.0 %) and “General contractors” (78.0 %).

Figure 83.10 shows in terms of the number of students employed, “General contractors” hired the largest number of graduates at 510 people, which accounted for 20.4 %, or a two-digit average of 10.2 graduates. The “Housing industry,” which was the second highest, hired 325 graduates, accounting for 13.0 % of the total.

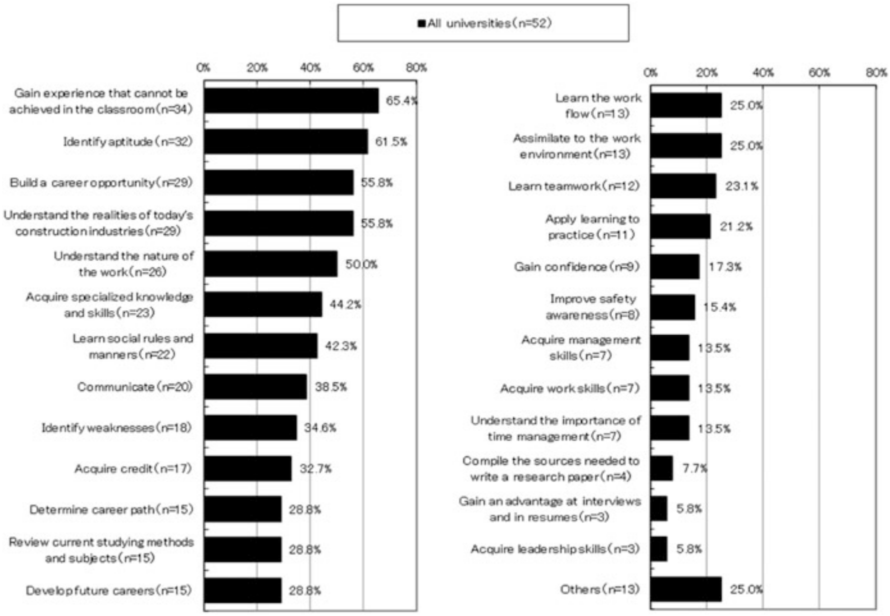


Fig. 83.5 The objectives of participating in internships

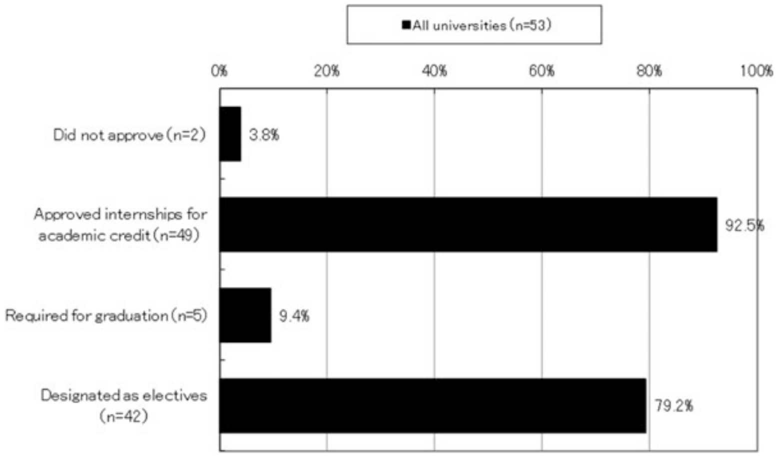


Fig. 83.6 Academic credit approval for completing internships

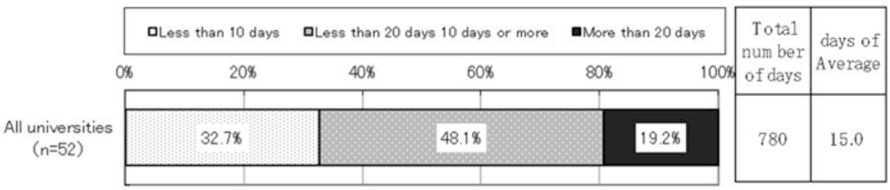


Fig. 83.7 Academic credit approval for completing internships (the number of working days)

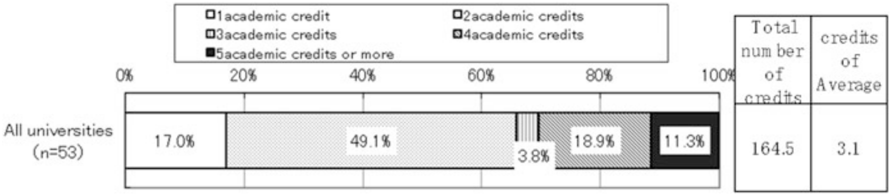


Fig. 83.8 Academic credit approval for completing internships (the number of academic credits)

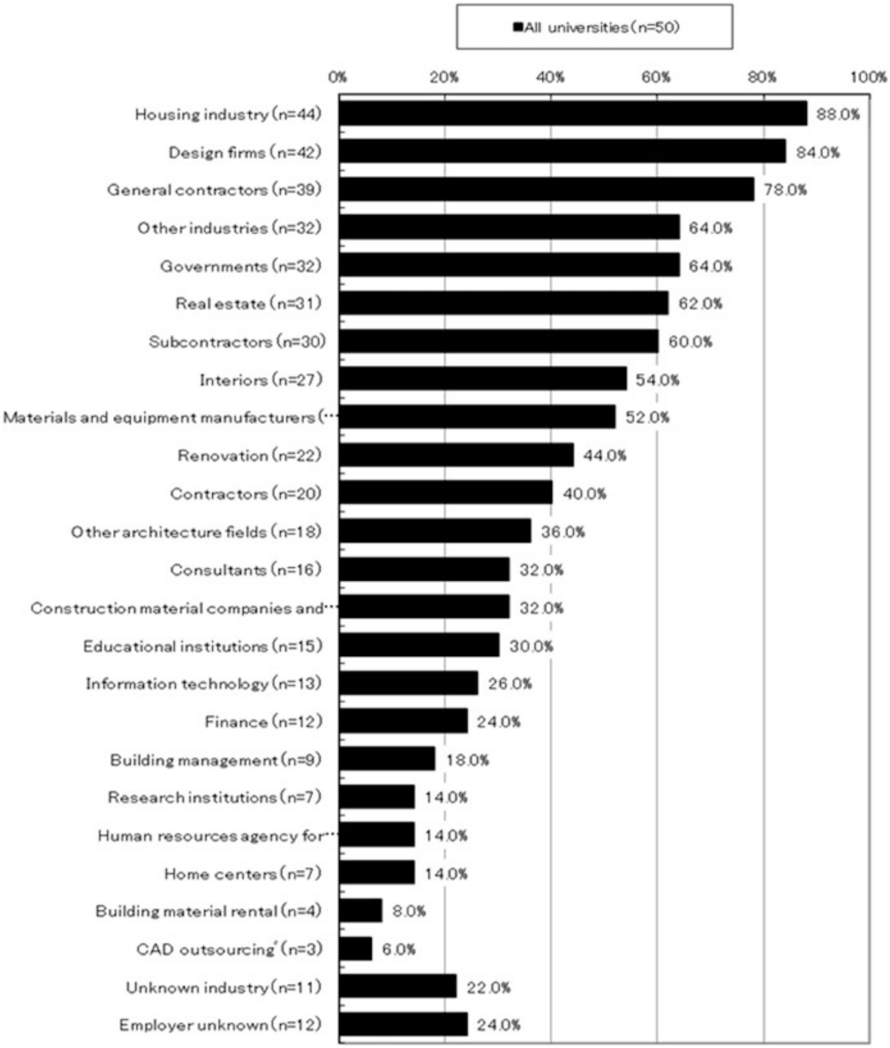


Fig. 83.9 The employers of graduates

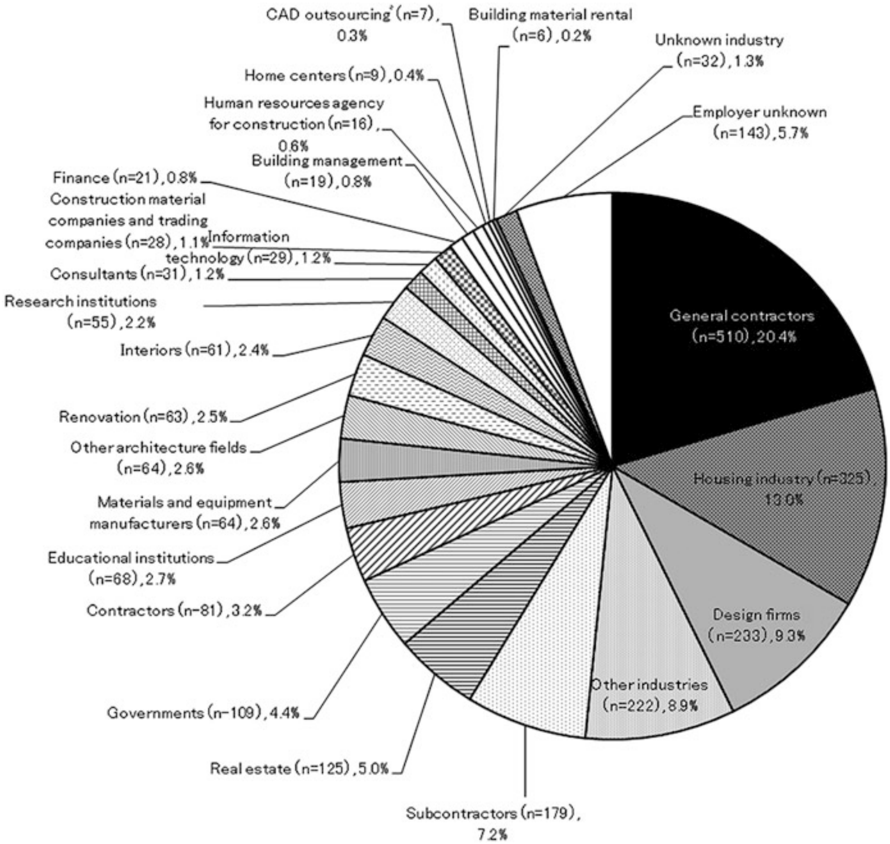


Fig. 83.10 The employers of graduates (ratio)

83.4 Conclusion

Results of the present study are outlined below.

83.4.1 The Significance and Objectives of Accepting Interns

Looking at the universities' objectives in implementing internship programs and their significance to the companies, the top two responses among the companies were that they "Can make a social contribution in helping the young determine their career paths and aptitudes" (83.1 %), and they "Can provide opportunities that help students determine their career paths" (79.5 %). The responses varied widely

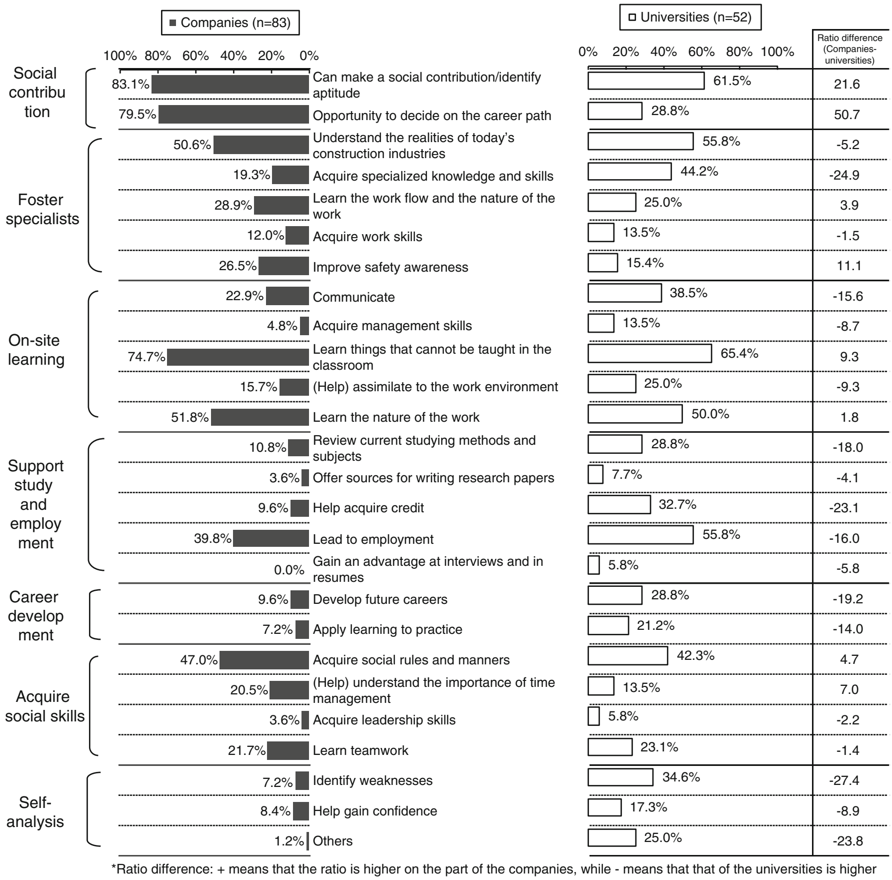


Fig. 83.11 The significance and objectives of accepting intern

between the universities and the companies. The results confirmed that the companies strongly considered accepting interns to be making a social contribution. Meanwhile, the universities expect the internship programs to "Lead to employment" (55.8 %) and expect the programs to support the students' job search. Furthermore, the objectives that the universities have in mind are for students to "Acquire specialized knowledge and skills" (44.2 %), "Identify areas for improvement" (34.6 %), and others goals that seek to foster the development of specialists and encourage self-analysis.

Meanwhile, the companies placed less emphasis on the development of specialists and self-growth. Additionally, the effect of internships on employment was on the lower side (38.9 %), indicating that company expectations were low. While some companies accept interns with the objective of making a social contribution, it was confirmed that the internships did not lead to the actual employment levels the universities expected (Fig. 83.11).

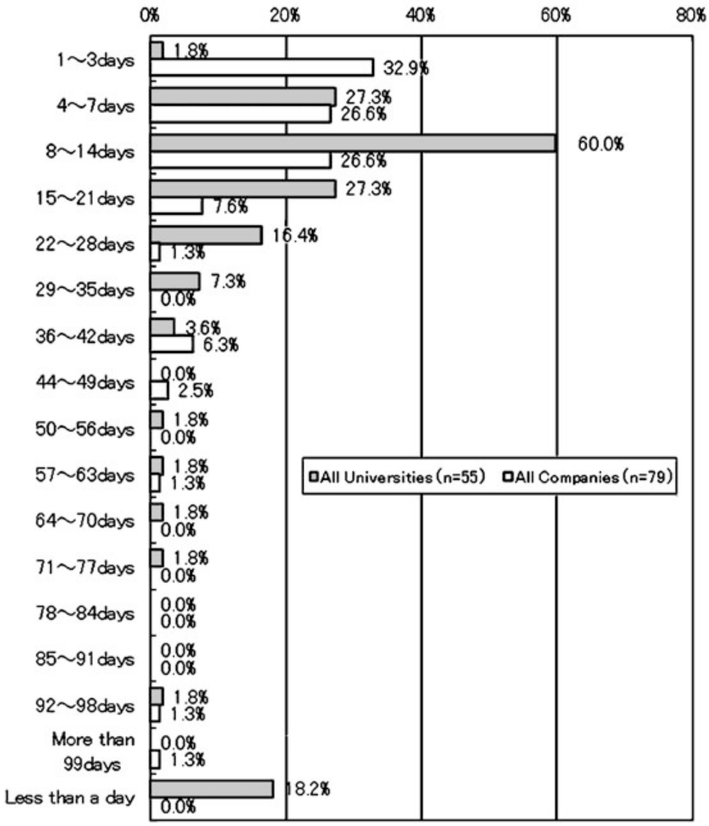


Fig. 83.12 The number of internship days

83.4.2 The Number of Working Days at an Internship

Regarding the number of working days at an internship, at universities, 60 % of interns spent around 8–14 days, while most interns at companies, or 32.9 %, spent around 1–3 days (Fig. 83.12).

This shows the disparity in the number of working days between the universities and companies. The highest number of interns accepted by the companies were from "Technical high schools" (41.8 %), showing the disparity in the number of working days among interns at universities and high schools. Most universities, or 92.5 %, "Approve" internships for academic credit. To receive credit, most universities, approximately 50.0 %, require "10 to less than 20 days." Internships are therefore considered a credit-granting program, resulting in a difference in the way internship programs are implemented among universities and high schools. The results indicated that internship programs at high schools were carried out as part of the class.

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Chapter 84
A Research of Knowledge Transfer Between Construction Consulting Project Teams from the Sociology Perspective

Weijia Song and Yali Du

Abstract Knowledge, as the carrier of construction consulting project teams, is the fundamental source of competitive advantage of the construction consulting firm. The level of knowledge management determines whether a consulting firm can get knowledge capital appreciation in competition, and ultimately improve the organization's core competitiveness. One of the core steps of knowledge management in construction consulting area is knowledge transfer between different project teams. This paper, from a sociological perspective, put forward a theory model of knowledge transfer between construction consulting project teams, extending the previous knowledge transfer research which in Information Technology, Behavior and Communication perspective and providing a new research idea for the study of knowledge transfer between construction consulting project teams.

Keywords Social Capital • Knowledge Transfer • Project teams • Cross Level

84.1 Preface

Knowledge, as the carrier of the consulting project teams, is the fundamental source of competitive advantage. The level of knowledge management determines whether a consulting firm can get knowledge capital appreciation in competition, and ultimately improve the organization's core competitiveness. One of the core steps of knowledge management is the knowledge transfer. Knowledge transfer between construction consulting project teams can promote the reuse of knowledge, avoid a lot of duplication of work, save project resources, improve the knowledge innovation, and improve the efficiency of project completion. How to improve knowledge transfer between project teams is becoming the focus of promoting the

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_84,

efficiency of the consulting business. Existing literature studied the knowledge transfer between project teams from the perspective of IT, Organizational Behavior, Communication and so on, and made some achievements, but these literatures ignored the nature of the knowledge transfer as a social process. Knowledge transfer between project teams ultimately depends on the interactive communication between members of the project, and this happens to coincide with the ideas of sociology. Therefore, this paper puts forward a model of knowledge transfer between construction consulting project teams from sociological point, in order to provide a new research idea for knowledge transfer between construction consulting project teams, and lay the theoretical foundation for further empirical research.

84.2 Review of Social Capital Theory

Glenn Loury [1] first proposed the concept of social capital, a new theoretical concepts corresponding to physical capital and human capital based on point of view of the impact of structure resources on the social economic activity. Bourdieu described social capital as “a collection of actual or potential resources which related with the lasting network by default or recognized relationship, and these relationships are more or less institutionalized” (1986). Burt [2] definition of social capital thinks the relationship between social capital within the enterprise and enterprise, this relationship is the ultimate decision whether competition can be the key to success. Lin Nan [3] proposed that social capital is resources embedded in social structures, and can be obtained through purposeful action. It was invested in social relations and to be rewarded in the market.

84.2.1 Analysis Levels of Social Capital Theory

Scholars initially studied social capital on an individual basis mainly, and later with the progress of the study, many scholars have found that social capital can not only at the individual level, but also in many other levels, such as the organizational level, inter-organizational level and throughout the national level. Coleman [4] as a pioneer of the social capital theory, classed social capital into individual social capital and group social capital. Brown [5] and Turner [6] took a good classification of social capital. They proposed micro, meso and macro three dimensions as a way to observe the social capital. Different from Brown et al. (2002) took a two-point method that divided social capital into external social capital and internal social capital.

For the analysis level of social capital, scholars have been from individuals, groups (teams), organization, and inter-organizational several levels and generated a certain number of research results [7–13]. Although the explanatory power of visible social capital is very powerful, the scholars' researches are limited to a single-level, not fully aware of social capital should have other meanings, antecedents, the results [14] at different levels, and not yet fully developed social capital potential from the multi-level perspective through which that we can better understand management and organizational phenomenon [15]. So, this article attempts to establish a multi-level social capital system to study.

84.2.2 Dimensions of Social Capital

Many scholars put forward different division of social capital dimensions based on a different point of view. The most famous is the concept that proposed by Nahapiet and Ghoshal [13]. They divided social capital into structural dimension, cognitive dimension and relational dimension. Since then, scholars study social capital mostly based on the three dimensions. However, even under a common framework, the various elements are quite different. Nahapiet and Ghoshal's classification clarified the idea for the researchers, but the measurement of dimensions they listed is hard to full use in specific issues. Therefore, future scholars greatly simplified and amendment of specific elements when learned from the framework of the three-dimensional division.

84.2.3 Effect of Social Capital on Knowledge Transfer

Social capital provides a new perspective for the study of knowledge transfer. Scholars at home and abroad have studied the influence of social capital on knowledge transfer from different angles and levels in recent years.

Granovetter [16] emphasized the weak links plays an important role in the information and knowledge transfer process, and put forward the theory of weak links advantage. Uzzi [17–20] was mainly concerned about the effect of connection strength on knowledge transfer, and tried to establish different types of links. The knowledge network concept was introduced into the subsequent researches, analyzing the impact of the length of the path of a business sector and other sectors within the network on knowledge transfer. The length of the path is inversely proportional with the establishment of direct links numbers, [21]. Tsai and Ghoshal [22] study suggested that the structural dimension and cognitive dimension of social capital can enhance trust and improve the degree of trust is perceived, so as to promote more exchange between enterprises or departments and integrate additional resources, such as information products or services, as well as other supports.

In addition to these scholars, there are many foreign scholars did theory or empirical research applying social network theory to knowledge transfer between individuals, groups and corporate [23–25], but the role of knowledge transfer between project teams has not been studied. This article based on this research gap, trying to set up the project social capital system, and studies the effect of project social capital on knowledge transfer.

84.3 The System of Project Social Capital

84.3.1 Definition of Project Social Capital

As mentioned above, although scholars studied social capital from the different levels of individual, group, organization, and definited it (Burt [2]; Coleman [4]; Oh et al. [26]; Pennings et al. 1998), but few studied the project level of social capital.

In essence, the project social capital belongs to comity social capital, but it is different from the organization and group social capital. Organizational level which reflects the unique resources is characterized by the company's internal social relations (Pennings et al. 1998), and has a long-term stability of characteristics. Project social capital differs from organization social capital because project-level social capital emphasizes the relationship between inside and outside of a particular project, and benefits directly to the project. And whether it benefits to the organization depends on the ability to manage these social relations outside the project, in such a case, the project social capital can be transformed into organizational social capital [27].

Project social capital is also different from the group social capital; Oh et al. [28] defined the group level social capital: a range of resources available through the social relations of the group members, these social relations exist in the social structure of the group itself, and also exist in a wider range of formal or informal organizational structure. Similar with the group, project is often composited by members to communicate with both insides and outsides. But different is that project much more emphasis the definition of a scenario. It is a more complex and innovative, time-bound activity, embedding into a higher degree in the context of the special items [27].

From the above analysis, this paper defines project social capital as an overall network that all social relations embedded in a unit project team, in which the project can obtain important resources.

84.3.2 Levels of Project Social Capital

Project is an independent action group between individuals and organizations. The staff of the project is a multidimensional concept. Similarly, project social capital also should be a multidimensional concept including the organizational

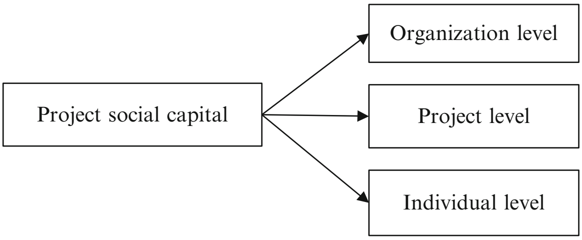

Fig. 84.1 Levels of project social capital

level, project-level and individual-level social capital. Therefore, this article divides project social capital into organizational level, project level and individual level (Fig. 84.1).

Organizational level refers to the organizational level of social capital for a project. The type of social capital, focusing on the organizational level, is social relations established and maintained for organizational development and maintenance of competitiveness which reflects the ability to use social resources in the name of the organization and senior leadership.

Project level, focusing on a certain project, refers to a project-level social capital. It is formal or informal social relations stetted up for completion of the project and reflect the ability to use social resources in the name of the project and project manager.

Individual level social capital refers to the social capital owned by individual project members. The type of social capital does not belong to a certain project or organization, but to the individual project members. It is informal social relations that reflect the ability to use social resources of individual.

Project social capital, including the above three types of social capital, can be used in a particular part of the project. The boundaries of such a classification are not absolute, there will be cross or swap depending on the environment. The project social capital, classified based on the purpose of classification management of social capital, is of great significance.

84.3.3 Dimension of Project Social Capital

As mentioned above, even under the same framework, the selected measure dimension is very different because of the different object of study and research purposes. Based on the research purpose, this paper sorts out the research dimensions of the project social capital in the background of construction consulting project teams.

84.3.3.1 The Structural Dimension of Project Social Capital

The project Structural Dimension refers to the sum of the various links of the project network of social relations and structural characteristics, it means the extent of links between nodes in the network. Departure from the characteristics of the project, this paper selects the indicators of network centrality, interaction strength and network density to measure the structural dimension of the project social capital.

Network centrality means in the core node or an important position node in the network, the nodes in that location has a more direct relationship than the other nodes of the actors.

The longitudinal interaction of structural dimension of social capital refers to the interactive frequency in a period of time, although this concept approaches to" relationship strength" which contains the emotional factors to the detriment of the clarity of the social capital dimension [29]. Therefore, in order to study the concept of a single dimension and clarity, this paper uses interaction strength to measure the structural dimensions of the project social capital.

Network density is measured from the horizontal level of social interaction to the dimension of social capital, and it refers to a universal degree of the contacts between different members of a certain time level, reflecting the tightness of the linkages between the various nodes within the network. Clearly, actors in high-density network can much more contact with the other members of the network than the actors in low-density network, and therefore information can flow more smoothly in the actors [30]. Therefore, the network density is as a measure dimension of social capital structure.

84.3.3.2 The Relational Dimension of Project Social Capital

The relational dimension refers to the assets created and used through the relationship, including trust, norms, recognition, etc. It is a potential standardized dimension to manage the behavior of the trading relationship [31], reflecting the indicators of the quality of networks. The main content of the relational dimension includes trust, norms and recognition; obligations and expectations [2], in which the trust and expectations is considered to be two key factors in the relational dimension of social capital [32]. For the project management, the role of trust and obligations and expectations is more prominent, so these two factors are used to measure the relational dimension of social capital.

Trust is a very important part of the relational dimension of social capital. Trust, the key factor for cooperation, can encourage members of mutual assistance and cooperation, smooth communication between nodes and, therefore, can not only enhance the cohesion of the network, and help maintain the network competitiveness. When trust exists between the actors, people are more willing to exchange knowledge. Due to the existence of trustful personal relationships, individuals have a strong knowledge transfer motivation, including a strong willingness to transfer and thus get a better reputation interests. Based on this, trust is used as dimension to measure the social capital relations.

Obligations and expectations, derived from the social exchange theory of sociology, is a commitment or responsibility for network members to engage in an activity in the future. Coleman [4] took the obligations and expectations as a form of social capital, that is, if actor A provided help to actor B, and believed that actor B would return in the future, then, A and B established an expectation, and B established a repayment obligation to A, thus, A and B constitute a relationship of mutual service. Coleman thought obligation was a responsibility relationship between both sides, and it is all the expectations that developed in a specific relationship. Obligations and expectations are necessary in the trusted network members.

84.3.3.3 The Cognitive Dimension of Project Social Capital

The cognitive dimension is the measure dimension that impacts the ability of exchange resource. Nahapiet and Gohoshal [13] thought the cognitive mainly refers to the resources that promote the identity or condensed awareness among individuals or organizations, such as various shared types of symbols, language, behavior mode, and so on. When individuals or organizations have more of this type of resource, the social capital is more abundant. Ke Jianglin et al. [10] in reference the study of Tsai and Ghoshal [22] and Aquino and Serva [33], used "shared vision" and "common language" referring to the cognitive dimension of social capital.

This article, different from Ke Jianglin' measurement from the internal team, adopts "common language" to represent the similarities of both sides in knowledge transfer, instead of the construct "shared vision" this because of shared vision is more important on the internal effect, but this article based on the point of view of cross project.

Common language refers to the shared language and means of communication of various actors in the social network. Common language is the basic platform of exchange of the actors and the basic premise of the interactive behavior. The view of group-specific language of communication is a valuable asset is more and more aware by scholars [34, 35]. If there don't exist communicate basis or communication inconsistent, it will limit each other's contacts and communications. Common language resource is a common conceptual basis of the resources sharing and the organization which made network members exchange to each other possible.

In summary, the dimensions of project social capital are divided as Fig. 84.2.

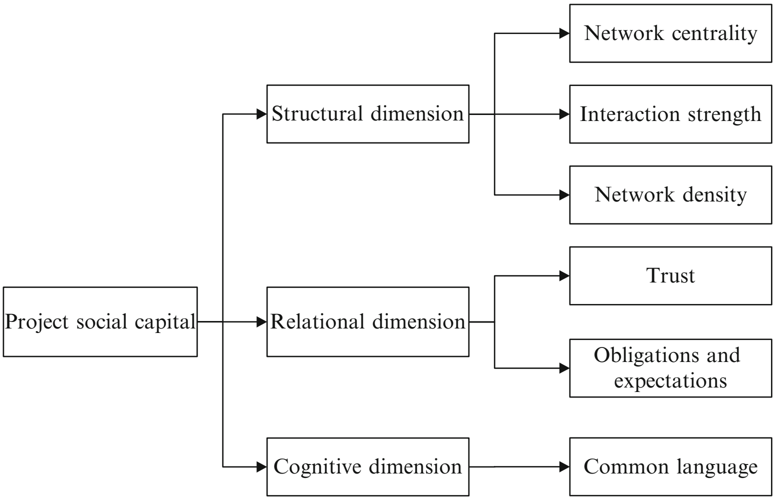

Fig. 84.2 Dimensions of project social capital

84.4 Research Model and Assumptions

The aforementioned theoretical analysis shows that social capital may have positive effect on knowledge transfer. This paper presents a conceptual model as Fig. 84.3.

It can be clearly seen from the research framework, the idea of this study is the effect of project social capital on knowledge transfer between project teams. In order to break the limitations of a single level in the previous social capital research, this paper attempts to study the project social capital and its impact on knowledge transfer from the cross-level perspective.

First, according to a division of the level of social capital, social capital is divided into three levels of the organizational level, project level and individual level to study the impact of the three levels of social capital on knowledge transfer between project teams.

Secondly, according to the analysis on dimension of social capital research, the research dimensions are all from the structural dimension, relational dimension and cognitive dimensions at every level. Thus, according to the research model, this paper proposes the following hypotheses:

H1 The structural dimension of organizational level project social capital has a positive effect on knowledge transfer between project teams.
H2 The structural dimension of project level project social capital has a positive effect on knowledge transfer between project teams.
H3 The structural dimension of individual level project social capital has a positive effect on knowledge transfer between project teams.
H4 The relational dimension of organizational level project social capital has a positive effect on knowledge transfer between project teams.

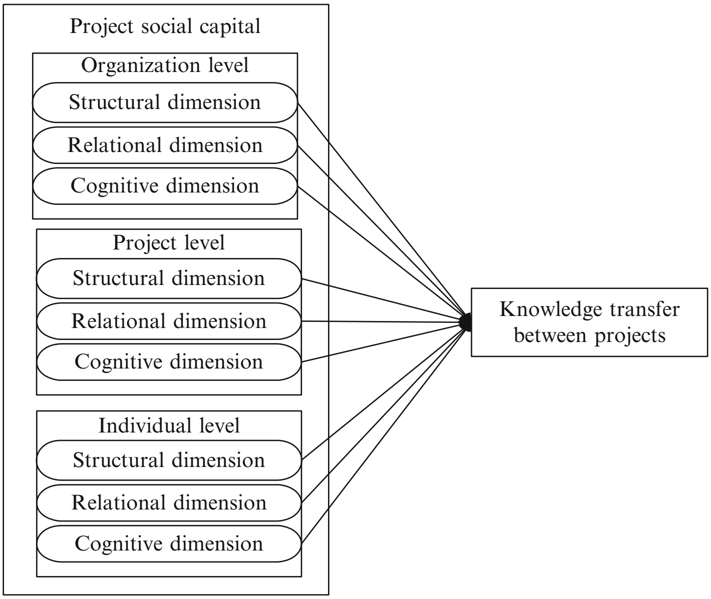

Fig. 84.3 Concept model

H5 The relational dimension of project level project social capital has a positive effect on knowledge transfer between project teams.
H6 The relational dimension of individual level project social capital has a positive effect on knowledge transfer between project teams.
H7 The cognitive dimension of organizational level project social capital has a positive effect on knowledge transfer between project teams.
H8 The cognitive dimension of project level project social capital has a positive effect on knowledge transfer between project teams.
H9 The cognitive dimension of individual level project social capital has a positive effect on knowledge transfer between project teams.
H10 The organizational level project social capital has a positive effect on knowledge transfer between project teams.
H11 The project level project social capital has a positive effect on knowledge transfer between project teams.
H12 The individual level project social capital has a positive effect on knowledge transfer between project teams.

84.5 Conclusions and Prospects

In this paper a system of project social capital is built, a research model of the effect of the project social capital on knowledge transfer is established, and theoretical assumptions are proposed, providing a theoretical foundation and research ideas for further empirical analysis.

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Chapter 85
Innovation and Patent Knowledge Management in the Construction Industry

Zhikun Ding, Jiayuan Wang, and Fungfai Ng

Abstract The innovations and new knowledge created during the construction process in China are not well managed. Therefore, this research aims to develop a TRIZ and patent laboratory (TP Lab) platform to promote innovations and manage the knowledge in the construction industry. TRIZ theory is applied to extract available patent knowledge. By utilizing Visual c++ 6.0 as the development environment and SQL Server 2000 as the database management system to store extracted patent knowledge, the graphic user interfaces and database structures of TP Lab is illustrated.

Keywords TRIZ • Patent • TP Lab • database

85.1 Introduction

Construction industry is one of the most crucial, knowledge-intensive, ill-structured, and challenging industries due to the complicated, uncertain, interactive, and dynamic nature of construction operations [1]. A project team is usually set up to manage construction operations at the beginning of a project and dismissed after the project objectives are achieved. Different designs, construction sites, and construction methods utilized etc. render each construction project unique. Innovations and knowledge are created during diverse construction processes. However, the innovations and new knowledge created during the construction process in China

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_85, © Springer-Verlag Berlin Heidelberg 2014

are not well managed. Therefore, this research aims to develop a TRIZ and patent laboratory (TP Lab) platform to promote innovations and manage the knowledge in the construction industry.

The TP Lab distinguishes itself from other knowledge management systems by focusing on TRIZ heuristics for construction innovations as well as construction patent knowledge in the industry. It enables users to not only utilize preserved knowledge "as it is" but also apply TRIZ heuristics to achieve innovations with high efficiency. Construction innovations provide social benefits by decreasing the costs of constructed facilities and making them affordable to a greater proportion of the population. Construction innovations also increase technical feasibility of construction activities by eliminating the technological barriers. Therefore it is important to develop a platform to facilitate construction innovations by integrating innovation theory such as TRIZ and available patent knowledge in the construction industry.

85.2 Literature Review

85.2.1 TRIZ

TRIZ is a romanized acronym for Russian meaning the theory of inventive problem solving. The basis of TRIZ is the discovery that technological systems evolve in accordance with certain patterns or regularities which are general for every engineering domain [2]. TRIZ theory has been successfully applied in different industries and to various subjects worldwide to achieve innovations [3, 4].

Two key concepts in TRIZ ideology are contradiction and heuristics. Contradiction means that in a technical system, while attempting to improve some features, other features may worsen as a result. In such situation innovation is called into play by resolving the technical contradictions without introducing compromises. Heuristics are criteria, methods, or generic resolution principles for deciding which among several alternative courses of action promises to be the most effective in order to achieve some objectives [5]. The heuristics in TRIZ are domain independent and their main target is to provide domain problem solvers the most promising directions to find solutions. In other words, heuristics are knowledge of knowledge i.e. meta-knowledge.

Figure 85.1 shows the process of how to apply TRIZ to solve specific problems. Schullter proposed 39 features and 40 principles as an innovation framework which could be universally applied to various problems in different domains [6]. Knowledge workers would define their domain problem at hand in terms of generic domain-free problems or contradictions that occur between different system features defined in TRIZ. General resolution principles are suggested by TRIZ to resolve the general contradictions. The knowledge workers have to interpret the suggested principles and generate domain specific conceptual solutions accordingly to solve the original problem. Without TRIZ, routine solutions may be derived under some circumstances but in most cases no innovations occur.

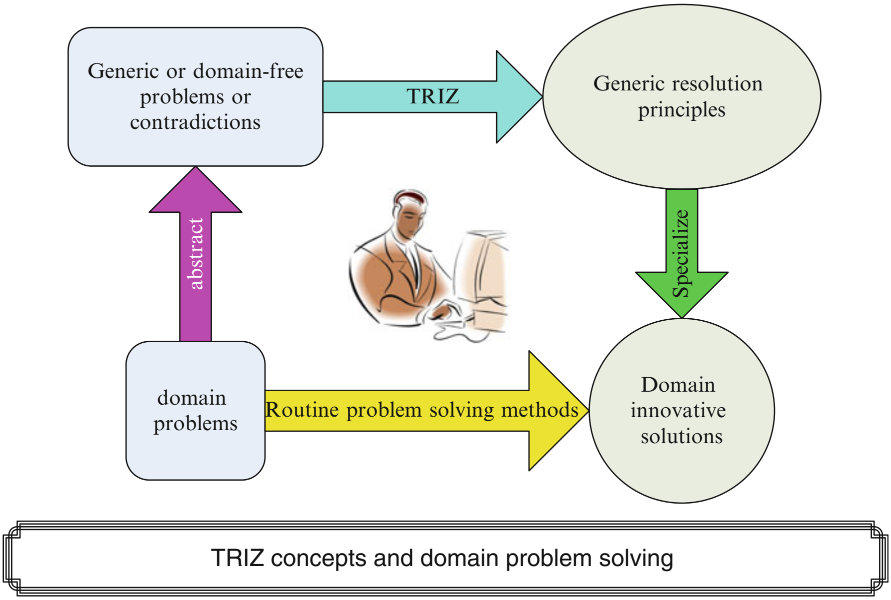

Fig. 85.1 The process of applying TRIZ to solve problems

85.2.2 Knowledge Management

Current knowledge management research are conducted from three perspectives i.e. a behavioral perspective e.g. Abrams et al. [7], Ding et al. [8]; a technical perspective e.g. Lindvall et al. [9]; an integration of the two e.g. Ganesh [10]. In this research, the roles of both knowledge workers and a knowledge management system i.e. TP Lab are integrated to manage knowledge at both meta-knowledge level and domain knowledge level. In particular, construction patent knowledge are integrated with TRIZ contradiction matrix to assist knowledge workers to solve construction related problems innovatively.

To develop TP Lab, knowledge has to be extracted from knowledge sources and then structurally preserved in a system database. Construction patents contain the status quo knowledge about technological innovations in the industry. Therefore, construction patents will be systematically analyzed with the framework of TRIZ contradiction matrix. Knowledge will be extracted from each target patent published on Guangdong Patent Information Service Platform [11].

85.2.3 Construction Patent

In IPC classification, part E is for construction patents. According to the patent statistics which was published by the State Intellectual Property Office in 2007, the

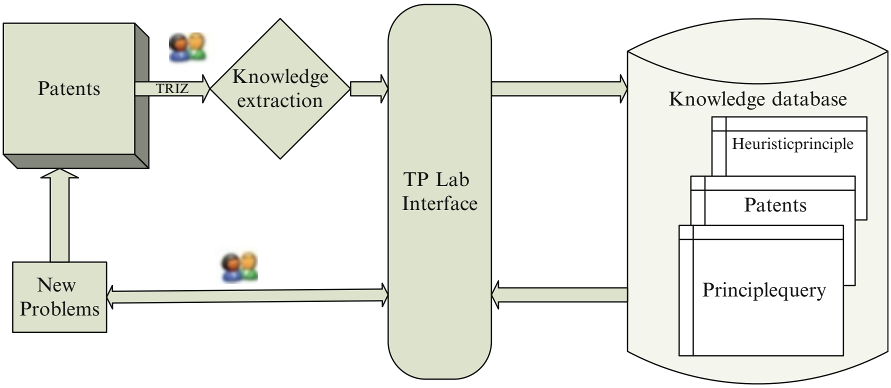

Fig. 85.2 The architecture of TP Lab application

total amount of construction patents ranked seventh in the eight listed categories, which means the construction industry is still lack of innovations.

Patent document includes abstract, claims, description and images. The description introduces technical background, problems solved and purpose of the invention. The claim illustrates the distinction from available solutions, and explains new ways of problem solving.

85.2.4 Architecture of TP Lab Application

The application of TP Lab involves TP Lab developer, users and information technology. In practice, TP developer should extract knowledge from patents according to TRIZ framework and store them in the database. The knowledge database should be updated from time to time. On the other hand, TP Lab users may encounter some new problems to solve and they may retrieve relevant knowledge from database to assist them to get innovative ideas. The whole application process fundamentally depends upon TRIZ framework. The architecture of TP Lab application is shown below Fig. 85.2.

85.3 TP Lab Development

85.3.1 Visualization

Graphic user interface (GUI) is a key element of motivating end-users to use TP Lab. By utilizing object-oriented programming (OOP), TP Lab contains the functionality of both interactive input and output. Visual c++ 6.0 is employed as the

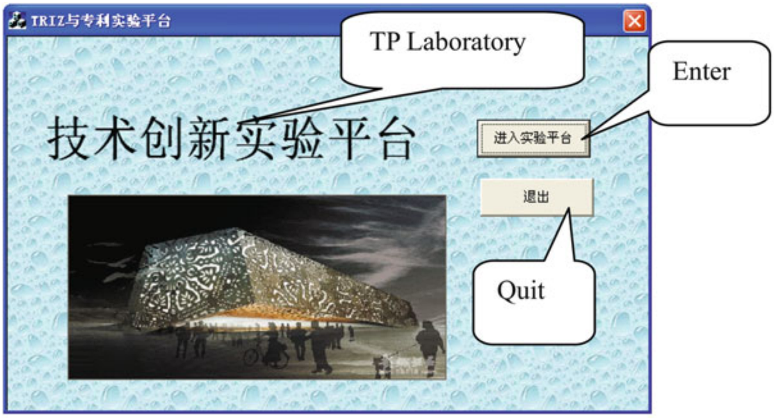

Fig. 85.3 The initial interface of TP Lab

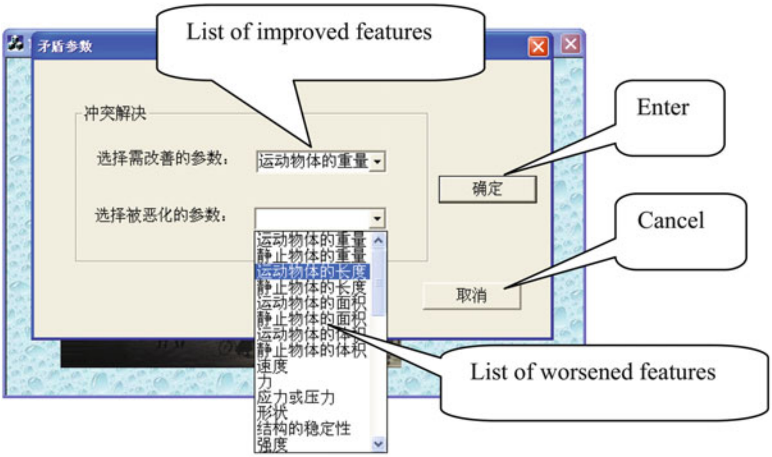

Fig. 85.4 The listed features in TRIZ contradiction matrix

development environment. SQL Server 2000 is the database management system to store extracted patent knowledge. Therefore, relational database structure is designed and adopted. It should be noted that TP Lab is developed in Chinese language. Figure 85.3 shows the initial interface of TP Lab. If the enter key is pressed, users will enter the lab and the interface in Fig. 85.3 will pop up.

In Fig. 85.4, 39 features in TRIZ are listed in the two list boxes. Users should select improved feature and worsened feature according to the problem at hand. The selection of both features will entirely depend on user's interpretation of the domain problem and generalizing it to domain-free contradiction within TRIZ framework. After selection, click enter button and the interface in Fig. 85.5 will pop up.

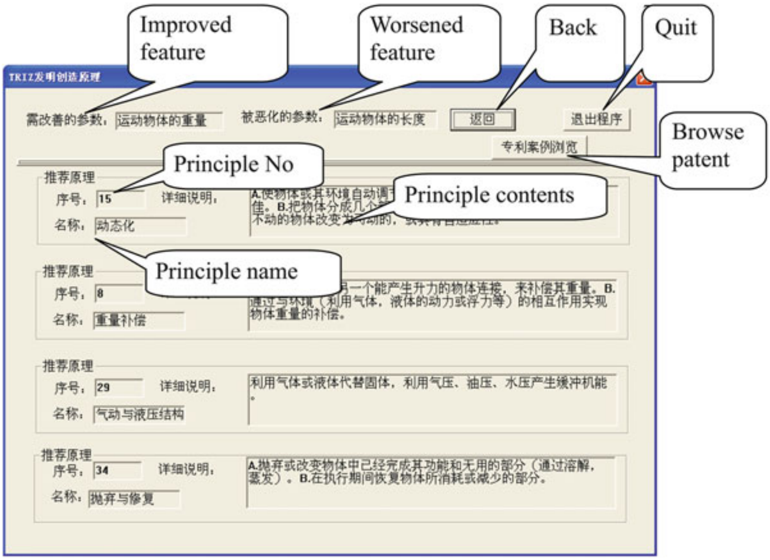

Fig. 85.5 The principles for innovation based on user's selected features

In Fig. 85.5, the recommended principles for innovation according to user's selected features are displayed and explained in detail. User could reinterpret the problem at hand with the principles and propose an innovative solution to solve it. If the principles are too abstract for the user and no quick solutions could be identified, the user could click the Browse patent button to have a detailed look at the construction patents in which the listed principles have been applied. In this way, user could get a better idea of how to use the suggested principles.

Once user clicks the Browse patent button in Fig. 85.5, the interface in Fig. 85.6 will pop up. All the key information and knowledge in patent documents are extracted and displayed here including problem description, problem illustration diagrams, features and principles for innovation applied, solution and corresponding illustration diagrams. If the above contents are not sufficient, user could click the Full patent document button to retrieve the original patent document and get a through understanding of the patent. In this interface user could also manage the patents in the database by adding, modifying, deleting patents.

85.3.2 Database

The successful implementation of the above user interfaces depend critically on the database storing related information and knowledge. Figure 85.7 shows the database called TRIZ&Patent managed by SQL Server 2000 database management

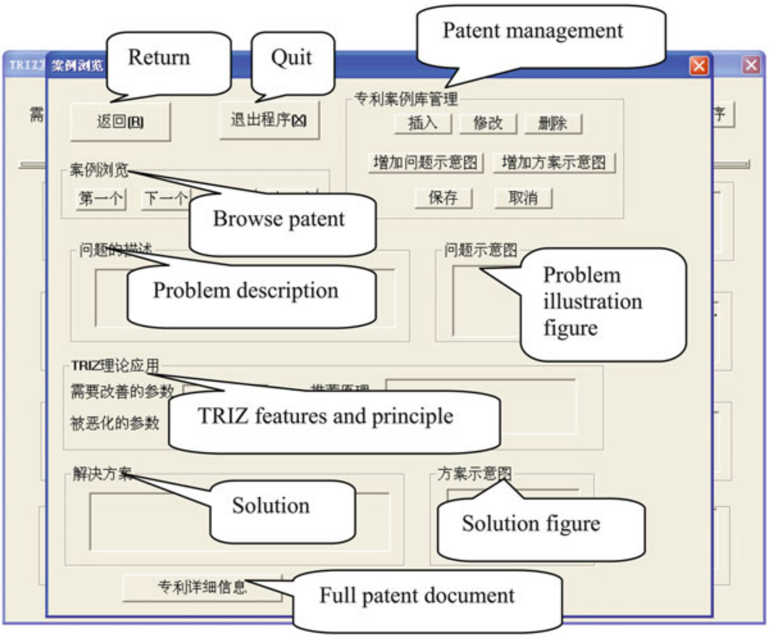

Fig. 85.6 The patent browse and management interface

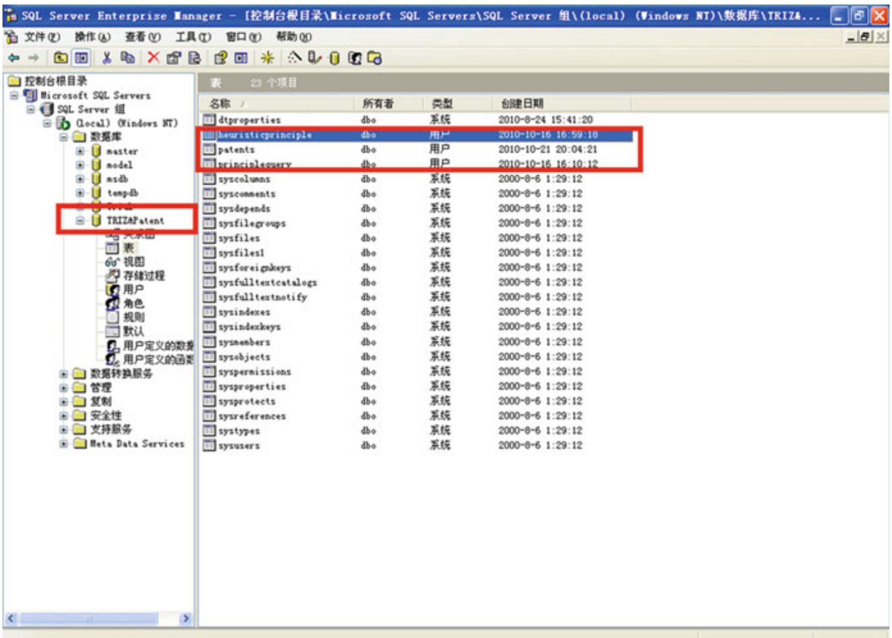

Fig. 85.7 Relational database TRIZ&Patent

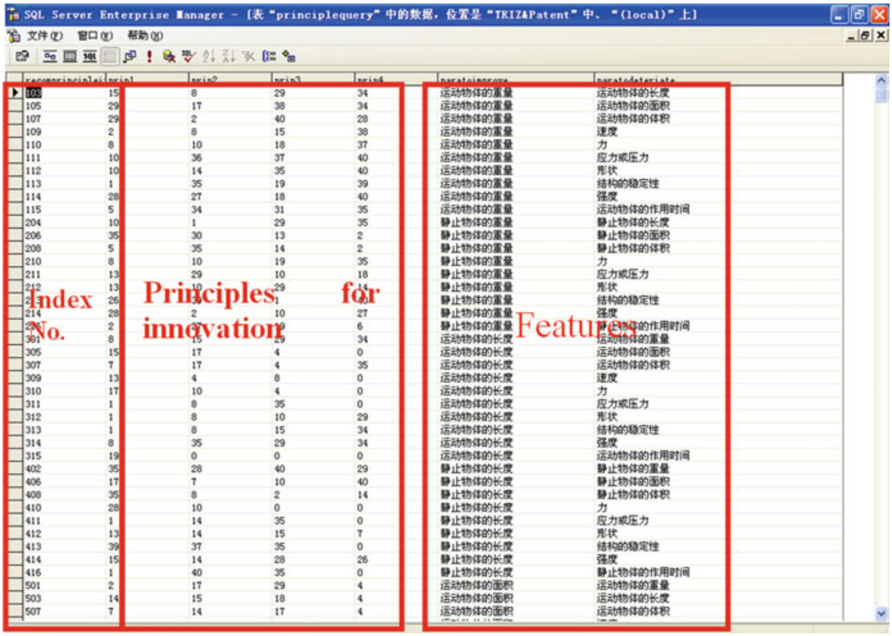

Fig. 85.8 The table of principlequery

system. There are three tables created in the database i.e. heuristic principle, patents and principlequery.

The table of principlequery is shown in Fig. 85.8. The first column lists the index number corresponding to TRIZ contradiction matrix. The next four columns displays the principles for innovation and the last two columns shows the improved and worsened features. The interface in Fig. 85.3 will depend on this table to identify principles for innovation.

The table of heuristicprinciple is shown in Fig. 85.9. The principle No., name and details are stored in it. The output in Fig. 85.4 retrieves data from this table.

The structure of table patents is shown in Fig. 85.10. Due to the patent knowledge extraction is ongoing, no information is loaded to the table yet. However, once data is stored in the table, the output in Fig. 85.6 will retrieve them from it.

85.4 Conclusion

An innovation and patent knowledge management system i.e. TP Lab is developed in order to improve construction innovations and manage knowledge in available construction patents. The system is designed and programmed with OOP and relational database. Knowledge in construction patents is extracted according to TRIZ contradiction matrix and stored in database for future application. Future

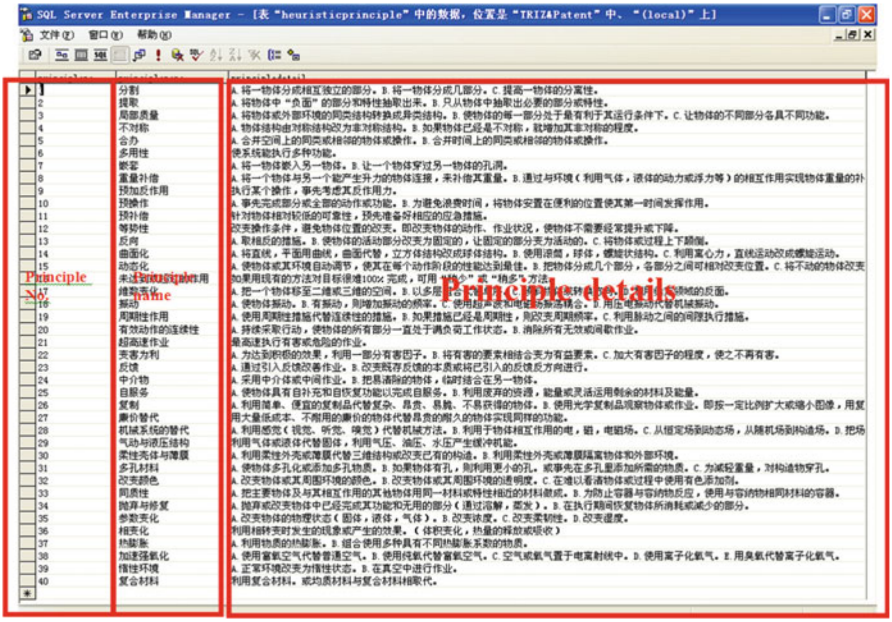

Fig. 85.9 The table of heuristicprinciple

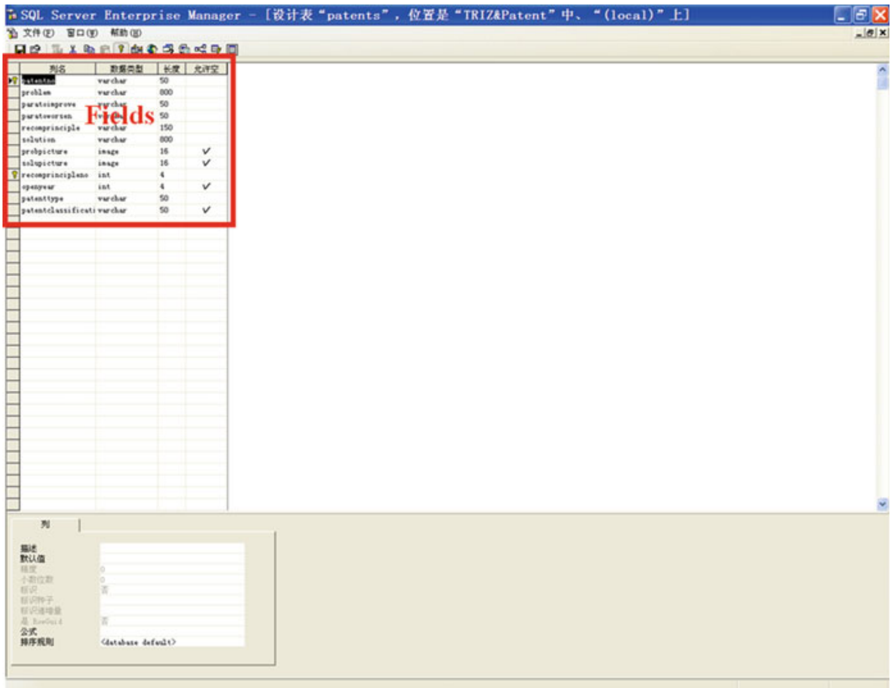

Fig. 85.10 The structure of table patents

users have a higher chance of success and being innovative in their problem solving process by referring to the knowledge in the TP Lab. Hence the objective of integrating TRIZ and knowledge management is achieved. The future research will focus on extraction of massive patent knowledge. Then the patent knowledge will be loaded to the relational database.

Acknowledgments This research is conducted with the support of the National Science Foundation for Young Scholars of China (Grant No. 71202101); Humanities and Social Science Research Funding (No. 10YJCZH025), Ministry of Education of P.R.C; Scientific Planning Research Grant (No. 2009-K4-17, No. 2011-K6-24), Ministry of Housing and Urban–rural Development of P.R.C; Shenzhen University Education Research Grant. The authors are also thankful to those who participated in this study and supported the research work.

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Chapter 86
An Exploration Study of Construction Innovation Principles: Comparative Analysis of Construction Scaffold and Template Patents

Zhikun Ding and Jiapeng Ma

Abstract A systematic study of patents according to innovation theories can accelerate the progress of technical innovations in the Chinese construction industry. The typical construction scaffold and template were selected as the research subjects by collecting publicly available scaffold and template patents in China. In total, 88 scaffold patents and 89 template patents were analyzed according to the Theory of Inventive Problem Solving (TRIZ). Two most often applied general parameters and innovation principles in both patents were identified based on the extraction of patent information and statistical analysis. The research shows that the technical development of both construction scaffold and template tends to increase difficulty of manufacture in return for useful quality on site. Moreover, preliminary actions and composability are the key tools of technical invention.

Keywords Patent • TRIZ • Construction scaffold • Construction template • Technical invention

As a critical industry for the national macroeconomy, construction involves a great deal of resource consumption as well as output, which defines its urgent demand in technical innovation. Especially in recent years, construction industry experiences a rapid progress because of technical innovations. For example, the combination of innovative energy saving technology and renewable energy development and utilization with building design lead to not only economic but also environment friendly benefits [1]. Because TRIZ (Theory of Inventive Problem Solving), which contains inventive principles that can solve technical problems for the industry, is efficient in assisting people to achieve technical innovations, it is widely used in various industries around the world in recent years [2]. However, TRIZ hasn't been

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_86, © Springer-Verlag Berlin Heidelberg 2014

paid enough attention by the academician and practioners of the construction industry. According to the patent statistics which was published by the State Intellectual Property Office in 2007, the total amount of construction patents ranked seventh in the eight listed categories, which means the construction industry is still lack of innovations [3].

In Mainland China, systematic research of the technical innovations for construction industry is at the very beginning, while in Taiwan and western countries like UK, USA, related research has already been conducted by scholars [4–7]. Therefore, it is important to identify the principles of construction innovation with TRIZ so as to improve competitiveness of the Chinese construction industry. As the important tools in construction industry, both scaffolding and template work consume a lot of labor, time and materials, and they are also similar to each other in some aspects such as transporting, storing and manual setting up. Hence, it's likely to identify innovation principles in the construction industry through a comparative study between construction scaffold and template patents. This article selected 88 typical scaffold patents and 89 typical template patents as research subjects, and identified the most applied engineering parameters and innovation principles in the two kinds of tools based on the extraction of main patent information and statistical analysis using TRIZ. The objective is to find the potential laws in the inventing processes of construction scaffold and template patents.

86.1 The Method of Patent Analysis

Patent document includes abstract, claims, description and images. The description introduces technical background, problems solved and purpose of the invention. The claim illustrates the distinction from available solutions, and explains new ways of problem solving [8]. This research focuses on analyzing technical background and claim of the patent with TRIZ.

By utilizing TRIZ theory, improved engineering parameter and worsened engineering parameter were extracted from the technical background of patents. Then the applied innovation principle in the contradiction matrix was identified after analyzing innovative feature of invention based on analysis of the description in depth. In order to reveal similarities of innovation in construction industry, statistical comparison about engineering parameters and innovation principle of scaffold patents and template patents was conducted respectively.

86.2 Extraction of Patents

Patent document contains huge information but this research only extracted relevant information for analysis according to TRIZ. Extracted information from the document includes patent's number, name, abstract, background, solved contradiction and innovation. Solved contradiction and innovation were extracted based on the analysis of patent documents, while other information was explicitly listed in the documents. Abstract summarizes the invention and its advantages; Background describes the disadvantages of available technology; Solved contradiction illustrates improved and worsened engineering parameters in patents; Innovation defines the problem solved and the invention principle used.

86.3 Patent Collection and Analysis Result

In IPC classification, part E is for construction patents, and all the subject patents are collected from catalog E04. We searched and chose patens in Guangdong patent information service platform [9].

86.3.1 Analysis of Engineering Parameter

After analyzing the subjects with 39 general engineering parameters [10] in TRIZ, we found that in scaffold patents, engineering parameters have been used 214 times in total and 2.43 times per patent, while in template patents, they have been used 364 times in total and 4.08 times per patent.

Table 86.1 shows that the top five used engineering parameters in scaffold patents: No. 36 device complexity, used 49 times; No. 35 adaptability or versatility, used 40 times; No. 13 stability of the object, used 36 times; No. 32 ease of manufacture, used 29 times; No. 33 ease of operation, used 14 times [12].

Table 86.2 shows that the top five used engineering parameters in template patents are: No. 23 loss of substance, used 51 times; No. 27 reliability, used

Table 86.1 Frequency statistics of engineering parameters in scaffold patents

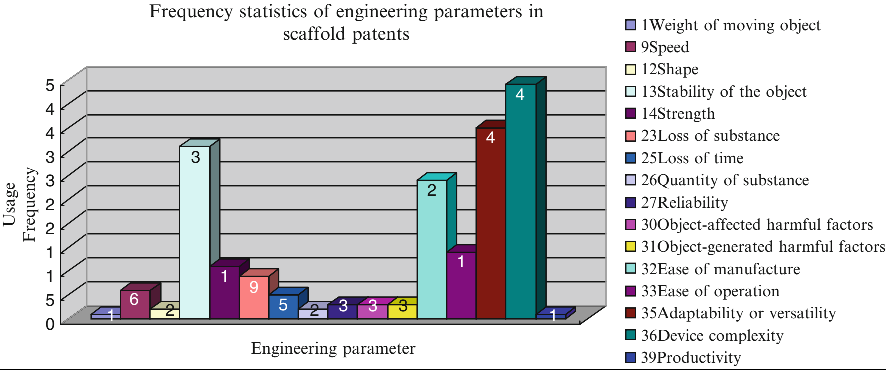
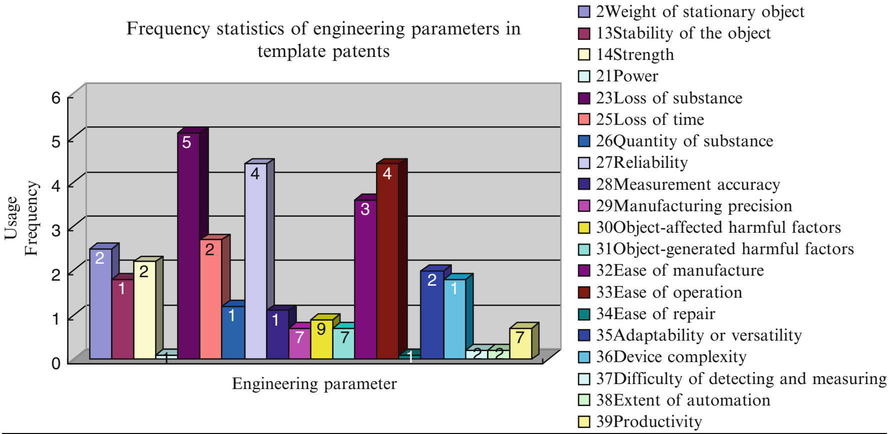


Table 86.2 Frequency statistics of engineering parameters in template patents



44 times; No. 33 ease of operation, used 44 times; No. 32 ease of manufacture, used 36 times; No. 25 loss of time, used 27 times.

After comparing the statistics of used engineering parameters, we find ease of manufacture and ease of operation are the most often used parameters in both scaffold patents and template patents. Specifically, the parameter of ease of manufacture usually appears in the two kinds of patents to be the worsened parameter due to various enhanced performances along with increasing difficulty of manufacture. It is mainly reflected in three aspects. Firstly, in order to produce new types of scaffold and template, producers need new matching mould and new requirements for manufacture processes which are inconvenient for massive production. Secondly, steel templates, or templates made from other materials with equivalent strength, are hard to incise in construction site. Some composite materials are not as easily acquired as the traditional materials. Most traditional scaffolds are constrained by fixed sizes in application processes, and their height following the height of a constructing building can't be adjusted, and they are also inconvenient for transportation. New technologies reduce the above disadvantages at the expense of ease of manufacture. Thirdly, many composable scaffold patents and composable template patents have better performance in terms of better connection among modules. New types of connection consume less material, need less connecting components and combine much easier. As a result, the difficulty of manufacture also increases (Table 86.3).

No. 33 ease of operation also appears many times in the subjects, however, it occurs more as the worsened parameter in scaffold patents while as the improved parameter in template patents. Because some scaffold patents solved the problems of console scaffold and overhang scaffold such as waste of resource and high cost in store and transportation. By designing overhang scaffold to be adjustable, then, the new scaffold becomes harder to operate.

For template patents, more attention are paid to the security and operating convenience of construction workers. Construction labors in the Chinese

Table 86.3 Statistics of top used engineering parameters

Parameter number	Engineering parameter		Usage frequency of improved parameter	Usage frequency of worsened parameter	Details
32	Ease of manufacture	Scaffold	1	28	Degree of facility, comfort, or effortlessness in manufacturing or fabricating object or system
		Template	4	32	
33	Ease of operation	Scaffold	2	12	Simplicity: The process is NOT easy if it requires a large number of people, large number of steps in the operation, needs special tools, etc. "Hard" processes have low yield and "easy" processes have high yield; they are easy to do right
		Template	42	2	

construction industry has high mobility and low educational level, therefore, complicate construction technologies lead to not only low efficiency but also worse project quality, higher training cost and security risk. Easier operation of construction template solves the above problem.

86.3.2 Analysis of Innovation Principle

After analyzing the patent subjects with 40 innovation principles in TRIZ, we found that in scaffold patents, innovation principles have been used 111 times in total and 1.26 times per patent on average. While in template patents, they have been used 91 times in total and 1.02 times per patent on average.

Table 86.4 shows that the top five used innovation principles in scaffold patents are: No. 15 dynamicity, used 28 times; No. 35 transformation the physical/chemical states, used 26 times; No. 10 preliminary action, used 15 times; No. 2 extraction, used 14 times; No. 1 segmentation, used 12 times.

Table 86.5 shows that the top five used innovation principles in template patents are: No. 40 composite materials, used 22 times; No. 10 preliminary action, used 17 times; No. 1 segmentation, used 8 times; No. 11 cushion in advance, used 7 times; No. 24 mediator, used 6 times.

After comparing the statistics of used innovation principles, we find segmentation and preliminary action are the most often used principles in both scaffold patents and template patents. The segmentation is used with a high frequency so as to get rid of disadvantages of traditional scaffolds such as nonadjustable height and

Table 86.4 Statistics of innovation principle in scaffold patents

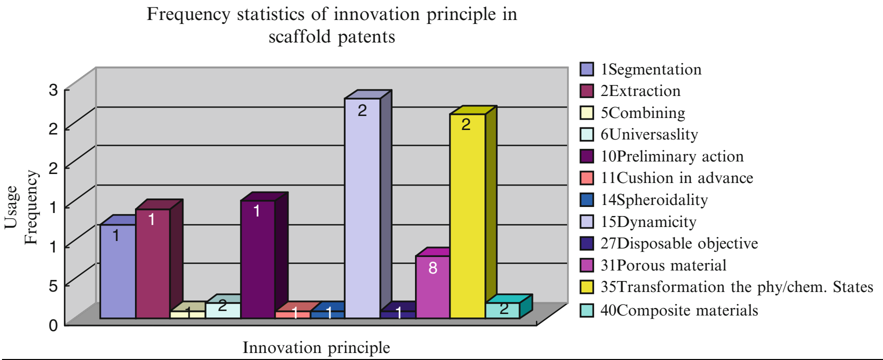
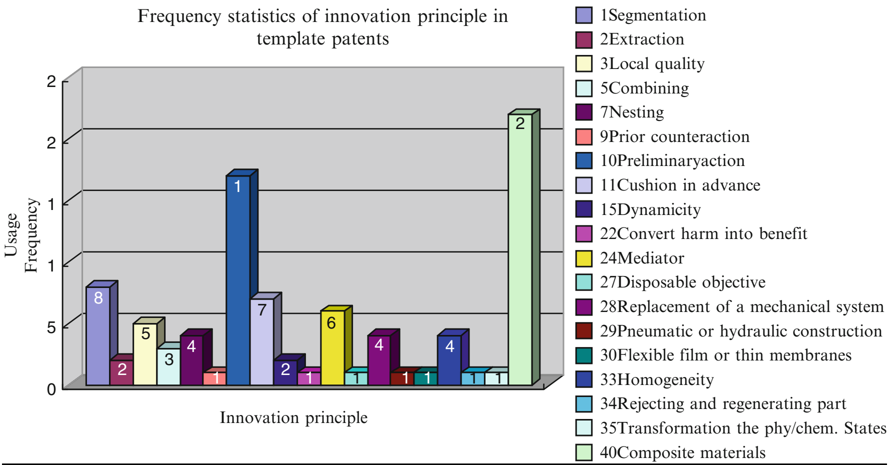


Table 86.5 Statistics of innovation principle in template patents



inconvenience when moving and assembling. New type of scaffold patents usually use frame elements instead of independent steel tube to build a scaffold so that the scaffold become more flexible in application processes. In the same vein, traditional construction templates are not convenient enough for workers and have high demand of labor due to their size and weight. The segmentation helps inventors to design templates with multi-modules and installation which not only enhance construction efficiency with less labor but also enable a template to be flexible (Table 86.6).

Preliminary action was applied with a high frequency because new inventions tend to obtain specific functions by adding subsystems in advance [3]. For instance, in a scaffold patent, electronic device was installed in advance so that the scaffold can rise simultaneously with the height of the building. In template patents, preliminary action also has been used in fair-faced concrete, which need to design beautiful patterns on the template surface. Besides, non-demoulding formwork is the other example of preliminary action.

Table 86.6 Statistics of top used innovation principles

Principle number	Innovation principle	Usage frequency	Details
10	Preliminary action	15	(a) Perform, before it is needed, the required change of an object (either fully or partially) (b) Pre-arrange objects such that they can come into action from the most convenient place and without losing time for their delivery
1	Segmentation	12	To divide object to independent parts, which are convenient to assemble and separate

86.4 Conclusions

Systematic research of available patents can help us innovate more efficiently, avoid duplication of efforts and take advantage of existing knowledge to inspire our creativity in the process of problem solving [11]. As an important tool in the construction industry, scaffold affects the whole process significantly and attracts increasing attention from people in the industry [12]. As important as scaffold, template also plays a significant role in construction. Statistics shows that in common concrete structure, the cost of framework is up to 20–30 % of total cost, and the labor of framework occupies 30–40 % of total labor, while the duration of framework is about 50 % of the construction duration [13]. Through the comparative study of engineering parameters and innovation principles extracted from construction scaffold and template patents base on TRIZ, we find that the technical development of both construction scaffold and template tends to increase difficulty of manufacture in return for desirable quality in application stage; meanwhile, preliminary actions and segmentation are the key principles of technical invention.

Acknowledgments This research is conducted with the support of the National Science Foundation for Young Scholars of China (Grant No. 71202101); Humanities and Social Science Research Funding (No. 10YJCZH025), Ministry of Education of P.R.C; Scientific Planning Research Grant (No. 2009-K4-17, No. 2011-K6-24), Ministry of Housing and Urban–rural Development of P.R.C; Shenzhen University Education Research Grant. The authors are also thankful to those who participated in this study and supported the research work.

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Chapter 87
The Application of the Earned Value Management in the Last Planner System for Project Performance Control

Lianying Zhang, Yanwei Li, and Jiawei Tang

Abstract Since the lean thinking was introduced to construction field as lean construction, many techniques have been used to help project manager to realize the lean construction, among which the last planner system (LPS) is the most popular method. The percent plan completed (PPC) is used to measure the performance of last planner system. However, it is insufficient to evaluate the performance of the whole project only by PPC. Thus, the Earned Value Management (EVM) is applied in LPS to help evaluate the performance of different levels of plans in LPS, and the results of each level are discussed.

Keywords Lean construction • Last planner system • Earned value management

87.1 Introduction

Lean Production was first implemented by Womack to describe the idea used by Toyota Production System. It is based on the study of the automobile industry in Japan and other countries. Womack and Jones [1] studied the general manufactory industry from the angel of automotive industry. And they raised the five principles of lean production, which is called the Lean Thinking. The principles are as below:

- Precisely specify value by specific product.
- Identify value stream for each product.
- Make value flow without interruptions.
- Let the customer pull value from the producer.
- Pursue perfection.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_87, © Springer-Verlag Berlin Heidelberg 2014

Koskela [2] introduced the three basic concept of production: Transformation, Flow and Value Generation. He provided a theoretical basis for appreciating the flow and value aspects of construction in addition to the well-established transformation view. Applied research using discrete event simulation has clearly shown the adverse impact of variation in production and delivery rates [3–5] and the benefits of pull flow of trade teams according to information maturity [4].

According to the PMBOK (2008 Edition), the earned value technique in its various forms is commonly used in performance measurement. It integrates project scope, cost, and schedule measures to help the project management team assess project performance. The EVM methodology integrates scope, schedule, and resource, to objectively measure project performance and progress.

Since the construction condition is complicated and uncertain, LPS should provide the essential tool of plan and control in project management. Plan ensures the project objectives and the process to achieve them. Control makes the process to follow the plan. In practice, the definition of control has some different points. Under the dynamic situation, the construction project is probably unable to implement the reliable plan which is the master plan in detail. Ballard [6] used the last planner system to eliminate the influence of uncertain environment by precisely define what can be done and used the percent plan completed to assess the performance of the execution of the plan. In practical situation, it is insufficient to use the PPC to evaluate the schedule performance only, since the significant relationship of the schedule performance index and the PPC is analyzed based on case study [7]. The result shows statistically positive trends. Kim et al. [8] compare the EVM and LBS from a management thinking angel. Kim et al. hold the opinion that the EVM is based on managing by result (MBR) while the LPS is based on managing by means (MBR). However, neither Olano et al. nor Kim et al. raise a detail method to improve the measurement of LPS or improve the PPC to evaluate the performance of the plan.

87.2 The Last Planner System

87.2.1 Four Tiers of Plan in LPS

According to Ballard's research, the concept of Last Planner System has five core elements: *Master Plan, Look-ahead Plan, Phase Plan, Look-ahead Plan, Weekly work plan* and *Percent plan completed & analysis of reasons for non-completed tasks* [6]. The purposes of each plan mentioned above are as below:

Master Plan conducted in the overall project, including the general objective and milestone. Master Plan is drawn up according to the contract.

Phase plan divides the Master Plan into several phases, in order to refine the work and build phase objective. Meanwhile, Phase Plan is the bridge between Master Plan and Look-ahead Plan. Phase plan focuses on which is the "should do" work.

Look-ahead Plan solves the problem of what is the following work, generally including the necessary work in next 6 weeks. This plan screens the "can do" works from the "should do" ones.

Weekly Work Plan allocates the specific work. Weekly regular meeting will list the work in next week, and summarize the constraints to avoid some obstacles. The details in Weekly Work Plan meeting include Weekly Work Plan, security problem, quality problem, resource, construction technique and so on.

87.2.2 Percent Plan Completed (PPC) of Last Planner System

Percent Plan Completed & analysis of reasons for non-completed tasks is through the continuous assessment and learning from failures to improve project Plan. PPC is the ratio of the tasks completed in time. It can be obtained by dividing the quantity of total planned tasks by the quantity of the tasks completed as planned. In general, the higher the PPC value means higher project execution efficiency, and thus, PPC has attracted much research.

Ballard [6] holds the view that, the measurement of performance in LPS level does not mean that it works only in this level. The inconsistency analysis of implementation of programs can help to find the basic reason of the problem; the plans of inferior quality or unsatisfied execution are probably caused by factor in every aspect, process and function of organization; the reasons of non-completed tasks confirmed by front-line managers provide the initial data to analyze and improve PPC, benefiting the following amendment of project planning, which contributes to improve the performance of management.

87.2.3 The Deficiency

The evaluation of LPS is mainly through PPC which measures the weekly plan execution efficiency, while for those which play important roles in the whole project process, such as look-ahead plan, phase plan and master plan, are lack of evaluation methods and evaluation index in practical situation.

Along with the approval of the effectiveness of PPC, it is the problem existing in these models that attracted considerable scholarly attention. Mota et al. [9] demonstrate that this system showed cyclical reasons in many application cases, and the influencing factors have not been identified clearly. They develop a system dynamics model to analyze the effort of variability, delay and project performance to the entire system, which explain the influence mechanism of past time to the fluctuate of PPC, and how to avoid the undesirable result. According to the data from 133 projects, Bortolazza et al. [10] make statistical analysis for the reasons of non-completed plan.

The Multiple Regression Analysis of 96 project shows that the low execution efficiency of plan is one of the main problem, and in the analysis of the factor of plan completion, labor and plan management become the important aspect affect the variance of PPC. In order to measure the performance accurately, Hamzeh [11] cooperates with the Lean Construction Institute conduct a survey. The result shows that the connection between weekly plan and main plan is weak, caused by the poor performance of prospective plan as the bridge, and, as the index of weekly plan performance evaluation, PPC cannot reflect the entire process of project progress, for example the delay of schedule with high PPC. For this reason, together with the method study of PPC, the work of developing connection between weekly plan and main schedule and prospective plan is also need more attention.

PPC demonstrates the execution situation of weekly plan, mainly from the view of quantity, and then, based on the analysis of non-completed reason; ensure to carry out the weekly plan. But it is obvious that considering the execution situation only is not enough to control the performance. For the reason of variability of construction condition during the progress, it should be not only complete the plan under specific circumstances, but also control the execution of entire project with a microscopic perspective.

87.3 The Application of EVM in LPS

87.3.1 Definitions in EVM

According to PMBOK (2008 Edition), the definitions of the three key dimensions in EVM are as below:

Planned value (PV) is also called BCWS (Budgeted Cost for Work Scheduled). It means the hours (or money) needed to complete the amount of work required in the process. PV mainly focuses on the amount of work required in schedule, rather than the used hours and money. The total of the PV is sometimes referred to as the performance measurement baseline (PMB). The total planned value for the project is also known as Budget At Completion (BAC).

Earned value (EV) is also called BCWP (Budgeted Cost for Work Performed). It equals the amount of actual completed work multiply by the used hours (or money). The EV being measured must be related to the PV baseline, and the EV measured cannot be greater than the authorized PV budget. The term EV is often used to describe the percentage completion of a project.

Actual cost (AC) is also called ACWP (Actual Cost for Work Performed). It means the used hours (or money) of the amount of actual Completed Work. It is a value of actual consumption in project implementation. The AC will have no upper limit; whatever is spent to achieve the EV will be measured.

Schedule Variance (SV) is the variance between EV and PV on the checking day, the formula is:

$$SV = EV - PV = BCWP - BCWS$$

When SV > 0, that means the project is ahead of schedule.

When SV $= 0$, that means the project is coincide with the schedule.

When SV < 0, that means the project is behind schedule.

Cost Variance (CV) is the variance of EV and AC of the checking day, the formula is:

$$\mathrm{CV} = \mathrm{EV} - \mathrm{AC} = \mathrm{BCWP} - \mathrm{ACWP}$$

When CV > 0, that means the actual assumed man work (or money) is lower than budget and high efficiency.

When CV $= 0$, that means the actual assumed man work (or money) is coincide with the budget.

When CV < 0, that means the actual assumed man work (or money) is excess the budget.

Cost Performed Index (CPI) means the used hour (or money) of the amount of actual Completed Work. It is an index of actual consumption in project implementation. The formula is:

$$\mathrm{CPI} = \mathrm{EV}/\mathrm{AC} = \mathrm{BCWP}/\mathrm{ACWP}$$

When CPI > 1, that means the actual cost is less than the budget.

When CPI $= 1$ that means the actual cost is equal with the budget.

When CPI < 1, that means the actual exceeds the budget.

Schedule Performed (Index) means the used hour (or money) of the amount of actual Completed Work. It is an index of actual consumption in project implementation. The formula is:

$$\mathrm{SPI} = \mathrm{EV}/\mathrm{PV} = \mathrm{BCWP}/\mathrm{BCWS}$$

When SPI > 1, that means the project is ahead of schedule.

When SPI $= 1$, that means the project is coincide with the schedule.

When SPI < 1, that means the project is delayed in contrast to the schedule.

87.3.2 The Application of EVM in LPS

On the purpose of eliminating the deficiency of the measurement in LPS, this paper applies the EVM in the four tiers of plan processes. Each plan process is analyzed by the EVM, and the result of different plan processes implies different information as shown in Table 87.1.

The EVM is treated as an analysis tool to assess each of the four tiers of the plan in LPS.

Table 87.1 The analysis result of implementation of EVM in LPS

Plans	Result analysis
Master plan	The EVM in master plan level can tell the project manager whether if the whole project is being performed as scheduled. Since the master plan is the base of all the plans, when deviation occurred, the manager should adjust the phase plan. Also the analysis data can be used to compare with the milestone which has already established of the expected period, so as to realize the alert in project level
Phase plan	Since the phase plan is a progressive detailing of the master schedule, the result of EVA in phase plan can exam whether of the phase schedule has found the best way to meet milestones stated in the master schedule
Look-ahead plan	The result of EVA in look-ahead plan level can tell whether or not should take more efforts to turn "should" work into "can" work, and adjust the workload of the next stage work to steady workflow
Weekly work plan	The result of EVA can help evaluate the performance of weekly work plan, and also supply the statics to identify the work that has been done has met the budget. And what more important is that, it can help to reduce the situation that the PPC is high while, however, the period is delayed

87.4 Conclusions

Since the lean thinking was first applied in construction field as lean construction, it has attracted much research. There are many technique applied in lean construction, among which the last planner system is treated as the most efficiency method to control the project. And the PPC is the most popular index used to measure the performance of the project in LPS. However, the PPC cannot tell whether the project is going as scheduled in contrast with the contract. So the EVM is applied in LPS in this paper. The results of earned value analysis of each plan in LPS imply different levels of information of the performance of project. And the project manager in different levels can focus on the affairs of their level, thus improving the performance of the project. However the result of implementation of EVM in LPS is qualitative and the quantitative indicator needs to be introduced to the analysis tool, and the case study remains to be conducted in the further research.

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Chapter 88
Innovative Design of a Suite of Low Impact Development Facilities in Civil Structure Experimental Building Complex

Jian Liu, Shicong Chen, Lingyi Wu, Nian She, William Lucas, and Benchi Li

Abstract This paper presents an innovative design of a suite of low impact development (LID) facilities including eco-roofs, bio-retention cells, natural drainage system, rain gardens, porous pavement, cisterns and multi-functional detention pond in the complex of the Civil Structure Experimental Building at Shenzhen University. The LID facilities are designed for the multi-purposes usage including testing different growing media of the eco-roofs for nutrient removal, evaluating performances of eco-roofs, bio-retention cells, rain garden and porous pavement for stormwater attenuation and reduction, testing rain water harvest using cisterns and detention pond, and serving as sustainable educational and training facilities for engineering students and professionals. This state of the art design also includes water circulation system and preinstalled climate and hydrological data monitoring and collection systems. A beautiful landscape and tour path will be built for the visitors.

Keywords Low impact development • Bio-retention cell • Eco-roof • Rain garden • Natural drainage system • Pond

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_88,

88.1 Introduction

Low impact development (LID) techniques (called as the LID model in China) hold very promising opportunities for improving the hydrologic regime of urban areas and removing pollutant loads in runoff. For this reason, extensive efforts are underway in many cities such as Seattle, New York and Philadelphia in the United States to utilize LID stormwater control measures to manage stormwater. Over 10,000 LID facilities have been constructed in USA since late 1990s, and Shenzhen, Sanya, Jiaxing, Beijing, Tianjin and Ningbo in China have been undertaking similar projects, although not at such a vast scale as in USA since the LID techniques were first introduced in China by Dr. Nian She of Seattle Public Utilities in 2007 [1].

Since the frequent flooding in urban area caused by the stormwater has becoming a bottleneck for the sustainable development in China, the Chinese Ministry of Housing and Urban–rural Development selected Shenzhen City as a pilot city to study the feasibility of LID projects in China, especially, to evaluate whether or not the LID techniques are feasible to be implanted in the large scale retrofit projects. A part of the governmental invested roads, resident houses and parks in Guangming New Development District and the environmental restoration projects in the Pingshan River Basin in Pingshan New Development District were identified as the pilot projects to test various LID configurations [2]. Shenzhen Government encourages the Developers to use LID techniques to the municipal infrastructures, house construction, water resources management, and environmental restoration. The suite of LID facilities of the Civil Structure Experimental Building Complex at Shenzhen University is one of these initiatives.

Although LID techniques have been studied extensively for some times, there are quite a few well controlled studies that properly evaluate each variable involved in the physical and biological processes in LID modules. Many field studies only examine a single installation with no controls in evaluating the performance. In this study, different media and outlet configurations for the eco-roofs and bio-retention cells are set to compare the performance of the facilities. A unique and innovative water circulation system is also designed to sustain the water quality of the detention pond.

88.2 Project Setting

The Civil Structure Experimental Building Complex at Shenzhen University is about 1.3 ha, comprising of a Structure Experimental Hall in the west, and North, Center and South Buildings in the east, a parking lot north of the North building, and 907 m^2 surrounding landscaping courtyard. The total roof top area of the complex is about 4,025 m^2, in which the roof of North Building is set up as a control and the runoff from this roof will discharge to three bio-retention cells in the courtyard for water quality treatment. The rest of the roofs will be constructed as

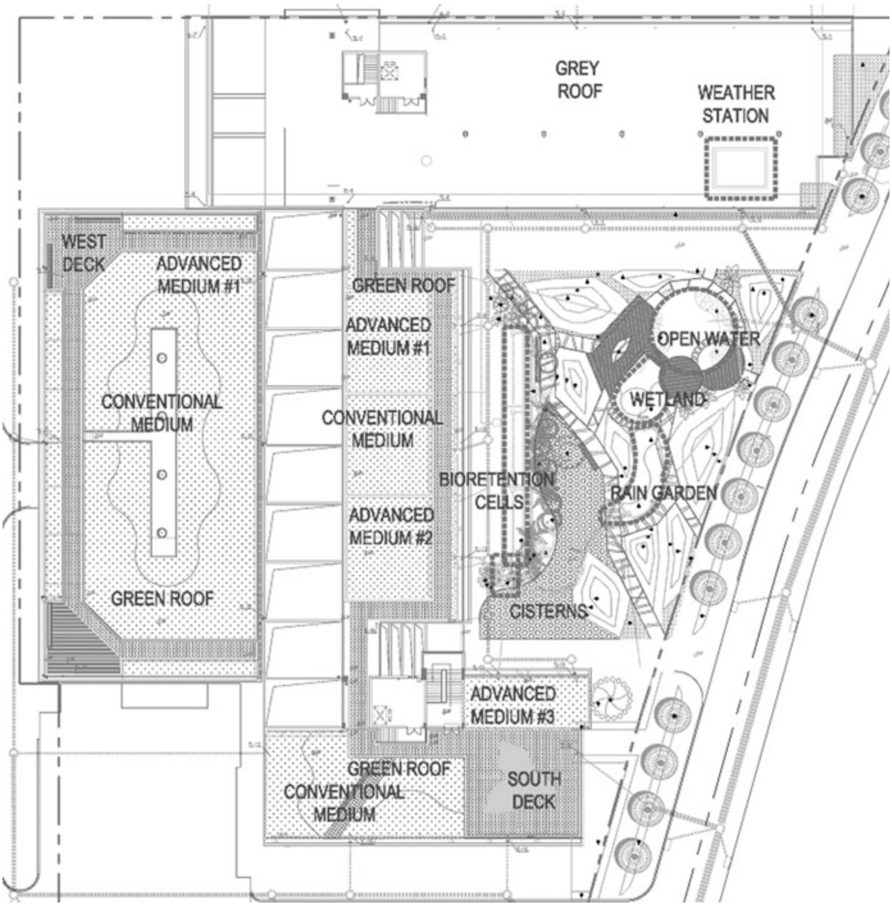

Fig. 88.1 Layout of the eco-roofs and LID facilities in the courtyard

eco-roofs with a total area of 2,100 m^2 in four different media that could provide an ample source of urban runoff for the designed water quality treatment, and be tested for the nutrient removals. A monitoring system was designed to capture the runoff from these media.

A multifunctional detention pond comprising wetland and open water body will be constructed to collect runoff from the roofs and the courtyard. A strawberry garden will be constructed in the corner of South and Center Buildings to make surrounding landscape closer to the nature. Two cisterns are installed at the south side of the bio-retention cells. A rain garden and natural drainage system are arranged in the area between the bio-retention cells and the detention pond. The sidewalks in the courtyard are built by permeable bricks made of construction waste. Figure 88.1 displays the layout of the suite of the LID facilities. Different monitoring facilities are installed in the natural drainage system and rainwater manholes. In addition to the LID facilities, lighting, parking and landscaping works on the roofs and the courtyard are also designed.

This design and construction are conducted by the joint venture comprising the Institute of Architectural Design & Research, Shenzhen University and Shenzhen Linwailin Landscape Engineering Co., Ltd. This project is the first LID project in China that has real time data collection systems, and is aimed at evaluating the performance of different LID components. The supervision institution is the Shenzhen Luban Construction Supervision Co., Ltd. The project started construction on July 16, 2012, and would be completed at the end of September 2012.

88.3 Innovative Design

88.3.1 Design Principles

The design work is an international collaboration. The team is led by Prof. Jian Liu and Prof. Nian She of the Ecological Technology Institute of Construction Engineering, Shenzhen University. The members include Mr. Lingyi Wu, civil engineer of the Institute, Dr. William Lucas, Principal of Integrated Land Management, Inc., Mr. Benchi Li, Landscaping designer and Mr. Penggao Li, civil engineer of the Institute of Architectural Design & Research, Shenzhen University, and Mr. Zhiwei Li, manager of contracting and budgeting of Shenzhen Linwailin Landscape Engineering Co., Ltd. The design integrated the most current LID settings, flow monitoring techniques and the thought of Chinese geomantic omen, which means that the structure and geomantic position of the project might lead to some unpredictable things happening in the future. Following these design principles, the LID facilities are designed in consideration of the local climatic conditions and materials available in Shenzhen. The design storm is the maximum daily precipitation of 25 years return period (387 mm). The storage of the LID facilities is designed according to the maximum historical hourly rainfall of 99.4 mm in Shenzhen [3]. The most of the roofs will be vegetated in order to reduce the hot island effect as well as the stormwater runoff through evapotranspiration. These eco-roofs will also provide a valuable open space amenity in a dense congested environment which will be appreciated by the occupants. These benefits illustrate some of the triple bottom lines (pollutant removal, energy savings and amenity).

88.3.2 Eco-Roofs

Three of four roofs of the complex will be greening by means of approximately 25 cm depth ecological structures. The eco-roofs are composed of the meadow planting, wind cover, medium, gravel, TRM geotextile protection, EPDM membrane, TRM geotextile protection and slotted PVC pipe inserted into the gravel. All of these eco-roofs will incorporate innovative outlet controls to enhance stormwater management, evapotranspiration, and improve nitrogen retention. One eco-roof will compare the effects of outlet controls to a free discharge treatment to examine the resultant effects upon hydrology and nutrient transformations.

Four different medium formulations will be evaluated in the eco-roofs. The first will be the standard eco-roof formulation used throughout China and the USA, comprising a mixture of expanded shale fines blended with local compost to provide additional water holding capacity and nutrients for plant growth. Due to the liability of compost, it is expected that this medium will export nutrients until the system stabilizes. The second medium is also based upon the same expanded shale fines, The compost is largely replaced by the water treatment residuals (WTRs) and coir peat. The WTRs from the Nanshan Waterworks will be used in this project. The WTRs have very high phosphorus sorption characteristics, while the coir peat provides high water holding capacity without leaching nutrients. A small amount of compost will be blended into the surface to promote initial plant growth.

The third medium will be almost the same as the first, but with a proprietary mixing of minerals and enzymes. This medium will not only provide information on how well the mixing materials can counteract the leaching losses of nutrients that occur within the standard medium, it will also show how the enzymes can enhance the nutrient taken up by plants. The fourth medium will blend the best aspects of the second and third media. The enzymes used in the third medium will be added to the second medium, along with a little more compost at the surface to further boost plant growth. It is expected that this medium would provide the highest removal rates for pollutants and nutrients of all the mediums evaluated. This will be evaluated in two roofs.

Utilizing the structural capabilities, the intensive eco-roofs will have a uniform medium depth of 15 cm, underlain by expanded shale pea gravel varying from 5 to 15 cm deep to equalize lateral flow through the stone to the collection manifold. This provides enhanced water retention and improved planting environment. Routed through the outlets, this hydraulic storage can be controlled to minimize offsite hydrologic impacts. All mediums will therefore have outlet controls to provide hydrologic benefits and increase pollutant retention. With outlet controls, runoff from large events is detained on the roof so it can be more effectively treated. This provides a level of control so these eco-roof systems can largely eliminate their hydrologic impact. This allows for the system to better replicate predevelopment hydrology, and reduce the site's contributions to flooding. One of the two blended treatments will be outlet controlled, with the other being free discharge, as typically used in eco-roof designs. This will quantify the effects of the outlet controls upon hydrologic and nutrient removal performance. Four different eco-roof experiments will be monitored simultaneously. In this way, the experimental setup will permit simultaneous evaluation of the effects of media type and outlet controls upon hydrologic performance and pollutant removal. Most of the remaining roofs will utilize the blended media, along with the outlets for overall hydrologic and pollutant retention performance [4]. Having an intensive medium depth, the eco-roofs will be primarily vegetated with both short and tall meadow grasses. Low lying shrubs and potted small trees will be placed at strategic locations as an amenities, and provide interest. Tall grasses will be used to screen larger air handling penetrations through the roofs. These grasses will promote high levels of evapotranspiration.

88.3.3 LID Facilities in the Courtyard

To treat the stormwater of the grey roof of North Building, three bioretention cells are built in the east side of Center Building in the courtyard. These systems will route into a simplified nature drainage system.

Treated flows from the bioretention cells pass down a simplified natural drainage system (i.e. infiltration channel), then flow into rain garden, and finally into a multifunctional detention pond. The rain garden will comprise 45 cm of the blended medium, underlain by 15 cm of pea gravel and another 15 cm of mason sand. An underdrain is used to convey treated runoff into the detention pond. Note that it discharges only when the medium saturated and the water level exceeds the pond water surface elevation. Otherwise, flows infiltrate into the soil. Overflows pass between the stepping stones. It is intended that the rain garden and natural drainage system infiltrate as much runoff as the underlying soils will permit.

The multifunctional detention pond is designed to collect a portion of runoff from the grey roof North Building, eco-roofs of Center and South Buildings, and the courtyard. The south part of the detention pond is designed in the type of wetland to purify the stormwater. An outlet with a weir is designed in the east side of the pond to overflow the surplus stormwater into the municipal drainage system under the road in the east of the courtyard. To prevent the eutrophication of the detention pond, a 1 kW pump is installed to pump the pond water into the outlets of the bioretention cells for water circulation. The pumped water will be purified by the natural drainage system and rain garden, and then flow back to the pond. In case of the eutrophication occurring, a composite enzyme will be put into the pond to improve the water quality.

A triangular weir in the middle of the natural drainage system is installed to measure the surface runoff when it is raining, and it also used for the hydraulic experiment class for the students. The outflow from the triangular weir will flow into the rain garden, and then into the detention pond to keep the pond water level and decrease the eutrophication occurrence.

The strawberry garden will plant strawberry, vegetables and other fruits to make the students know where the foods come from. To utilize the treated water from the eco-roofs, 2 m^3 cisterns are installed in the courtyard. The water in the cisterns will be used as experimental water to the triangular flume, irrigation water to the plants in the courtyard and supplement water to the detention pond.

88.4 Measurement and Experimental Analysis

Each of these eco-roofs and bioretention cells will be continuously monitored for flow, with composite sampling of every runoff event in the beginning 2 years. As mentioned above, the flow of the eco-roof of Center Building will be measured by four outlet controls comprising 60 °V-Notch weir and tee. Collected samples will be composited to obtain seasonal mass loads of nutrients, metals and other stressors in runoff into and leaving each facility. A series of selected events will also be evaluated to obtain the range of performance that occurs over each season. This will provide a full factorial analysis of the system responses.

Since runoff will have been effectively treated by the bioretention cells, flows passing down the natural drainage system and into the rain garden would not be monitored for water quality. Instead, flow monitoring of the difference between inflows and outflows will quantify the infiltration performance of these cells. A flow meter in the underdrain of the rain garden will be combined with a weir at the surface to measure flows leaving the rain garden. An intermediate flume will be installed to partition flow losses between the channel and rain garden. Compared to flows exiting the bioretention cells, a complete mass balance will be possible [4].

Depending upon collection setup and available budget, the remaining eco-roofs may also be monitored for flow. This could provide an unmatched record of how state of the art installations of hydrologic stormwater control measures can substantially eliminate runoff from roof surfaces in urban settings.

The meteorological data such as rainfall, evaporation, humidity and temperature around the Civil Structure Experimental Building Complex will be measured by using the mini meteorological station on the roof of South Building. The measured data will be used for analyzing the effects of the eco-roofs and the LID facilities in the courtyard.

88.5 Conclusions

The improved LID techniques are used to design the LID facilities of the Civil Structure Experimental Building Complex at Shenzhen University. The eco-roofs use advanced media and innovative outlet controls, and it will also advance eco-roof engineering to levels unmatched by current technologies. The bioretention cells to treat grey roof will provide a broader evaluation and comparison of the potential for advanced bioretention systems. The eco-roofs and the LID facilities in the courtyard form a good water circulation from the stormwater management to utilization of the rainwater in the source. The multifunctional detention pond can not only regulate the stormwater, but also be used as landscaping pond. The eutrophication of the detention pond will be solved by the innovative design by the international team. In this way, the LID facilities of the Civil Structure

Experimental Building Complex will advance the state of the science and engineering in developing and deploying cost effective LID stormwater control measures.

Acknowledgments The research was supported by Fund of Land Investment & Development Centre of Shenzhen Works Bureau for Rainfall Usage Study of the Longhua No. 2 Line Project (Contract No. 2007139). The authors gratefully acknowledge Prof. Haiyan Ming, Prof. Zhu Ding and Prof. Yongning Niu of College of Civil Engineering, Shenzhen University, Mr. Penggao Li of the Institute of Architectural Design & Research, Shenzhen University, and Mr. Zhiwei Li of Shenzhen Linwailin Landscape Engineering Co., Ltd.

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Part VII
Traffic Planning, Logistics and Supply Chain Management

Chapter 89
Study on Multi-Resolution and Multi-Objective Site Selection Model for Logistics Distribution Centre

Lian-fu Jiang and Yong-jie Cui

Abstract According to the idea of multi-resolution model, the objective of the paper is to establish site selection model through the combination of qualitative and quantitative site selection methods to get the best site selection scheme of distribution centers. The primary site selection scheme is obtained by using Analytic Hierarchy Process which analyses the macro factors influencing the site selection. After the primary selection, the mixed integer programming is used to get the final site selection scheme. In the mixed integer programming model, besides basic influencing factors, environment protection, distribution centre management and customer satisfaction are considered. Genetic algorithm is used to solve the models which would be calculated in Matlab software to ensure the accuracy of model solution. In the end of the essay, the case study analysis illustrates that the effective combination and integration of qualitative and quantitative site selection methods could make the site model more comprehensive, more accurate and accord closer with practical situations.

Keywords Multi-resolution site selection model of distortion center • Analytic hierarchy process • Mixed integer programming model • Genetic algorithm

89.1 Introduction

As the key node in the supply chain system, logistics distribution center is the modern logistics infrastructure which integrates many services including warehousing, packaging, product processing, distribution, information processing etc. Any strategic decisions concerning logistics distribution centers will make long-term influence on the performance of the enterprise. So it becomes the key issue which specialists and

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_89,

entrepreneurs pay much attention on that how to select the locations of distribution centers effectively in order that the performance of logistics system and logistics service level could improve dramatically with the minimum cost.

Zhou Ailian, Li Xuhong, Mao Haijun divided site selection planning into several periods in order to get the best decision sequence by using dynamic programming method [1]. Chang Yanjie narrowed the selection field through mixed integer programming model, then used analytic hierarchy process to ensure the final site selection scheme [2]. Zhu Chaocai established a bi-level programming model of site selection which takes potential competitive factors into consideration [3]. Zhang Liyan, Ma Jian, Sun Yan who introduced multi-resolution, the economics concept, into the research field of location selection of logistics distribution centers, proposed to get the optimal location scheme gradually from macro-level site selection to micro-level location determination [4].

Traditional site selection methods of distribution centers generally consist of qualitative methods which consider the influencing factors of location decisions systematically and comprehensively with subjective judgment influence of experts and quantitative approaches which could help get the objective and accurate results but involve limited factors influencing site selection scheme. On the basis of the idea of multi-resolution, the paper proposes to establish site selection model by combining and integrating qualitative and quantitative location selection methods to get the optimal site selection scheme of distribution centers. The primary site selection decision could be made by using analytic hierarchy process which analyses the macro factors influencing the site selection of logistics distribution centers. Then the mixed integer programming model which takes the influencing factors including transportation cost, construction cost, environment protection, distribution centre management, service level and customer satisfaction into account is used to get the final site selection scheme. Genetic algorithm is used to solve the models which would be calculated in Matlab software to ensure the accuracy of model solution. In the end of the paper, the case study analysis illustrates that the multi-resolution site selection model could make site selection schemes more comprehensive, more accurate and accord closer with practical situations.

89.2 Multi-Resolution Site Selection Model

89.2.1 Multi-Resolution Modeling

Multi-Resolution Modeling (MRM) means that to solve practical problems, models should be made in all levels and dimensions in order to obtain efficient and accurate modeling cluster. When MRM is applied to the research field of selecting locations of distribution centers, site selection models should be built in three levels, namely macroscopic level, mesoscopic level and microscopic level. The more macro the models are, the more abstract and general the influencing factors considered are. On the other hand, the effective establishment of micro models depends on a large amount of accurate and real statistics.

89.2.2 Analytic Hierarchy Process

Based on mathematics and management theory, the Analytic Hierarchy Process (AHP) is a structured technique for organizing and analyzing complicated decisions by combining qualitative and quantitative methods. According to the requirements of decision objects, the hierarchy decision system is firstly established to describe the elements relating to the decision problem [5]. Then in the light of concrete data and judgment criteria, decision-makers build assessment matrixes to systematically evaluate the various elements by comparing them to one another at a time, with respect to their impact on an element above them in the hierarchy. A numerical weight is derived for each element from the assessment matrix, allowing diverse and even incommensurable elements to be compared to one another in a rational and consistent way. In the final step of the process, numerical priorities as the optimal decision-making basis are calculated for each of the decision alternatives which represent the alternatives' relative ability to achieve the decision goal.

89.2.3 Mixed Integer Programming Model

89.2.3.1 The Objective of Distribution Center Site Selection

On the basis of meeting customer requirements, the traditional site selection model for distribution centers whose objective is to minimize transportation costs of the location selection scheme only takes the elements influencing cargo transportation expenses into account. The essay improves the traditional model by taking the total costs including transportation expenses, capital construction cost, logistics administration cost and environmental cost and customer satisfaction into consideration in order to make the model closer to the actual situation.

89.2.3.2 Distribution Center Site Selection Model

Objective Function

$$\mathrm{Min}\ f_1=\sum_{i=1}^{n}\sum_{j=1}^{m}c_{ij}x_{ij}+\sum_{j=1}^{m}\sum_{k=1}^{l}c_{jk}x_{jk}+\sum_{j=1}^{m}Y_j(F_j+E_j)+\sum_{j=1}^{m}\sum_{k=1}^{l}C_jx_{jk}+c\left(\sum_{i=1}^{n}\sum_{j=1}^{m}x_{ij}+\sum_{j=1}^{m}\sum_{k=1}^{l}x_{jk}\right)(1) \tag{89.1}$$

$$\mathrm{Max}\ f_2=\sum_{j=1}^{m}\sum_{k=1}^{l}\mu_{jk}(t_{jk})y_{jk}\,(2) \tag{89.2}$$

Formula (89.1) means to minimize the total cost of distribution center site selection; Formula (89.2) means to maximize the customer satisfaction.

Variable Description

i:supplier i, $i = 1 \ldots n$;
j:distribution center j, $j = 1 \ldots m$;
k:client k, $k = 1 \ldots l$;
x_{ij}, x_{jk}:the freight volume from supplier i to DC j and the volume from DC j to client k;
c_{ij}, c_{jk}:unit delivery cost from supplier i to DC j and the cost from DC j to client k;
d_{ij}, d_{jk}:the distance between supplier i and DC j and the one between DC j and client k;
X_k:the demand of client k;
Y_j:whether DC j is selected or not;
F_j:the capital construction cost of distribution center j;
E_j:the fixed environmental cost of distribution center j;
C_j:unit administrative management cost of distribution center j;
e:unit environmental cost per unit transportation distance;
t_{jk}:the delivery time spent between DC j and client k;
y_{jk}:whether DC j and client k have supply-demand relationship;
P:the total number of distribution centers needed;
μ_{jk}:customer satisfaction of client k whose cargoes deliveried by DC j;
$[ET_k, LT_k]$:the maximum delivery time range client k could endure;
$[ET_k^d, LT_k^d]$:the delivery time range client k expects;

Model Constraints

Formula (89.3) indicates that distribution centers as transfer nodes have no stock; Formula (89.4) expresses the total number of distribution centers needed; Formula (89.5) means that the goods of each customer needed are distributed by one and only distribution center; Formula (89.6) shows that potential distribution centers could deliver cargoes to clients only when they are selected; Formula (89.7) means that the cargo volume distributed is equal to each customer demand; Formula (89.8) ensures whether the distribution center is chosen to establish; Formulas (89.9) and (89.10) where M is an infinite constant indicate whether the distribution centers have supply–demand relationships with clients depends on the establishment of distribution centers; Formula (89.11) is the function of customer satisfaction.

$$\sum_{i=1}^{n} x_{ij} = \sum_{k=1}^{l} x_{jk} \tag{89.3}$$

$$\sum_{j=1}^{m} Y_j = p \tag{89.4}$$

$$\sum_{j=1}^{m} y_{jk} = 1 \tag{89.5}$$

$$y_{jk} \le Y_j \tag{89.6}$$

$$\sum_{j=1}^{3} x_{jk} = x_k \tag{89.7}$$

$$Y_j = \begin{cases} 1, & chooseDCj \\ 0, & else \end{cases} \tag{89.8}$$

$$y_{jk} = \begin{cases} 1, & x_{jk} > 0 \\ 0, & else \end{cases} \tag{89.9}$$

$$x_{ij}, x_{jk} \ge 0 \quad x_{jk} - MY_j \le 0 \tag{89.10}$$

$$\mu_{jk}(t_{jk}) = \begin{cases} 0 & , t_{jk} \le ET_k \\ (t_{jk} - ET_k)/(ET_k^d - ET_k), ET_k < t_{jk} \le ET_k{}^d \\ 1 & , ET_k^d \le t_{jk} \le LT_k^d \\ (LT_k - t_{jk})/(LT_k - LT_k^d), LT_k{}^d < t_{jk} \le LT_k \\ 0 & , t_{jk} \ge LT_k \end{cases} \tag{89.11}$$

89.3 Case Study

89.3.1 Primary Site Selection by AHP

A manufacturing enterprise prepares to build two logistics distribution centers in eastern China to raise delivery service level (Fig. 89.1). The basic statistics and relevant information of the distribution network have already been known (Table 89.1).

Through the assessment matrix calculation, the numerical weight is derived for each element in the criteria level as W = [0.119, 0.226, 0.127, 0.463, 0.062] which also passes the consistency test (Tables 89.2 and 89.3).

Based on the comprehensive scores of potential locations, the primary site selection scheme is Hangzhou, Shanghai and Wuxi.

89.3.2 Final Site Selection by Mixed Integer Programming

As the model in the paper is a non-polynomial hard problem, genetic algorithm which is a heuristic search that mimics the process of natural evolution to generate solutions

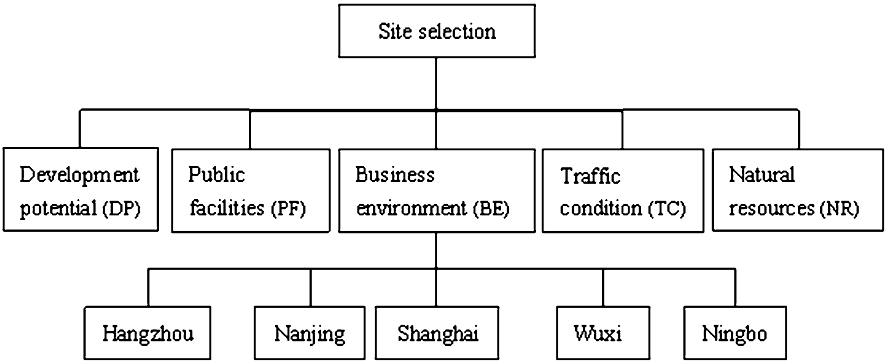

Fig. 89.1 Hierarchical structure

Table 89.1 Assessment matrix between objective level and criteria level

A	DP	PF	BE	TC	NR
DP	1	1/2	1	1/4	2
PF	2	1	2	1/2	3
BE	1	1/2	1	1/3	2
TC	4	2	3	1	9
NR	1/2	1/3	1/2	1/9	1

Table 89.2 Professional evaluation of alternative points

A^*	DP	PF	BE	TC	NR
Hangzhou	4	5	4	5	3
Nanjing	4	4	4	4	2
Shanghai	5	5	4	5	2
Wuxi	5	4	3	5	4
Ningbo	4	3	3	4	3

Table 89.3 The comprehensive scores of alternative points ($W^* A^*$)

Hangzhou	Nanjing	Shanghai	Wuxi	Ningbo
4.615	3.846	4.672	4.443	3.573

to optimization problems using techniques inspired by natural evolution, such as inheritance, mutation, selection, and cross-over is used to solve the site selection mode [6]. In the light of genetic algorithm codes, the calculation results could be obtained in Matlab software environment (Tables 89.4, 89.5, 89.6, and 89.7).

To get the balance between the total cost of site selection and customer satisfaction, Program 2 is chosen to be the final site selection scheme (Table 89.8).

Table 89.4 Unit freight cost from suppliers to DCs (yuan/t)

Unit freight cost	Shanghai	Hangzhou	Wuxi
Beijing	818	668	456
Chengdu	864	798	660
Shenzhen	868	758	736

Table 89.5 Management cost (yuan/t), capital cost (yuan) and environmental cost (yuan)

Distribution centers	Shanghai	Hangzhou	Wuxi
Unit management cost	29.86	25.80	19.35
Construction cost	3,673,768	3,503,547	3,483,899
Fixed environmental cost	256,321	241,300	189,580
Unit freight environmental cost	2.5	2.5	2.5

Table 89.6 Customer demand (t) and unit freight cost from DCs to clients (yuan/t)

Clients	Changzhou	Zhenjiang	Jinhua	Jiaxing	Wenzhou	Nantong	Shaoxing
Demand	9,905	5,853	16,658	12,156	19,810	3,602	18,459
Shanghai	39.44	70.76	121.94	35.38	177.15	32.35	72.09
Hangzhou	54.98	72.848	54.67	24.12	127.3	74.47	20.11
Wuxi	9.28	29	125.96	35.38	181.79	23.89	76.11

Table 89.7 Delivery time from DCs to customers and delivery time range

Delivery time	Shanghai	Hangzhou	Wuxi	Maximum time range	Expected time range
Changzhou	2.25	2.88	0.98	[0.8, 2.5]	[1.0, 2.0]
Zhenjiang	2.87	3.06	1.62	[1.5, 3.5]	[2.0, 3.0]
Jinhua	3.5	1.97	3.97	[1.5, 4.5]	[2.5, 3.5]
Jiaxing	1.56	1.23	1.9	[1.0, 3.0]	[1.5, 2.5]
Wenzhou	5.6	4.6	6.58	[3.5, 6.5]	[4.0, 5.0]
Nantong	1.72	2.98	1.72	[1.0, 3.5]	[1.5, 2.5]
Shaoxing	2.67	1.1	3.12	[1.0, 3.0]	[1.5, 2.5]

Table 89.8 Final site selection schemes

DC allocation program	Total cost ($*10^8$ yuan)	Customer satisfaction
Shanghai, Hangzhou	1.51	4.653
Hangzhou, Wuxi	1.41	4.738
Shanghai, Wuxi	1.77	4.901

89.4 Conclusion

Based on the idea of multi-resolution model, the paper proposes to improve traditional site selection models through the combination and integration of qualitative and quantitative site selection methods. The potential positions of distribution centers are primarily selected by using Analytic Hierarchy Process which analyses the macro factors influencing the target of site selection. Following the primary selection, the mixed integer programming model is used to get the final site selection program. Then the models are solved through genetic algorithm in Matlab software to determine the final selection scheme. By effectively combining qualitative and quantitative site selection methods, the model tries to integrate accuracy with comprehensiveness to accord close with practical situations. However, the study in the paper has some limitations that the model is presumed to be in the distribution network of a single product without considering competitive factors, stock of products and distribution network coordination. The author myself will do further research to perfect the site selection model of distribution centers and sincerely hope the paper could help other scholars do research in the site selection field.

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Chapter 90
Analysis of the Problems Existing in the Logistics Management of Construction Enterprises in China

Hong Zhang and Meiling Yang

Abstract Modern logistics management has become an effective means for all walks of life to improve the efficiency of material flow, accelerate the capital turnover rate, and reduce costs. In construction enterprises, it has proved to be a tendency of non-changeover to combine construction industry with thoughts of logistics management. However, when applied to construction enterprises, logistics management does have to produce all kinds of issues, and these issues do more often than not to be the critical factor of the development of enterprises. This text has collect vast materials though consulting so much document and data, and then sum up the issues of the development of logistics management of the construction enterprises of our country, such as logistics cost control, materials management, information systematic management, and HRM(human resource management). In this paper, it has also refined the four aspects of the problems, that is, each aspect of the big problems is also divided into several small problems in order to achieve a systematic and comprehensive purpose. At the same time, it can also help construction enterprises find the direction of improving logistics management, saving cost, increasing revenue and enhancing competitiveness and so on.

Keywords Construction enterprise • Logistics management • Issue

90.1 Introduction

The construction enterprise is an economic entity engaged in the production and operation of building products. It is a dominant force in the development of architectural productive forces and the technological progress of construction,

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_90, © Springer-Verlag Berlin Heidelberg 2014

and mainly engages in construction, civil engineering, line pipe installation works, new construction, expansion and renovation of fitment engineering and other activities [1]. Construction enterprise logistics is a series of logistics activities in which people can change the architectural design into building products and then make it reach to the owners, wholesalers and final consumers and eventually enable it to be used. Just like manufacturing, construction enterprise logistics also has the basic features of the circulation, namely, logistics, information flow and capital flow are intertwining and circulating with each other. Construction logistics management includes the external logistics management and the internal logistics management. External logistics management refers to the planning, organization, coordination and control of material flow, information flow and capital flow occurred by the related suppliers, designers, contractors and owners of construction projects. Internal logistics management includes the procurement management, transportation management, warehousing management, and material handling management of various goods in the production process of the construction project, and accompanied by the logistics information management and so on.

90.2 The Four Aspects of the Problems

From the functions of business management as well as the basic features of circulation, the logistics management of construction enterprises can be grouped into four areas: logistics cost management, material management, logistics information management and the management about people. The roles in the logistics management of construction enterprises are shown in Table 90.1.

Analyze the present status of logistics management of construction enterprises, and the common problems are summarized as follows.

90.2.1 The Logistics Costs of Construction Enterprise

According to the survey, logistics costs as a percentage of GDP has been high in China over these years, compared with developed countries there is still much room for development in the aspect of the logistics cost control. As shown in Table 90.2:

Table 90.1 The role of logistics management in the construction and production of construction enterprises

Item	Logistics cost management	Materials management	Logistics information management	Management about people
Function	Core, ultimate purpose	Main aspect, the key of control	Coordinate all parties, promote process effectively	Active subject, enhance the level of specialization and work efficiency

Table 90.2 Logistics costs as a percentage of GDP (%) of China compared to the U.S. from 2000 to 2009

Item	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Average
China	19.4	18.8	18.9	18.9	18.9	18.6	18.3	18.4	16.9	18.1	18.5
United States	10.1	9.5	8.7	8.5	8.6	8.6	9.9	10.1	10.5	7.7	9.2

Data sources: China Logistics and Purchasing

Whatever they are logistics companies or construction companies, how they optimize the allocation of their own logistics resources, how they implement management and make decision accurately, and how they gain maximum benefit at minimum cost are all serious problems enterprises must face.

From the production function, the total cost of construction enterprise logistics includes the costs of procurement, transportation, storage, and inventory holding. The procurement cost refers to all the other costs except the raw materials purchase costs that the construction enterprises must pay for in the procurement process, including travel costs, order processing fees, communication fees and so on. Transportation costs include the cost of automobile transportation, the maintenance fees of transportation equipment, and other transportation costs. The storage costs include costs of loading and unloading, inspection, storage, and the replenishment. Inventory holding costs means the cost which changes along with the change of the inventory number in the production process, including the capital costs occupied for holding stock of goods, inventory costs (such as payment of taxes, insurance premiums, etc.), storage costs (such as public warehouse storage fees), inventory risk costs (such as loss costs, shift positions cost) and so on.

The awareness of logistics cost management of most construction enterprises is still weak, few logistics costs have been listed separately in the existing enterprise accounting system, and various items of the logistics costs are scattered in the different accounts of the corporate cost accounting, so managers can't see the hidden cost of logistics, resulting in a tremendous waste which is called "the third profit source waste". The problem existed in logistics cost management of construction enterprises in China was showed as follows:

90.2.1.1 Some Necessary Record of Logistics Costs Is Missing

Although many scholars have given detailed analysis and calculation methods for the cost of construction enterprise logistics management, such as Guoping Dan used the method of activity-based costing to calculate the cost of logistics enterprises [2], just very small construction enterprises have noted these potential and huge costs. Senior managers tend to believe that the core competitiveness of enterprises is not here, so there is no need to put too much energy, resulting in a lot of logistics costs have not been recorded. Definitely speaking, the total cost of logistics costs of the evaluation system of building enterprise engineering economic are not listed separately, the transportation costs, storage costs, inventory holding costs, information costs, staff salaries and other expenses are scattered in other costs, so all of these problems make enterprise can't have a comprehensive record of the surface and hidden logistics costs, can't have a comparative analysis of the cost of logistics, and can't conclude the enterprise logistics cost, resulting in the so-called "logistics iceberg", that is the management can only see a small amount of logistics costs floating in the face and turn a blind eye to the hidden logistics costs, such as logistics infrastructure costs, the costs of construction companies using their own vehicle transporting materials and using their own warehouse to storage materials, the costs of using their own person, and so on.

90.2.1.2 Component of Logistics Cost Is Not Clear

There is no effective control of logistics costs, especially the internal logistics costs. In the logistics management of construction enterprises, the costs incurred from the procurement, transportation, warehousing, loading and unloading, outsourcing, logistics, and infrastructure construction should be counted to the logistics costs of corporate financial accounting. Construction enterprises are not clear on the composition of the logistics costs, and the situation that logistics costs can't be fully grasped is more, such as residues in the building materials maintained in warehouse, transporting of building materials, loading and unloading materials, warehouse management, equipment maintenance and the costs happened in logistics and transport process and other costs incurred. Due to the composition of logistics costs not explicitly indicated, the case that these costs are neglected in the financial accounting often happen.

90.2.1.3 Logistics Cost Performance Evaluation Is Not Practical

Logistics cost performance evaluation is to use methods of statistics and operational research, use specific indicators of system and contrast to uniform evaluation criteria, through qualitative and quantitative analysis to make objective, fair and standard comprehensive evaluation to the out-put consumed cost-effectiveness of logistics resources after taking certain control measures to the logistics activities of the enterprise in a certain period [3]. Construction companies do not have the theory of the performance evaluation of logistics costs applied to the evaluation system of the building works, and business managers often according to their own understanding and experience to control logistics costs, so that there is no systematic evaluation methods and standards used to logistics costs. Managers are lack of scientific and accurate knowledge to logistics costs. They can't find the problem in a timely manner, can't make the adjustment of the management methods, and finally can't effectively reduce the unnecessary logistics costs.

90.2.2 Materials Management

The materials management in construction projects refers to the whole management of the planning of the construction enterprise production, purchase orders, transportation organizations, inventory custody, reasonable supply, and recycling of a variety of materials required for production and management activities, etc. [4]. The smooth conduct of the materials management helps to ensure timely supply of construction enterprises supplies, accelerate cash flow, reduce procurement costs, reduce material consumption, save administrative costs, and improve management systems. Problems in the materials management process are as follow:

90.2.2.1 Procurement Quality Control Is Not in Place

In materials management of construction enterprises, the purpose of purchasing management is to ensure at the proper quality the construction enterprises can at the right price procure appropriate number of materials from the appropriate vendor at the right time, and to ensure a smooth start and process of the construction project. Under the traditional procurement model, the process of building enterprise materials management department access to raw materials from suppliers is too simple, the same raw materials can be gained from a variety of suppliers, the quality of the materials vary, the standard of the procurement of goods only according to national and industry standard of the materials to check the purchase, the work of the purchaser and supplier do not open, the purchaser can't participate in the supervision of production of building materials, thus all of these weaken the purchaser's ability to identify and control the quality of production. When the user's needs change, the purchaser must re-adjust the demand relationship and re-select suppliers. Due to poor response capabilities, materials can't be supplied timely so that it will delay construction duration and bring great economic losses to construction enterprises.

90.2.2.2 The Cooperative Relationship Between Construction Enterprises and the Suppliers Is Not Solid

Three reasons led to the instability in the cooperative relationship between the construction enterprises and their suppliers. Firstly, it is decided by the project itself. Due to the short time limit for a project, long life cycle, and the contractor assumes projects is also one followed by one, and also because different projects cause different demand for raw materials; therefore, construction enterprises can't have long-term stable cooperative partnership with suppliers. Secondly, it is impacted by the different degree of information technology. Some material suppliers own modern management information systems for supply of material, but because construction enterprise has no logistics management information system, it leads to the information can't be linked between enterprises and their suppliers, information resources can't be shared, with the addition of construction projects often influenced by the owner, design, supervision, climatic factors and geographical environment, it also leads to the construction enterprises can't be able to carry out accurate, timely logistics management, and finally logistics costs can't be controlled effectively [5]. Thirdly, there have not a set of scientific and modern procurement management system. Traditional procurement focuses on how to conduct business transactions with suppliers to gain low-cost procurement. The traditional procurement process exist a typical non-symmetric information game phenomenon; that is the purchasers retain their private information as possible as they can, but to the suppliers they will hide their information in competing process. This is not conducive to the purchaser and supplier to entering into a long-term collaborative relationship. However, using modern procurement management model, changing purchase from stock purchases to purchase orders, making procurement management change to the external resource management, building long-term relationship with suppliers, and penetrating procurement activities to the vendor's product design and product quality control process, in addition, applying to establish strategic partnerships with few suppliers to continuously improve the quality of products and services and promote common development of enterprise and suppliers, these will be no doubt that it will take advantage for enterprises to enhance their competitiveness.

90.2.2.3 Warehouse Management Can Be Improved

Building materials warehouse management is mainly responsible for the custody of the building materials, and timely supply of construction materials, to ensure construction projects build smoothly. The production of construction enterprises need great number of supplies, transportation costs are high, and inventory finance are also very big, so learn from the modern logistics management, vendor managed inventory (VMI), construction companies and suppliers can establish a good strategic partnership by vendor managed inventory to achieve the minimum total cost. Vendor managed inventory is not the question who will pay for the cost, but how to work together to reduce the total cost of construction enterprises. Design vendor managed inventory system elaborately can reduce the level of construction supply chain and inventory, reduce costs, increase cash flow rate, ensure the quality of construction products, accelerate the construction schedule, and share the transparency of needs and access to higher trust with suppliers.

90.2.3 Logistics Information Management

The purpose of building enterprise logistics information management is extracting the logistics-related information from the flow of materials of construction companies and products transaction process, and then use to store, process, summarize, analyze, and process control to adapt to business needs. On the one hand, it serves for the enterprise's own management; on the other hand, it serves the needs of customers. In China, logistics information systems management theory of construction companies is not yet complete. A lot of information transmission and management methods of these companies are still very backward, and the supporting infrastructure is also very lack, not to say computer full control technology. The vast majority of enterprise warehouse management did not use the advanced technology of computer network control, the statistics of the access of the goods often take personnel transcribe, some computer equipment of the enterprise is just used to do a simple project contract, file storage operations. What's more, feedback system of material inventory information is less time-sensitive and the regulatory capacity of stocks is also very weak; as a result, enterprises pay a lot of manpower, material and financial resources in inventory management. In the supply chain, among enterprises, because the information system is not incomplete, a variety of suppliers, contractors, and wholesalers can't achieve the rapid transmission of information and exchange. Due to changes in demand, it is difficult to carry out timely adjustments to the requirements of the construction production, definitely, it will spend a lot of time and costs, and it's not conducive to the establishment of credit and good cooperative relationship among the supply chain companies.

90.2.4 Human Resource Management

At present, the logistics management of construction enterprises faces shortage of professionals. In construction enterprises, as the auxiliary personnel of the production, his position in the enterprise was placed to be minor, and it is unable to absorb the technical personnel. In the enterprise, whose people who not only understand information technology but also understand the logistics management technology; not only understand economic management but also understand the law are rare. Construction enterprises generally would not think about absorbing talents of the direction of logistics management. In the field of logistics management of construction enterprises, person from logistics management is also not a small gap.

In addition, professional training is extremely shortage. Construction workers are often impacted by their masters, and gradually produce an attitude of valuing experience and lightening scientific theories. In some construction enterprises, it exists the phenomenon of the aging of personnel knowledge, the phenomenon of people unwilling to accept the concept of modern logistics management, the phenomenon of lack of logistics management system and professional training, the phenomenon of senior management often judging from experience, and other phenomenon such as there is no scientific and rational performance evaluation standards and staff incentives policy, managers can't encourage innovation, can't enhance the sense of responsibility and a sense of belonging of the employees, and so on.

90.3 Conclusion

Logistics management is not only a technology but also a method. Logistics management is directly related to the economic interests of the enterprise and to construction enterprises. There is no doubt that it will be a huge "the third profit source", if they can identify and deal with the issue of logistics management well. The ultimate goal of the logistics management of construction enterprises is to control costs and increase profits. Referencing the theory of modern logistics management in logistics management, enterprises can make optimization of self-structure, and establish logistics cost management system, performance evaluation systems, logistics management information systems, and supply chain system, and they can also build long-term strategic partnership with suppliers, contractors, and wholesalers, and all of these are important experience and direction for construction enterprises to improve logistics management.

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Chapter 91
Methods of Traffic Impact Analysis for Large-Scale Residential and Commercial Construction Project

Lv Shen and Tian Feng

Abstract Traffic Impact Analysis (TIA) of the large-scale residential and commercial construction project plays an important role in keeping the balance between supply and demand of urban transportation and promoting rational urban development. Traffic demand forecast caused by the proposed project is one of most key tasks of TIA, which directly affect on evaluation results of TIA and traffic improvements. The traditional demand forecast model is macroscopic model which are mainly applied in the urban comprehensive transportation planning. Individual characteristics of trip behavior and microcosmic performances of urban road network are critical actions on the demand forecast of TIA, which are ignored in the macroscopic models. The purpose of this study was to develop the microcosmic traffic demand forecast model to predict the traffic demand caused by the proposed project. Integrating the tracking of moving vehicle with analogous analysis technique, the methods of the trip distribution and network assignment of TIA were put forward. Taking the traffic demand forecast of Daxin business building in Shenzhen as an example, the results indicate that the proposed microcosmic demand forecast method is feasible and effective to predict the traffic demand caused by the proposed project.

Keywords Traffic impact analysis • Traffic demand forecast • Trip distribution • Network assignment

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_91,

91.1 Introduction

The objective of Traffic Impact Analysis(TIA) is to quantificationally affect on urban transportation caused by urban land developments and alterations, to bring out the improvements and to reduce the impact on the circumjacent traffic load from land development [1]. In recent years, many large-scale residential and commercial construction projects have been built in big cities of China. It has greater effect on urban traffic than the ordinal commercial or residential project as the intensive and sweeping project in the cities. Therefore, A rational TIA will be importantly strategic significance to smooth the traffic, coordinate the relationships between urban land uses and transportation systems and promote the logical urban development.

The methods of TIA have been advanced with urbanization process and urban land development accelerated. Jiang et al. [2] put forward the method of Traffic Impact evaluation for large special events. Chen et al. [3] systematically described the results of the hongqiao hub traffic impact evaluation at the period of hub ontology planning, designing and the regulatory planning of surroundings. Huang [4] summarized the pros and cons of TIA conducted in Hong Kong and identified challengers and problems in China other cities. Zhou and Li [5] established an evaluating system composed of monomial indices and comprehensive indices to evaluate the traffic impact caused by large commercial project. Wang et al. [6] designed the traffic impact analysis procedure with traffic microscopic traffic simulation of VISSIM and took the western area of zhongguancun in Beijing as an example. With enacting Technical Standards of Traffic Impact Analysis of Construction Project, not only analysis scope criterion, evaluation period and evaluation methods of traffic impact degree have been indentified, but also higher requirements for traffic demand forecast, evaluation and optimization of improvement measures have been brought out. It is also important problems-solving during the TIA of the large residential and commercial project that how to rationally forecast the traffic demand caused by the proposed project and establish the improvements to reduce the impact on the urban traffic.

According to Technical Standards of Traffic Impact Analysis of Construction Project, this research puts forward the microcosmic forecast model to predict the traffic demand caused by the proposed project without the OD volume. Then, the traffic demand forecast caused by Daxin business building in Shenzhen is taken as example.

91.2 Traffic Demand Forecast Caused by the Proposed Project

The four-step traffic demand forecast method belongs to macroscopic model and the corresponding demand forecast software includes EMME/2, TransCAD, Cube and so on, which are mainly applied in the urban comprehensive transportation

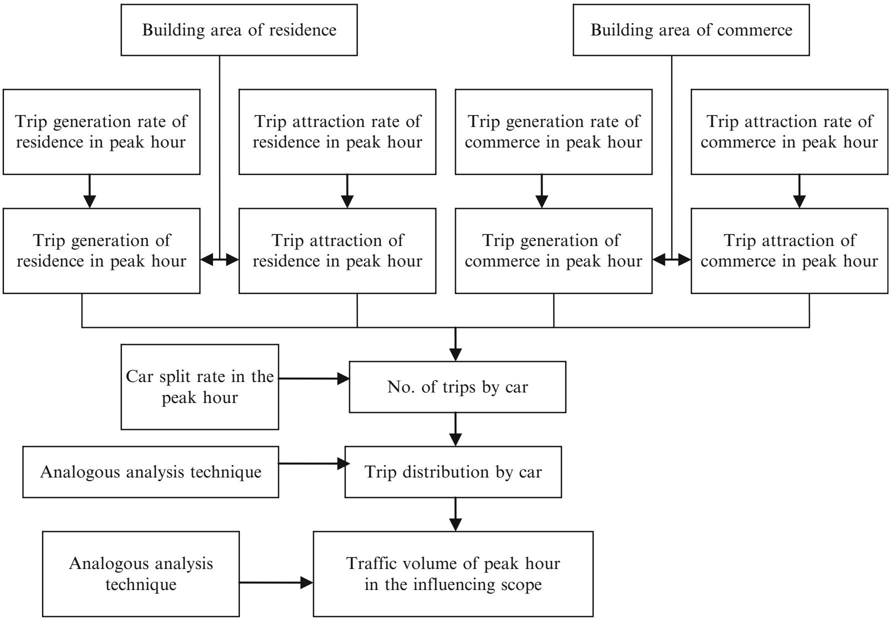

Fig. 91.1 Traffic demand forecast cause by proposed project

planning. Because the traffic demand caused by the large residential and commercial construction project belongs to the microcosmic forecast, it makes great difference between the forecast results and the actual traffic demand caused by the project using the above-mentioned macroscopic model. Therefore, the microcosmic forecast method should be research to predict the traffic demand caused by proposed project.

91.2.1 Traffic Demand Forecast Flow Chart

Traffic Demand Forecast method caused by the project consists of four major stages, as shown by Fig. 91.1.

91.2.2 Tip Generation and Attraction Forecast Caused by the Proposed Project

Trip generation and attraction are caused by residential and commercial land use respectively in the paper. Category analysis was used to forecast the number of trip caused by the proposed project. Trip rate of residence an commerce can be indentified by surveying the number of trips per 100 m^2 dwelling area and commercial area, which are similar to the large residential and commercial project of TIA in the scale and function. The formula can be expressed as follows.

$$P = \sum_k \alpha_k L_k \,; \quad A = \sum_k \beta_k L_k \tag{91.1}$$

Where P, A = trip generation and attraction in the peak hour caused by the proposed project respectively; L_k = residential and commercial building area of the proposed project respectively; α_k = trip generation rate of the similar residential and commercial land use per peak hour per 100 m^2 respectively; β_k = trip attraction rate of the similar residential and commercial land use per peak hour per 100 m^2 respectively.

91.2.3 Modal Split

The qualitative method was used to modal split in the paper. The future percentage of choosing the bus or car can be determined by comprehensive analysis of the current car or bus travel sharing rate, bus strategic goal and bus supplement planning in the analysis scope.

91.2.4 Trip Distribution

Macroscopic trip distribution models mainly include growth factor technique, the gravity model. Firstly, the whole and partial OD volume is required to calibrate the above-mentioned models. However there is often no OD volume when forecasting the traffic demand caused by the proposed project. Secondly, individual characteristics of trip behavior and microcosmic performances of urban road network are more important to predict the trip distribution of the proposed project than the whole characteristics of traveler and macroscopic performances of urban road network. Therefore, the growth factor technique and the gravity model are not appropriate to predict the trip distribution of the proposed project. From the point views of individual characteristics of trip behaviors and microcosmic performances of urban road network, the research design microcosmic method using analogous analysis technique and tracking of moving vehicles to predict the trip distribution of the proposed project.

1. Determination of investigated project
   In the analysis scope, the residential and the commercial project are respectively selected to investigate trip distribution, which are similar to the proposed project in the scale and function.

2. Identification of the critical routes and intersections
   By the field survey, the critical routes and intersections are distinguished, where traveler can enter in or depart from the investigated project in the analysis scope.
3. Tracking of moving vehicles
   In peak hour, surveyors are arranged to record vehicle identification number, car type and entry and exit time at entry and exit of the investigated project. At the same time, the vehicle identification number can be recorded by setting the video camera in each critical intersection.
4. Main access routes in the analysis scope and division of traffic zones
   The analysis scope is the region enclosed with the urban arteries. According to the above critical routes and intersection, main access routes in the analysis scope were distinguished. Then, the traffic zones were divided by analysis of reaching to district through each access route.
5. Trip distribution of the investigated project
   Based on the tracking of moving vehicles, the traffic volumes enter in or depart from the investigated project and the traffic volumes of main access route can be counted. According to the divided traffic zones, the trip distribution of the investigated project can be represented as

$$\eta_{Pk} = \frac{Q_{k1}}{Q_1}, \ \eta_{Ak} = \frac{Q_{k2}}{Q_2} \tag{91.2}$$

   Where η_{Pk}: the trip percentage from the investigated project to traffic zone k; η_{Ak}: the trip percentage from zone k to the investigated project; Q_{k1} : the traffic volume on the access road k caused by trip generation in peak hour; Q_{k2} the traffic volume on the access road k caused by trip attraction in peak hour; Q_1: total number of trips produced in the investigated project in peak hour; Q_2: total number of trips attracted to investigated project in peak hour
6. Trip distribution of the proposed project
   As the difference in the trip distribution between the proposed project and the investigated project were overlooked, the current trip distribution of the proposed project are the same as the investigated the project. Then, the percentage between the proposed construction project and the traffic zone in the future can be slightly adjusted on the current percentage by analyzing the alteration of urban land uses.

91.2.5 Network Assignment

The last step is the assignment of traffic flows to actual routes through the given network in the analysis scope. The results consist of traffic volume on the road segment and turning traffic volume of intersection. The conventional assignment approaches are based on the assumption that each individual choose the route perceived as being the best, that is, each individual minimizes or optimizes travel time or cost. However, when the analysis scope is relatively smaller, the actual individual behavior on the route selection mostly depends on out of changeless habit of traveler. It is assumption that the individual route selection behaviors of the proposed project are similar to the investigated project. Therefore, the percentages of assignment on the road network caused by the proposed project are the same as that caused by the investigated project.

1. Traffic volumes on the road segment are formulated as follow:

$$Q'_{j1} = P_c \times \frac{Q_{j1}}{Q_1},\ Q'_{j2} = P_c \times \frac{Q_{j2}}{Q_2},\ Q'_j = Q'_{j1} + Q'_{j2} \tag{91.3}$$

   Where: Q'_{j1}, Q'_{j2}: traffic volume on the road segment j caused by the trip generation, trip attraction of the proposed project respectively; Q'_j: the total traffic volume on the road segment j caused by the proposed construction project; P_c, A_c: trip generation,trip attraction of Passenger Car Unit(PCU) in the peak hour caused by the proposed project respectively.
2. Turning traffic volumes of the critical intersection are formulated as follow:

$$Q'_{mjk} = Q'_{mj} \times \frac{Q_{mjk}}{Q_{mj}} \tag{91.4}$$

   Where: Q'_{mjk}, Q_{mjk}:turning traffic volumes of turning k of entrance lane j at the intersection m caused by the proposed project, the investigated project respectively; Q'_{mj}, Q_{mj}: traffic volumes of entrance lane j at the intersection m caused by the proposed project and the investigated project respectively.

91.3 Case Study

91.3.1 Project Profile

Daxin business building lies in the intersection of Xuefu and Taoli street in Qianhai center, Nanshan district, Shenzhen, as shown by Fig. 91.2. It is a large residential and commercial project, of which the total area is 51,974 m^2 and the total construction area is 40,947 m^2 with commercial area of 11,000 m^2 and residential area of 29,947 m^2. Based on the Technical Standards of Traffic Impact Analysis of Construction Project, the analysis scope of TIA are enclosed by Yue liangwan road, Xuefu street, Qianhai street and Guimiao street. Combined with the built time, the forecast year is 2015.

Fig. 91.2 Location and the analysis scope of Daxin business building

Table 91.1 The number of trip generation and attraction forecast

Land use	Building area	Trip generation rate in peak hour	Trip attraction rate in peak hour	Number of trip generation in peak hour	Number of trip attraction in peak hour
	Squre meter	Passenger/100 square meter · hour	Passenger/100 square meter · hour	Passenger/hour	Passenger/hour
Residence	29,947	0.71	0.54	213	162
Commerce	11,000	1.5	1.5	165	165
Sum	40,947	/	/	378	327

91.3.2 *Trip Generation and Attraction Forecast of Daxin Business Building*

The Yang guang-zonglv district is chosen to be the investigated project by comparing to Daxin business building in the scale and the function. The number of trip generation and attraction can be predicted by using the Formula 91.1. The trip generation rate and trip attraction rate of the residence and commence can be indentified by survey at the Yang guang-zonglv district in the peak hour. The results are listed in Table 91.1.

Table 91.2 Trip generation and attraction by car in the perk hour

Land use	Number of trip generation Passenger/hour	Number of trip attraction Passenger/hour	Car mode split rate	Passenger load factor	Number of trip generation pcu/hour	Number of trip attraction pcu/hour
Residence	213	162	0.4	1.8	47	36
Commerce	165	165	0.4	1.8	36	37
Sum	378	317	/	/	83	73

Table 91.3 Trip distribution of investigated project

Main access routes	Traffic volume in peak hour(pcu/h)	Percentage of trip distribution (%)
Turn right to Taoli street	28	5.90
Turn right to Yue liang-wan road	240	50.80
Turn left to Yue liang-wan road	32	6.80
Through Xuefu street	82	17.40
Through Xuefu road then turn left to Qianhai street	14	3.00
Through Xuefu road then turn right to Qianhai street	15	6.40
Through Xuefu steet, turn right to Qianhai street, turn left to Guimiao street	23	9.70

91.3.3 Modal Split of Daxin Business Building

The travelers by bus reach to 52 % of motorized travel mode, the others by car reach to 48 % of the motorized travel mode at present. Integrating the bus strategic goal with the bus supplement of the analysis scope in the forecast year, the bus – sharing Ratio is predicted to 60 % of motorized travel mode in the forecast years. So trip generations and trip attractions by car are shown in Table 91.2.

91.3.4 Trip Distribution of Daxin Business Building

The Yang guang-zonglv district is chosen to be the investigated project. Because the exit of Yang guang-zonglv district lies in the Xuefu street where exit and entrance of Daxin business building lie in, it is assumption that the trip distribution of Daxin business building is the same as trip distribution at exit of Yang guang-zonglv district. Based on the tracking of moving vehicle, the main access routes and traffic volumes are shown in Table 91.3. Based on that the above access routes can

Table 91.4 Trip distribution of Daxin business building in 2015

Traffic zone	Qian hai and Bao an	Fu tian and Luo hu	She kou	Hou hai	Science park and Nan shan CBD
Percentage	50.80 %	27.10 %	6.80 %	6.40 %	8.90 %

Table 91.5 Traffic volume on the road

Road	Bidirectional traffic volume(pcu/h)
Yue liang-wan	89
Gui miao	15
Qian hai	10
Xue fu	27
Tao li	9

reach to the district of city, the five traffic zone can be divided (seen Table 91.4). As the forecast in the near year is carried out in built-up district, great change of urban land use can not take place., which make it reasonable that the future trip distribution is equivalent to the current.

91.3.5 Network Assignment of Daxin Business Building

Based on the tracking of moving vehicle, the traffic flows in the analysis scope are assignment by using the Formula 91.3 and 91.4. The results are shown in Tables 91.5 and 91.6.

91.4 Conclusion

Traffic demand forecast caused by the large residential and commercial project is one of most important tasks of TIA, which directly affect on evaluation results of TIA and traffic improvement measures. Not only there is no OD volume, but also the traffic demand of TIA can not be accurately predicted using the macroscopic traffic demand forecast models. Based on the individual behavior of trip route selection, the microcosmic traffic demand methods are brought forward by tracking of moving vehicle and analogous analysis technique. Then traffic demand forecast cause by Daxin business building in Shenzhen is taken as example, which indicated the above-mentioned methods are feasible and effective.

Table 91.6 Turning volume of intersection

Entrance lane		East			South			West			North		
Direction		Left	Straight	Right	Left	Straight	Right	Left	Straight	Right	Left	Straight	Right
Xuefu and Yue liang-wan	Volume	6		42			6				37		5
Xuefu and Qianhai	Volume		6				5	2	7	5			2
Guimiao and Yue liang-wan	Volume					3	2				3	3	
Guimiao and Qianhai	Volume		2	5					3		5		

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Chapter 92
A Critical Review of Vulnerability of Transport Networks: From the Perspective of Complex Network

Zhiru Wang, Albert P.C. Chan, and Qiming Li

Abstract Vulnerability in transportation networks is a problem of an insufficient level of service not just a safety problem. This paper reviews the methodologies used in vulnerability analysis of transportation networks and particularly focuses on the application of complex network theory in this field. Considerable researches have been conducted on transport vulnerability, covering from theory to practice. However, only a few comprehensive reviews literatures on vulnerability of transport networks from the prospective of complex networks. The purpose of this paper is to fill this gap. This paper shed some new light concerning to the main issues in vulnerability analysis of transportation network like topological methods, attack strategies, and vulnerability indicators. The challenges for vulnerability research are to develop robust and vulnerable measure methods which need to combine physical structures and social functions of transportation networks, to test the efficiency and preciseness of the assessing models, to explain the results from engineering view. These challenges are common to the vulnerability analysis in other real-world networks.

Keywords Vulnerability • Transport network • Complex network

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_92,

92.1 Introduction

In an era where damage from natural or technological disasters routinely cost billions of dollars, impacting local, regional, and international economics. Transportation networks provide citizens, industry and trade nationwide. Transportation networks are becoming more and more interconnected and interdependent. Transportation systems threats emerge from nature, technology, and humans, exacerbated by complexity and population growth. Disturbances in one infrastructure often traverse to other dependent infrastructures and inflict large consequences to health, safety, security and the economy [1]. So, researchers transfer their focus on vulnerability analysis of transportation networks.

Vulnerability of transportation networks has been studied so far in different ways, from individual links performance [2] to Game Theory approach [3, 4], from risk related analysis [5] to user inequity implications of road network [6]. However, all these classical approaches haven't taken into account of different attack scenarios which may affect the performance of the network under attacks. The system vulnerability is often measured by summing vulnerability value of each individual links, but the system-wide impacts and interrelated impacts could not be measured in this way.

Complex networks theory [7] help in considering the functionality of all the elements in the system related with the response of the whole network to their attacks. In the second part we will give out detailed review on vulnerability of transportation networks particularly in terms of complex networks theory.

The purpose of this article is to review existing knowledge on vulnerability of transport networks particularly from the perspective of complex networks. We conduct our review from the main issues in vulnerability of transport networks analysis. But firstly, we distinguish the related terms risk, reliability and vulnerability in Sect. 92.2. Based on this step, the review can be conducted focused on the vulnerability researches, which is presented in Sect. 92.3. Arguments and conclusion are presented in Sects. 92.4 and 92.5.

92.2 Distinguish the Related Terms

92.2.1 Vulnerability Versus Risk

In the framework proposed by the scientific community under the umbrella of the International Strategy for Disaster Reduction (ISDR), the term risk is defined as the "probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environmental damage) resulting from interactions between natural or human-induced hazards and vulnerable conditions" (ISDR [21], p. 16). Vulnerability is generally perceived as the predisposition of societies to be affected and incapacity to cope with disasters [8].

A mathematical expression for risk in terms of hazards and vulnerabilities is represented as follows:

$$\text{Risk} = \text{Hazard} * \text{Vulnerability} \tag{92.1}$$

Where * represents the function that describes the combination between the hazard and the vulnerability. Hazard is the probability or possibility of the disasters, which can be classified as natural, technological and social or human-induced causes [8]. The same definition between two terms could be found in [9].

So, it could say that vulnerability and risk are related concepts [9]. Risk is a composite of the probability for an incident to occur and the resulting consequences, should the incident occur [10]; while vulnerability is a factor that contributes to increasing the risk [9].

92.2.2 Vulnerability Versus Reliability

It is widely accepted that the term reliability can be defined as the probability of a device performing its purpose adequately for the period of time intended under the operating conditions encountered [10]. This means that reliability studies are generally concerned with probability, but [11] regarded the vulnerability is related to the consequences of link failure which is different from reliability.

Reliability describes the ability to continue to function of the network under disturbance. Vulnerability describes the susceptibility to fail to function of the network under disturbance. A reliable network and a vulnerable network exhibit a converse degree of operability [9].

Vulnerability analysis of transportation networks regards the networks as a whole and involves identifying a spectrum of incidents and critical components in the networks. But reliability analysis of transportation networks regards the performance ability of individual link/route which could not meet the interconnected and interdependent of the systems, or it could not demonstrate the impact on neighborhood network which would also have evil effect on the system.

A figure can be used to conclude the distinguish analysis between risk, reliability and vulnerability (see Fig. 92.1). Vulnerability of transportation networks is regarded not from a safety point of view, but rather as a problem of reduced accessibility that occurs because of various reasons. An incident is an event, which directly or indirectly can result in considerable reductions or interruptions in the serviceability of a link/route/transport network [10].

92.3 Vulnerability of Transportation from Complex Network Theory

When we try to identify the reaction of transport networks under disturbance, the following five problems need to be solved as which are the necessary problems to be solved in an vulnerability research: (1) weighted or un-weighted networks

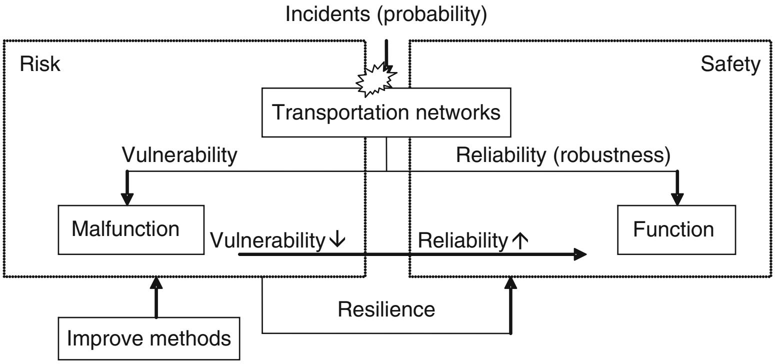

Fig. 92.1 Difference between risk, vulnerability and reliability

(2) topological methods; (3) small world or scale-free properties; (4) attack strategies; (5) indicator of vulnerability. Consequently, we conduct our review following these main problems need to be solved.

92.3.1 Weighted or Un-weighted

Weighted and un-weighted networks are basement for the current studies, because different choice will affect the results and conclusions of the studies. Weighted network is a combination approach which considers two sides of transport networks: physical structure topological and social functions, which provide services to the society. Un-weighted network just consider the physical structure topological of the transport network but ignore its social functions.

But most literatures study the vulnerability of transportation networks based on complex network theory use un-weighted graph. In other words, they study the vulnerability of transportation network only focusing on the physical structure, but fail to consider its social functions, (e.g. travel time, frequencies and traffic flow). Han and Liu [12] studies vulnerability of un-weighted subway networks in ten cities in China. Berche et al. [13, 14] and von Ferber et al. [15] focus on un-weighted public transport networks vulnerability in 40 cities in the world.

In the aspect of weighted vulnerability of transport networks, Lamanna [16] uses travel time and frequencies of services as weight of three fixed networks (U-Bahn, S-Bahn and Regional Bahn) in Burlin and finds some of these sub-systems and entire system have small world and scale-free properties.

92.3.2 Topological Methods

There are four topological approaches used to represent real-world transportation networks: L-Space, P-Space, B-Space, and C-Space. L-Space represents stations by nodes; link between nodes indicates that there is at least one route services the two neighbor stations [13, 16–18]. In this representation, the removal of a station node does not otherwise interfere with the operation of a route that includes this station. It rather splits this route into two (operating) pieces [13]. P-Space is defined by nodes which are stations and links if the two neighbor stations are serviced by a common route [13]. B-Space is a bipartite graph, where routes and stations are both represented by nodes. The set of station graph is called P-Space as we have mentioned. The set of route is called C-Space where any two routes are neighbors if they share a common station [15]. The same network properties would have different means in different topological methods, so which topological method will be chosen depends on research objectives.

Three type topological methods L-Space, P-Space, and C-Space were used to analysis the characteristics of sub-system (U, S, U + S) and entire system (U + S + B) in [16] and measure the resilience of public transport networks against attacks [15].

92.3.3 Small World and Scale-Free Properties

There are two contrary analysis results existing, the first is real-world transport networks have small world and scale-free properties, the second has contrary conclusion. All the sub-systems and entire system represented by L-Space, P-Space, and C-Space follow a power law, and which can be defined as scale-free. But the values of L and C show the small world phenomenon only on C-Space for all the sub-systems and entire system [16]. Most of 33 subway systems are scale-free (2.10–5.22) and small-worlds networks in [20].

Even the largest networks in their database are too small to draw any general conclusions to their class of complexity [19]. They find the mean degree and mean shortest path length is not characteristic of traditional small-world or scale-free networks, they explained this phenomenon: since a network that grows by adding chains not by adding single vertices. Not all the public transport network under their consideration are small world or scale-free networks which depends on the topological method used [15].

92.3.4 Attack Strategy

Disturbances to transport networks are coming from technology failure, bad weather and social incidents. Most of these incidents are random, just a little of them are targeted attacks. But those occasional happened targeted attacks would cause more huge loss than those caused by random incidents.

The most common method to simulate random incidents is the way presented by [13], in which they remove nodes starting from the unperturbed network and eliminating at random step-by-step 1 % of the nodes up to 1. They find (1) different PTNs react on random removal of their nodes in different, which range from rapid abrupt breakdown to a slow almost linear decrease; (2) vulnerability of PTNs depends on the applied indicator: S = N1/N or <l−1> (represents the mean shortest from i to j after attack). Some literatures measure the impact of random failure to three fixed networks in Berlin by removing nodes following a probabilistic function of historical recording of failures in the system instead removing nodes entirely randomly [16]. This method could decrease the calculating time by computer but could not predict or calculate lose caused by those random incidents which have not happened before.

The types of targeted attacks strategies are abundant. Sixteen different scenarios to attack a network had been defined [13], like initial and recalculated degree, closeness, graph, stress, betweenness, clustering coefficient, next nearest neighbors and randomly removing a chosen neighbor of a randomly chosen node. They find the most effective scenarios which result in a fast decrease of the largest component size are those governed by betweenness, stress centralities, node degree, and number of next nearest neighbors. Lamanna [16] uses initial degree distribution (ID removal) as removing nodes order. All the sub-systems (U, S, U + S) and entire system (U + S + B) represented by L-Space and P-Space is very vulnerable to targeted attacks at its most critical nodes but is more robustness of criticisms on attacked stations represented by C-Space. This means that a failure or an attack at these nodes is critical both for the infrastructural connections and for the most efficient paths of travel. Many networks are vulnerable to targeted attack on high degree vertices, since these vertices play an important part in the overall connectivity of the network and robust to random attack. All the largest networks also proved to be able to survive the loss of high degree vertices before serious fragmentation [19]. By comparing result with two attacks, they find terrorists have also learnt the lesson of network theory.

Betweenness based attack strategies are often more harmful than Degree based attack strategies, because the former concentrates on reducing the total number of edges in the network as fast as possible whereas the latter concentrates on destroying as many shortest path as possible [12, 19]. Recalculated index based attack strategies are often more harmful than initial based attack strategies, as vertices play an important part in the overall connectivity of the network [12].

92.3.5 *Vulnerability Indicator*

Connectivity is a common used indicator for assessing the vulnerability of transportation networks which is an available way to ignore the difficult of data collection. Han and Liu [12, 13] and Berche et al. [13] quantify the vulnerability of subway networks in terms of relative size S of the largest connected component under the incidents, $S = N'/N$, where N and N' represent the numbers of nodes in the largest component before and after the incidents respectively. Some study takes number of cycles in a network, and the total number of vertices as vulnerability indicator [20]. They found that large scale networks are more robustness than small scale networks, because the former ones offer more alternatives to get from A to B. This is different from normal vulnerability analysis in complex networks. Berche et al. [13] use two indicators to measure network vulnerability. The first one is defined by: S = N1/N, with N and N1 being number of nodes of the network and of its largest component correspondingly. The second one is the mean inverse shortest path length defined by:

A mathematical expression for risk in terms of hazards and vulnerabilities is represented as follows:

$$< \imath^{-1} >= \frac{2}{N(N-1)} \sum_{i>j} \imath^{-1}(i,j). \tag{92.2}$$

In complex network view, there is a little researcher measure the vulnerability of transport networks by travel time, frequencies and traffic flow, which are considered as the social function side for providing service to society. But Lamanna [16] use travel time and frequencies efficiency measure the vulnerability which is defined by:

$$E_{TF}(G) = \frac{1}{N(N-1)} \sum_{i,j \in N, i \neq j} \frac{F_{ij}}{t_{ij}}. \tag{92.3}$$

where t is travel time between every pairs of nodes and F is the frequency of the services evaluated on the shortest path which maximizes the frequencies of services on the shortest travel time. This indicator combines both physical structure topologic character and social function of transport networks together.

92.4 Arguments

92.4.1 Topological Methods View

As nodes and links have different means in different topological networks, like nodes represents stations in L-Space but routes in C-Space. Therefore, removing vertex or route has different impacts on the connectivity of networks under different topological method. Generally, at least two neighbor links will be deleted if a vertex which is not the start or final point removed. But at least two vertexes will fail function if one link is removed.

Additionally, whether the transportation network under consideration has properties of small world or scale-free, how would be the networks reactions under attacks in some ways depends on the topological method they use. But most related researches use one type of the topological methods mentioned above. Although von

Ferber et al. [15] identified this phenomenon, they have not given more explanation about it. So two questions come to us: (1) why they are different? (2) Which topological is more effective and accurate? These problems still have not been faced.

92.4.2 Mechanisms View

Although some analysis have identified which are vulnerable and others, which are particularly resilient against attacks in transportation networks under their consideration, mechanisms behind this structural vulnerability have not been revealed.

92.4.3 Connectivity View

Although nodes i to j are connected their frequency may be changed by the malfunction of neighbor links which also could affect passengers, like the incident happened on 21st Oct 2010 at Yau Ma Tei Station in Hong Kong, the frequency of trains running between Jordan and Central was reduced to about 6 min, from the usual 2 min. Trains from Tsuen Wan station to Yau Ma Tei station had their frequency reduced to 4 min from about 2 min. This also needs to be considered.

92.4.4 Un-weighted Network View

Most of above mentioned literatures try to model and analysis public transportation networks vulnerability just from the physical structure, called un-weighted networks, but has not taken into account their social function, called weighted networks, like travel time, frequencies, and traffic flow. Hence, the general approach on real transport networks needs to extended to their social function in order to capture typical engineering features related with travel time, frequencies and traffic flow of services; to analysis how the relationship between transports networks dynamical components as travel times, frequencies of the services, traffic flow and network vulnerability.

92.5 Conclusions

Many kinds of topological approaches have been developed and they show different reaction to disturbance. Although some researchers have found that the most vulnerable nodes are different in different topological networks, the engineering explanations have not been given out. Among those assessing methods of vulnerability of transport network, which one is more effective and accurate? This empirical puzzle still needs to be tested by historical incidents. Connectivity is a common used indicator for assessing the vulnerability of transportation networks which is an available way to avoid the difficult of data collection. More social function indicator should be considered in vulnerability assessment.

Acknowledgements The research work for this paper is funded by the Hong Kong Polytechnic University Research Committee (Code No. G-u786). It is also partly funded by the National Natural Science Foundation of China (Grant No. 50878049, 51008073 and 71001027) the Priority Academic Program Development of Jiangsu Higher Education Institutions (PAPD).

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Chapter 93
Logistics Costs Control Model Based on Fuzzy Mathematics Analysis

Hongyan Li and Xiaojie Wu

Abstract Firstly, logistics costs and logistics cost control are introduced and analyzed, and then for many companies do not know the status of their total logistics costs and how the assessment of the level of integrated logistics costs. Based on the basic principles of fuzzy Mathematics analysis, let's take the southern China electronics manufacturer as example, the model of the new evaluation of enterprise logistics cost level was put forward. According to the score of the model to the cost of logistics enterprises, the reference of cost score and the level of logistics costs table can tell their own level of logistics costs and each cost level was given the appropriate measures, to provide the basis for the development of logistics cost control policy.

Keywords Logistics costs • Cost evaluation model • Cost score

93.1 Introduction

For enterprises, the significance of logistics cost management is to strengthen the effective control of expenses in the process of logistics activities to improve the business and socio-economic benefits. To Control is necessary to have an evaluation on the level of logistics and logistics costs, however, look at previous studies found that there were many cost control theory, such as target cost control, and system cost control, process cost control, the level of cost control, control theory

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_93,

can detect the cost of business level in some way, but is mainly focused on how to control costs, there is not a specialized evaluation models and theories on the level of business logistics costs.

Many companies want to improve their own logistics, but do not know the grade of their own logistics level, the need for improvement and the extent improvement. Based on this problem, I come up with a new and easy to operate logistics cost control model to provide a basis for enterprises to effectively control the cost of logistics by using fuzzy mathematical analysis.

93.2 Logistics Costs Literature Review

93.2.1 Foreign Logistics Costs Study History and Current Situation

To promote the rationalization and economic efficiency of the logistics, in-depth study of the cost of logistics is very important, in recent years, various foreign logistics cost theory is shown in Table 93.1:

Table 93.1 Foreign logistics costs study history and current situation

Research Scholar	Doctrine theory	Conclusion
Peter Drucker (1962)	Black mainland doctrine	Logistics was compared to a virgin land, the last virgin land to reduce the cost
Nishizawa syuu (1968)	Logistics iceberg said	Understanding of the logistics costs is a blank, or even false
Nishizawa syuu (1970)	"The third profit source" doctrine	When two major profit sources of resource areas and human potential is getting smaller and smaller and increasingly difficulty to develop exploration, the logistics play a role as the third profit source
Robin Cooper and Robert Karan [1] (1988)	Activity based costing	Achieve combination of Cost calculation and control to comprehensive cost management system
Howard T. Lewis, James W., Kerry Washington, and Jack D. The Stiller (1956)	Total logistics costs and benefits of backscattering	The reduction of the total system cost can increase the level of profitability. When a functional element of the interests to be optimized at the same time, it will cause the loss of the interests of one or several functional elements, and vice versa
Ford Harrisr T [2] (1913) Clark and Searf [3] (1960) Jinn-TsairTeng [3]	Inventory costs	(1) Production/inventory system; (2) inventory/distribution system; (3) production/inventory/distribution system; (4) inventory distribution system

93.2.2 The Concept of Logistics Costs

In 1992, the American Society of Management Accountants pointed out: logistics costs was produced in planning, implementation, control the costs incurred in the process of internal and external logistics activities, including in the costs incurred in the typical activities like procurement, transportation, warehousing, materials and inventory management, order processing, customer service, forecasting and production planning, related information systems, and other logistics support activities.

Here logistics costs also contains the costs incurred in order to obtain the physical among the logistics costs, the research of logistics costs starting point is no longer the transport phase after getting physical, but that kind of procurement stage as a starting point, it can be said a expansion of the concept of logistics costs.

According to the national standards The Constitution and Calculation of Business Logistics Costs, logistics costs represent the monetary performance of logistics activities in the consumption of materialized labor and living labor. That is cost produced of Products in the packaging, transportation, storage, loading and unloading, distribution processing, logistics, logistics management, cost the sum of human, material and financial and inventory-related occupancy costs of funds, goods, loss cost, insurance and tax costs.[1]

In summary, this article advice we should learn from foreign advanced logistics cost point of view, make the costs incurred in order to obtain the physical credited to the cost of logistics. Costs incurred in order to obtain the kind mainly Manifested in the transaction costs for the purchase of the negotiations, signing and so on.

93.2.3 Logistics Cost Components

Manunen [4] think the constitution of logistics costs be: transportation costs, sending costs, customs costs, warehouse costs, purchasing costs, ordering costs, transaction costs, the cost of materials management in production process, sales costs. Lin et al. [5] believe that the main logistics costs were inventory storage costs, purchasing costs, order processing costs, transportation and warehouse costs.

James R. Stock and Douglas M. Lambert [6] thought that inventory-carrying cost of capital is part of the inventory holding costs in the logistics; the cost is also unique in the logistics process. Ruud Teunter and Erwin van der Laan [7] considered that when analyze the average cost inventory models, people always accustomed to multiplied the discount rate by the product occupied funds, and coupled with the actual expenditure of the inventory cost rate, and In this way, the cost of capital will be included.

[1] National standard:"Composition and calculation of enterprise logistics cost"(GB/T 20523-2006), 2007-5-1.

The Yasemin Aida and Jean-Claude Hennet [8] thought that the goal of inventory management is to reduce inventory levels, to invest in other projects and to provide customers achieve a balance between the high level of service. Bayindir et al. [9] pointed out that inventory holding costs including the unit cost of holding cash and the unit opportunity cost of inventory.

In summary, in recent years of many foreign literatures, the research enterprise logistics cost factors mostly related with several factors like the frequency of transportation, inventory levels, and order quantities. Scholars have begun to realize that the enterprise logistics cost should be managed from an overall perspective. I think different type of enterprises, its logistics costs constitute content should be somewhere different. They should select the enterprise logistics cost factor according to the actual situation of the enterprise itself.

93.2.4 The Logistics Cost Control

Logistics cost control, is various factors that affecting the cost of logistics in the logistics process, according to the standards prepared in advance to have supervision, finding the deviation to be corrected, so that all kinds of resource consumption and cost of the logistics process can be controlled within the limits standard.

Enterprises must have an overall understanding of logistics costs level to control the cost of logistics.

93.3 Logistics Costs Control Model Based on Fuzzy Mathematical Analysis

93.3.1 The Basic Principles of Fuzzy Analysis Method

Fuzzy analysis method is a scientific method to depart the large system into smaller systems and then break small system down into smaller factors, then determine the weight of the smallest factor to derive the importance of the whole system finally when a thing is difficult to be assessed. The smallest factor is easy to perceive or calculate the importance, so the assessment can be more accurate. And then the overall evaluation of the thing is corresponding scientific.

93.3.2 *Steps of Evaluation Models Based on Fuzzy Analysis of Enterprise Logistics Cost Level*

93.3.2.1 Decomposition of Enterprise Logistics Business Process

Enterprise logistics business process is the whole process of a series of operations from market research, until the goods sent to shopping malls. These constitute the cost of business processes are known as the logistics cost factor, represented by i. Each enterprise can choose the most suitable logistics cost factor according to the actual situation of its own business. Set it to be the N in order to be more realistic. They Contact and affect each other, the cost is not only generated in the process, but also produced in the process, strong implicit.

Guangzhou M Company is one of the largest electronics manufacturer in southern China, according to the company situation, the logistics cost factor was set to procurement costs, inventory costs, packaging costs, transportation costs, management costs, just as $n = 5$.

93.3.2.2 To Determine Cost Factor Weights

Perceive or calculate possibility cost of the subdivided business processes directly, first time to define the weight.

Determine the industry standard weights recorded as ai, and

$$\sum \mathrm{ai} = 1,\text{defined: } R = (\mathrm{a1},\ \mathrm{a2},\ \cdots \mathrm{an})$$

Based on the comprehensive evaluation method to get the weights of this five cost factors as the following Table 93.2.

93.3.2.3 Determine the Cost Factor; s Probability Matrix

If we divide the subdivision of business process's produce cost into five leves: larger cost, big cost, medium cost, little cost, less cost. Respectively define as 5,4,3,2,1,entered $Q = (5,4,3,2,1)$, meanwhile, estimate the extent of this process which its produces are larger cost, big cost, medium cost, little cost, less cost. Determine each cost factor get 5,4,3,2,1 score of probability, so from larger cost to

Table 93.2 M Company's weights of logistics cost factors

Logistics cost factor	Inventory cost	Transportation cost	Purchasing cost	Packing cost	Management cost
Weights	0.3	0.3	0.15	0.15	0.1

Table 93.3 The probability table of Guangzhou M Company's logistics cost factors

	Score probability				
Cost factor	5	4	3	2	1
Inventory cost	0.1	0.2	0.5	0.1	0.1
Transportation cost	0.1	0.2	0.5	0.2	0
Purchasing cost	0.1	0.1	0.6	0.2	0
Packing cost	0.1	0.3	0.5	0.1	0
Management cost	0	0.2	0.4	0.3	0.1

less cost, we could get each cost factor's probability bij, and $\sum bij = 1$, then get its probability matrix:

$$P = \begin{pmatrix} b_{11} & b_{12} & b_{13} & b_{14} & b_{15} \\ b_{21} & b_{22} & b_{23} & b_{24} & b_{25} \\ b_{31} & b_{32} & b_{33} & b_{34} & b_{35} \\ b_{41} & b_{42} & b_{43} & b_{44} & b_{45} \\ b_{51} & b_{52} & b_{53} & b_{54} & b_{55} \end{pmatrix}$$

For example: Guangzhou M Company's probability of logistics cost factor, as shown in the Table 93.3

So we can get the cost probability matrix of Guangzhou M Company:

$$P = \begin{pmatrix} 0.1 & 0.2 & 0.5 & 0.1 & 0.1 \\ 0.1 & 0.2 & 0.5 & 0.2 & 0 \\ 0.1 & 0.1 & 0.6 & 0.2 & 0 \\ 0.1 & 0.3 & 0.5 & 0.1 & 0 \\ 0 & 0.2 & 0.4 & 0.3 & 0.1 \end{pmatrix}$$

93.3.2.4 Get the Enterprise's Probability Value A by This Five Levels

If $A = RP$, so Guangzhou M Company is $A = RP = (0.090,0.200,0.505,0.165,0.040)$, and this enterprise have 0.090 confidence to think its total logistics costs is large, 0.200 confidence to big logistics costs, 0.505 confidence to medium logistics costs, 0.165 confidence to little logistics costs, 0.040 confidence to less logistics costs.

93.3.2.5 Given Horizontal Weighted Average Score V of the Logistics Cost

If $V = AQT$

We can see that V score's size is also the size of that enterprise's logistics cost. Then, we can make out that enterprise's costs' score $V = AQT = 3.135$, as known that enterprise logistics cost in the industry is at a big level and exists some problems in cost control, so we can suggest Guangzhou M Company make a analysis and review its logistics cost control, they must change vigorously with control policy. On the one hand, they must give a review of logistics' function, like transportation, storage, package, handling, distribution, circulation processing and information; on the other hand, they must make a coordination and control with the supply chain. We can consider the logistics process' system reorganization, institutional integration and turn variable dispersion management logistics to the centralized system management, all this action could let the enterprise go to the real system management.

93.4 Conclusion

As to control of logistics cost, from the systematic point, this paper mainly discussed that the enterprise make the control of logistics cost can not only focus on cost control, but also should pay more attention to the influence of it's overall cost. The basic requirement of the logistics cost control should have a clear understanding of the present situation, based on the fuzzy mathematics method of logistics cost evaluation model now just play its important role. Through the example of Guangzhou M Company, we can see that the model is very simple and easy to operate and can well reflect the overall level of the enterprise in the logistics cost control, at the same time to be a reference to it's control strategy.

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Part VIII
Informatization and Information Technology in Construction

Chapter 94
Research on General Framework of Digital Railway

Ying Zhou, Yi-sheng Liu, and Chong-yi Zhou

Abstract The digital railway provides information service and decision support to the construction, operation, management and development of railway, which would help to improve the management level of construction, the control ability of safety, the production efficiency of transportation, the economic benefit and service quality. The paper defines clearly the research objectives for China's construction of digital railway and their key technologies while putting forward the general framework and composition of China's digital railway, the information standard system for digital railway, etc., which would present important significance for guiding the construction of digital railway.

Keywords Digital railway • Standard system • Framework system • Information sharing

94.1 Introduction

Digital railway refers to the comprehensive use of computer, GIS, communication, network, remote sensing, remote measuring, virtualization, multimedia technology, etc., which constitutes an railway information system making good use of the resources regarding national fundamental geographic information, railway exploration and design information, railway construction information and railway operation information to construct the railway spatial data warehouse, by which organization of railway transportation, marketing of passengers and commodities,

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_94,

management fields and their fixed facilities, information of mobile equipment can be collected, excavated, processed and displayed in a digital form. The digital railway provides information service and decision support to the construction, operation, management and development of railway, which would help to improve the management level of construction, the control ability of safety, the production efficiency of transportation, the economic benefit and service quality. In recent years, one of the objectives of railway informatization construction in China is to build digital railway [1].

94.2 Research Objectives of Digital Railway

Research objectives of digital railway can be summarized as "a database, a drawing, a platform, three industrializations, three systems and a management".

1. A database: A shared railway spatial data warehouse composed of metadatabase, public spatial database, infrastructure database and operation database is built based on national natural resources and the resources regarding fundamental geographic information, railway exploration and design information, railway construction information and railway operation information, so as to achieve centralized and efficient management of valid data of new and existing railways.
2. A drawing: An electronic drawing for the national railway construction and maintenance is provided to serve each business information system.
3. Railway information sharing platform: The railway information sharing platform is built based on the railway spatial data warehouse, and comprehensive use of the geographic information technology, satellite positioning technology, remote sensing technology, intelligent image processing technology, 3D visualization technology and so on [2], so as to achieve linkage between the "digital stream" in every link of the railway system, realize information sharing between business information systems in the fields of transport organization, passenger and freight marketing and operation management, and that between related systems beyond the railway, provide each railway business information system with uniform public basic code, fundamental transport information and basic spatial information service, and eliminate the problem that it is difficult to share the information resources caused by "strong network system in longitudinal departments and weak network system in horizontal departments" and "information island".
4. Three industrializations: Achieve intelligentization of railway transport organization, socialization of passenger and freight marketing, and modernization of operation management.
5. Three systems: (1) Digital railway standard system; (2) Railway information security system; (3) Railway operation and maintenance management system.
6. A management: Achieve digitized railway management.

94.3 Key Technologies of Digital Railway

1. 3S technology
   As the generic name of geographic information system (GIS), global positioning system (GPS) and remote sensing techniques (RS), 3S technology is the foundation for digital railway construction, and is applied together with its integration in railway spatial data acquisition, updating, integration and management, positioning and navigation, 3D visualization of railway information and so on from the railway survey and design stage to its operation and maintenance stage. RS is mainly used for the railway spatial data acquisition and updating; GPS is mainly used for the railway spatial reference, spatial technical information acquisition and updating, positioning and navigation service, etc.; and GIS technology is mainly used for railway spatial information integration and management, three-dimensional modeling and visualization application etc.
2. Virtual reality technology
   The application of virtual reality technology in digital railway can provide the users with intuitive railway visual information. In fact, this technology is used to truly reproduce the whole railway and related information thereof to the railway. Through the virtual reality system and with the unceasing improvement of the resolution, any department, construction site, line, station, bridge or tunnel of the railway can be "inspected", and enquiry, analysis and other operations of its information are available for the users. The visualized and digitized 3D railway model is built through technical research of the application of the virtual reality technology in the digital railway, research of the visualized 3D railway lines, stations, tunnels, bridges and so on, and in combination with the digital measurable image technology [3].
3. Multi-dimensional railway spatial data warehouse
   Spatial data warehouse aims at solving the problems such as mass data storage, enquiry and processing based on the data warehouse, through introducing the space dimensionality, increasing spatial data storage, management and analysis capabilities, and intercepting the information of different spatiotemporal scales from transient state to sectors and until the whole railway system from different "digital railway" application systems according to the subject.
4. Information sharing and security technology
   As the railway spatial information service platform, digital railway can effectively eliminate the problem that it is difficult to share the information resources caused by "strong network system in longitudinal departments and weak network system in horizontal departments" and "information island" through application of the digitized railway engineering and spatial information technology, in combination with the data fusion and exploitation technology, and research of the railway spatial data sharing technology and method, and can promote accelerated construction of the railway information sharing platform, so as to provide various users with uniform and abundant railway spatial information service. On this basis, the information security technology system is researched,

and the information security should include the physical security, network security, host security, application and data security and safety management system, etc. Information security can be guaranteed using the credible security technology system, digital certificate and so on.

94.4 General Framework of Digital Railway

94.4.1 Summary of the General Framework of Digital Railway

Composed of the railway information infrastructure, railway spatial data warehouse, railway information sharing platform and application system (transport organization, passenger and freight marketing and operation management), general framework of digital railway is focused on construction of the railway spatial data warehouse and centralized and efficient management of valid data of new and existing railways, so as to achieve linkage between the "digital stream" in every link of the railway system through the railway information sharing platform, realize information sharing between business information systems in the fields of transport organization, passenger and freight marketing and operation management, and that between related systems beyond the railway, enhance the intelligent railway transport system level, and provide the social public with advanced comprehensive application services of railway passenger and freight transport, as well as railway transport service with high security, high efficiency and high quality, through the railway application mainly based on e-commerce and modern logistics.

94.4.2 General Framework Structure of Digital Railway

The digital railway shall be an application system composed of the base layer, data layer, service layer and application layer.

1. Base layer: It is composed of the high-speed railway broadband communication network infrastructure platform, hardware, software, and network security platform, which meet the voice, data and image transmission requirements of digital railway, and lay the solid foundation for digital railway. According to the imagination of the national information highway, the network should be an integrated, digitized and intelligentized broadband without spatiotemporally limited communication and with good universality and expandable operation system, which involves a variety of scientific technologies. The information transmission network is the main supporting technology of "digital railway".

2. Data layer: The railway spatial data warehouse establishes a multidimensional spatial database mainly including the 2D and 3D spatial data, builds the business support oriented special database, spatial model database and business model base, constructs an uniform multidimensional railway spatial data warehouse, integrates the railway spatial information, and densifies the informationized basic railway platform content relying on the national fundamental geographic data, based on the uniform spatial coordinate system and 5D data (digital elevation model (DEM), digital orthophoto map (DOM), digital line graphic (DLG), digital raster graphic (DRG) and digital measurable image (DMI)), and using the distributed database technology and data warehouse technology, so as to lay the foundation for sharing and effective development and utilization of the railway spatial data resources. The data layer fuses and integratedly manages the electronic map of the national railway, remote sensing image, digital measurable image, video information, picture material, public special graphics of various business departments and other multi-source data, correlates the attribute with spatial information, carries out timely data interaction, and forms the uniform platform data structure system comprising data object, data acquisition and data management.
3. Service layer: As the railway information sharing platform and railway engineering framework support, the service layer provides 2D spatial data service, 3D data application service, line video application service, digital measurable image service, special data application service and data model application service, etc. The problem that it is difficult to share the information resources caused by "strong network system in longitudinal departments and weak network system in horizontal departments" and "information island" can be effectively eliminated through applying the digitized railway engineering and spatial information technology, paying attention to integrating the modern information technology application with railway information resource development and utilization, combining with the data fusion and exploitation technology and researching the railway spatial data sharing technology and method, so as to promote accelerated construction of the railway information sharing platform, provide various users with uniform and abundant railway spatial information services, provide the managers at all levels with the spatial, networking, intelligentized and visualized railway management and service, satisfy the production and operation management requirements within the railway transport organization, and external demand of the society for railway information and interactive services, and realize the transition from paying attention to the "material"-oriented service to paying attention to the "people"-oriented service.
4. Application layer: It is the business application system mainly based on transport organization, passenger and freight marketing and operation management. It can enhance the application system quality combining with the digitized means of business process, achieve the intelligentization of transport organization, socialization of passenger and freight marketing and modernization of operation management, serve each business management within the railway, provide the social public with advanced comprehensive application services of railway

passenger and freight transport through the railway application mainly based on e-commerce and modern logistics, and enhance the intelligent railway transport system level. It is the external representation form providing application for end users in digital railway framework.

94.4.3 Data Standard and Standard System

The digital railway is built under the premise of establishing a perfect digital railway standard system, which should include the data content (including metadata) standard, data quality control standard, data exchange standard, SOA (service oriented architecture) standard and information sharing service standard.

1. Basic railway spatial data content and standard
   Basic railway spatial data content and standard is the main part of the spatial data management standard, mainly including the basic railway spatial information, sharable professional spatial information and metadata content standard etc. Digital railway should realize the expansion and compatibility of national metadata standard based on referring to the international standard. The digital railway metadata standard construction mainly refers to the following international metadata standards: ISO 19115 metadata standard, ISO 19139 metadata standard, XML Schema implementation standard, and ISO 15836 Dublin core metadata standard, etc.
2. Data quality control standard
   At present, the spatial data used in various business systems of the Ministry of Railways are separately purchased and produced, different systems have different requirements of the spatial data, and the data are implemented in different business systems at different time, so that the free spatial data quality in various departments is different. During the digital railway construction, it is necessary to strictly control the spatial data quality in accordance with corresponding national standards and industrial standards of the spatial data, and using convenient and easy data quality inspection tools, so as to ensure the validity and utility of the spatial data in storage.
3. Data exchange standard
   The core of the digital railway is sharing, so the standardization of the spatial data exchange format is also a very important link. Digital railway should realize the data exchange between the data providers and data users under different platforms through the data exchange formats. As a result, it should be able to guarantee supporting the frequently used data formats, such as DWG, TIF, DXF, etc.; supporting the virtual standard exchange formats, such as E00, SHP etc.; supporting the national standard exchange formats, such as VCT etc.
4. SOA standard
   Digital railway provides the social public with advanced comprehensive application services of railway passenger and freight transport through the railway

application mainly based on e-commerce and modern logistics, and needs to provide standard Web Service using the SOA, so as to provide a variety of public services and interfaces. As a result, it is still necessary to follow certain SOA standards during construction of the digital railway information sharing platform, including WSDL (Web Service Description Language Protocol), UDDI (Universal Description Discovery and Integration Protocol), and SOAP protocol (Simple Object Access Protocol) etc.

5. Information sharing service standard
   Shared services provided by the digital railway information sharing platform should be able to support reading and allocating the heterogeneous system, so as to achieve the purpose of the system data integration and function sharing. As a result, this digital railway information sharing platform adopts the service-oriented architecture, which involves many interoperability standards.

94.5 Conclusions

This paper clearly shows the research objectives of digital railway and key technologies required to build digital railway in China, and proposes the general framework and structure of the digital railway in China, and standard system of digital railway information etc.

With the large-scale development of the railway, especially high-speed railway China, future task of the railway construction and operation is very heavy and complex. It is in very clear and urgent need of promoting and enhancing the railway development by informatization, and the research of digital railway is of great significance for the railway informatization construction in China.

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Chapter 95
IT Governance on the Move Towards Construction Sector

Sureerat Saetang and Abrar Haider

Abstract In the information age, both business and IT organizations always concern and seek the ways to align the business and IT strategies by implementing IT governance to ensure that IT can effectively provide IT functions which meet the business requirements. This study scrutinizes the dynamics of integration between IT governance, IT organization, IT systems, and business organization in achieving objective performance measures. It examines the relationship among them, which affects to IT adoption and organizational environments in any industry, especially construction sector.

Keywords IT Governance • IT organization • IT systems • Business organization • Objective performance measures

95.1 Introduction

In construction industry, there are major building projects, where IT systems are the main integrator to maximize productivity, minimize investment costs, and deliver value [1]. In this way, IT systems support construction organizations in providing more opportunities to reach and attain the scarce technical resources. To use the resources wisely and achieve competitiveness in this decade, every organization must be flexible in order to implement IT systems, which are initiated and developed from IT organization and then apply to adaptive business processes of business organization. Based on the relationship of IT and business organizations, they empower to gain higher business efficiency, attain more profits with cost reduction, and meet objective performance measures. Therefore, IT systems are

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_95,

considered as one of the main players in most business activities through workforce [2], which lead to involve the organizational management concept [3]. In so doing, organizations always encounter different difficulties by implementing IT systems in the enterprise settings to facilitate the business and overcome all the challenges. In keeping with the advantages of IT systems, business organizations in construction sector invest in IT systems heavily as the main factor to connect technologies and business processes in order to develop and manage their construction projects [4].

At this point, business organizations pay high attention on IT organizations, which are realized as vital department in the organizations because they can improve performance of competitive and non-competitive businesses. Throughout these procedures, they are concerned as business activities in IT governance processes. Consequently, every organization sector, especially construction industry should understand to underpin successful implementation of IT governance. Based on the foregoing research results of IT governance, there are abundant construction organizations, which were involved in data collection processes as participating organizations [1, 2, 4–9]. Referring to their surveys, they dealt with varied areas of IT governance practice. This paper appears to have a concern that there are not only commercial sectors, which draw attention to IT governance but construction sector also has some concerns and shows interest in IT governance. At this stage, it understands that every organization in every sector has different difficulties, which they always seek the appropriate ways to support their business processes.

This paper scrutinizes the dynamics of integration between IT governance, IT organization, IT systems, and business organization in achieving objective performance measures, which affects to IT governance in IT adoption within organizational environments. Also, it draws the attention from business and IT professionals in different roles to learn in practice. It examines the relationship among them, which affects to technology adoption and organizational environments. This study intends to support business and IT professionals in any industry, especially construction sector in gaining further construction development, sharper decision makings, stronger internal business operations, and better relationships within organization. In the next section, this paper presents the combination of factors including: (1) IT governance, (2) IT organization, (3) IT systems, (4) business organization, and (5) objective performance measures. In sequence, it discusses the research methodology. Finally, the conclusion is described at the end of this paper.

95.2 Literature Review

95.2.1 IT Governance

IT governance is the organizational ability, which is managed by the board of directors, senior corporate executives, and IT management people, who lead both organizational structures and directions and execute IT strategy to assure the integration of business and IT [10]. In this paper, it is divided to IT and business organizations. In terms of IT governance structure, it consists of top management people and organizational structures and processes [11]; responsibilities of the board of directors and the organizational resources and information management [12, 13]; decision making arrangements, alignment processes and collaboration mechanisms [14]. Certainly, IT governance also allows top management of business and IT plan the policies and processes by using them in specific areas of the operations through the examination results [15]. Thus, these components of IT governance develop the management control systems and assure the strategic organizational development with business objectives. Due to the capability of IT governance, it works as a tools of strategic business-IT alignment [16, 17]. Therefore, these factors and procedures lead IT governance to align business and IT successfully and effectively.

To build and operate the organizational strategy to meet business objectives, it is compulsory to have these components: (1) accountabilities of boards and executive management, (2) business governance, and (3) organizational directions, and (4) IT organizational infrastructures with processes [18, 19]. Meanwhile, the organizational structures, processes and business relationships collaborate simultaneously to establish IT governance [20]. However, boards and top executives must adopt the most applicable processes, which can establish in the organizations and comport to the business environments, particularly measuring IT governance effectiveness, providing proper budgets and consistent financial support services, and allocating a suitable amount of IT resources with higher capabilities [16, 18].

95.2.2 IT Organization

Organizational structures are emerged from the collaboration between technologies, organizational planning, and leaders [21] who manage and have power in both business and IT organizations. At this point, these organizations are located in the main organization, which contains a socio-technical system by comprising with complex processes with varied conditions, decision makings on both knowledge and technical disciplines, and organizational management [22]. According to the IT organization, it is important to sustain and secure the traditional strategic planning with few changes of transformation and innovations by concerning to adaptive action planning [23]. Moreover, IT organization is viewed as innovation management by adopting advantage and potential of IT to support business strategy, solve complex problems, create dynamic processes, and overcome business obstacles [24]. These lead to gain operational creativity and flexibility in complex organizations, which move the process rapidly and constantly. Simultaneously, IT organization decentralizes and amplifies IT activities across business units or centralizes into a detached department to achieve the development of systems and applications, the maintenance of systems, the processing of data, and the support services of application [25].

Concurrently, IT organization concerns to the entire processes within the organization by focusing on the structures of all information and resources, functions, units, departments, activities and integrating them through the overall organization [26] and also delivering strategic value to meet objective performance measures [25] to meet customer satisfaction on services and products by having a well-constructed customer support processes [27]. In this way, IT managers must know how to adopt IT effectively and also ensure the alignment of business-IT productively throughout the organization [21]. This is the reason why IT solutions are significant to implement in supporting their organizations, which are required to make decisions by the Chief Information Officer (CIO) and IT leaders [28–33].

95.2.3 IT Systems

According to IT system, it is operated as the computerized information processing to support different business processes and functions within organizational environments [34], which is viewed as the organizational wide IT system [35]. Originally, IT system was emerged from the concept of Information System (IS) by arming with the manual information processing and computerized information processing [36–38]. Based on theory, the IS concept is broader than computer science area in computerized information processing [39]. On the other hand, the IS concept in practice is accounted as a system for computerized information processing [34].

In line with the concept of Information System (IS), it is important to highlight the significance of a business perspective [40–42] by analyzing business prior to developing or changing IT systems [43]. Then, IT organization follows the requirements by implementing the applications and infrastructures to meet current business problems within organizational environments, which help to create business value and gain IT benefits at the same time [34]. In this way, IT systems support to analyze the prospect behavior of potential situations [44]. In turn, IT systems are an associated part of organizational environments and also have socio-material practices [39, 45, 46]. Moreover, IT systems are considered as decision support in human activities and implemented by IT experts, which mainly provide comprehensible and well-defined functions to distinguish data [22] from business analysis of business perspective. It could explain further that IT systems are vital in organizational environments, which provide and support different business activities to meet the business requirements [36, 47, 48]. Consequently, these lead to have more demands in the use of IT systems, which are proper positioned and maintained in the organizational environments.

95.2.4 Business Organization

Business organizations comprise with different business departments within the company, which have clusters of people, who operate their roles and responsibilities in varied business areas by interacting with other business departments and IT organization inside the company and outside the company (customers, competitors, suppliers, and influencers) to achieve objective performance measures [49]. In doing so, these interactions and influences affect to roles, responsibilities, and information across the boundaries of organization. In the turbulent twenty-first century, there are more complex human resource management concerns and rapid changes, in which stakeholders and executive management people are one of the kingpins within the business organizational contexts, who have power to develop and move forward organizations efficiently [50]. Moreover, their involvements in decision makings are essential to solve problems in most parts of management, in particular product innovations, productions, and product lines [51, 52]. This means stakeholders and executives can make decisions and provide most fundamentals and standards, which create established social structures within organization.

Then, it is compulsory to have cooperative relationships in business organizations to create added-value functions by directing all business activities to (1) understand the benefits of partnership relationship and cooperate with other organizations within and outside the company [53], (2) share knowledge and realize job productiveness [54, 55] and (3) gain better organizational performance. Based on these issues, business organizations must provide well-constructed internal structures, strengthen competencies, and enrich organizational culture to create reliable processes and gain innovative activities to the existing concerns and the remaining practices through the foundation of achievement [56, 57]. At the same time, business organizations should focus on financial success, market share of various products and services, and long-term capabilities to gain customer-valued technical advancements to meet future requirements by delivering them on-time [58]. To focus on project management effectiveness in business organizations, they comprise with four factors; (1) organizational structures, (2) leadership abilities, (3) leadership qualifications, and (4) technical skills [59]. Consequently, these characteristics lead to support the leaders in construction industry effectively in order to manage, cooperate, and control people in divergent levels.

95.2.5 Objective Performance Measures

Originally, performance measurement was emerged in the late 1880s through the 1980s. Organizations mainly focus on strategic developments, IT implementations, and deployment methods in production management (computer-integrated manufacturing (CIM), flexible manufacturing systems (FMS), just in time (JIT), optimized production technology (OPT) and total quality management (TQM)) by heavily concerning to profit, return on investment, productivity, low-cost production with higher quality of products, flexibility, short lead time and dependable delivery, and more ranges to gain a competitive edge companies [60]; and meeting customer satisfaction, internal performance measures of time, cost and technical requirements [61].

Fundamentally, it is important to implement suitable metrics to measure the effectiveness and interrelated components, which support to clarify the clear purposes, business objectives and organizational performances with expectations [62]. Absolutely, performance measures assess the organizational abilities and performances by identifying the types of customers, their demands, and the required satisfaction level of organization, which encourage internal quality development and external benchmarking as they can be changed and get effects from different influences [63]. These concerns lead to classify the five classifications of performance measures, which are (1) productivity, (2) efficiency, (3) effectiveness, (4) internal structure, and (5) growth and development [64], together with five characteristics of performance measures (1) relevance, (2) interpretability, (3) timeliness, (4) reliability, and (5) validity [63]. In doing so, it is vital to meet the organizational objectives by having the understandable data as the basis source, providing the effective intrapersonal communication with comprehensible manner, delivering valuable data on-time to support decision makings, reporting data consistency regularly, and measuring the proposed quality indicator. After that, organizations evaluate and develop data in the performance measurement subsequently, which are (1) selecting the assessment areas (the significance of the area, the prospective quality improvement, and the level of measurement in controlling the quality improvement), (2) choosing the performance indicators, (3) planning the requirements for the measure to meet satisfaction, and (4) analyzing the measure by technical methods to meet reliability, validity and interpretability [65]. Consequently, performance measures are designed, developed, and applied to measure the achievement of enterprise-wide organizational objectives, which are drawn to the entire strategy.

95.3 Research Methodology

An interdisciplinary field study has been conducted in this research [66]. This research conducts an interpretive qualitative approach with semi-structured interview, personal observation, and qualitative surveys for data collection from partaken organizations to study and investigate IT governance. According to the alignment between IT and business organizations, it is compulsory to implement IT governance to ensure that IT organization provided the proper IT systems to run IT functions effectively and meet the business requirements at the right spots. In this way, the right people can prioritize to plan, design, execute, and implement to progress the IT systems to solve the current problems by organizing IT experts, who have comprehensive skills to support the business organizations. This leads to have more confidence within organization due to both organizations of IT and business have agreeable solutions and consensus agreements, which meet objective performance measures. The objective of this study is to scrutinize the dynamics of integration between IT organization, IT systems, and business organization in achieving objective performance measures, which affects to IT governance in IT adoption within organizational environments. Also, it draws the attention from business and IT professionals in different roles to learn in practice [67–70] and take advantages from this study to apply and support their organizations [71, 72]. Certainly, this study intends to support business and IT professionals in any industry, especially construction sector in gaining further construction development, sharper decision makings, stronger internal business operations, and better relationships within organization.

95.4 Conclusion

To sum up, this study encapsulates how IT governance manages the integration of IT and business organizations by adopting IT systems to meet the objective performance measures. It is essential to concentrate on the business requirements within business organizations, which stakeholders and delegates from IT and business organizations must involve and make decisions to solve problems of the in-needed projects mutually. However, it is significant to recognize and concentrate on the intensive business objectives, analyze existing business problems, evaluate the potential IT systems prior to implementing, and examine the desired objective performance measures. Then, both IT and business organizations have to seek the ways to align the business and IT strategies by implementing IT governance to ensure that IT can effectively provide IT functions, which meet the business requirements. Furthermore, they also consider how to implement business-IT alignment, IT infrastructure implementation, IT strategic deployment effectively in an integrated system, which comprises with IT and business organizations, IT systems, and objective performance measures, which involve strategic value delivery. So that, IT governance indicates the solutions that IT organization is designed and administrated to deliver mechanisms to facilitate the development of integrated business and IT plans, the allocation of responsibilities within the IT organization, and the arrangement of IT initiatives.

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Chapter 96
IT Governance, Risk Management and Value Delivery in Construction Organizations: Literature Review Analysis

Sureerat Saetang and Abrar Haider

Abstract According to the business oversights, many international organizations collapsed, suffered heavy losses with big scandals in different industries. Furthermore, they were recognized that their financial situations, technological fundamentals, and organizational environments were not steady, riskier, more volatile, and less effective, which were egregious mistakes. It is vital to most organizations, in particular construction organizations to concentrate on avoiding any type of risk and also protecting from uncertain situations. Thus, organizations should take a closer look in managing risks regularly to avoid displeasure brazenly apparent from customers and investors by implementing IT governance as a resourceful solution. At the same time, best practices support to reduce daily operational fluctuations to the values of organizational assets, including IT infrastructures and IT resources, which would also foster an appreciation of opportunities in delivering value among individuals and impacting the way they manage organizations. Consequently, this paper explores the potentials of collaboration between risk management and value delivery in IT governance within construction organizations. These domains concern to IT adoption in the contexts of organization through risk management and value delivery, which could support IT experts in enhancing IT phenomenon in construction organizations.

Keywords IT governance • Risk management • Value delivery

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_96,

96.1 Introduction

According to higher influence of construction and more buildings in the constructed environment, the governance of construction segment development establishes a vital policy concern in various European countries [1]. This leads to indicate and identify different difficulties and challenges, which are based on the Latham Report [2]. Since 1990s, the Danish construction industry has recognized these problems and have tried to revise them [3] by focusing and correcting the inadequate productivity development, ineffective product quality, conflicted relationships, and inferior performance on people mismanagement and cultural problems as well [4]. Moreover, the construction industry can be described as a sensitive industry, which is considered as a project-based. According to accomplish the requirements of customers (buy or rent the finished buildings and other structures), construction projects are planned and implemented by integrating the resources and capabilities of multiple organizations that are specialized in architect, electrical design, contractor [5–7]. Therefore, it is compulsory to have more supports from various factors to support and develop the construction industry and achieve positive profits. With this intention, current frameworks of innovation are based on a single platform, which is operated as the main driving force in coordinating external drivers and different associations by creating innovations and building them to become valuable returns in construction industry [8].

With this in mind, Information Technology (IT) is one of leading innovations, which can support and develop the business for construction organizations. Based in the digital age, IT is becoming powerful to both organizational management and business. In doing so, it supports and develops internal processes progressively and also applies in the organizational environments. In this decade, IT has been invested heavily in different sectors especially, construction sector [9]. On top of that, IT has developed and supported in architecture, engineering and construction [10]. In this way, IT is conceptualized as a method to integrate, consolidate, and apply unsynchronized flows of information in an smart way through the building development by connecting and operating information on geometrics, price, planning, maintenance, inter alia all the way through the construction development and the lifecycle of the building [1]. Moreover, the IT practice of the construction industry is compulsory to be re-examined, which has to be improved and adjusted to the technological possibilities [11].

Most organizations concern to the processes in developing their businesses. Similarly, construction organizations concern to the solutions in improving and correcting the uncontrollable of illogical collaborations and combinations by employing the instruction and theory of governance system model [12]. Therefore, IT governance was emerged to implement in various natures of business including construction sector. IT Governance is the twenty-first century topic, which is necessary to discuss in the round table meeting. It is on-demand issue, which is concerned as a prerequisite in current business [13, 14]. Moreover, it is a component of corporate governance, which supports strategic planning, resources allocation, information analysis, decision making, and business processes automation [15]. Thus, it is compulsory to have IT governance to manage all confused business activities.

Meanwhile, the performance of construction processes is usually inconsistent in particular, time and quality [1]. This leads organizations to re-assess all activities to meet all established standards and rules, which are engaged to review due to ensuring all processes and frameworks of internal tasks and collaboration in building new concept or new practice [11]. This affects to strengthen in managing risk carefully and effectively. In line with IT governance, it reinforces IT project implementation successfully [10] and also supports the business by identifying risk from IT project development with productive control [16]. Moreover, IT governance objectives mainly implement reliable frameworks to gain and develop successful IT projects [17].

Further, value delivery is the methodology, which focuses on the holistic view of the comprehensive range of processes by emphasizing in planning and implementing IT projects to meet customer requirements [18]. Generally, the value delivery process is concerned as the project implementation plans, which require meeting both customer demands by providing the required products and services [19], as well as stakeholder satisfaction in minimizing costs to use the restricted delivery capability/resources and maximizing value to use the restricted value opportunities [20]. In doing so, value delivery allows IT to facilitate and empower the business and also maximize benefits at the same time [21].

Consequently, IT governance, risk management, and value delivery could be the resourceful aspects in uncertain organizational environments, which require taking strong actions in coordinating perspectives on poor quality of IT adoption. This paper aims to explore the potentials of collaboration between risk management and value delivery in IT governance within construction organizations by concerning to IT adoption. This leads to improve the performance of construction industry by delivering stronger collaborations and more qualified activities to provide a legitimate perspective on industrial change.

96.2 Literature Review

96.2.1 IT Governance

IT governance is the organizational ability which is managed by the board of directors, senior corporate executives, and IT management who lead both structure and direction of the organization and execute IT strategy to assure the integration of business and IT [22]. According to the structure of IT governance, it consists of top management and organizational structures and processes [23]; responsibilities of the boards and the resources and information management of the entire organization [24, 25]; decision making arrangements, alignment processes and collaboration mechanisms [26]. Indeed, IT governance also allows top management of business and IT plan the policies and processes by using them in particular operations through results examinations [27]. Thus, these components of IT governance extend and develop the management control systems and assure that the organizations always maintain IT and develop the strategies of organization to achieve business objectives.

Due to the capability of IT governance, it works as an instrument of strategic business-IT alignment [28, 29]. Therefore, these factors and procedures lead IT governance align business and IT successfully and effectively. According to effective IT governance, organizations will definitely gain existent commercial profits from effective IT governance, such as reputation, reliance, renowned product, and decreased expenses [17]. To obtain effective IT governance, organizations recognize the proficient formulation to develop IT organization arrangements beforehand. Planning IT governance arrangement is a massive demanding task due to acquiring the success of IT strategies and processes as well as facing various obstructed factors from mutual connections and relationships of people and artifacts which are interdependent organisms from internal and external aspects [17].

96.2.2 Risk Management

Further, risk can be described as a problem, a threat or even a concern and needs to be solved as it is an unwanted and unexpected situation that produces disqualification and dissatisfaction for a project [30]. Risk management is the combination of basic risk management and IT risk management by providing methodologies, concepts, and sources, which produce a success framework with lower risk. Control can be achieved and deployed at different levels within and across organizations by understanding and focusing on a suitable IT risk management methodology to gain better decision making and use fewer resources more wisely [31]. Risk management is a primary aspect of project management, which most big organizations employ by raising significant resources to support management and prevent business risk [32]. Moreover, there are five levels of risk management which are “risk management planning”, “risk identification”, “qualitative and quantitative risk analysis”, “risk response planning”, and “risk monitoring and control” [32]. Risk management is important to every project, which consists of (1) the assessment approach (risk factor analysis) and (2) the management approach (decision-making process) [33].

According to Fig. 96.1, there are different stages of risk management, which are (1) context analysis, (2) risk identification, (3) risk analysis, (4) risk evaluation, (5) risk treatment, (6) examination and review, (7) communication and consultation. The figure shows how the improvement of risk control can become stronger, while the possibility of a risk progressing can be seen as a loop of risk development which needs management to analyze, identify, treat, check and revise the outcomes [34–36]. Leaders can find some good opportunities within threats and take advantage of them by evaluating the possibilities and likely impacts of identified risk. Therefore,

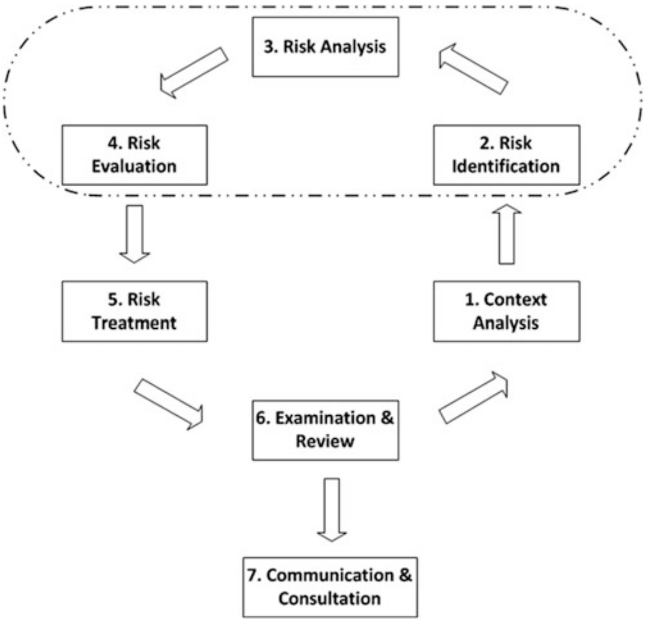

Fig. 96.1 Risk management stages. Source: Aloini et al. [36]

a higher probability may lead to higher risk. Executives must always be aware of and focus on risk management, which are vital issues to organizational management and must consider control as a continuing process by identifying, assessing, moderating, and observing risk within the project.

96.2.3 Value Delivery

Prior to delivering value, it is crucial to conceptualize how capabilities are configured in value creation. Value creation is a vital determinant in organizational integration [37], which supports and develops any business by responding to customers' demands for something new and different, which gets people focused on and interested in changing functions, outlooks, features, prices, ideas and so on. Therefore, new products and services can obtain more attention and gain more customers rather than relying on existing conditions – this is the effect of value creation. As it is, the powerful organizations gain higher profits and more advantages of using advanced business networks and high technology with new business models, due to comparing with other competitors who operate businesses traditionally without technology to support their businesses [38]. In order to construct value delivery, there are three main concepts to deliver high dominance in the market which are (1) the Porter's value chain [39], (2) the classic resource based view [40] and its application to support information systems [41], and (3) the information system development lifecycle theory [42]. As well, value creation model joins innovative decision making and comprises with environmental aspects and distinctiveness of business patterns, as well as, alliances with them [43]. Further, organizations can identify their value creation structures and re-organize their current businesses to be compatible and suitable to their environments [38].

Based on the construction industry, all stakeholders must involve in complex projects with complicated relationships as they mutually share vision and must understand the meaning of value, which relate to delivery capabilities to meet customer requirements by making assessments through design, construction and develop [44]. Of course, it is compulsory that stakeholders must show their interests, provide their management support, and manage their operations effectively, which leads to gain successful value delivery [45]. Moreover, organizations need assistance in managing various value chains and their relationships when more detailed models are developed by using value delivery to support in avoiding conflicts and difficulties with existing techniques [46]. In turn, it is a helpful function for governance which produces value for end customers [38]. Ultimately, value delivery requires market exploration, right products and services, and proactive delivery structure [47].

96.3 Conclusion

This paper has discussed how IT governance, risk management, value delivery fit in construction organizations. It outlined them to minimize the illogical collaboration, poor productivity and performance, multiple difficulties and problems of IT adoption and incidents to achieve business objectives and meet customer needs. This paper encapsulates the key factors to develop organizational environments, which integrate both strategies of business and IT in construction organizations positively by developing and sustaining organizational performance successfully. As a result, these factors have high potential to transform the changes and decrease the weaknesses by controlling and managing activities, which must be bonded to the decision makers who are board of directors, top management and leaderships in different business operations. Then, the results will be succeeded in most projects or any construction development. Furthermore, they also assist in developing existing management by the use of IT. In doing so, the business objectives increase a more focused in implementing IT governance to gain effective competitive advantage. Certainly, IT governance enhances construction organizations in mitigating risks, delivering more values to achieve more productivities results and meeting customer requirements. At the same time, stakeholders should use IT to deliver the business value robustly. Therefore, this research leads to improve the performance of construction industry by delivering stronger coordination and more qualified activities to provide a legitimate perspective on industrial change and achieve better organizational environments.

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Chapter 97
Research on the Practice Traits of BIM and Its Relationship with Construction Organization

Guiyou He, Wenjuan Zhang, and Guangbin Wang

Abstract Many literatures propose that project organization should be changed when implementing Building Information Modeling (BIM) technology. However, few literatures provide detailed analysis on this issue. Based on the comparative analysis with traditional technology in construction industry and innovation technology in other industry, the practice traits of BIM technology is analyzed. Four practice traits of BIM technology are proposed: inter-organization, high embedded levels of task interdependence, non-customizability, and technology exogenous. Then, based on the practice traits of BIM and theories on the relationship of Information Technology and organization, the relationship between construction organization and BIM technology is analyzed. The findings have important significance to construction organization with BIM technology assimilation and implementation.

Keywords Building information modeling • Practice traits • Organization • Information technology

97.1 Introduction

Compare to traditional technology in construction industry, such as 2D CAD technology, BIM is an innovative technology. It is not a simple modification to existing technology, but rather a major revolution [1, 2]. The contents, presentations and uses construction information are changed by BIM technology.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_97, © Springer-Verlag Berlin Heidelberg 2014

BIM technology is considered to be an inevitable trend of construction industry and has a broad application prospects. But now, its range of applications in the construction industry is still very limited. Many literatures consistently accused its slowly diffusion speed, which is significantly lower than the previous generation of similar technologies in the construction industry [3, 4]. The most important reason is the organization obstacle in assimilating the BIM technology. Many literatures state the same issue, but few literatures provide the reason. So, this paper will analyze the practices traits and the relationship between BIM technology and organization based on related theories.

97.2 BIM Practices Traits Analysis

97.2.1 Inter-Organization

The effective realization of the BIM potential value needs inter-departmental and inter-organizational information exchange, coordination and cooperation in construction project. Dossick and Neff [5] surveyed two commercial construction projects using BIM technology based on ethnography research method, and found that BIM-enabled projects are often tightly coupled technologically, but divided organizationally. This means that while BIM makes visible the connections among project members, it is not fostering closer collaboration across different companies. Harty [2] proposed that inter-organization collaboration is required for successful BIM implementation based on the empirical study of T5 terminal at Heathrow Airport in London. BIM is required to facilitate the interactions both within a range of actors and between the actors and technological artefacts. Wang and Cao [6] proposed that BIM can be positioned as a 'inter-organizational technology' and 'inter-organizational innovation' based on BIM technology features. Taylor and Levitt [1] defined similar cross-organizational BIM technology as systemic innovation and proposed that its implementation requires the project participants to change their processes and cooperation in a more collaborative approach. Fox and Hietanen [7] proposed that BIM technology across the organization led to a lot of potential obstacles to its application. In summary, the application of BIM technology needs to break the boundary of the enterprise departments and projects participants to communicate and cooperate.

97.2.2 High Embedded Levels of Task Interdependence

Task interdependence is the extent to which an individual team member needs information, materials, and support from other team members to be able to carry out his or her job [8]. Thompson [9] proposed and analyzed three primary types of task

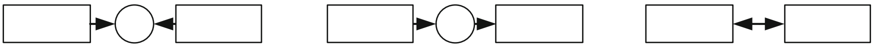

Fig. 97.1 Three types of task interdependence

dependencies (as showing in Fig. 97.1): (1) pooled interdependence – the lowest level of task interdependence; (2) sequential interdependence, which is frequently used in production or assembly lines; and (3) reciprocal interdependence.

Pooled interdependence is only limited level of material, resource and information exchange. It is low level task interdependence. In contrast, sequential and reciprocal interdependence involve higher level of exchange, and they have high level of task dependency.

BIM application process can be divided into two types of task activity: model building and functional analysis, model-based communication and coordination. According to the definition of task interdependence and related theories, we will respectively analyze their high embedded level of task interdependence.

97.2.2.1 Model Building and Analysis

Due to diversity and richness of the information contained in the model, the model building process requires multi-disciplinary collaboration, such as architecture, structure, the MEP/FP and other professional engineers jointly working together to complete the BIM models. Based on the content of the National Building Information Modeling Standard (NBIMS), there are 25 kinds of uses and 14 kinds are common uses, such as collision checking, energy analysis, lighting analysis, schedule simulation. The implementation of these uses of BIM requires multi-disciplinary integration. Meanwhile, certain priority and logical relationship embedded in these functional analyses increase the level of task interdependence. Nearly all of the uses need inter-department and inter-organization coordination and cooperation, as shown in Fig. 97.2. The workflow transforms from linear to mutual overlap of cross organization interdependence.

97.2.2.2 Model-Based Information Communication and Coordination

As BIM implementation required multi-disciplinary cross-organizational cooperation, participants are required to communicate and coordinate across traditional organizational interface. Traditional 2D CAD technology point to point information communication model communication should turn into BIM-based information sharing model (as shown in Fig. 97.2). BIM-based communication model exacerbated the task interdependence.

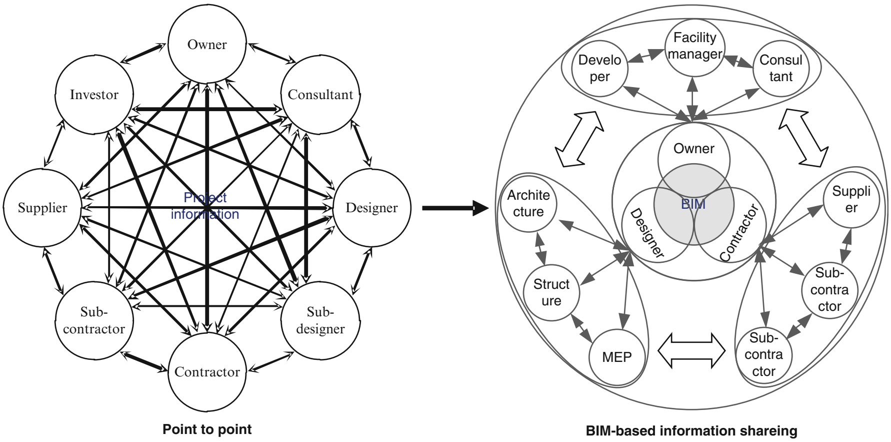

Fig. 97.2 BIM-based information sharing

97.2.3 Non-Customizability

Technology customizability refers to that the technology cannot be mass-produced, which is developed for specific customer, specific applications and specific functional requirements. Although some well-known software developers provide services on technology and its applications solutions service for specific customers, these services are provided on the basis of its existing software products and there are no services on improve technology or product customizability for user-specific needs.

In the BIM technology market, there is only limited number of BIM software developers. Each single BIM software developer only provides relative simple products. The products are relatively homogeneous, with similar product features and the intrinsic structure between different software developers. A limited number of developers dominate the BIM software market, which caused customers had narrow choice. Coupled with its software product uniformity and similarity, it results BIM technology similarity used in different enterprises. Looking at domestic universities and research institutions engaged in BIM research field, they are mostly focus on BIM basic theory research, the localization of foreign BIM theoretical achievements and the research and development of BIM universal technology and standards. There are few of them provided BIM customizability service. Large-scale software development enterprises also focus on generic BIM technology research and development. As the knowledge of us, the related institute and enterprise provided BIM technology customizability service are rare. BIM technology and ERP (Enterprise Resource Planning) technology are quite different. The development of ERP technology is usually based on scale, workflow and current situation of enterprise. However, BIM technology has typical non-customizability.

97.2.4 Technology Exogenous

Technology exogenous refers to the technology used by an organization from another organization [10]. The organization implemented technology does not have the ability to master the core structure of the technology or to carry out structural adjustment and technological transformation. The biggest difference between the technology exogenous and technology endogenous is that technology designer is within the organization or outside the organization. Given the complexity of BIM technology and its software products, BIM applications organization often do not have the ability of BIM software development. Normally, software development is not the main business for the construction organization. Most of the construction organizations do not want to invest too much resource. The organizations of BIM application usually purchase corresponding BIM technology products and services from BIM software developers (such as Autodesk, Graphisoft, Bently, Teckla, and so on). So far, we have not seen that construction organization develop BIM technology based on own characteristics and management process. Therefore, from the process of organization assimilation for BIM technology, BIM technology has typical exogenous.

97.3 Relationship Between BIM and Organization

97.3.1 Related Theories

The research of the relationship between technology and organization began in the 1950s. Through more than half century of development, the theory formed two relatively stable and representative mainstreams: Woodward's technological determinism (TD) [11, 12], Giddens's technology structuration (TS) [13]. Both theories provide operability perspectives for understanding and analysing the relationship between technology and organization. TD introduced technology as a critical factor impacted on diversity of organization structures, which emphasized impacts of technology on organizational reconstruction and developed a new area in organization studies. On the other hand, TS brought theory of structuration from Giddens into organization field and tried to offer dynamics of the relationship between technology and organization, which focuses on organizational structure that shapes technology. With perspective of practiceness of technology, Qiu [10] argues that technology and organization are inter- constructed in IT diffusion with rigidity and flexibility in both technology and organization, inter- construction of technology and organizations determines their relationships.

97.3.1.1 Technological Determinism

TD theory had occupied the research on relationship between technology and organization for many years and produced a series of theoretical and empirical achievements. Woodward [12] pointing out that technology is a common determinants of the organization and has profound impact on organizational structure, human relations, company size, internal coordination, management decisions and employee behaviour, based on the empirical study of 100 manufacturing companies in the United Kingdom-Essex region. This research established this relationship is a linear, relatively simple and intuitive relationship based on empirical data.

Perrow (1967) proposed the conceptualization and operationalization of the definition based on systematic research. He argues that organization is a production process organization and technology is how to achieve the transformation of this production process. The greatest significance of TD theory is that technology is viewed as an independent variable, and has decisive impact on the organization. Technology is no longer dependent on other variables to impact on the organization of additional factors, but plays a decisive impact.

97.3.1.2 Technology Structuration

As to in-depth impact of technology on organization's day-to-day operations, especially plays an increasingly important role in the IT organizational processes setup and inner structure, some researchers proposed structured theory extended to the field of IT based on Giddens's Structuration theory. In Giddens' framework, structure is understood paradigmatically, that is, as a generic concept that is only manifested in the structural properties of social systems. Structural properties consist of the rules and resources that human agents use in their everyday interaction. These rules and resources mediate human action, while at the same time they are reaffirmed through being used by human actors.

Technology structuration theory coincides with the period of rapid development of IT and there have been a large number of papers on this research field. Barley [14] firstly introduced Giddens's structuration theory to organizational research. In Barley's research, technology is treated as a social rather than a physical object, and structure is conceptualized as a process rather than an entity. Orlikowski and Wanda [15] developed a new theoretical model with which to examine the interaction between technology and organizations (Fig. 97.3).

97.3.1.3 Inter-Constructed Theory

Inter-constructed theory refers to that the relationship between technology and organization is mutual constructed. Qiu [10] proposed that two aforementioned theories was based technology and organization of one-way relationship and

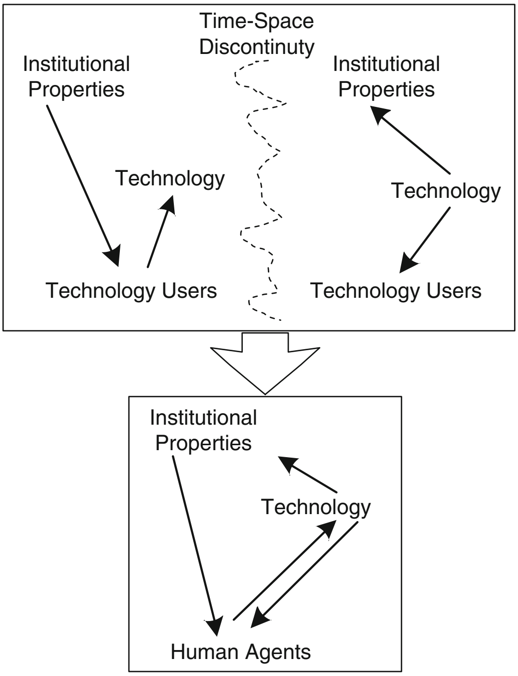

Fig. 97.3 Structurational model of technology

ignored the practiness of technology. With perspective of practiceness of technology, he argues that technology and organization are inter-constructed in IT diffusion with rigidity and flexibility in both technology and organization, inter- construction of technology and organizations determines their relationships. Zhang and Qiu [16] proposed that this theory provides a good perspective, from a technology practice characteristics and its application environment to explore the specific mechanism between technology and organization relationships.

97.3.2 Relationship Analysis

Qiu [10] pointed out that the practice characteristics of the technology must be included in the analysis of the relationship between technology and organization. The technology has its own structure; the structure is usually from the requirements of the technology itself as well as the wisdom of the technology developers. Generally speaking, the elasticity of organization endogenous technology is higher than the organization exogenous technology. Customization technology can be designed based on existing organizational structures and their needs. Contrast to non-customizable technology, its structure is more flexible. Qiu [10] also pointed out that previous studies stressed that the technology most organizations rely on is

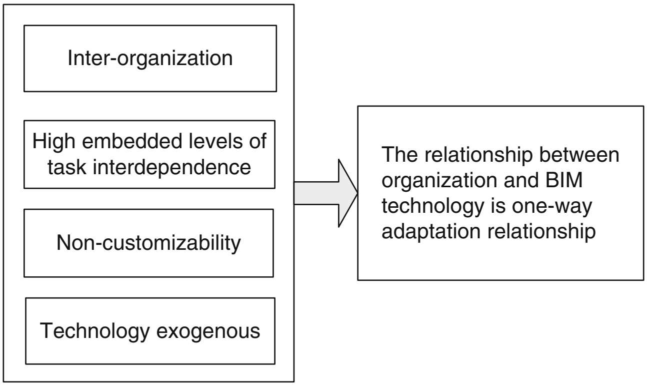

Fig. 97.4 The relationship between BIM technology and organization

exogenous technology. The technology stressed that technology development dependents on the organization is endogenous technology.

Based on the three aforementioned BIM technology practice characteristics and the theory on relationship between technology and organization, we proposed that the relationship between BIM technology and organization is one-way adaption relationship (as shown in Fig. 97.4). In other words, BIM technology adaptation to organization is weak and Organization must adapt to BIM technology when it assimilates BIM technology. Technology itself carries dual structure (the logical structure of technology and organizational structure required for use of technology). Compared traditional 2D CAD technology used in construction industry, BIM technology is an innovation technology embedded in a high degree of task dependencies and inter-organization which result in the coordination way adapted to traditional technology being not conducive to the potential value of BIM technology. During the process of organization assimilation of BIM, structural requirements of technology and organizational structure of status quo have a certain degree of structural rigidity and flexibility, which makes mutual constructed be possible. According to practice characteristics of BIM technology, its technology exogenous decides its structural rigidity and weak elasticity of BIM technology (as shown in Fig. 97.4); the effect of organization to the construct of BIM technology is less, and even can be ignored.

Although there are no papers researched the relationship between BIM and organization, some researchers directly proposed that organization problems accoutred when organization assimilates BIM technology, which indirectly confirm the research result. Fisher (2008) proposed that the lower degree of synergy in traditional organization structure and division of labor caused by current project organization is an important obstacle to hinder BIM applications. Davis et al. [17] pointed out that the main obstacle for BIM application is the failure of organizational change to support BIM applications. Jernigan [18] also pointed out that BIM has brought significantly change to construction industry, which lead to organizational inertia and resistance.

97.4 Conclusions

BIM is the inevitable technology for construction industry. However, many obstacles occurred when organization assimilates. This paper analyzed BIM technology practice characters and researched the relationship between organization and BIM technology based on its practice characters and related theory. Four practice characters were proposed. The results showed that the one-way adaptation relationship between organization and BIM technology. As an innovation technology, organizations have to change to adapt BIM technology when organization decides to implement BIM. The results provided for provide theoretical basis for organization assimilation of BIM technology.

Acknowledgement The International S&T Cooperation of Ministry of Science and Technology (2011DFG73520) is gratefully acknowledged. The financial support of Shanghai Jianke Engineering Consulting is also acknowledged.

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Chapter 98
The Research on Management Informationization of Railway Construction Project

Ying Zhou, Chong-yi Zhou, and Yi-sheng Liu

Abstract The railway is moving to its new construction climax currently, therefore, the improvement of railway construction informationization has important realistic meanings to enhance the management level of railway project construction, efficiently control the schedule, quality and investment of railway project construction, and fully realize the strategic target of leapfrog development of railway. This paper explains the popularization and application approaches of project management information system of railway construction fully from the aspects of project identification background, popularization and application, problems existing and suggestions, and it will be useful for this system and relevant information system to play their role in construction project management, and improve the level of railway informationization.

Keywords Digital • Railway • Standard system • Framework system • Information sharing

98.1 Introduction

According to the Medium or Long-term Rail Network Plan approved by the State Council, during the "eleventh five-year" period and quite a long period thereafter in our country will set off the new climax of railway construction. By 2020, the dedicated line for passenger transport of more than 12,000 km will be built, basically forming the "four vertical and four horizontal lines" of rapid railway

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_98, © Springer-Verlag Berlin Heidelberg 2014

passenger transport corridors, and three inter-city rapid passenger transport systems of circum-Bohai-Sea, Yangtze River delta and Pearl River delta, the target value of passenger train speed is to reach above 200 km/h. The dedicated line for railway passenger transportation is constructed with high technical standards, large project investment and strict quality requirements. If the traditional construction and management mode with the extensive form is followed, obviously the goal of "building up a world-class dedicated line for railway passenger transportation" can't be achieved. Construction of the passenger dedicated railway lines have the characteristics as the line coverage with long distance, multiple construction units, high technical standards, tight construction period, multiple significant projects and great difficulty in construction, the modern management idea must be introduced; a set of advanced, practical construction and management information systems must be applied throughout the engineering construction. Only by strengthening the scientific and standard process management, can the first-class construction quality be guaranteed with the first-class management.

Thus the Railway Construction Project Management Information System (hereinafter referred to as "RCPMIS") emerges at a historic moment. In early 2005, soon after the founding of the special group of China's first batch of lines for railway passenger transportation of Wuhan-Guangzhou, Beijing-Tianjin, Hefei-Ningbo and etc., the Ministry of Railways set up a dedicated topic group, organized the information technology center in the department and the preparatory groups of all relevant companies of the dedicated line for passenger transportation officially started the project development work, and the author acted as the project manager and overall designer in this subject.

RCPMIS is an important industrial application system with the Ministry of Railways and the construction units as the main service object, with large and medium-sized railway construction project as the carrier, in order to realize the implementation of macro-management by the Ministry of Railways on the national railway construction projects, particularly the dedicated line for passenger transportation and the implementation of whole process management of the assigned project by the construction unit. Its main features are: With the needs of the construction unit as the foundation, all the essential data and important data in the project construction process are integrated to establish an information platform with network technology, computer technology and modern information technology as the support within the jurisdiction scope, with the function of engineering management, standard management and collaboration office [1]. With the platform support, the advanced project management software is integrated and developed to implement effective dynamic management and control on the project schedule, cost, quality and safety. The management level of railway construction is improved through the advance of the standardization, scientization and modernization in the project management. The system consists of the system at the level of the Ministry of Railways and the system at the level of the construction unit, this article mainly elaborates the system at the level of the construction unit.

98.2 Popularization and Application of RCPMIS

RCPMIS system at the level of construction unit is constituted by 21 subsystems. It includes office management, project knowledge management, project data management, post management, management of bidding and tendering, coding structure management, progress management, cost management, quality management, contract management, supervision management, materials and equipment management, security management, risk management, etc.; it also includes the project scheduling command center with geographic information system (GIS) platform as support.

Since the determination and construction of the RCPMIS system in early 2005, more than 20 subsystems have been developed, and successively put into application in 52 railway companies such as Wuhan-Guangzhou, Beijing-Tianjin, Beijing-Shanghai and Guizhou-Guangzhou, the system at the level of the Ministry of Railways also went into operation in 2006; all of them have obtained good effect. For example, in the initial construction of the dedicated passenger transportation line of Wuhan-Guangzhou, there were 18 bid sections, 25 construction units in the whole line, if the traditional construction scheduling and submission method is used, the form can not be filled out promptly, normatively and completely, and the summarizing workload of report forms such as monthly report and weekly report is great. After the RCPMIS progress management subsystem is adopted, the scheduling staff in the construction unit only need to enter the project finished every day on a uniformly defined account, the rest data such as week accumulation, month accumulation, accumulated starts, completion percentage are all completed by the automatic calculation of the system, thus the workload is greatly reduced. In addition, according to the design document there are 2,842 worksites in the whole Wuhan-Guangzhou line; more than 600 thousand inspection lots are produced every day, more than 18 million inspection lots are produced every month, more than 216 million inspection lots are produced in a year. If artificial statistics is made on such a tremendous data, the workload is quite huge. And the RCPMIS quality management subsystem has the automatic statistical function, which replaces difficult and complicated artificial labor. With the constantly expanded popularization and application scope of the system, more remarkable economic and social benefits will be produced.

98.3 The Existing Problems

RCPMIS system is the information management system that is developed under the unified leadership of Ministry of Railways for the first time in the history of China's railway construction and promoted and implemented throughout the whole railway lines, its coverage range is second to none both geographically and professionally in the country. The construction of the system promotes the change in the relevant management concept, system and approach; it is also a major reform in the traditional construction management. However, it can be said that the advancing process of informatization construction is very difficult; there are a lot of problems.

98.3.1 There Is Some Deviation in the Understanding of Informatization by Some Construction Units

First of all, the management in some construction units is most concerned about what informationization means can be taken to realize effective monitoring and management of the construction project, how can the problems and risks existing in the project be known ahead of time, and how can the effective measures be taken for the timely rectification and improvement. Namely, it is more weighted towards how to use the information construction results, but the reality that "early investment of informatization is large, the cycle from the development, operation, to mature application up to the reflection of the overall value is long" is ignored. Hence the situation often appears that enthusiasm runs high at first, then some disappointment comes, and it is ended with little support and involvement at last. This brings about variables for the smooth progress of the entire informatization construction. Secondly, the information technology has been really applied to the project construction practice for only the history of 20 or 30 years, the construction project management personnel with some experience and technology are mostly aged over 40 years, their computer ability is generally not very high, and their understanding and acceptance capacity of informatization construction also has some limitations.

98.3.2 There Is Deviation in the Application of Informatization

Firstly, the restructuring progress of business and organization flow can not keep up with the progress of system promotion. Construction projects are still using traditional organizational models, for example, the manners such as paper documents and oral report are still used for the information-sharing and communication manner, many networking information exchange means can not complete the normal operation due to the lack of digital signature and other "official" links, thereby hindering the process of project informatization.

Secondly, the enterprises lack the organizational culture necessary for the project operation, such as openness, equity, democratic management and transparency. According to the author use sampling investigation method and statistical analysis method, in the present construction units using this system, only 45 % of them can apply the contract management subsystem very well, and only 10 % of them can use the investment management subsystem for investment analysis, which is because the management personnel are not inclined to completely open the contract data and the investment completion in this unit.

Thirdly, the primary standard system of information resource management has not been really formed; there is the phenomenon of "isolated information resources”. For example, the public infrastructure data coding of information management, equipment management and investment management system is inconsistent with each other, they respectively form individual systems, run their individual encoded modes, “multiple inputs and multiple uses” of the same data appears, which causes that the data can not be shared, the management component is cumbersome, and the cost increases.

Fourthly, because the parties of building, construction, supervision and so on establish their own accounts, once the data can not coincide with each other, a lot of manpower, material resources and effort are spent in checking, which reduces the work efficiency, and artificially results in the collision with the advance of the information system.

Fifthly, the conflict between the inherent requirement of the project management information system and the current situation of the railway construction project management. The project management information system requires large amounts of essential data for support, and introduces the modern project management tool to conduct the statistical analysis, and finally reaches the purpose of decision support. The acquirement of these data inevitably requires the owners to implement meticulous management on the project, and the current railway construction project is still dominated by extensive management, institutionalization, format and programming are not achieved in the management work, and the implementation capacity factor is not excessively emphasized.

Sixthly, the management models of each construction unit and their individual needs are different, there is no uniform standard, which causes the information system needs to change dramatically, causes the program change to increase significantly, and hinders the system implementation process. According to the statistics, the program modification caused by the customization of construction units reaches 2,966 man-days after the edition of the RCPMIS system is finalized, which accounts for 68 % of the total implementation workload.

98.4 Suggestions

98.4.1 Fully Understanding the Importance of Information Resource Planning

Management informationization of railway construction project is a systematic project. Its diversified, multi-level and interdisciplinary characteristics decide that the overall objectives, technical solutions, the basic data coding and business process must be planned comprehensively, scientifically and systematically, their respective needs and mutual information supports must be clearly defined, the scattered, isolated information and data must be converted into the effective networking resources to realize timely collection, transmission, synthesis and sharing of information resources and provide the basis of decision-making for leadership and departments at all levels. The starting point and destination of engineering project informationization are to develop and utilize information resources, and to improve the sharing degree of information resources. Computer information system (CIS), whether to be developed or to be introduced, should be built on the overall planning of information resources, should seize the initiative of information resource standard. Only by making a fundamental, pilot enterprise information resource planning, can an integrated, networking enterprise computer information system be set up. This needs to comprehensively conduct formal information demand analysis, to express the standardized information needs of the decision-makers, management and operation level, to prepare well for the planned, stepwise development and utilization of the information resources of the whole group, at the same time to clear up the inconsistency, redundancy and complicated interface problems of the existing database resources through system data modeling, to establish the standardized data structure of the production and management information demand, and to lay a solid foundation for transforming and establishing high-grade data environment.

98.4.2 Optimizing the Management System and Business Process

Through the application of the project management information system, a project management mechanism covering the related departments of project management is established on the basis of scientific and reasonable rules and regulations, so that it can achieve efficient, unified, standardized and harmonious management and control in the railway project construction process. This modern management method with the application of modern management concepts as the fundamental, with the application of computer technology as an important operational means will inevitably require changes in the management system and business process. Therefore, further promoting the application of construction management information system in the railway construction field will optimize the business process reengineering (BPR) [2] and the management system.

98.4.3 Strengthening Leadership Decision-Making and Organizational Guarantee

The implementation of project management information system involves every aspect of project management in the company, which will inevitably affect the concept and consciousness of the people, the traditional operation mode of the management business, and the business collaboration between the business sectors in the company, etc. in the relevant departments and the relevant units. In the final analysis, system construction is the reengineering of management ideas, methods and means. All these need communication, understanding and reaching consensus. Communication can deepen understanding; the basis of consensus is the survival and development of a company. To do these jobs well, the key is the thinking and organizational decision-making of the leader for promoting the informationization construction, so it is necessary to establish the determination of applying modern technology for management, to form a unified and coordinated organization system from the implementation layer, management layer to the decision-making layer and all layers of the project management in the construction unit, so as to truly realize the original intention of improving the overall management level.

98.4.4 Persisting in the Promoting Mode of 'Gradual, Step by Step'

At present, the informationization management of the railway construction project is still in its initial stage of development, the informationization construction can not be accomplished at one stroke, and it must be gradually improved and implemented step by step. Firstly, it should be able to satisfy the needs of the on-site construction management, can normally operate in the management chain up to the Ministry of Railways, and down to the design, supervision, construction and other construction units, reduce the manual labor intensity, improve work efficiency, and effectively play the role of the main body in the construction project management. Secondly, in accordance with the development requirements in combination with advancement and practicality, the system software should try to incorporate the modern management idea as far as possible from the present situation of railway construction, use and provide some of the commonly used modern management methods and technologies, and gradually improve the construction management level and the application environment of the system. On this basis, we must face the future and upgrade the demand analysis datum to a considerable degree comparable with the international advanced level. Management function is the theme and core of the management information system, an information management system expected to reach the international advanced level should of course have the modern management function with the international level. The present system must not only satisfy the management needs of fully supporting the current railway construction, but also be adapted to and satisfy the needs of the modern development of railway construction management.

98.4.5 Creating a Comprehensive Environment Favorable to Promoting Management Informationization of Railway Construction

Through the effort for years, the railway information network has covered the authorities in the Ministry of Railways and the railway administrations and most stations and segments, and created a network operation and maintenance team from bottom to top. Therefore, it can utilize the existing resources to the greatest extent, and fully mobilize the enthusiasm of all construction parties for accelerating the information management service of railway construction project. At the same time, we should promptly develop and improve the technical standard systems and regulatory systems in e-commerce, intellectual property protection, government procurement, information safety, information resources, etc., develop one unified and complete standardized system of project management, and establish good regulatory environment [3]. In addition, we should effectively change the present situation of lack of talents in railway enterprises by the means of setting up a platform, excitation mechanism, and intensive training, etc., and store up good reserves in abilities and talents for informationization construction.

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Chapter 99
Lessons Learned from Case Projects and Enterprises Where BIM Was Utilized

Honglei Liu and Lei Zhang

Abstract Construction industry is pillar industry of national economy, however productivity in construction industry always stay at a lower level. BIM (Building information modeling) is an innovation idea and benchmarking technology which will have great impact on construction industry. However, implementation and practice of BIM is still in exploring and studying period in China. During this period, the organizations of construction project have some problems in construct model, sign contract, implement plan etc. Based on above reasons, survey and analysis guaranteeing successful factors of BIM implementation in construction project and relationship between BIM and business process reengineering. It has great theoretical and practical significance for BIM implementation and practice in China. Firstly, this paper introduces situation of low efficiency in the construction industry and necessity of survey and research. Then paper introduces research method and an overview of case projects and enterprises where BIM was utilized of this research study. Finally, analysis guaranteeing successful factors of BIM implementation in construction project and relationship between BIM and business process reengineering which provide a certain foundation for the further research of BIM.

Keywords BIM (Building Information Modeling) • Case projects • BPR (Business Process Reengineering)

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_99,

99.1 Introduction

Construction industry is pillar industry of national economy, however compared to the manufacturing industry, productivity always remain at a low level [1]. U.S. Department of Labor statistics show that in the past 40 years (1964–2003), productivity index increased by 230 % in industry and service, while labor productivity in the construction industry did not increase, decreased by 19.2 % [2]. Accompanied by continued low labor productivity, construction costs of building facilities is also increasing, and the increase is much higher than the average Producer Price Index (PPI). According to the statistics of the world leading construction cost consultants: From 2002 year to 2007 year, global health facilities construction costs increased by about 40 %, while PPI for construction industry only increased by 18 % [3], this trend in Fig. 99.1.

This means owners want to get building products have same functionality, need to pay increasingly high price. BIM (Building information modeling) is an innovation idea and benchmarking technology which will have great impact on construction industry, Stanford University research project for the global BIM applications show that through the effective application of BIM can be reduced by 40 % of the design changes, labor productivity and the construction site efficiency of 20–30 %, and the application of BIM also helps to improve the building products operational performance, and significantly to the promotion of sustainable construction [4]. More and more construction project participants and management department begin to started to pay attention and actively participate in BIM technology practice and implementation. But implementation and practice of BIM is a gradual process and is still in exploring and studying period in China [5]. With the development of BIM technology and information and communication technology, survey and analysis guaranteeing successful factors of BIM implementation in construction project and relationship between BIM and business process reengineering. It has great theoretical and practical significance for BIM implementation and practice in China.

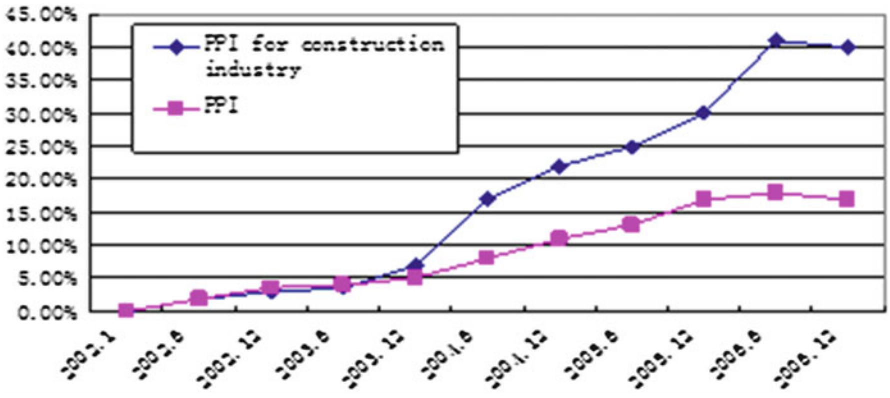

Fig. 99.1 Increase of PPI for construction industry compared with average PPI from 2002 to 2006 (Source: www.davislangdon.com/EME/Research)

99.2 Research Method and an Overview of Case Projects and Enterprises Where BIM Is Utilized of This Research Study

99.2.1 Research Method-Survey Questionnaire

In order to understand guaranteeing successful factors of BIM implementation in construction project and relationship between BIM and business process reengineering, the authors conducted extended survey questionnaire and face to face interviews with professionals (such as BIM managers, project managers, designers, estimators and schedulers) who work in case projects and enterprises. During the face to face interviews, a questionnaire, designed by the authors, was used to guide the interviews. Each section of this questionnaire was specific to a group of participants and incorporated questions specific to that group. The groups included subcontractors, software vendors, owners, and general contractors. In addition, for each project that was provided as an example by the participant, the authors asked about further questions to learn the project characteristics and the status of using BIM in project and enterprise.

99.2.2 An Overview of Case Projects Where BIM Is Utilized and Enterprises of the Research Study

This research survey ten large and complex case projects where BIM is utilized in China, include Shanghai Tower, Shanghai World Exposition project, etc. The large enterprises involved in case projects also utilize BIM in many projects. These enterprises have rich BIM implementation experience compared to other enterprises. This research study mainly survey situation of BIM implementation in different phases in construction projects, and then make statistics for this research in Table 99.1.

99.3 Lessons Learned from Case Projects Survey and Study of BIM Implementation

99.3.1 Guaranteeing Successful Factors of BIM Implementation

According to surveying and ten large-scale construction projects and large enterprises, in the guaranteeing successful factors of BIM implementation include: senior managers support, project organization structure support (Set up special BIM application coordination team or department), owners need of BIM, proficient in

Table 99.1 Situation of case projects and enterprises where BIM is utilized

Number	Projects	BIM application phase / BIM influence phase: Project type	BIM Users	Design phase: Plan design	Design phase: Preliminary design	Design phase: Detail design	Preparation before construction	Construction phase	Operation and maintenance
1	Tianjin Port International Cruise Terminal	Infrastructure	CSC International	★ ★	★ ★	★ ★	★ ★	 ★	
2	World Expo German Pavilion	Public facilities	Shanghai modern engineering consulting company		★ ★	★ ★	★ ★	 ★	
3	Olympic Sports Center Stadium in Hangzhou	Public facilities	CSC International		★ ★	★ ★	★ ★	 ★	
4	Shanghai Tower	Public Building	Shanghai Tower Construction and Development Co., Ltd.	★ ★	★ ★	★ ★	★ ★	★ ★	 ★
5	Physical Information House of East China Normal University	Public facilities	Tongji Architectural Design (Group) Co., Ltd.		★ ★	 ★	 ★		
6	Nanchang airport project	Public facilities	CSC International		★ ★	★ ★	★ ★	 ★	 ★
7	Shanghai World Exposition project	Public facilities	CSC International		★ ★	★ ★	 ★	 ★	 ★

8	San Francisco International Airport-Terminal 2	Public facilities	Gensler	★	★				
					★	★	★	★	★
9	Zhongshan Hospital	Public facilities	Shanghai Shangan M&E Design Office Co., Ltd.				★	★	
							★	★	
10	Cao Feidian Tangshan Project	Public facilities	Shanghai modern engineering consulting company	★	★	★	★		
					★	★	★	★	

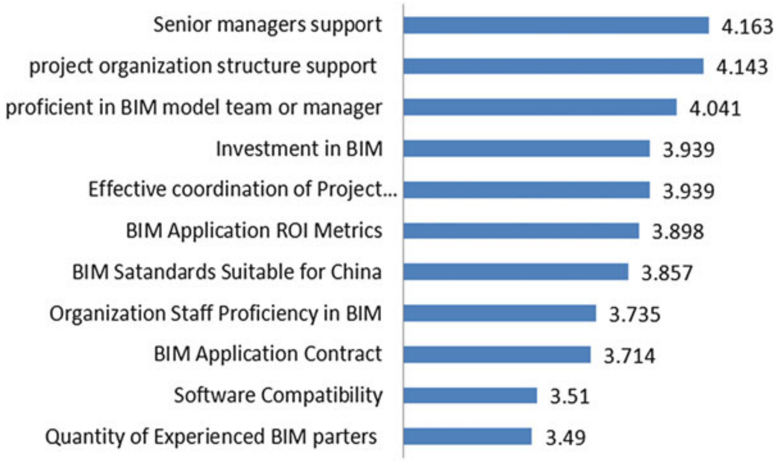

Fig. 99.2 Important degree of guaranteeing successful factors of BIM implementation

BIM model team or manager are most important. These guaranteeing successful factors determined and identified by reading a large number of articles about BIM and interview with experts. Instead, software compatibility is not the dominant, which because of BIM application phase in China. The factors show in Fig. 99.2.

99.3.2 BIM-BPR

BPR is the abbreviation of Business Process Reengineering. During business management, it is the process that an enterprise redesigning and remodeling its most essential and basic management and operation procedure, which is normally used in order to greatly improve the performance of cost, quality, service, etc. The objective of quoting the BPR concept is to interpret that when BIM is considered an innovational technology and when it has been selected to be applied in a project, every procedure no matter between or within project involvers, have to get adjusted by all involved enterprise.

99.3.2.1 Necessity

First of all, the current engineering construction industry is still at the stage of producing and using individual drawings and documents. Construction design includes several subjects, such as architecture, structure, heating ventilation, hydraulic and power engineering, etc., which are developing vertically but individually. Although there are interactions between each other, the fixed boundary of each organization (type of work) limits communication and cooperation. A single change may require adjustments of plan, elevation and section simultaneously, or more unpredictably, require other adjustments. Thus professionals in this field have already got used to the quality of numerous drawing problems discovered after all the drawings have been integrated. However, not only this problem affects project progress, the subsequent rework also increases the risk of investment control, and hinders the development of the architecture industry.

On the other hand, the scarcity of natural resources and the critical condition of the environment require a low-carbon and energy conservational way for the architecture industry. Under the circumstances, the traditional procedure from architecture design, to structure design, to facility design, to evaluation, and finally design revision, is extremely ineffective.

Moreover, design and construction are two separate procedures. Some cannot be constructed according to the drawings. One common condition is concrete cannot be poured successfully because of the high density of reinforcing steels, thus engineering adjustment should be made after discussion, certification, and technical approval, then the designers should revise the drawings, and construct according to new drawings. This is also a procedure that affects both progress and investment.

Undoubtedly BIM has provided a perfect integral information platform. Cooperation design can be achieved with ease during the design stage, and revisions made by any involver can be shown to others immediately, which reduce unconformity. More importantly, designers can be set free from numerous hand drawings, to the more essential job of improving design qualities by the relativity of components and the achievement of any view. And when communicating with developers, the "view-is-what-to-be-constructed" scheme can clearly express the design results and effect, and enhance communication efficiency and developers' satisfaction. Before constructing, designers and constructors can analyze, coordinate and optimize the construction scheme, improve the constructability of drawings, and minimize the elements that effect progress and investment.

99.3.2.2 The Procedure of BIM-BPR

BIM-BPR has three levels: project level, business level and functional level. According to project characteristics, project level can be subdivided to civil architecture project, industrial project, public projects, and other projects. The reason of subdivision is decided by project characteristics. The design procedure of a typical civil project is: from facility, to architecture, and to structure. The procedures are different even in one industrial project. For instance, electric equipment and heating and ventilating equipment are essential for a power facility building, within which the most important is electric equipment, and drainage facilities are rare. At this moment, a detailed procedure should be: professional electric engineers select required electric equipment first, then architects finish the designs of locations of equipment, space, and openings, finally structural engineers ensure the safety of structure.

On the BIM-BPR business level, the four involvers of the architecture construction are: the developer, the designer, the constructor, and the supervisor. It is a most basic framework which can be continuously extended to the supplier, the consulter, etc.

On the functional level, BIM-BPR requires detailed procedure planning. The American company BuildingSMART Alliance has listed 25 applicable elements in "BIM Project Execution Planning Guide Version 2.0."

99.4 Conclusion

To review the previous discussions, no matter project level, business level, or functional level, requires communication between professional BIM workers and each involver from each unique project, company and the objective of using BIM. It is the successful building of BIM's each level procedure by BIM-BPR that BIM can be operated smoothly, which in other words, BIM procedure is the blood vessel of BIM. The success of BIM demands a high efficient BIM procedure, and in China the current BIM is in a great need of such a BPR.

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Chapter 100
Survey of BIM Application Status and Characteristics in China

Lei Zhang, Guangbin Wang, Tianmin Chen, and Guiyou He

Abstract BIM has been widely spread in China's construction industry since 2008. This paper considers that application status and characteristics of BIM technology by investigated adaption of BIM among stakeholders in Shanghai. In the survey, it finds that the stakeholders reached a consensus about the trends of BIM implementation and have achieved a certain difference level of experience. The attitude between most of them is just cautiously optimistic for BIM adaption in future. However, there are still some differences in the scope of application, benefits and barriers for them. Compared various countries, BIM's top benefits in China are consistent with them, but others are scattered and unclear. Stakeholders do not pay much attention to the defects of construction standards, information security and intellectual property. In macro factors of BIM development, government and other administrative departments should play an active role in promoting the training of BIM, standardizing rules and specifications, improving the relevant legal mechanisms. In driving forces of BIM stakeholders, owners should play a leading role and others parties should play their different roles in difference phase. In addition, the government should establish policies and create good conditions for the development of BIM.

Keywords Building Information Modeling (BIM) • Application status • Characteristics • Survey

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_100, © Springer-Verlag Berlin Heidelberg 2014

100.1 Introduction

Construction market in China has been very active with the market size of 15,112.063 billion dollars in 2010, ranked as first in the world. However, the adoption of BIM (Building Information Modeling) was several years behind several advanced countries. An increasing number of construction project participants and government departments have begun to pay close attention to BIM technology, which has been widely spread in China's Construction industry.

"A basic premise of BIM is collaboration by different stakeholders at different phases of the life cycle of a facility to insert, extract, update or modify information in the BIM to support and reflect the roles of that stakeholder" [6]. BIM is a technology with manifold aspects to it: coordination, collaboration, automated drawing production, intelligent objects, detailed performance simulations, interoperability, and so on [1]. Stakeholders of BIM started to strive to use it from different aspects and made some valuable experiences [2, 3]. Nevertheless, the application of BIM in China is still in the primary stage, which means we have to face many obstacles in internal or external to the organization and have little experience in industry standardization, technology localization, and responsibility of stakeholders, etc.

The purpose of this paper is to explore the application status and characteristics of BIM technology in China. The questionnaire was based on previous studies and interviews with experts.

100.2 Outline of the Survey

We took advantage of a seminar to develop the questionnaire field survey. Tongji university held the seminar on the application of Virtual Design and Construction in China in Shanghai on May 11, 2011,More than 260 construction project participants attended the conferences. To ensure the validity and reliability of the questionnaire, our team set a rough draft and distributed it to 40 AEC professionals and experts.

Out of 170 people who were queried, 105 (61.76 %) responded. and 96 questionnaires were valid. Based on their roles, the respondents are classified into several groups: 27 were architects and engineers (28.1 %), 15 were contractors and sub-contractors (15.6 %), 18 were BIM consultants (18.8 %), 10 were BIM researchers (10.4 %), 7 were BIM software suppliers (7.3 %), 6 were owners (6.3 %), 7 were supervision engineers (7.3 %) and 6 were association numbers (6.3 %).

100.3 Survey Findings

The selected results of the survey are presented within the following three topics: BIM adoption, BIM future; BIM Implementation. In the survey, the importance of BIM options is measured on scale of 1–5, with 5 being the highest score and 1 being the least score.

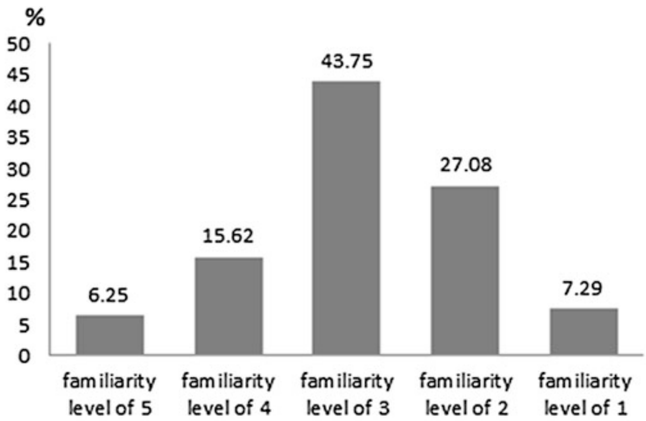


Fig. 100.1 Percentage using of BIM software level

100.3.1 BIM Adoption

The purpose of this topic is to understand the BIM experience levels of respondents, including three aspects: familiarity to BIM, basic way of using BIM, years of using BIM and BIM usage on Projects.

100.3.1.1 Familiarity to BIM

Figure 100.1 shows that 21.87 % of people are familiar with BIM and more than 78.13 % of people know less about BIM. Through tracking investigation of the respondents, we found that many quitters are those who knows little about BIM.

As can be seen from Fig. 100.2, professionals' experiences of BIM differ from person to person. Obviously, the experience of BIM of designers and research institutions is much more than that of the clients and the contractors, which is due to the fact that BIM technology is first as architectural software. Consulters also lack of deep understanding of BIM. The characteristics in this application stage and users experience of BIM are also shown in Figs 100.2 and 100.3.

100.3.1.2 BIM Adoption and Usage

According to the above results (Fig. 100.3), architects have the highest level of BIM adoption and proficiency. Among the responders, more than two-thirds of them (73 %) have never adopted BIM, with 3 % of them creating BIM models and 10 % also analyzing them. Today, 14 % of responders who use BIM consider themselves advanced or expert in using BIM tools to analyze models and create their own models. It reflected that almost respondents are still in low level.

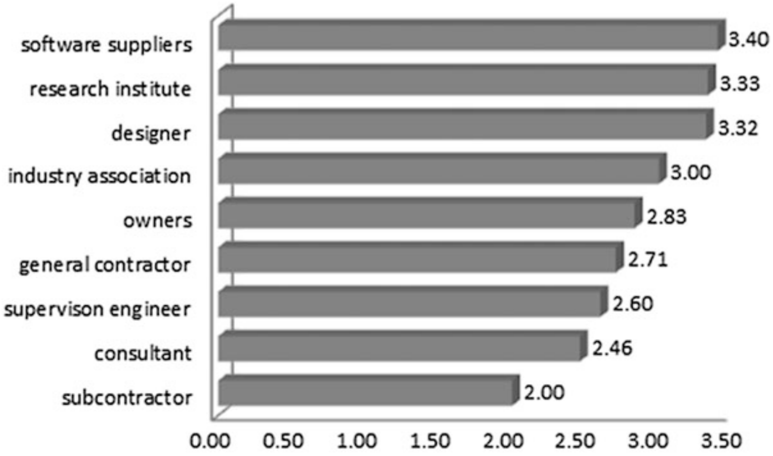
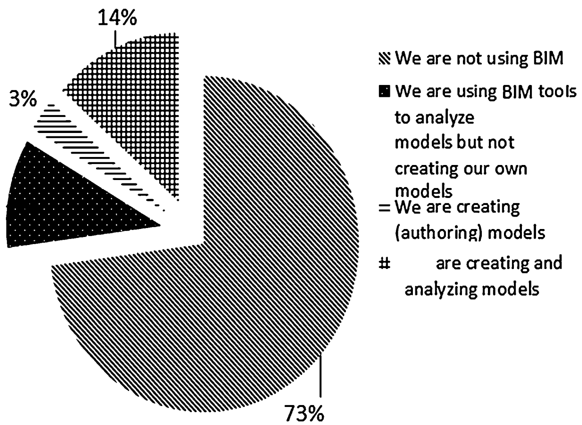


Fig. 100.2 The differentiation of familiarity on BIM

Fig. 100.3 BIM adoption and usage



100.3.1.3 Years Using BIM and BIM Usage on Projects

As shown in Fig. 100.4, people who have used BIM for less than a year and a year account for 56 % and 14 % respectively. Most users have learned less knowledge and are just in superficial level of BIM; Meanwhile, BIM got a tremendous development during the past year in china. Over 10 % of BIM adoption in China (13 %) occurred over 3 years ago.

The average using years of architects and engineers are more than that of the others (as shown in Fig. 100.5). Using years is limited to 1 year for the owners, contractors and supervision engineers, which lagged behind the design phase. The majority of respondents have not used BIM in specific project operation (61.5 %), but beginners are very optimistic that they will expand the use of BIM quickly (Figs. 100.6 and 100.7).

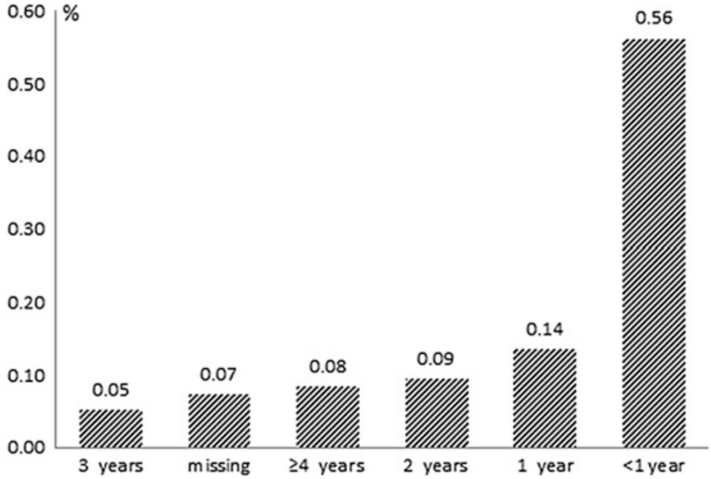


Fig. 100.4 Years using BIM

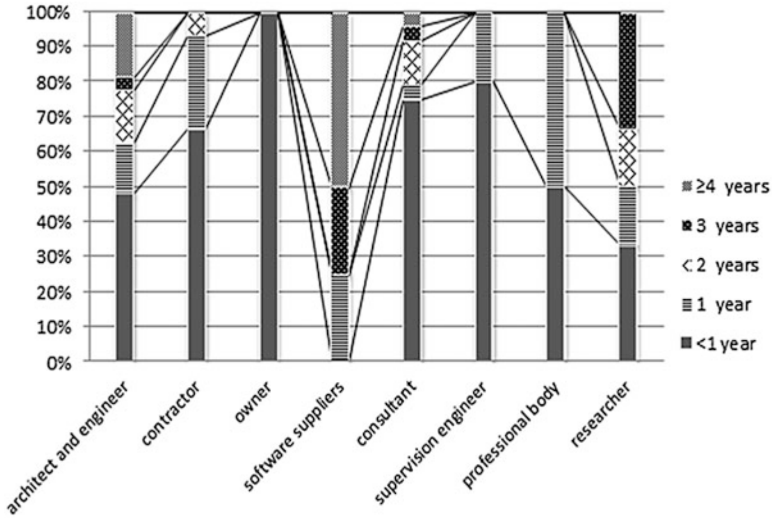


Fig. 100.5 Years using BIM of professionals

100.3.2 BIM Future

100.3.2.1 Attitude of Stage

In the survey, we want to know the attitudes of respondents on the possible stage in 2011. It is shown in Fig. 100.8 that 41.57 % of them indicated cognitive stage, while 48.31 % of the respondents believed it should be introduction stage, only fewer (10.11 %)deemed it development stage. The level of adoption is still very low.

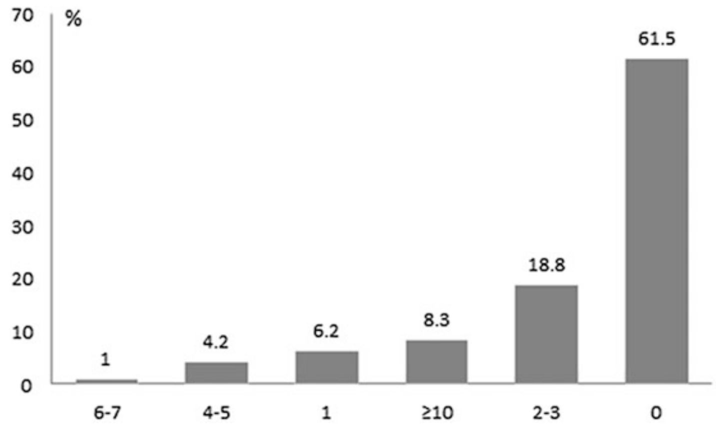


Fig. 100.6 BIM usage on projects

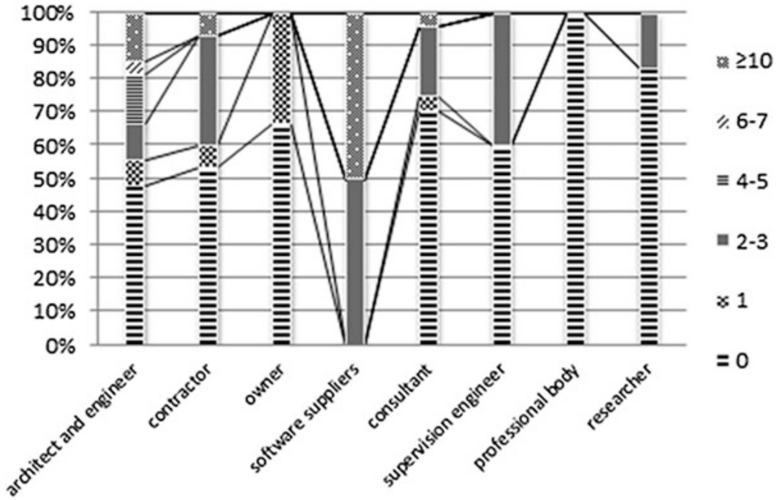


Fig. 100.7 BIM usage on projects of various professionals

100.3.2.2 Future Outlook

About 10 % of respondents (11 %) believe that BIM will be highly or very highly important to the industry in the next 2 years. However, more respondents (73 %) actually believe that the development of BIM depends on the change of the environment. And 16 % of them deem it hard to make choices. There are certain doubts about BIM application among them. The usage of BIM in the future is not quite clear, the future of BIM using level of proficiency will rely on the change inside and outside of the organization and on the jointly efforts of stakeholders (Fig. 100.9).

Fig. 100.8 Attitude of stage

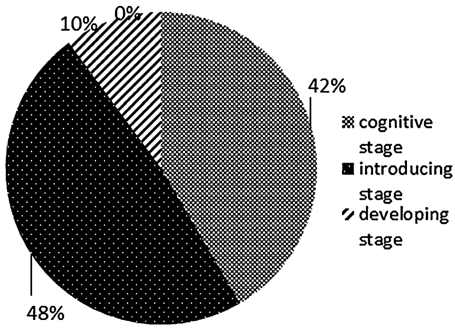
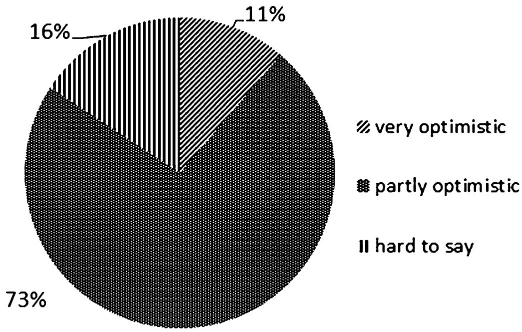


Fig. 100.9 Attitude of BIM application in 2 years



100.3.3 BIM Implementation

The purpose is to understand some perspectives of respondents about necessary reference for guiding the BIM application promotion.

100.3.3.1 Business Benefits

Business benefits from BIM in terms of ten major items. Relative importance of BIM benefits are showed in Fig. 100.10, less change orders due to design defaults, better collaboration among project team, better contract documents and drawings are the top rated business benefits. This is the top benefit that is being realized by all participants. On this point, there is no difference between China, North America and Western Europe, compared with the Smart Market report of McGraw-Hill Construction in 2010 [4]. On the other hand, saving project cost and time are less impartment than the top. It should be specially explained that the benefits of raising the budget and cost estimates are not apparent, one major reason of which is that engineering quota and Bill of Quantities in China cannot be compatible with construction software at present, especially to BIM. As the owners have less experience about BIM, they think BIM does smaller promote for new markets. According to the development of BIM in developed countries [5], with BIM technology continuous

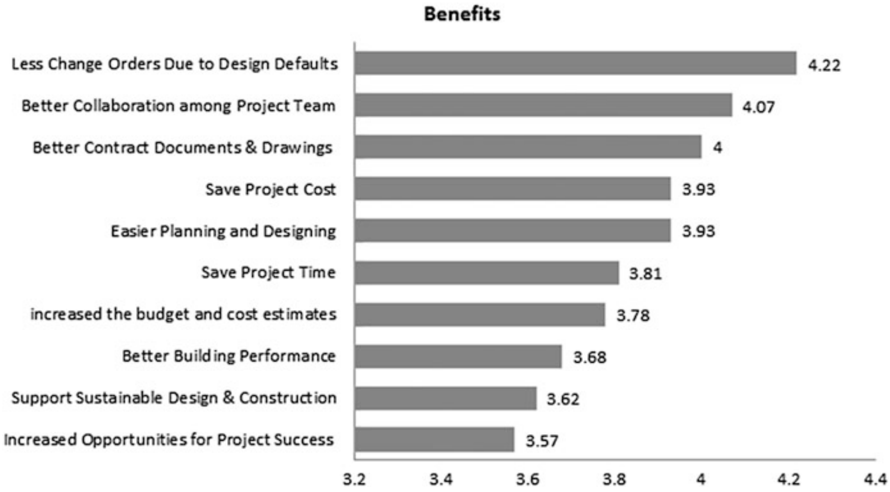


Fig. 100.10 Relative importance of BIM benefits

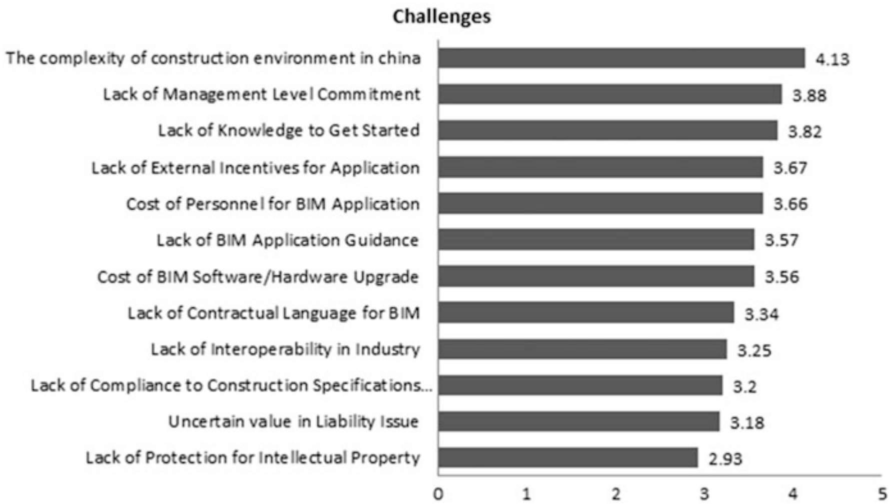


Fig. 100.11 Relative importance of BIM challenges

diffusion and development, an increasing number of owners will make contract engagement to use BIM technology in bidding phase. BIM technology will become an important means to tender and win new market business in the future.

100.3.3.2 Challenges of BIM Application

There are many factors with great impacts on the success of BIM in projects, 12 items are listed in Fig. 100.11. One of the key factors affecting the ability of

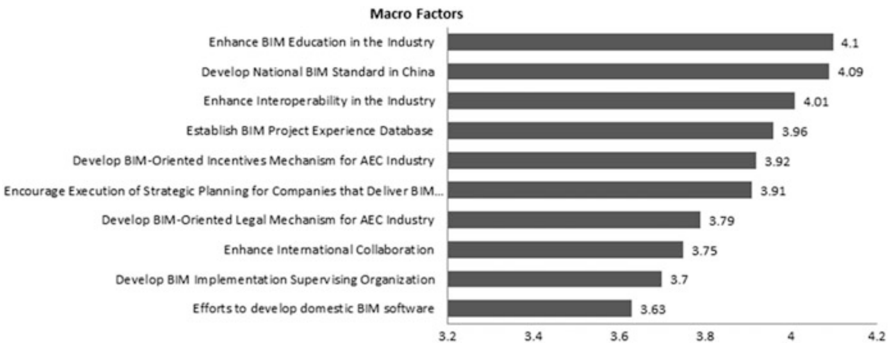


Fig. 100.12 Relative importance of BIM macro factors

users to perceive value on projects is the complexity of construction environment in china, which belongs to the external organization factors. It shows that our country construction industry environment has been branded “the very strong Chinese character“, and there is a significant gap between the domestic and abroad industrial environment and project management mode at present. Huge challenges of BIM application and popularization will exist for a long time; it is a good opportunity to promote the transformation of the Chinese construction with the help of BIM technology. The two factors, lack of management level commitment and knowledge to get started, which are parts of the internal organization factors, are also very impartment. It also shows that the enterprise managers’ knowledge and employees’ learning ability determine the adoption level of BIM. Another investigation of interview in Shanghai also demonstrated that smooth implementation of BIM in internal organization depends mostly on the leadership support.

In the survey, we also found that the investment of hardware and software is not the most major obstacles. Nevertheless, they do not pay much attention to the defects of construction standards, information security and intellectual property. It just reflects the present characteristics of BIM adoption.

100.3.3.3 Macro Factors of BIM Development in China

As we can see from Fig. 100.12, the macro factors promoting BIM development in China, “Enhancing training for BIM technology” is currently the most important task for all parties of construction, and “Develop national BIM standard in China” followed, so CBIMS (China Building Information Modeling Standard) is very important for government, which is the guidance of BIM strategic planning, which was formulated by Tsinghai University and phased achievements had been obtained. And “enterprise BIM strategy” and “BIM-oriented legal mechanism”, “software development” related macroscopically factors in the secondary status, because these work must be based on the primary factors completed. Therefore, the government and other administrative departments should play an active role in promoting the training of BIM, standardizing rules and specifications, improving the relevant legal mechanisms.

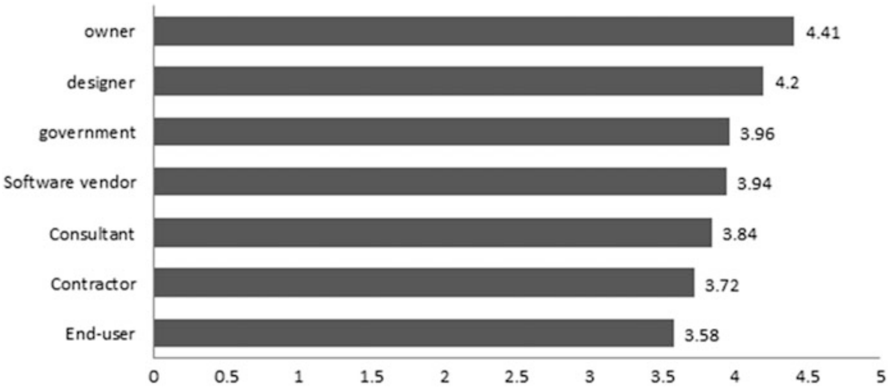


Fig. 100.13 Relative importance of driving forces

100.3.3.4 Driving Forces of BIM Stakeholders

Through analyzing the questionnaires (Fig. 100.13), the owners should play a leading role in promoting the implementation of BIM. Respondents also generally thought that designers and the government should promote their effect, but from Fig. 100.13, we can also see that the difference between them is not clear in the relevant driving force. At present, there's no big difference among driving forces of stakeholders. In other words, at the current state, there is no clear and unified opinion about BIM, The reasons to which include China's national conditions, the depth of understanding of BIM, the project practice and the application phase.

100.4 Conclusion

Since 2008, concepts related to BIM technology have been disseminated rapidly among participants of the construction industry in China. BIM is gradually accepted and implemented by industry-leading design units, and BIM's application is extended to the construction phase. The parties have reached the following views: BIM has been the future direction of construction industry, but given so many obstacles to apply BIM to one specific project, the attitude of most stakeholders are just cautiously optimistic. From the "value" aspect, all parties just benefit from software application, and the value is not based on a project's life cycle, so BIM's value is scattered and unclear. At present, only Shanghai Centre in China is trying and exploring to use BIM through a project's life cycle. From the "challenge" aspect, it is essential for all parties (all companies in the supply chain) to realize and define their roles in applying BIM technology, and solve the difficulties within and among organizations with a joint effort. As for the "macro factors" aspect, the government should play a major role in guiding and developing standards and norms for China BIM. In addition, the government should go along with the developing trend of construction industry to create good conditions for the development of BIM. From the "driving force" aspect, all parties should play their different roles in difference phase. At cognitive stage, software developers (Autodesk) play a major role in spreading BIM concepts. At introducing stage, the demands of designers and owners enhance the application of BIM. The mission for the government is mainly to improve the China BIM standard, which is expected to have more apparent effects in the next phase.

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Chapter 101
The Development Trend and Government Policies of Open BIM in China

Lei Zhang, Guangbin Wang, and Honglei Liu

Abstract Currently, Building Information Modeling (BIM) adoption has been led by several developed countries, and technical support needed for adopting BIM in the world. IFC has been called as an open BIM standard for exchanging and sharing BIM data among BIM software products. Yet, the current IFC standard might not be the best interoperability solution under all circumstances. In China, A great industry innovation is spurred by BIM, the research for China BIM Standard (CBIMS) is a very important landmark. Early in 2009, Tsinghua University carried out a theoretical and empirical research for CBIMS and completed BIM framework. This paper explains the basic content of IFC-based open BIM, discusses how open BIM, with the aid of IFC, and analyzes the development trend of open BIM in construction industry and proposes to the government policies for open BIM in China. It is still necessary to develop an open BIM solution that may support prediction of life cycle performance. Such a solution needs to be communicative to any open BIM software and thus has to be built upon open standards.

Keywords Open BIM • IFC • Development trend • CBIMS • Government polices

101.1 Introduction

Construction is a collaborative teamwork process with successful projects dependent upon a strong weave of owner, architect, engineer, contractor, and supplier into a collaborative team, a working society [13]. Traditionally, the construction sector

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_101, © Springer-Verlag Berlin Heidelberg 2014

has been seen as a low-tech industry, with little innovation compared to other industries [14, 15]. Due to the fragmented production structure, only 10 % the proportion of the value activities is created in buildings, while the proportion of non-value added activities as much as 57 %. BIM is continuing its proliferation in both industrial and academic circles as the "new CAD paradigm". Building Information Modelling (BIM) is a set of interacting policies, processes and technologies generating a "methodology to manage the essential building design and project data in digital format throughout the building's life-cycle". BIM is one of the important areas in currently Virtual Reality (VR) research and is expected to envision efficient collaboration, improved data integrity and intelligent documentation, distributed access and retrieval of building data and high quality project outcome through enhanced performance analysis, as well as multidisciplinary planning and coordination [1, 2].

Both architecture and engineering professions are embracing new modes of interdisciplinary information sharing and focusing on two emerging and fast growing concepts: BIM and integrated project delivery (IPD) [2–4]. BIM is now a complete platform made accessible for teams. The exchange and sharing of data is the essence of BIM, and the core point is how to set up an reasonable the standard of data, based which the global users could got the model and shared information each other using different softwares in projects. Building SMART (International Alliance for Interoperability, IAI) has developed, maintained and issued certifications for the data model standard known as Industry Foundation Classes (IFC). The IFC standard was accepted by ISO (ISO/PAS16739: 2005).

In order to measure and achieve the full value of using BIM and achieve the objective mentioned above, with the help of software venders and professional bodies, many countries begun to establish the programmers of Open BIM IFC-based and explored government policies.

101.2 Research Objectives and Scope

The objective of this research is to identify innovative government policies and trends in the area of Open BIM in AEC industry. One of the main goals is to bring together academic and professional expertise from multiple disciplines to discuss current problems and speculate on new solutions and trend for the future and identify government policies in various countries. More and more countries began to develop the BIM implementation roadmap or strategic planning, took various measures to promote the application of BIM in AEC industry based on the IFC standard and developed some "Open BIM programmers". In US, General Services Administration (GSA) began the implementation of the national 3D-4D-BIM project since 2003, the Cabinet Office of UK carried on White Paper of the BIM strategy in May 2011. In Asia, South Korea and Singapore had already established different plans to promote implementation of BIM.

The paper continues with an explanation of the research content of Open BIM in China. A great industry innovation is spurred by BIM and the research for China BIM Standard (CBIMS) is a very important landmark in the process of BIM adaption. Early in 2009, Tsinghua University carried out a theoretical and empirical research for CBIMS and completed BIM framework in 2011. This paper explains the basic contents of open BIM IFC-based, discusses how open BIM, and analyzes the development trend of open BIM in construction industry and proposes to the government policies of open BIM in China.

101.3 BIM, IFC and Open BIM

101.3.1 BIM

The National Institute of Building Sciences (NIBS) through its Building Smart Alliance program has developed this working definition: BIM is a digital representation of physical and functional characteristics of a facility and a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life cycle; defined as existing from earliest conception to demolition.

The definition of open BIM, or Integrated BIM, is extending this definition by stating that *Integrated BIM, when you share information, requires open standards* [17]. This definition suggests that, when using BIM for internal purposes, the need for standardization of interfaces is not as strong as when you are using BIM for exchange purposes.

101.3.2 IFC

The Industry Foundation Classes (IFC) data model is a neutral and open specification that is not controlled by a single vendor or group of vendors. It is an object oriented file format with a data model developed by buildingSMART to facilitate interoperability in the building industry, and is a commonly used format for Building Information Modeling (BIM). From 1992 to 2008 the FIC mission was to *improve the performance of facilities over their full life-cycle by fostering common and open standards and an integrated life-cycle information model for the A/E/C & FM industry.* IFD Library provides flexibility for an IFC-based building information model (BIM) allowing for the link between the model and various databases with project and product specific data (Fig. 101.1).

IFC can manage snap shots of the information, but to manage the whole life cycle, there is a need for a standard like PLCS, Product Life Cycle Support (ISO 10303–239) (ISO 2008), which supports some critical business needs faced by companies as they seek to implement Product Life cycle Management (PLM) and other broad enterprise-based initiatives. The Model Servers shall secure

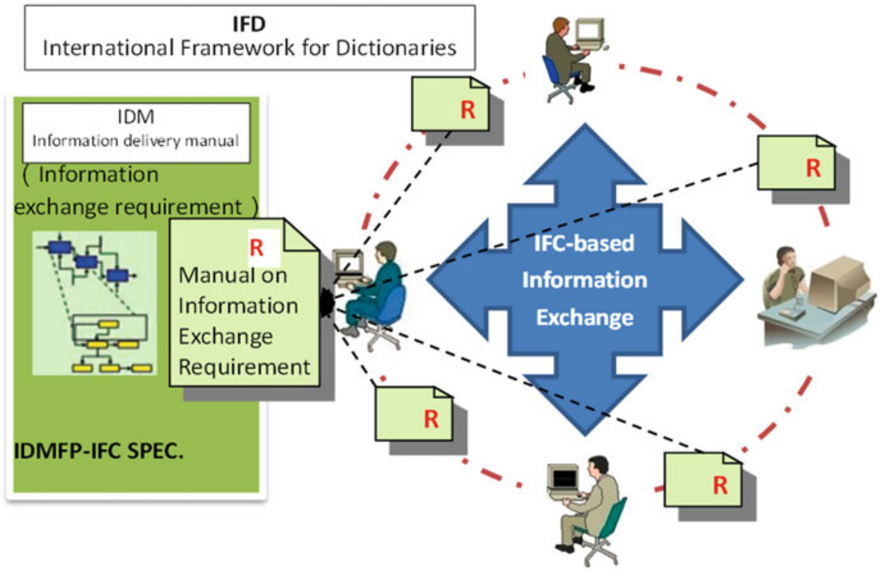

Fig. 101.1 IFC standard (Recourse: Seo Jong Cheol 2012)

collaboration both within an organization as well as throughout an extended enterprise and its various participants. Currently, IFC is available in practice. The confidence and reliability is growing within the AEC industry. The current IFC standard might not be the best interoperability solution under all circumstances, and BIM software products might still need to develop direct links to some others for more efficient communication and tighter integration.

101.3.3 Open BIM

Currently, BIM adoption have been led by several countries, and technical support needed for adopting BIM in the countries have been led by their own buildingSMART chapters. The BuildingSMART International is an international organization established to provide a universal basis for process improvement and information sharing in the AEC industry using Industry Foundation Classes (IFC). Currently, IFC has been called as an open BIM standard for exchanging and sharing BIM data among BIM software products, and the alliance divisions (or chapters) have led the technical support for implementing BIM with process improvement.

101.3.3.1 Definition of Open BIM

Integration of open standards (e.g. IFC) into BIM (open BIM) seeks solutions to improve the productivity and efficiency of the building process by enabling interoperability between AEC/FM BIM softwares applications. Open BIM, is the concept of having all the relevant information for the buildings, like physical objects (walls, doors, ducts, elevators, etc.) and abstract objects (relationships, types, groups, etc.) in open formats, making them accessible and readable for anyone, and not locked into proprietary software formats. Open BIM must cover all disciplines and allow for different processes to access the information. To enable this large scope, there will be several open standards needed to support different parts of the information map [5].

The buildingSMART® International gave the official definition of Open BIM:

> Open BIM is a universal approach to the collaborative design, realization and operation of buildings based on open standards and workflows. Open BIM is an initiative of buildingSMART and several leading software vendors using the open buildingSMART Data Model.

101.3.3.2 Benefits of Open BIM

The benefits of Open BIM is demonstrated world-wide by the buildingSMART mission and industry representatives such as Senate Properties, Norwegian State Building Agency and GSA have, to various extent, mandated initiatives on supporting the use of the IFC standard [23]. Firstly, workflow integration results in greatly reduced coordination errors compared to sheer file exchange-based coordination of the different disciplines. Secondly, project members can work with the best-of-breed solutions in their respective fields without risking "incompatibility" in certain BIM projects. Thirdly, project members can maintain full control over the using of softwares independently from their peers on the different AEC projects. Lastly, accessibility of BIM data is provided for the whole lifecycle of buildings including design, construction and operation [6]. As shown in Fig. 101.2, with the integration of open standards any open BIM software application will be able to communicate and exchange information with any other open standard software application. The ability to communicate and exchange information is of special importance for open system concepts [7].

101.4 Open BIM Experience in Various Countries

Various countries including the USA, Finland, Norway, Denmark, Germany, Singapore and Korea are currently in the process or have released for BIM guidelines. The number of involved companies in the BIM initiatives by International Alliance for Interoperability (IAI) and buildingSMART in European countries is on rising. The only goal of the Open BIM movement is to promote open collaboration workflows for better-coordinated projects. This goal is primarily achieved through a globally Open BIM branding supported with clear definitions, specific requirements and best practices to spur implementation.

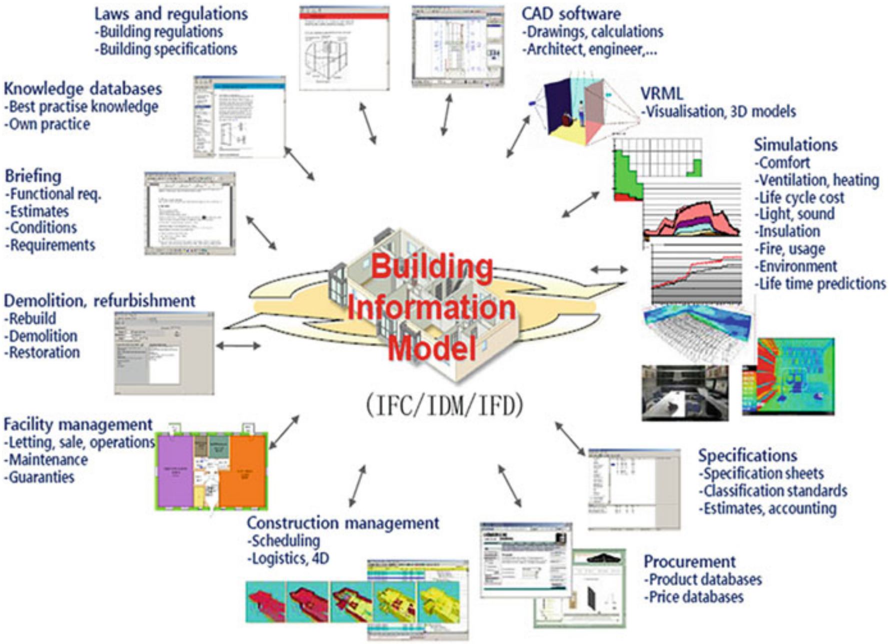

Fig. 101.2 Delivering high-value workflows in BIM (Source: http://buildingsmart.com/openbim)

101.4.1 US

Significant efforts are being undertaken to "solve" the interoperability problem by developing IFC model views that carefully define the contents needed in specific exchanges. BIM Program was put into execution by the GSA, which developed GSA-2010 BIM standard for government design and review. This approach is laid out in the National BIM Standard (version1.0, part 1) in 2007. The NBIMS-US Project Committee is a project committee of the buildingSMART alliance which is a council of the National Institute for Building Sciences (NIBS). On November 2011, NBIMS-US™ V2 was distributed which including nine approved reference standards.

These efforts have largely targeted single or a small set of exchanges. None of the National BIM Standard efforts have yet completed a set of exchanges that address a large AECO domain. On October 25 in 2011, initial results of the National Precast BIM Standard were demonstrated [19]. Five precast concrete software systems participated and six exchanges were made between these applications using IFC as the neutral data schema. The exchanges are those shown in Fig. 101.3.

101.4.2 UK

In UK, a working group invited by BIS tried to find out the benefits of BIM in the phases of construction and post-occupancy. The strategy was recommended to

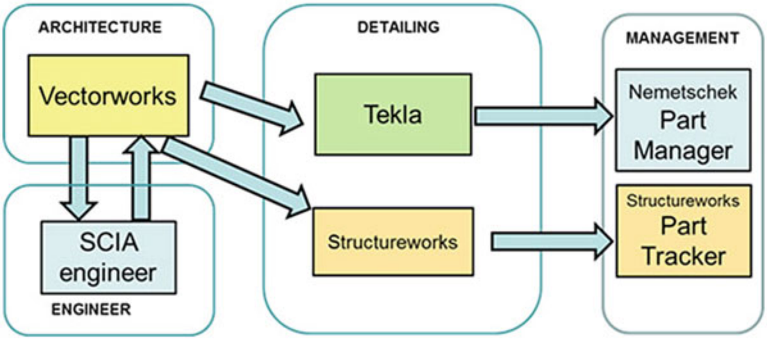

Fig. 101.3 A simplified workflow of precast model exchanges

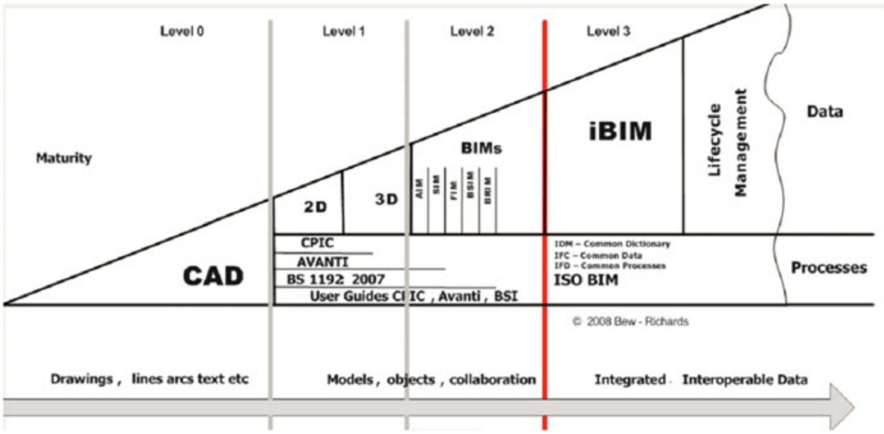

Fig. 101.4 BIM maturity levels

deliver a structure government/sector capability to increase BIM take-up over a 5 year horizon as part of a joined up plan to improve the performance of the government estate in terms of its cost, value and carbon performance. A "push-pull" strategy was descripted in 2011. There are five identified stages of the program in the maturity model which are detailed in Fig. 101.4. This will drive a mass of improvement upon which they will build over the 5 year period, by which time they expect all pliers to the Government Estate to be capable of operating at Level 2. Government was advised to mandate BIM on all central projects in excess of £50 m.

101.4.3 Singapore

In Singapore, to push for a sustainable built environment, the Building & Construction Authority (BCA) of Singapore has set clear mandates for buildings to be more energy efficient and environmentally friendly. BCA set up a BIM Execution Plan to spur the depth and breadth of applications. In order to raise productivity and build up the capability of construction firms, it launched the $250 million Construction Productivity and Capability Fund (CPCF) in June 2010. BCA has also set up a BIM fund to subsidy up to $105,000 per firm for training, consultancy and acquiring of hardware/software. Singapore BIM Guide (Version 1.0) was published in May 2012 and it was initiated by the BIM Steering Committee, set up in 2011. Reflections at Keppel Bay, provides an illustrative example of the role of Open BIM in collaboration between disciplines in projects of architecturally complexity and an iconic design for luxurious waterfront living at the entrance to Singapore's historic Keppel Harbor. IFC was adopted as the Open BIM format and each subcontractor was able to export their model in IFC format and integrate it into the central model which was managed by the general contractor.

101.4.4 Korea

As a precursor in Asia, with the support of buildingSMART Korea, Korea has greatly deeper understanding to Open BIM. The attention in BIM application has increased greatly in the government as well as construction industry, and PPS (Public Procurement Service) requires BIM from 2012 for all the public projects of 50 billion Won (around 45 million USD) and above. MLTM (Ministry of Land, Transport and Maritime Affairs) is also proceeding with various research and development projects regarding BIM technology. Design and construction projects Open BIM-based by both government and public organization are rapidly increasing in Korea. The national BIM Guidelines and Roadmap was launched by the MLTM, and it was carried out by buildingSMART Korea and Kyung Hee University in 2009. The forums for the issue of 'The BIM' were held six times, which made greatly influence among stakeholders in construction industry. BIM expertise is provided in various ways such as the BIM education about "BIM AWARDS" and "BIM Professional Training Program". In 2012, the training of 5 days' workshop was held to comprehend a concept of BIM and applicable methods for domestic circumstance.

101.4.5 Open BIM Program for Improved Collaboration

BIM should be considered in the context of the increasing globalization of the construction supply-chain and more homogenization and greater consistency of basic construction-client information requirement. There are a number of national deployments of BIM currently in progress across USA, Scandinavia/Europe, the Far East and Asia which are at varying levels of maturity. So in 2011, the GCCB of UK planned to form a strategy level alliance with the US Federal Facilities Council, the US National Institute of building science (including GSA) and their equivalencies in Scandinavia and Europe. In 2012, Open BIM Programme is a marketing campaign initiated by GRAPHISOFT®, Tekla® and other members of buildingSMART® to urge and facilitate globally coordinated promotion of the Open BIM concept throughout the AEC industry, with aligned communication and common branding available to program participants [8].

101.5 Development Trend of Open BIM in China

101.5.1 Development of the IFC Specifications

IFC is the international standard for Open BIM. This article deals with brief explanation about IFC4 standard development in a mind as mentioned in Fig. 101.5. IFC2X4 has been in development for several years. It has now been published, actually as "Release candidate 2", which means that no more changes are expected, but the documentation is still being refined. Currently, BSI began to formulate IFC4 RC3. In other words, IFC4 RC3 was developed for the requirements in practice and comparisons of existing IFC specification with compatibility.

101.5.2 Different Background of Using BIM in China

Compared with developed countries, the construction industry is the pillar industry of our country. In 2011, construction output value up to 11.7734 trillion Yuan, which is an increase of 22.6 % over the previous year. The proportion of investment of construction information has been less than 1 % and application of modern information technology in the construction industry is still very low. There is still a huge gap between China and many developed countries. In a survey for BIM in China

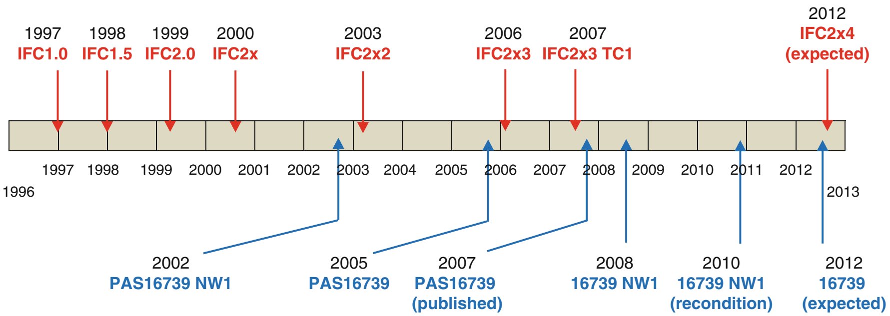

Fig. 101.5 Development of the IFC specifications and ISO standardization roadmap

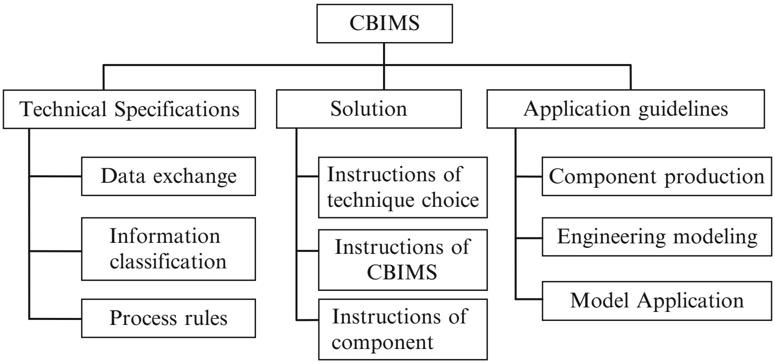

Fig. 101.6 CBIMS framework (Recourse: Gu Ming, 2010)

Wang guangbin [20], it was shows that 21.87 % of people are familiar with BIM and more than 78.13 % of people know less about BIM. Though we got great progress for BIM application, China's government policies for BIM is still lack systematic planning and a detailed roadmap development in BIM implementation guide.

101.5.3 Development Trend

BIM was first promoted in China by Autodesk in 2004. From 2008, application of BIM had been greatly developed in china. It is necessary to research on China BIM Standard urgently in order to share and implement BIM among construction supply chain. Chinese standards and the key algorithms cannot be easily implemented through customizing existing BIM-based application software (Ma zhiliang 2011). Basic research and Open BIM programmer had been done in recently years. China Institute of Building Standard Design & Research put forward the standard of JG/T198-2007 in 2007, which was only the platform part. And in 2008, according to country standard, a platform standard based on IFC (domestic suggestive technology file) was developed. Hong Kong House Agency is the department charging of BIM surplus, it orders that bid file must be delivered in BIM. BIM standard (vision 2.0) had been proclaimed to public. Hong Kong Institute of Building Information Modelling (HKIBIM) published BIM Project Specification (Rev 3.0) in 2011 [9]. To the government, BIM was paid attention in the 11th five-year plan in 2008. A subproject was sponsored to develop BIM-based next generation application for buildings.

The research on China BIM standard (CBIMS) was started in 2009 by Tsinghua University,which belong to National 863 hi-tech research plan. The research group proposed the framework of CBIMS (Fig. 101.6) in 2010, In the technical specifications, the team referred to NBIMS standards, There were three aspects of BIM information exchange: the specification of the database for data storage format; exchange requirements and rules in the specific exchange process [10–12].

In addition, Tongji University had actively take part in the research on Open BIM since 2010 (Wang guangbin 2011). Jointed with Kyung-Hee University, Korea, they research on the project named "ICT-based Construction Management using Open BIM". The project focuses on enhancing the academic and industrial communication in AEC industry between Korea and China, as well as improving the productivity and value-added for AEC industry using Open BIM and pushing the ICT application in AEC industry of China.

101.6 Conclusion

Currently, Open BIM standards are greatly developed in the world. Respond to changes in international construction environment and the requirements of the standard to converge, the BSI roadmap 2020 had presented. Looking at the experiences of various countries, they had launched government policies and develop a clearly roadmap to BIM implementation according to their regional practice in AEC industry and make great significance to the guidance of Open BIM. We can learn from the various countries and developed strategy for China to Open BIM. BIM quality evaluation based Open BIM is getting more popular and will be essential in a near future.

Our government policies should be taken as following:

Development of BIM strategy and roadmap
In China, the government departments had recognized the value of BIM and taken some actions to promote BIM application. Government can carry out the pilot projects in public sectors and get experience BIM strategy should be the most important task. Different task should be cleared in different stage and the roadmap should be implicated step by step.

Collaboration of organizations
BuildingSMART is an alliance of organizations within the construction and facilities management industries dedicated to improving processes within the industry through defining the use and sharing of information. Collaboration of stakeholders is necessary. Though we have lots of organizations for BIM, they are so scattered that it is difficult for them to collaborate for the BIM strategy. So, we can apply to be the chapter of BuildingSMART. Organizations within the alliance include architects, engineers, contractors, building owners, facility managers, manufacturers, software vendors, information providers, government agencies, research laboratories, universities and more. Only in this way, we can execute the Open BIM program smoothly.

Improvement to CBIM
The framework of CBIMS was delivered, but it was still in very low level compared to NBIMS and HKBIMS. We must launch the first edition of CBIMS as soon as possible and develop it during the period of research and practice. Because of the globalization for BIM, government must collaborate with other countries or areas to

strengthen the broad and depth application for BIM. We should intend to use relevant existing industry or Government organizations, associations, interest groups, other collaboration forums to deal with the requires of our collaboration. It is common that real estate agencies and public owners support the development and implementation of open communication standards for our sector and facilitate the utilization of information technologies based on these open standards, create the best possibilities for the exchange of relevant information and efficient collaboration between AEC/FM stakeholders.

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Chapter 102
The Optimal Strategy of Using BIM in Construction Management

Cong Liang, Rong Zhang, and Weisheng Lu

Abstract Measuring the benefits of using Building Information Model (BIM) has recently been investigated by the researchers in the construction management field of study. Yet due to BIM is an emerging technology within the construction industry, there is still not much information available in the markets, giving rise to quantifying the benefit and other economic outcome via traditional statistical model from the perspective of the project management is a mission impossible target. To fill such knowledge gap, this paper intends to introduce a real option model, through which an optimal strategy by using BIM in the construction management is given. Typically, the result of the model would answer the how much opportunity cost that the company should sacrifice would produce the optimal payoff.

102.1 Introduction and Background

Recently, the appearance of Building Information Model (BIM) brought about a revolution in Architect, Engineering and Construction (AEC) industry. According to Eastman [5], BIM is "a digital representation of the building process to facilitate exchange and interoperability of information in digital format". Organizations such as the Associated General Contractors of America (AGC) (2006), the American Institute of Architects (AIA) (2008), the General Services Administration (GSA) (2007), also contribute to the proliferation of BIM definitions. Researchers and practitioners are actively promoting it by envisaging that the emergence of BIM can

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_102,

help alleviate many well-ingrained problems in the AEC industry, such as deploying a flawed Design-Bid-Build (DBB) procurement system, fragmented building processes, lack of communications, low productivity, and poor performance. Over 60 % of architects in the US employing more than 50 people are using any form of BIM according to the AIA report on the Business of Architecture, while the equivalent figure from the Finnish ICT Barometer for all architects in Finland is 93 % [6]. A Smart Market Report (2008) stated in their survey that 62 % of BIM users would use it on more than 30 % of their projects. Some of the public building owners in the US, Denmark, and Finland are starting to demand BIM in their projects [9].

Without evident benefits to companies, BIM may not continue to flourish, as BIM programs are costly and competing for companies' limited resources. To provide this legitimacy, researchers have endeavored to measure the benefits contributed by this emerging technology [1, 3, 8, 10, 12, 13]. As will be reviewed in greater detail later, the major difficulty to do so is that BIM's benefits are hard to disentangle and even more difficult to quantify. This is particularly true when BIM is increasingly exhorted to be integrated in managerial aspects such as improving communication, and encouraging collaborative work. The situation is further exacerbated by the fact that data about BIM applications in the industry is not readily available. Too often, existing models underestimated or exaggerated the benefits contributed by BIM.

This paper aims to theoretically introduce a stochastic model-real options model to measure the benefit of BIM within the lifecycle of AEC process. The reason to choose real options model is quite obvious since the future conditions are uncertain for nearly most of construction projects, but the parties that involved in the AEC process like architects, engineers and project managers should make a decision in each construction phrase. Very often, construction phases are painful to be irreversible, if not completely impossible. As such, the architects, engineers and project managers carefully take into account some possible analytic skills to shape the implementation of the project. That is to say, they need to understand the opportunity cost by using BIM in lieu of the traditional process and how much benefit could be generated for almost every decision (option) he or she makes. Real option approach is conceptually *ex ante;* managers are not committed to undertaking the obligations in real world [2, 4]. The execution/implementation of construction projects is determined by managerial decision for the ongoing basis in the long run. Compared to the traditional Net Present Value (NPV) method, real option based approach enables the managerial board to consider the project in the continuous time manner [7, 11, 14]. In short, the real option approach not only provides some sources to measure the uncertainty to make the managerial decision, but also overcomes the hardship of the standard analytical method. To better present the framework of study in terms of real option approach, we first address some assumptions:

1. The objectives that employ BIM to conduct construction project are well developed and sophisticated such that they satisfy the ongoing basis;

2. The market where the construction company conducts the construction project is complete and sufficient;
3. The company is rationale in that the project is profit maximization oriented, resulting in the project considered in the following framework of study would not default and cease. The project would start to generate the cash flow when the construction phases are finished;
4. The time to exercise BIM is independent of the amount of payoff/benefit the construction company could generate;

By utilizing the rigorous mathematical theoretical framework of study, we intend to answer by investing how much percent of BIM on the construction project would generate the optimal benefit in theoretical manner. The structure of this paper is organized as follows: after a brief introduction, a theoretical real option model is presented, and then draws the conclusion.

102.2 Model

Suppose a construction company (well developed) has an opportunity to try the Building Information model (BIM) during the lifecycle of construction project. The benefit V_t via this technique in the whole project should vary in different phases such as design, bidding, construction and facilities management, which means that the benefit[1] during the whole project fluctuates and stochastically follows the geometric Brownian motion [11, 15]:

$$dV_t = (r - \delta)V_t dt + \sigma V_t dB_t, \quad V_0 = v \geq 0 \tag{102.1}$$

where r, δ and σ are constant[2] over the whole project period, B_t is Brownian Motion under martingale measure P In the study, we assume that each company follows a mechanism that all the project managers are thirsted for maximizing benefit. In reality, BIM may not play a key role during the whole construction project, i.e. the time to use BIM may not cover the period from the beginning of the project till the end since the BIM is an emerging technique, BIM needs much time to be fully utilized by practitioners. Then the benefit generated by BIM is named as

[1] To distinguish the terms benefit and payoff, we denote that benefit here means the cash flow could be generated when the construction project is finished and start to operate, while the payoff is the total profit minus the total cost in the framework of measuring BIM advantageous.

[2] r, δ and σ stand for the risk-free rate, dividend rate and volatility in financial model, but in this article, these three terminologies represent the market rate of return of conducting construction project for the company, the reinvestment rate like the some proportions of the construction project has been finalize and begin to operate and the risk of undertaking the construction project respectively.

marginal benefit rate[3] of BIM Q, which depends on opportunity cost that the project managers have to sacrifice the traditional method by summiting initial cost (investment) q on using BIM covering the period ℓ, resulting in the benefit by using BIM is Q^{ℓ}, where $\ell(0 \leq \ell \leq 1)$ is the duration of using BIM in the project. Thus, to calculate the total payoff by using BIM is ascribed to solve the following mathematic problem, which is similar to Vollert [15]:

$$\pi_0(V_0) = E\left[e^{-rt} \max\left(Q^{\ell}(V_t - k) - qQ, 0\right)\right] \tag{102.2}$$

where k is the cost for generating benefit in the progress of using BIM, including equipment installation fee, management fee, training fee and consultant fees, etc., E(•) is the expectation sign under martingale measure P. To solve the problem (102.2), we cannot avoid thinking of a series of fundamental problems in the framework of advanced probability. But recall that our purpose is to investigate the maximum payoff at time 0 by assuming that the company is consistent with the going concern basis, then we consider an extreme case where the construction company already utilizes BIM to conduct the construction project and start to operate once the construction project is finalized, which could generate a stable cash flow, then the benefit would become [14]:

$$\begin{aligned} \pi_1(V_t, Q) &= \int_0^{\infty} e^{-rt} Q^{\ell}(V_t - k)dt \\ &= \int_0^{\infty} e^{-rt} Q^{\ell}\left(Ve^{(r-\delta)t} - k\right)dt \\ &= Q^{\ell}\left(\frac{V}{\delta} - \frac{k}{r}\right) \end{aligned} \tag{102.3}$$

where V is a deterministic benefit function that need to be ascertain. To determine the value of $\pi_0(V)$, which is the discount total payoff at time 0, we try a retrospective method by take advantage of Ito's lemma on linking π_1 and π_0 to generate the fundamental equation in the solution region C^d (on or before time d). As the problem we consider here is time homogeneous, $\pi_0(V)$ should satisfy the ODE (ordinary differential equation):

$$\frac{1}{2}\sigma^2 V^2 \frac{d^2\pi_0}{dv^2} + (r - \delta)V\frac{d\pi_0}{dv} - r\pi_0 = 0 \tag{102.4}$$

The general solution to this ODE is given by

[3] The marginal benefit rate is some kind of opportunity cost in the project management, results from the rate of use (BIM) in lieu of traditional procedures in the whole construction management.

$$\pi_0 V = \omega_1 V^{\alpha_1} + \omega_2 V^{\alpha_2} \tag{102.5}$$

where ω_1, ω_2 are constants that need to be certain, α_1, α_2 can be obtained by substituting the general solutions to Eq. (102.6). In simplicity, we consider the characteristic equation

$$\frac{1}{2}\sigma^2\alpha(\alpha - 1) + (r - \delta)\alpha - \mathrm{r} = 0 \tag{102.6}$$

The roots of (7) are

$$\alpha_{1,2} = \frac{1}{2} - \frac{r - \delta}{\sigma^2} \pm \sqrt{\left(\frac{r - \delta}{\sigma^2} - \frac{1}{2}\right)^2 + \frac{2r}{\sigma^2}} \tag{102.7}$$

where $\alpha_1 \geq 1, \alpha_2 \leq 0$. Also, we define the payoff function by pondering the initial investment Q as

$$\varphi^d(\pi_0(\mathrm{V})) = \max Q\{\pi_1(\mathrm{V}, Q) - qQ\} \tag{102.8}$$

Then the continuous region C^{d} is defined as

$$C^d = \left\{V \in \mathrm{R}_+ \cup \{0\}; \quad \pi_0(\mathrm{V}) - \varphi^d(\pi_0(\mathrm{V}))\right\} \tag{102.9}$$

Though Eqs. (102.8) and (102.9), we intend to solve the optimal V*(Q*) at which the construction company attempts to employ BIM to generate the optimal benefit rate Q*. The solution is independent of time t, which echoes with our previous statement that BIM is a versatile and flexible instrument for the construction project. In other words, the construction company could use BIM whenever they consider it is the right moment. The following procedures will turn to solve π_0, but first we need to supplement one more property:

$$\lim{}_{V \to 0}\pi_0(\mathrm{V}) = 0 \tag{102.10}$$

That is to say, if the construction company could not generate the benefit via BIM, the total discount payoff is termed as zero. Equation (102.10) also indicates $\omega_2 = 0$. Now we restrict $\pi_0(\mathrm{V})$ remains stochastically C^2 which gives rise to the payoff value is suitable for optimal stopping at the benefit level V* and Q is kept fixed for a moment, then we have the following condition from Eq. (102.9):

$$\pi_1(\mathrm{V}^*(Q)) = \pi_1(\mathrm{V}^*(Q), Q) - qQ \tag{102.11}$$

$$\frac{d\pi_0(\mathrm{V}^*)}{d\mathrm{V}^*} = \frac{d\pi_1(\mathrm{V}^*(Q), Q)}{d\mathrm{V}^*} \tag{102.12}$$

Know also that $\pi_0(\mathrm{V}) = \omega_1 V^{\alpha_1}$ from the previous discussion, then substitute it in Eqs. (102.11) and (102.12), we have

$$\omega_1 V^* \alpha_1 = Q^\ell \left(\frac{V^*}{\delta} - \frac{k}{r} \right) - qQ \tag{102.13}$$

$$\omega_1 \alpha_1 V^* \alpha_1 - 1 = \frac{Q^t}{\delta} \tag{102.14}$$

Thus, the optimal benefit for BIM is

$$\mathrm{V}^*(Q) = \frac{\omega_1 \delta (k + rqQ^{1-t})}{(\omega_1 - 1)r} \tag{102.15}$$

$$\pi_0(\mathrm{V}) = \frac{Q^t (k + rqQ^{1-t})}{r(\omega_1 - 1)} \left(\frac{V}{\mathrm{V}^*(Q)} \right) \omega_1 \tag{102.16}$$

By the same procedure shown above (similar to Eqs. (102.11) and (102.12)), we next solve benefit rate Q* that maximizes $\pi_0(\mathrm{V}^*(Q))$, the solution is

$$Q*^{1-\ell} = \frac{\ell}{\omega_1(1-\ell) - 1} \frac{k}{rq} \tag{102.17}$$

$$\mathrm{V} * (Q*) = \frac{\omega_1(1-\ell)}{\omega_1(1-\ell) - 1} \frac{\delta k}{r} \tag{102.18}$$

The interpretation of Eq. (102.17) and (102.18) is simple. The maximum benefit $\mathrm{V} * (Q*)$ could be acquired when $Q^* = \left(\frac{\ell}{\omega_1(1-\ell) - 1rQ} \frac{k}{rQ} \right)^{\frac{1}{1-t}}$, which means the project manager could generate optimal benefit by employing BIM in the rate of Q* for the whole project (i.e. sacrificing Q* of opportunity of time using the traditional method).

102.3 Conclusion

This paper attempts to introduce a real option based approach to theoretically measure the optimal BIM benefit. This framework of study considers opportunity cost that the construction manager would choose. One important finding of this paper is to answer how much payoff results from utilizing BIM, given the decision maker sacrifice Q* of opportunity of time using traditional method. The contributions of this framework of study are in two manifolds: first, it provides a theoretical analytical approach to help different parties who involved in AEC process to better understand the BIM benefit under uncertainty circumstances; second it provides an optimal strategy to use BIM in the construction project, which is rarely seen from the previous study. However, due to the difficulty of collecting the data and related information of using BIM during the construction process from the construction industry, the solution of this paper could only provide the theoretical approach for the solution for BIM benefit optimization problem, we suggest that the future studies could link the game theory as well as statistical model to the real options approach such that more deeply and broadly investigation of optimizing BIM benefit could be carried out.

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Chapter 103
Development of Building Information Modelling Enabled Code Checking Systems for Australia

Shan-Ying Shih and Willy Sher

Abstract Building projects in Australia need to be checked manually against the Building Code of Australia (BCA) before the commencement of construction. This process is error-prone and time-consuming for building industries. Technical developments in Building Information Modelling (BIM) provide potential for a new generation of software in automated code checking (ACC) to assist with these activities. In addition to enhancing the efficiency and accuracy of checking processes, ACC using BIM offers opportunities to identify non-BCA compliant aspects of buildings during the design phase. This paper reviews previous studies to identify the main factors informing ACC development and highlights the existing limitations and assignments that need to be resolved, thereby providing support for future studies in establishing ACC systems for Australia.

Keywords Automated code checking • Building Information Modelling • Building codes of Australia

103.1 Introduction

Technical developments in building industries have given rise to considerable changes in the ways in which architects, engineers and construction managers (AEC) engage with each other during design processes [1]. Since the introduction of Computer Aided Design (CAD) tools, project stakeholders have benefited from improvements in design, communication and schedule [2]. Taking design modifications as an example, CAD accelerates the time required to prepare high performance designs compared to the re-work required using traditional hand

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_103, © Springer-Verlag Berlin Heidelberg 2014

drawings. Moreover, 3D visualizations enhance stakeholders' awareness of design objects, decreasing misunderstanding and errors for project members during the design process [3]. However, CAD provides little assistance to designers in identifying whether their designs comply with the requirements of the Building Code of Australia (BCA) – a set of continuously changing and increasingly complex regulations.

Ensuring that building designs comply with BCA is an onerous and error-prone task [4]. Developers need to secure a development approval (DA) from local councils before construction can commence. Where proposals are non-compliant, delays and expense ensue. Building Information Modeling (BIM) has emerged as an innovative evolution in the ways the construction industry designs, constructs and manages buildings [1]. It has potential for a new generation of software to facilitate automated code checking (ACC). In addition to enhancing the efficiency and accuracy of the checking process, ACC using BIM offers opportunities to diagnose non-compliance with codes and regulations during the design phase thereby improving collaboration between the AEC professions [5].

Furthermore, related studies indicate that ACC systems require two fundamental objects [6]. Model software firstly requires universal and international applications and secondly, rule programs have to be established for specific and regional codes and regulations. To date, most ACC systems export BIM models in a universal format – Industry Foundation Classes (IFCs) and then check their compliance with the corresponding codes. A challenge that several studies identify is that IFC models cannot provide all the information that ACC systems require [6, 7]. Additional data therefore needs to be provided by project members through other means and/or forms. This paper explores the provision of BIM-enabled software that allows designers to assess the compliance of their proposals before they are submitted for DA approval. In addition, it highlights the existing challenges and assignments that need to be resolved. This supports future studies in establishing BIM-enabled ACC systems for Australia to improve the collaboration between AEC practitioners. Such applications therefore will streamline the design process and benefit stakeholders.

103.2 Why Use BIM

To successfully check for compliance with the BCA, ACC systems must understand and utilize design information from source objects. One of the ways this has been achieved in the past is to produce and adapt 2D CAD drawings. This starts with geometric elements (such as lines, circles and arcs), assembles them as readable objects (such as doors and walls) and groups objects to generate different spaces and functions (such as bathroom and bedroom). ACC systems then analyze these objects and areas for code compliance. However, grouping is an error-prone activity and there is a lack of a strict universal drawing standard, which increases the complexity of these processes [8].

3D CAD modelling was subsequently developed as a visualization tool containing objects with explicit functional descriptions as well as design parameters [9]. In contrast to grouping lines and arcs as a defined object in 2D CAD drawings, objects in 3D CAD models are all predefined with relative attributes (e.g. a window comprises frames, layers and tracks). Moreover, designers can explicitly define or modify spaces or rooms and their properties during the design process. For example, a space can be tagged as a bathroom with various properties such as egress accessibility, door swing, light fixtures, fire assistance and so on. However, designers may only tag some functions of spaces and components or not correctly tag them all, which causes fragmented information for ACC systems. Furthermore, some object definitions within CAD software differ from vendor to vendor and other software does not easily recognize them. Some objects therefore may not easily be analyzed by ACC when a model lacks attribute definitions or is created with different definitions for attributes.

With some similarities to traditional 2D and 3D CAD technologies, BIM currently has emerged as a combination of interactive policies, communicative processes and technological implementations, and provides a platform supporting project data from different disciplines in digital format [10–12]. Industry Foundation Classes (IFCs), a standard format for BIM models developed by the International Alliance of Interoperability (IAI) [13], enables interoperability of data between different software packages. IFCs have a hierarchical structure that helps clarify the nature of BIM models. For example, a class of lavatory may contain some sub-classes such as washbasins, bathtubs and water closets; whereas, a washbasin also can have taps and valves as its sub-classes. However, the information description required by ACC may differ from the IFC schema. For example, a water closet is a well-known description in Australia but it is represented as a “sanitary flow inlet” in IFC schemas [6]. An additional activity may be required to accept mappings of disparate descriptions through the use of a translator.

103.3 Inhibitors of ACC Systems

The development of ACC systems has extended over two decades and became practicable within building industries with the emergence of BIM tools. Several developed countries have made efforts in evolving their own ACC systems to accelerate the certification process for governing bodies. CORENET (Construction and Real Estate NETwork), a project initiating the development of ACC systems, was funded by Ministry of National Development in Singapore. Not only is it a pioneering ACC system, it also provides an internet-based electronic system to check building designs using BIM. CORENET is seen as a basis for the evolution of ACC systems in Norway (Statsbygg), Australia (DesignCheck) and the United States (International Code Council, ICC). The factors that affect the development of ACC systems are complex. They comprise the growth of BIM, the continuous changes of building codes, the abilities in programming platform and the interoperability of data between them. Although these systems are either specific to various building codes or focus on accessibility, the checking platforms they adopt are varied. Eastman et al. has addressed several inhibitors within four landmark ACC systems and these are summarized as below [14].

CORENET: captures and extends object data (in IFC format) in accordance with the required attributes for Singapore codes. Whilst development of CORENET is ongoing, some difficulties in verifying data quality and in supporting checking during the different design phases have been reported.

Statsbygg and ICC: As distinction from CORENET, both of the Statsbygg and the ICC use the Solibri Model Checker (SMC) as their checking platform. The advantage of SMC is that it checks the IFC based BIM models against the rules directly, whereas missing attributes in IFC files can result in improper checking.

DesignCheck: Compared to the above, Express Data Manager (EDM) was used for automated code checking for the DesignCheck project in Australia. IFC-based models can be checked by the DesignCheck system through the use of EDM. This translates BIM data from IFC format into the DesignCheck schema. Another benefit of DesignCheck is to help check for compliance in different design stages, thereby improving the checking performance of architects and other designers. The challenge of the DesignCheck system is that checking results are represented in text format rather than as 3D visualizations.

103.4 Specialized ACC Systems

The development of specialized ACC systems may be restricted by human and financial resources. However they can provide additional checking facilities for specific items (e.g. fire resistance and building envelope) or areas (e.g. Queensland, New South Wales and Victory etc.). From the perspective of the building industries, the adoption of specialized ACC system not only reduces expenditure but help building designs to adapt to particular requirements. The introduction of three specialized ACC systems, their comparison and commonalities are described below.

103.4.1 Portugal: LicA

LicA checks domestic water systems against the main Portuguese regulations [5]. It uses Scratch [15] software to develop its platform including the code checking algorithms and its graphical user interface (GUI). This system comprises three main components: LicA, LicAXML, LiCAD. The LicA database is the main component in the toolset. It contains a set of tables that describe the domestic water system (its physical components and their relevant properties) and modules for hydraulic calculation, code checking and reporting. All of these items are contained in a single SQL database. LicAXML allows for the exchange of information between the designer and the entity that performs the code checking. The design information of a BIM model is performed using the XML standard format. LiCAD not only edits and browses functions, it allows designers to check the compliance of domestic water system designs with national regulations before certification by the governing bodies. This system represents a combination of 2D (plans, elevations, etc.) and 3D (projects, perspectives, etc.) and other construction documents (bills of quantities, code checking reports, etc.). The checking results are shown in text format although this software also provides 3D modeling functions.

103.4.2 Canada: ACCBEP

The purpose of the ACCBEP (automated code checker of building envelope performance) system is specificly to check building envelope design for compliance with building codes [16]. The framework of this approach comprises four components: Extended Building Information Model (EBIM), Extended Building Code (EBC), Rules Engine and Assessment Results. The XML is adopted to be the representative format of EBIM due to its flexible characteristics. The XML-based objects are generated from an incorporation of the widely-recognized representatives of BIM model – IFC (Industry Foundation Classes), IAI (International Alliance for Interoperability) or GDL (Geometric Description Language) into simulation tools such as Moist [17], 1D-Ham [18], Wufi Pro [19] and Moisture-Expert [20]. EBC consists of an electronic version of the building code and XML-based decision tables, which express the logic of the building code. The core algorithm of the Rule Engine (Rete algorithm) treats EBIM and EBC as nodes to be checked and then the matching results are obtained. Finally, the Assessment Results reports the compliance checking results, the related design regulations, reference indices as well as advice on decision-making to designers.

103.4.3 Korea: GTPPM

This study focuses on the checking compliance with building codes regarding fire resistance [4]. The checking process of this system can be divided into two parts: a re-interpretation of codes for automated checking and an extraction of building information from BIM models. These two parts are then combined as a system – Georgia Tech process to product modeling (GTPPM) – to facilitate automated checking. The authors categorized codes into five topics: Egress Way, Material/Capability, Principles of Evacuation, Evacuation Stairways and Fire Protection Partitions. These were established as criteria in the code interpreter. The information extracted from BIM models using IFC is representing in 2D format and then checked by the code interpreter. The checking results are then shown in a text report.

Table 103.1 Comparison between LicA, ACCBEP and GTPPM

	Portugal: LicA	Canada: ACCBEP	Korea: GTPPM
Target rules	Domestic water system	Building envelope	Fire resistance
Platform	LicA, LicAXML, LiCAD	EBIM, EBC, rule engine, assessment results	Building code interpreter, BIM model
Rules code	SQL tables	XML based decision tables	Computer code
Object format	XML	XML	IFCs (2D)
Reports	Text report	Visualization	Text report

103.4.4 Comparison of Specialized ACC Systems

The three specialized ACC systems described above provide information about Target Rules, Platforms, the algorithm of Rules Code as well as the form of their reporting. Although the Target Rules they comply with are different, there are some commonalities between them. Selected data from these studies are shown in Table 103.1.

First of all, an interpreter (i.e. LicA, EBC and Building Code Interpreter) is required to define the context of building codes in logical and readable ways that the attributes of BIM models can conform to. Although the algorithms of their interpreters (SQL Tables, XML based Decision Table and Computer code) are varied, they represent some of the ways these may be derived from the building codes.

Since model and information exchanges using IFCs are undertaken between different project stakeholders and during different project phases in many cases, the above studies have highlighted the creation of a component (i.e. LicAXML and EBIM) to extract the required information from BIM models or to integrate BIM models into a new digital schema. Both the LicA and the ACCBEP projects use this approach to generate a XML based model that provided the required information to the Interpreters while the GTPPM adopts the BIM model in IFC format directly to comply with its rule component. Because the interpreter and the extractor provided by ACCBEP are all based on the same language format, XML, these provide a reference for future development of ACC systems in Australia.

In addition to the interpreter and extractor, a module to represent the assessment results is required. This needs to provide detailed checking results, advice as well as historical decision-making for designers. At this stage, the reports shown in visualizations seem clearer than textual representations.

103.5 Challenges and Future Work

The DesignCheck project provides a robust foundation for the future development of ACC systems for Australia, although some deficiencies of EDM are reported in Eastman et al.'s findings. For example, they argue that EDM is restricted to checking compliance with accessible regulations; the objects EDM checks are 2D drawings; and checking reports are presented in text format. Improved solutions can be provided from the LicA and ACCBEP systems. The BIM based IFC data can be incorporated into an extractor to re-form a new object format (i.e. XML format) that conforms to the requirements of code checking software. This will not only help transit the checking objects from 2D to 3D BIM models, it will strengthen the presentation of results through visualization.

Furthermore, the EXPRESS language was used to define the rule schema in the DesignCheck project. The description of building codes needs to be translated by IT professionals into performance requirements using computer code. This may complicate and delay updating of rule schema when the BCA changes. Hence, the evolution of EBC in the ACCBEP project potentially provides a resolution in rule schema design. The ACCBEP separates the rules and program, thereby enabling users to update or modify the rules without the involvement of IT specialists.

In addition to identifying the shortages of the DesignCheck project, there may be further challenges in developing ACC systems for Australia. With the gradual development of the BCA, ACC systems need a mechanism that can automatically adapt to the latest regulation information. Asynchronous updating between team members can cause varied checking results, leading to inefficient collaboration. The ACC systems would therefore benefit from being set up on a server as an independent system rather than being installed by individuals. Not only would this independence of ACC systems provide synchronous checking reports for teams, it would facilitate the integration of model information between designers, access authorities, the decisions they make and would thereby avoid fragmented information being distributed between them. Moreover, providing an audit-trail of decision-making in a database of ACC systems would provide a seamless pathway for job deliveries and produce alternative solutions for future projects.

103.6 Conclusion

This paper has provided an overview of some BIM-enabled ACC systems that are currently available, identifying the requirements in developing the next-generation of ACC systems using BIM to assess compliance with the BCA. Not only does an ACC system have the potential to enhance the awareness of building codes for designers, it improves interactions among designers, engineers, contractors and other project stakeholders during the design process.

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Chapter 104
Monitoring Construction Projects Using Information Technologies

Xiao-Hua Jin and Yun Le

Abstract A project manager requires timely and accurate information that makes him aware of any potential or real problems. However, measuring progress in terms of cost and time, especially in the construction industry, is considered the most challenging problem. Information technology can help eliminate such problem by automating progress measurement and disseminating information thereby enabling timely decision making. However, research shows that the construction industry lags behind in their adoption of information systems as a result of unsupportive construction environment. With changing times, the construction industry is also changing but an effective automatic progress measuring system is yet to be realized. A study is thus undertaken to investigate how information technology can be more utilized to track the progress of a project at any moment and by those authorized to do so, thus helping save rework costs, facilitating communication and enabling timely decision. In this paper, the preliminary findings of the literature review stage are reported.

Keywords Project management • Schedule • Information technology • Real-time monitoring

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_104,

104.1 Introduction

Considered as the most important person in a project team, the project manager has to ensure the successful completion of a construction project by managing and monitoring the project throughout its duration for any slippage in cost, time, or quality [11]. A project manager requires timely and accurate information that makes him aware of any potential or real problems. However, measuring progress in terms of cost and time, especially in the construction industry, is considered the most challenging problem. One of the most challenging reasons is that construction activity durations typically vary depending on the task and progress is usually measured monthly due to the time consuming and expensive process of collecting data on current progress [8, 11]. While attempt is made to capture the required data in a timely manner, it is not persistently carried out quick enough to inform the project manager [10]. As a result, extensive data collection is not typical of many construction industries and real-time data collection even lesser [8]. This leads to an inability of the project manager to have any control on time. As a result, delays can occur in construction projects causing budgets not being met and time overruns. These causes in delays could be due to unrealistic planning which could be resolved by preparing realistic plans or real-time progress monitoring.

It is also important to note that action needs to be taken in real-time post a deviation in order to be effective and to avoid any impact on the time and cost of the project. Real-time data is required to identify any discrepancy between the desired and actual performance which enables timely corrective measures to be taken which in return allows reducing the potential damage that could be caused by these discrepancies. Monthly data collection obviously means delays are noticed much later. Corrective measures at this stage would be complex and expensive if at all possible. About 12.4 % of construction cost can be attributed to such delayed detection of defects [7]. Communication of timely information could help eliminate such human errors. However, research reports indicate that only 20 % of the information eventually reaches the site workers [2, 7]. Inadequate communication was also identified as the one of the main reasons for low motivation and productivity of workers. Geographically diverse stakeholders also require a way to monitor project progress in a timely and accurate manner so as to make timely decisions.

Information technology can help eliminate these communication problems by automating progress measurement and disseminating information thereby enabling timely decision making. However, research shows that the construction industry lags behind in their adoption of information systems as a result of unsupportive construction environment. With changing times, the construction industry is also changing but an effective automatic progress measuring system is yet to be realized [2]. This research work is undertaken to investigate how information technology can be more utilized to give a more correct answer on what percentage complete a project is and more importantly to be able to track the progress of a project at any moment and by those authorized to do so, helping save rework costs, facilitating communication and enabling timely decision. In this paper, the preliminary findings of the literature review stage are reported.

104.2 IT Technologies Used to Automate Progress Monitoring

Project Monitoring is the set of procedures and management practices used to collect information about the performance achieved or forecasted in a project and the developing organization, based on a set of performance metrics [9]. Osgood [9] explains that a project plan is considered as the foundation of effective monitoring. The components of effective project monitoring are:

Effective Performance Metrics established at the planning phase.
Well-defined Milestones
Reporting Schedule depending on the criticality of the activity, rate and difficulty of work and financial importance of the activity.
Performance reward schemes
Reviews and Audits

Monitoring the activities on the critical path also helps keep a project on schedule. Although at the same time, with changing priorities, changes in task durations, start times or finish dates can alter the critical path and it becomes more essential to keep checking for any changes in the critical path.

Software like Microsoft Project is effective in planning a project as well as monitoring it by providing various views of the project. The Gantt chart, the Network diagram, Resource Histograms, Critical Path, etc. can be readily obtained once the details regarding each task has been added in terms of name, duration, start and finish dates (either manually or derived through linking to other activities), predecessors, etc. Viewing the project from various aspects helps in planning as well as monitoring and controlling any changes.

Once the plan is prepared, the usual technique adopted is to manually collect the data either by the project manager who consults each team member regarding the status or the team member reports the work done at the end of the stage (i.e. week, month etc.) The project plan is updated manually. Software like Microsoft Project Server provides an option to team members to directly update the plan.

Ahmed Memon et al. [1] explain a typical traditional progress measuring and monitoring process for a construction project. This process occurs on a monthly basis. These progress reports provide information on the project progress with planned work and budget to completion along with issues, changes in contracts, modifications in designs, etc. Photographs of the site are used to illustrate the current progress. These reports can consume the majority of the time of a project manager leaving him with little or no time for other activities.

Navon [8] explains the complexity in measuring performance and more importantly converting this data into useful information that could be used to compare against the project plan. He gives an example in his research: to calculate productivity, one needs to know the activities each worker has completed as well as the effort put into each activity (in hours). These data, however, cannot be compared to the project plan; it needs to be converted into something more meaningful. Consider that

500 h were spent on an activity A, and 1,000 units is associated with this activity, from this we can derive meaningful information that it takes two units/man hour to complete the activity. The number of units can be determined by identifying and calculating the building elements along with the quantity for each utilized. If we consider activity A as the formwork erection for the fourth floor of building 8, then the first step would be to identify all the slabs and beams of that floor as well as calculate the area of the formwork.

This process when executed manually does not sound complicated but is definitely labor-intensive and not only requires extensive monitoring, but also requires using data from drawings and databases as well as calculations. So while the process itself may not be complicated, automating it becomes more complicated.

Osgood [9] explains that progress on construction projects is typically measured based on time spent or money spent. However, it was suggested that progress should be measured based on how much is yet to be completed. Progress can be measured by understanding the units completed, incremental sub-task milestones, subjective opinion of the supervisor, binary start-finish, and earned value management.

Ibrahim et al. [5] propose a method of automating progress measurement based on work packages and visual assessment. The framework forms an extension to Building Information Systems (BIS). It consists of a Work Breakdown Structure (WBS) assignment module that allows for modelling and assigning of components to work packages based on given criteria ("Elements", "Work Section", "Construction Aids" and "Physical Location") and a visual assessment module that can interpret captured images and figure out the status of components thereby estimating the progress of the work packages.

The WBS Assignment Module requires classifying each design object based on the discussed criteria. The module then automatically groups all elements and creates work packages. The visual assessment module involves capturing images, processing the images for normalizing the intensity distribution, etc. and identifying the changes.

The framework has several limitations. For one, the construction aids criterion is usually not represented in the building model but may be required for creating the WBS – this is not handled by the framework. Visual assessment has its own limitations such as components that may overlap other regions thereby hiding the activities and the progress information on them. Ibrahim et al. [5] also acknowledge that the approach is not totally reliable but can be improved by combining multiple sources of images and additional information.

Hsieh and Hung [3] suggest a scalable IT infrastructure for automated monitoring systems consisting of distributed computers and SOAP (Simple Object Access Protocol) web services based on SOA (service-oriented architecture). SOA is based on the principle of loosely coupled and autonomous services that separate changeable elements from the unchangeable thereby supporting agility. In this case, the three logical services are data services (DS) that handle data storage and retrieval, field services (FS) that retrieve field data through sensors and forward it to the DS for further utilization, and coordination services (CS) that act as an intermediary between the field and data services.

This model allows for monitoring multiple projects. The infrastructure is also scalable, reliable and accessible and can be used for large-scale deployments. The model, however, does not address security issues, authentication, etc. that come up with distributed and remote access of data.

Ahmed Memon et al. [1] proposed a Digitalized Construction Monitoring (DCM) model; implemented using object oriented and event-driven programming. The model requires capturing digital images from the construction site and developing a 3D model of the image using PhotoModeler software. AutoCAD drawings were used for the 3D design of the building to compare the model against. The data is stored in primary and secondary databases (Microsoft Access) and used to calculate the actual progress. With the help of Visual Basic, the actual progress will be calculated and Microsoft Project will be updated to reflect the actual progress in bar chart.

PhotoModeler software requires taking pictures using digital, film, or video cameras, and loading them into the software. As far as possible, two or more overlapping photographs taken from different angles should be used. The software requires marking and referencing features on the photographs using Point, Line and Edge tools available with the software. The points are matched across the photos using the referencing functions. Finally a Process function adjusts all the input data to produce a 3D model. Using the PhotoModeler software contains a lot of work involved in marking and referencing features, especially in case of a construction project. This is a major limitation. Also, this may be required to be repeated each time as photographs are taken on a regular basis for processing.

The method proposed by Rebolj et al. [10] consists of two ways of automated data collection – one through 4D site images compared with 4D graphic representations within the same time-frame and the second through automated material tracking. While the two can be used individually, Rebolj et al. [10] concluded that the combination of both data collection methods provides more reliable data.

Known as the 4D Automated Construction activity Tracking system (4D-ACT), the system consists of modules such as 4D tool, segmentation, calibration, etc. and makes use of logical, temporal and spatial information obtained from a 4D model and compares it with the construction site images. Segmentation involves marking the negative regions (unwanted areas) in the image and filtering it out to obtain an extracted site image area. Temporary equipment or other issues may lead to unsatisfactory segmentation; hence multiple calibrated cameras are used and images merged to get the most appropriate image. An automated recognition algorithm compares the segmented site image and the model image and identification is based if the difference between the two elements is below a predefined threshold.

The automated material tracking method was based on the hypothesis that the usage of material can give an indirect indication of the project's progress. Based on the 4D model, the material resources and BIM elements are linked together using the activity plan (that includes resource information) of the 4D model. The information on quantities of material as well as the scheduling requirements can be obtained from prefabrication and material procurement processes. The construction site registers the arrival of material along with all details as well as when the same was used during the building activities. This information can then be fed into the information systems. These two systems are joined by a third Dynamic Communication Environment (DyCE) that utilizes a mobile network accessible by site workers. The system allows communication of issues and other information related to a project task or activity. It also serves as a purpose of indirectly verifying the information obtained by previously discussed methods.

The system proposed by Rebolj et al. [10] requires extensive use of Building Information Management (BIM) technology, consistent activity definition, and relating activities and material resources which at present is not done. The system also requires additional training of all participants for an organization to be able to get full benefits of the system; therefore stakeholder buy-in is required before implementing the system.

Navon [8] explains in his research that based on knowledge of a worker's location at a given time, along with additional information related to the schedule and the physical design of the building, it is possible to determine the activity he or she is working on. They also propose collection of labor data through the use RFID, barcode or PDA technologies.

Zhang et al. [11] propose an automated progress tracking system using computer vision which is a technology that provides computers with functions typical of human vision. Computer vision can be used to derive 3D objects from 2D images and consists of typical tasks like recognition, scene reconstruction, image restoration, etc. Using computer vision, a system can be utilized to automatically analyze the site images to measure the current construction progress. This technique, however; can only be used when there is visual evidence of the construction. The authors acknowledge that the system may not be able to fully automate progress monitoring but it can assist the process by providing an early warning for potential delays.

As part of the attempt by Zhang et al. [11] to automate progress measurement, an Integrated Building Information System (IBIS) was developed to help monitor the current progress of construction of the superstructure of buildings. Using computer vision technology, the system determines the progress from the site images. The system also consists of a semi-automatic approach that helps link the progress information with schedule and cost information.

The system consists of four modules – computer vision module that obtains progress information from the sites images, a WBS module that consists of a semi-automatic approach to link the building components, work packages and costs, a scheduling and budgeting module that loads work package information into Microsoft Project for further processing as required, and a progress measurement, valuation and early alerts module which uses the inputs from first two modules to generate a report on progress, etc. The implementation of this system is costly and can be argued as not effective as the investigation concluded that this system was only able to measure current progress of construction of the superstructure.

As wireless network devices and connectivity services are constantly improving, it is but obvious that the use of these in the automated progress monitoring in the construction projects should be researched. One such attempt was made by Leung et al. [7] who propose a web-based monitoring and collaborative system using wireless technologies and network cameras. The system provides images of real-time progress on construction sites and through the use of the wireless technology these images can seen from any location in the world with the help of a computer with internet access. The collaborative system allows online meetings where geographically dispersed team can come together and resolve issues thereby helping in controlling progress issues. The system, however, does not automate the progress monitoring process itself unlike other systems mentioned before have attempted.

Kim and Kano [6] explain a method of using construction site photos and VR images created using VR technologies. The VR technology is used to create a 3-dimensional viewpoint of the construction site photo which is compared to a model to see the difference between the actual situation and the design intended.

Hewage et al. [2] consider communication as a major hindrance in all construction projects. A survey conducted by them revealed that the workers and foremen preferred to use a PDA with digital camera capabilities that could help them communicate the activities/tasks completed and discuss any issues thereby facilitating the communication of the progress at the construction site.

Based on the literature review, many promising technologies and designs have been found that are being used in order to automate the progress monitoring. The following can be seen from the literature review:

Multiple methods need to be deployed in order to improve the reliability on the data collected.

Multiple cameras need to be used in order to get a full view of the site and to overcome problems that come from temporary obstructions.

Images need to be segmented before they can be processed.

Cameras need to be aligned properly and calibrated before they can be used to merge photographs from different angles.

Computer Vision/PhotoModeler software can help model the images obtained from the site.

The information obtained from comparing the site images with model can be used to automatically update the schedule created in Microsoft Project, thereby automatically providing an updated bar or Gantt chart.

Automated material tracking system (using RFID, barcode, PDA technologies, etc.) can serve a dual purpose – material management as well as provide an indirect indication of the progress.

Although technical discussions have been limited, the use of SOA in implementation seems to be advantageous as it can be used to separate the field, data, and co-ordination services, thereby improving agility of the applications. This allows for quick changes to the application if need be.

Wireless network, wireless devices like PDA and web based platform can be utilized to provide information on the progress of the construction project at any time and at any place.

There may be need to align the components of the building, work packages and costs in order to match WBS and the work packages that will assist in automating the progress monitoring. Some amount of automation in generating the WBS and work packages can be helpful not only during planning stage but also during the construction stage since it will bring about consistency in the WBS and work packages and relate them automatically.

104.3 Selection of Information Technology for Progress Monitoring

At present, there have been several methods attempted by various authors which have been discussed above in using various technologies to assist with the process of monitoring construction projects. Yet, there are several limitations on the effectiveness and value of these methods that have been attempted, which include cost; simplicity to set up; usefulness and ability to be used on any project; the ability to measure construction progress accurately, not only partial; the ability to automate the progress measurement procedure; and the ability to monitor construction without aid from surrounding buildings. These limitations will form the basis of the chosen type(s) of information technology to be utilized to monitor and calculate the current progress of construction on building sites.

In order for the proposed solution to be effective the information technology will need to address the limitations identified. The three main areas of most importance that summarize these issues are: cost, automation of progress measurement, and monitoring capability.

A cost is the value of money that has been used up to produce something. Any proposed method to automate progress measurement needs to be cost effective otherwise it will be unfeasible as the cost to use produce and implement the research method will outweigh its benefits. It is of prime importance that the system will not be a one-off design, but that if it is successful in meeting the required objectives the proposed method will be able to be utilized on any other construction site/project.

Progress measurement is the analytical process of determining the actual percentage complete a construction project is at. It includes comparing actual progress to that which was planned prior to starting the project. Effective progress measurement helps to identify the variances to the plan early enough to either mitigate the impact, or cease the opportunity as actual progress is compared to that which was planned. The automation of this process is the ability for a system(s) to perform the task of determining the percentage complete of a project is without aid of human intervention.

Ibrahim et al. [4], Zhang et al. [11], and Ibrahim et al. [5] have made previous attempts to automate the process of progress measurement. All researchers have the common method incorporated into their proposed method that photos are taken of the construction and they are compared against a 3D model to determine what percentage complete the project is.

The proposed method of this research will include an automated system that in part will compare photos to a 3D model as a means to help determine the current progress of the construction project. The method will also include taking photos of internal works as previous research has attempted this in part but has been unsuccessful. The monitoring function of the proposed design method will be done in real-time. In so doing it will allow anyone involved in the project the possibility of seeing firsthand what is currently happening on the construction site.

The method proposed by Leung et al. [7] will form the basis of the real-time monitoring system. The intention of using this system will also include further research into combining this system into the process of calculating current progress of construction. It will act as a secondary method to calculate current progress.

The second function of the monitoring part of the proposed monitoring function will be a materials tracking system similar to that proposed by Rebolj et al. [10]. The hypothesis is that the spending of money on materials can effectively serve as an indirect measure of a project's progress. The idea is based on the fact that it is necessary to establish an automated material resource tracking system in order to achieve better productivity, avoid project delays, and reduce waste.

104.4 Conclusion

Measuring progress in terms of cost and time, especially in the construction industry, is considered the most challenging problem. Information technology can help eliminate these communication problems by automating progress measurement and disseminating information thereby enabling timely decision making. However, research shows that the construction industry lags behind in their adoption of information systems as a result of unsupportive construction environment. With changing times, the construction industry is also changing but an effective automatic progress measuring system is yet to be realized. This study is undertaken to investigate how information technology can be more utilized to give a more correct answer on what percentage complete a project is and more importantly to be able to track the progress of a project at any moment and by those authorized to do so, helping save rework costs, facilitating communication and enabling timely decision. It has been found that many promising technologies and designs have been used in order to automate the progress monitoring. However, each has its own limitations on their effectiveness and value. Main limitations are discussed, which include cost, automation of progress measurement, and monitoring capability. These limitations will form the basis of the chosen type(s) of information technology to be utilized to monitor and calculate the current progress of construction on building sites.

Acknowledgments The authors are grateful to Mr. S. Connell for assisting in this study.

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Part IX
Professional Education for Real Estate and Construction Management

Chapter 105
Applied Research of Integrated Project Teaching Method in Applied Engineering Management Major Teaching

Huanchang Fu

Abstract The introduction of integrated project teaching method is in connection with lack of practical engineering management professional talent and a lot of issue in engineering management major Teaching. This paper is based on theoretical study basis of project teaching method and characteristic, clarified goal and principle of Integrated project teaching method in engineering management major, proposed reorganization of curriculum content and the change of the teaching methods, and the detailed implement scheme is also proposed. New teaching mode go through the whole the curriculum learning in engineering management major, which enhance teaching quality of Whole courses and implement application-oriented talents cultivation.

Keywords Project teaching method • Engineering management • Teaching • Application • Practice

105.1 Introduction

Engineers have the higher ability on general technique in our country at the moment, but they are poorly known about economic, management and law, managers are unfamiliar with engineering technology. However, practical construction protects are not only proved and analyzed its feasibility from the economic angle, but also are analyzed, proved and estimated from project programming perspective, construction management perspective, investment control perspective, operation maintenance, investment income and so on. For the above reasons, which bring about the engineering technology out of joint with economic management in our country, and which lead to all-wave and all-process project consulting services with lower level.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_105,

The training goal of applied engineering management major is that bring up senior engineering management personnel who has civil engineering technology and engineering management-related management, economic, low and the other basic knowledge, and get the engineers basic training, have definite ability of practice and innovation ability [1]. Therefore, the research and practice of a model of training on the applied engineering management major is very necessary and urgent on demand for talent and discipline construction. This paper introduces and research project approach to bring up applied talent in keeping with social development needs who Understanding engineering, economic, management and law [2].

105.2 Theoretic Research Foundation and Characteristics of Project Teaching Methods

Before 1940, the engineer education in American used a "engineer technical" model, which was focused on the control of singular professional technical knowledge, with the development of engineer technical and the increase reliance of scientific progress, engineer education began to emphasize scientific and academic style, formed "engineer science" education model out of project. Until 1980, the education model could not satisfy the demands of the society, which led to the "engineer return", that engineer education should return to project and practice was proposed [3]. In 1933, president "Mole" of Massachusetts Institute Of Technology proposed the concept of "large project", which especially cared the system and integrity of engineer practice and education, paid more attention to or increased the engineer practice contents on the base of definite engineer science and integrated some engineer projects creatively, which formed the new "engineer technology" education model through the engineer science theory to guide engineer practice, which is still popular today [4].

Compared with traditional teaching model, comprehensive project teaching method is a way to help students understand and use a subject central concept and principle to complete one or several entire projects through the conduct of the teacher and student together [5]. Under the guidance of the teacher, student learned to study actively and comprehensively through the accomplishment of one or several education projects pre-designed, which enhanced the education content in time and made the unite of metal and physical work [6]. This education model improved the professional education quality to realize the goal of intellectual cultivation through the reunite of subject contents and the change of the education style, which made students obtain the career ability needed on the job. On the base of engineering management professional guidance committee syllabus, revise the existing teaching programs, put material/mechanics/design/construction and so on into a special project, build a basic knowledge system of profession, meanwhile, avoid of "junior college education of undergraduate", educate students to be application-oriented talents full of comprehensive expertise and great practice ability.

105.3 Application Characteristics of Teaching Method of Project

The characteristics of the applied project management major mainly lies in the function to provide good conditions and basis for the implementation of project-based learning model, It is very consistent with the core concept of the integrated project teaching mode. Integrated projects teaching can help project management master the basic theories and methods of project management and basic theoretical knowledge of the investment in the economy. Also help to familiar with the principles and policies of the civil engineering and technical knowledge and project construction. Hands-on experiences and learning of actual projects during the whole process by students has been the basic and actual ability to work which engaged in project decision-making and management of the whole process [7].

Application of project management teaching project teaching method has the following characteristics.

1. Science: Develop science teaching objectives and lesson plans based on the school's faculty, teaching conditions and the actual situation of the students.
2. Level: At present, China's university curriculum is generally consistent of foundation courses and professional courses. The existing subject teaching is the foundation of an integrated teaching project. The convergence and transition between the theoretical study and practical should be coordinated in the course arrangement.
3. Typicality: The selected item should be representative. Project contains the teaching content to combine knowledge as far as possible. It can reflect the typical problems with few teaching project, which can combine knowledge or skills with actual project closely.
4. Practicality: Project teaching emphasizes the training of the students' practical abilities and hands-on learning. It contact with the reality of life and social practice in the teaching process when students unable to participate in a specific project in a timely manner and periodically.
5. Comprehensive: The integrated project teaching is from the freshman to the senior. The Selected project which used in actual teaching must cover complete information which involved various stages of the project.
6. Guide: Integrated teaching projects guide students practice when they can learn and practice. This is the biggest difference with the existing teaching methods which impart students only based on the academic book knowledge.

105.4 Specific Implementation of Integrated Project Teaching Method in Engineering Management Major

Combining and completing integrated project teaching method and traditional teaching method, overcomes many of the shortcomings of traditional teaching method. Integrated project teaching method are applied in engineering management major, that

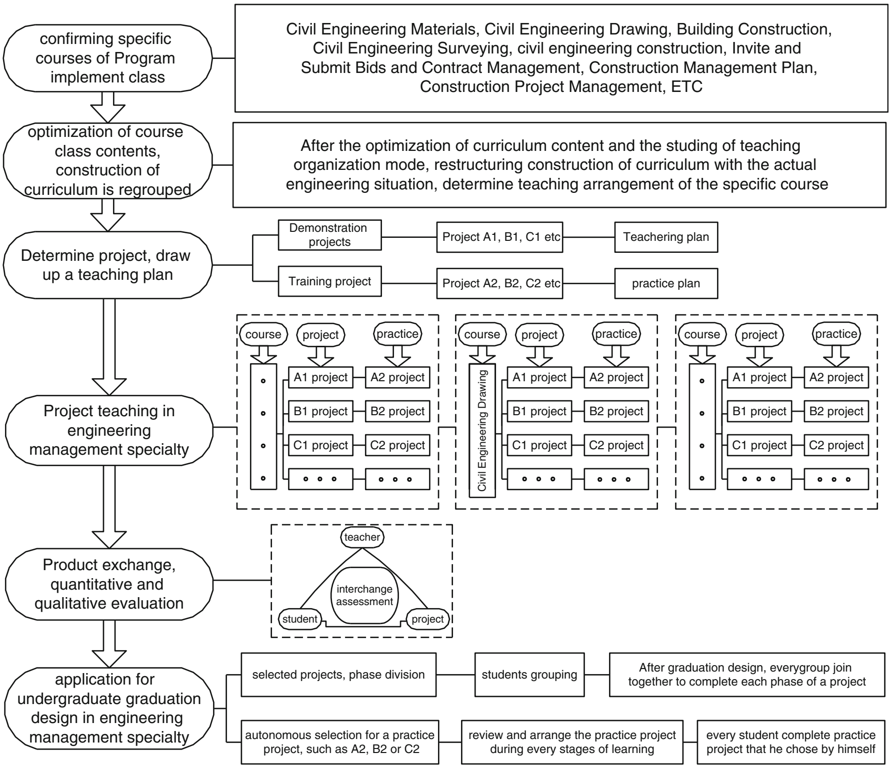

Fig. 105.1 The implementation process of teaching method of project

improve learning interest, train kinds of ability, Construct the knowledge system, improve the occupation ability. But the project teaching method is not all of the daily teaching, and it is only a very important part of the teaching link, so it is impossible to replace all of the regular teaching. Must handle well the joining and transferring between basic teaching and project teaching, clear theoretical teaching is the basis and guidance of actual project, and only the correct application of integrated project teaching method which can obtain the better teaching effect. The integrated project teaching method throughout the whole process of the students study professional knowledge in engineering management major, instead of focusing on one's course and same links at the sometime (Fig. 105.1). The implementation process are as follows:

1. Filtering the project management professional in addition to general education courses and all specialized core course, specialized and professional elective course out of the national ideological and theoretical class, construct the professional course system that have the projects as the main body, and sort these courses according to the specific implementation of the practical project;

2. Set up perfect integrated project teaching resource library, the teachers choose the Specific several demonstration projects and the integrated training project after they consult and decide from the integrated project teaching resource library, and always with a selection of these items throughout all the learning process, work Out the teaching Plan and the project practice program, design the project teaching.
3. We made regular exchanging result, quantitative assessment and Qualitative evaluation for work of project and the project teaching practice to improve insufficiency in integrated project teaching; When the students study bridge structure, who can be sectioned, then every group show their final works, and set out what problems is encountered and how to solve them during the design process at the sometime. In the project, through the students assessing themselves and correcting reciprocally, pointing out some advantages and disadvantages, which make the students have a clear understanding about their learning, identify their learning goals while and future occupation. Teachers can also know students' s mastery of the knowledge level by the students works show in order to carry out later teaching.
4. The integrated project teaching is used in the graduate of engineering management professional design. The students are divided into several groups. Each group completed a stage of a project or reunites the various stages of the project participated by students. Students review.

The knowledge learned for 4 years and operates the whole project to complete the learn from the investigation – design – construction.

105.5 Concluding Remarks

At present, China engineering education is the transition from the "engineering science" education model to the new engineering education model. So, introduce the integrated project method to the Applied project management for undergraduate education, is clearly in line with China's national conditions and the scientific concept of development. Integrated project pedagogy in teaching and learning model for project management professional applications can greatly stimulate the enthusiasm of the students' learning, and fully mobilize the enthusiasm of the students. It is emphasized that a student-centered, interdisciplinary, collaborative learning. Self-inquiry learning is associated with the real world and life practices. It develops students 'teamwork, develop students' innovative spirit and practical ability. This learning model can effectively integrate the civil engineering course and avoid excessive repetition and better adapted to the status of the Civil and registration examination system. These students get a smoothly career path after graduation.

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Chapter 106
A New Way to Teach Structural Steel to Construction Management Students

Ajay Shanker

Abstract This is an informational paper that introduces a new way to teach structural steel design and construction t construction management (CM) students. The method relies on CAD and shop drawings, videos, PowerPoint presentations, Steel Sculpture, Steel Frame Model, digital project images and web resources. The paper also describes topics that are essential for education of CM students. The paper will help instructors who are currently teaching structural steel to or are planning to teach in near future.

Keywords Structural Steel • Shop Drawings • Steel Sculpture • Web Resources • PowerPoint presentations • Videos

106.1 Introduction

Structural Steel is taught in engineering, CM and architecture programs all around the world. It has been recognized that students in these three disciplines should be taught differently so that they are able to accomplish the tasks they are assigned in their professional careers. For example, it is appropriate to teach rigorous design of beams, columns and connections to engineering students, whereas, the topics appropriate for CM students are, (i) materials and specifications, (ii) shop drawings, (iii) basic structural concepts of beams and columns, (iv) construction loads due to equipment, (v) worker safety, (vi) trouble shooting field problems (vii) design and selection of temporary structures for construction and (viii) steel fabrication for constructability and safety etc.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_106,

It may be noted that many undergraduate CM programs in the US offer only one 3 h structures course that covers structural concepts of concrete, steel and wood. The American Council of Construction Education (ACCE), the accreditation agency in the US, requires more emphasis on management, estimating, scheduling and safety and only basic understanding of structural aspects of steel and concrete. This thinking, although correct for training future construction managers, limits the number of hours that can be spent to teach structural steel. It, therefore, becomes more important that topics appropriate for CM students are carefully selected and taught. At Rinker School two structures courses; one for concrete and another for structural steel; were recently combined to a single course to align the program with the general norms of CM education in the US.

Reduced focus on teaching structures to CM students has led to a dearth of appropriate text books for these students. Few that have been written are not updated to reflect all the revisions in Steel Manuals and Building Codes. Many books, however, are available to address the needs of engineering students. Construction management professors generally use selected topics from these engineering books to teach their students as well. However this approach, because of the adopted text, leads their course to be still focused on engineering and design and leaves many important topics uncovered.

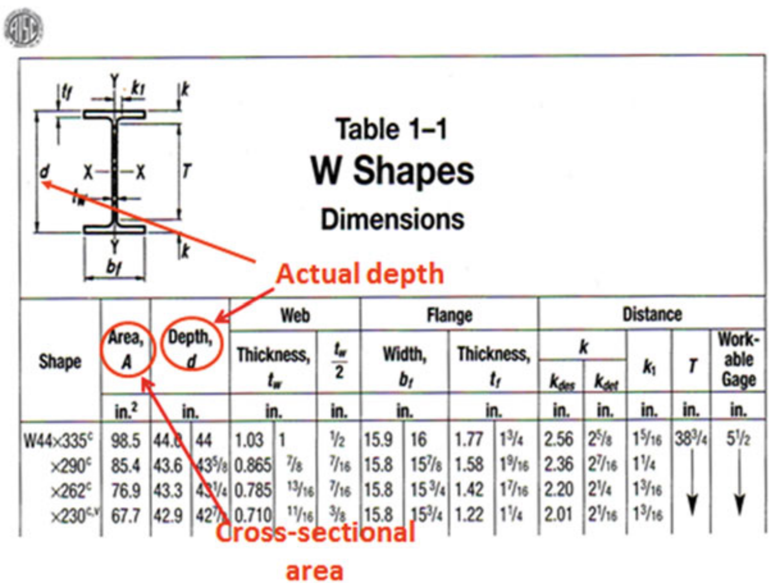
The author has been teaching structures courses in the Rinker School, University of Florida, for the past 22 years to undergraduate and graduate students. The author has also completed a research grant on steel structures curriculum development for CM students funded by the American Institute of Steel Construction (AISC). This paper describes essential topics appropriate for CM students as determined by the Partners in Education (PIE) committee of AISC as well as several experts associated with the steel industry. This informational paper describes detailed listing of topics, content and resources available to the CM faculty. Many resources are freely available at the AISC website [1] and the author's website [2] in the CRIOCM2012 folder. The files include PowerPoint presentations, videos, digital project images, Steel Sculpture, steel frame model for laboratories and shop drawings. The paper provides information for the following essential topics

(i) Structural shapes and section properties using AISC manual.
(ii) ASTM standards and material properties
(iii) Beam design, plastic section modulus and lateral support.
(iv) Steel Sculpture for understanding connections
(v) Steel construction videos
(vi) Shop drawings, notations and bill of materials
(vii) Composite construction with steel beams and metal deck
(viii) Open web steel joists: types, selection and installation
(ix) Column base plate design and details
(x) Architecturally exposed structural steel
(xi) Crane selection for steel frame projects
(xii) OSHA steel erection rules and site safety
(xiii) Design and selection of columns and braced column

(xiv) Bolted connections: high strength bolts
(xv) Welded connections, AWS weld symbols and details

A brief description of the necessity of abovementioned topics and available resources is presented below

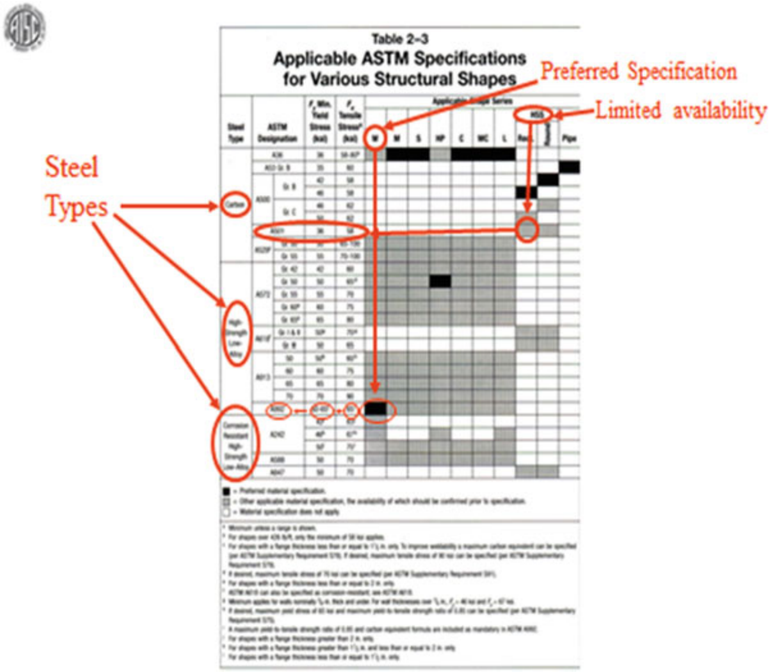
106.1.1 Structural Shapes, Section Properties Using AISC Manual



Shape	Area, A	Depth, d		Web Thickness, t_w		$\frac{t_w}{2}$	Flange Width, b_f		Flange Thickness, t_f		Distance k k_{des}	k_{det}	k_1	T	Workable Gage
	in.^{2}	in.		in.		in.	in.		in.		in.	in.	in.	in.	in.
W44×335^c	98.5	44.0	44	1.03	1	1/2	15.9	16	1.77	1 3/4	2.56	2 5/8	1 5/16	38 3/4	5 1/2
×290^c	85.4	43.6	43 5/8	0.865	7/8	7/16	15.8	15 7/8	1.58	1 9/16	2.36	2 7/16	1 1/4		
×262^c	76.9	43.3	43 1/4	0.785	13/16	7/16	15.8	15 3/4	1.42	1 7/16	2.20	2 1/4	1 3/16		
×230^{c,v}	67.7	42.9	42 7/8	0.710	11/16	3/8	15.8	15 3/4	1.22	1 1/4	2.01	2 1/16	1 3/16		

CM students need to be fully aware of all steel shapes, notations, weights, structural properties and their appropriate uses. The latest AISC manual 14th edition covers all shapes that include Wide-flange (W), Miscellaneous (M), American Standard Shapes (S), Piles (HP), Channels (C), Angles (L), Hollow structural Shapes (HSS) etc. The latest entire shapes database **AISC Shapes Database V14.0 – Current** can be freely downloaded from the AISC website [3]. AISC has an educational discount program wherein students can also buy the AISC manual at a substantial discount. A detailed PowerPoint presentation, ***Structural Shapes and ASTM Standards***, has been developed by the author and can be downloaded from the author's website [2] from the conference folder. The PowerPoint describes all shapes with detailed animations.

106.1.2 ASTM Standards and Material Properties



Structural Steel is available in many chemical compositions, e.g., carbon, high strength low alloy, corrosion resistant high strength low alloy, quenched and tempered alloy and quenched and tempered low alloy to meet different construction requirements. Further each of the chemical composition can be made for various yield and ultimate strengths. CM students have to thoroughly understand steel specifications and strength properties as many cases of incorrect shipments from fabrication shops have been documented. These errors occur due to illegible or hand written ship marks. The PowerPoint presentation, ***Structural Shapes and ASTM Standards*** describes all the ASTM standards for rolled, plate stock as well as connectors

106.1.3 Beam Design, Plastic Section Modulus and Lateral Support

Although CM students may not be involved in the structural design they must fully understand the design process, the intended function of steel beams as well as construction situations where situations where the moment capacity or stiffness may be compromised. They may also have to deal with various fabrication errors and decide if those errors are acceptable or need to be rectified. Author has develop a PowerPoint presentation ***Plastic Sectional Modulus and Design of Steel Beams*** that can be downloaded from www.ajayshanker.com

106.1.4 Steel Sculpture for Understanding Connections

Steel sculpture designed in early eighties at University of Florida has been constructed at more than 100 campuses across the US to teach structural steel connections. The sculpture is about 8 ft tall has most of the shear and moment connections, column and beam splices. Author has developed a detailed PowerPoint ***Steel Sculpture*** that describes every connection. The PowerPoint is available at the author's website [2]. Images of the sculpture made across many campuses are available at this Facebook website [4]. Please visit the AISC website [5] for downloading steel connection tool kit for detailed description of Steel Sculpture. Instructors can also email **universityprograms@aisc.org** or the author to get the shop drawings of the Steel Sculpture. AISC has already provided help to establish the Steel Sculpture in other countries and will be very happy to provide shop drawings as well as necessary guidance. Steel Sculpture is an excellent tool to make students understand the steel connections.

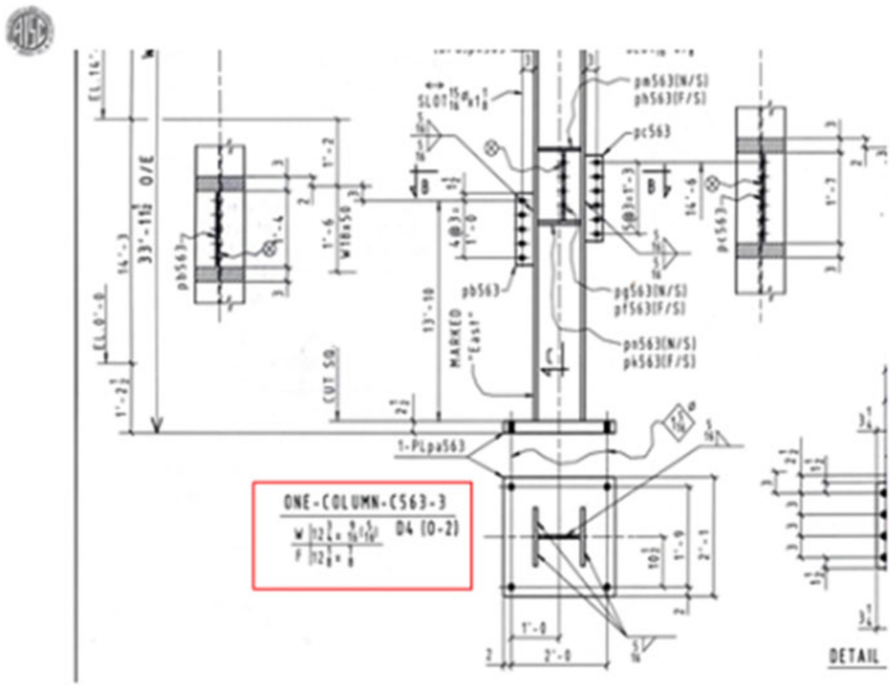
106.1.5 Steel Construction Videos

AISC has made available many steel construction videos suitable for CM students at the AISC website [6] The titles of videos are (i) Fabrication Detailing, (ii) Single-Storey Building, (iii) Structural Steel Erection, (iv) Structural Steel Production, (v) The Behavior of Columns, (vi) The Behavior of Unrestrained Steel Beams, and

(vii) Today's Steel: Shaping the Future. These videos are of 10–20 min duration and are quite engaging. The author has been assigning the students to watch these videos as an out of class assignments. Students response regarding understanding of steel construction by videos has been very positive. Author uses HW assignments and exam questions to ensure that students complete the video assignment.

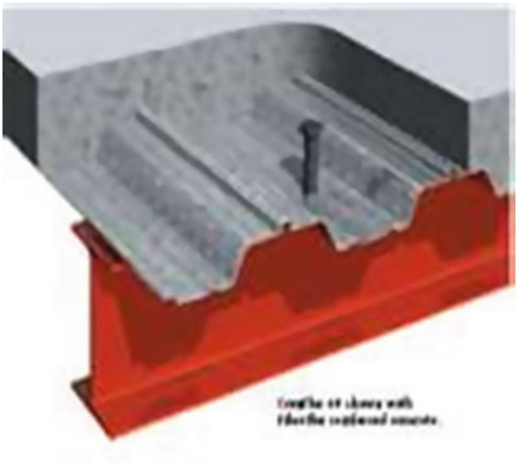
The author has also compiled at set of videos with titles, (i) Bending Hollow Steel Sections, (ii) Brick Cladding for Steel Frame Buildings, (iii) Cambering W-shape Beams, (iv) Precast Flooring with Asymmetrical W-Shape Beams, (v) Lateral Stability of Steel Frames, (vi) Oxyacetylene Cutting, (vii) Manufacturing Composite Metal Decks (viii) Shielded Metal Arc Welding (ix) Steel Column Splicing, (x) Continuous Casting for Making Steel (xi) Manufacturing Steel Tubes mostly from Corus Steel and other online resources. These videos are available at the author's website [2] in the conference folder.

106.1.6 Shop Drawings, Notations, Bill of Materials



Review and approval of shop drawings is an important task of Construction managers. CM students have to learn each and every detail and notation called out on shop drawings and ensure the constructability of the assembly. Author has prepared a detailed PowerPoint **Shop Drawing** and has made available at *ajayshanker.com*

106.1.7 Composite Construction with Steel Beams and Metal Deck

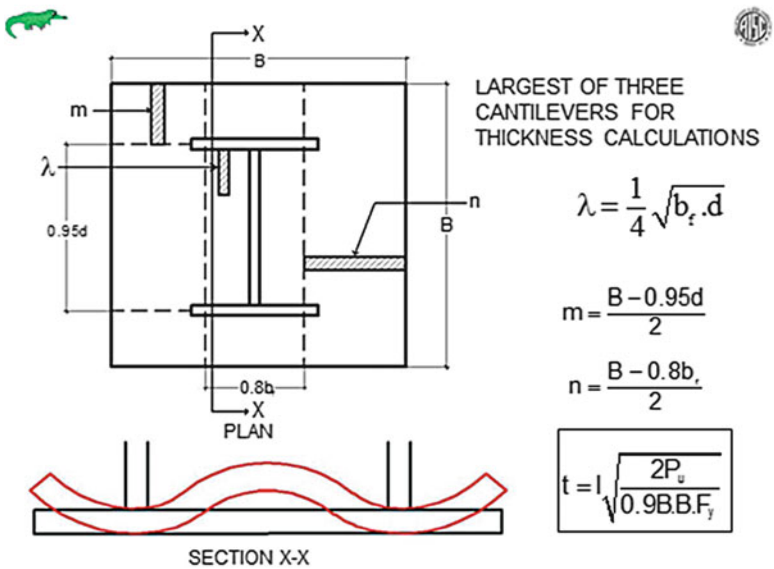


Composite construction with W-shape steel beams, composite deck and shear studs is very common in the US for floor construction of buildings. Composite construction reduces beam sizes and the construction costs. AISC provides a detailed PowerPoint presentation **Composite Construction** at the AISC website [7].

106.1.8 Open Web Steel Joists: Types, Selection and Installation

The Open Web Bar Joists serve large segment of construction industry especially the roof systems for single story retail buildings. Roof systems made with open web bar joists are extremely popular because of low cost and quick construction. Information about the steel joists can be obtained from the SJI website [8]. This website offer many free publications, videos and CAD drawings to understand steel joists and the industry. The website [9] provides all the information for galvanized steel roof decks, composite roof decks as well as floor decks. Author has also created an informational PowerPoint ***Steel Joists*** and is available at *ajayshanker.com* in the conference folder.

106.1.9 Column Base Plate Design and Details



Construction students should learn about the design detailing structural properties and detailing of column base plates in detail. In the US this part of steel columns creates many problems especially about the mis-alignment of the anchor bolts. The PowerPoints (i) ***Shop Drawings*** and (ii) ***Column Base Plates*** both provide adequate information about the base plates. Both PowerPoints are available in the conference folder at *ajayshanker.com*

106.1.10 Architecturally Exposed Structural Steel

Advance in steel fabrication and the bending equipment to shape structural members in circular, parabolic and other aesthetically pleasing shapes have given birth to a new industry called **A**rchitecturally **E**xposed **S**tructural **S**teel. In US it is known by the acronym AESS. This type of construction utilizes welding, grinding and painting structural members in pleasing colors. This construction relies on sprinkler system for fire protection as structural members are not insulated. Extremely tight tolerances can be used for bolted connections. US steel industry has developed specification for AESS and is available at the AISI website [10]. A good PowerPoint about AESS is also available at the AISC website [11]

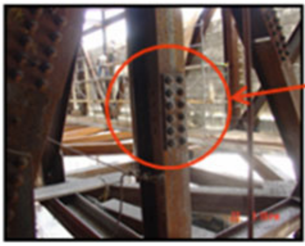
106.1.11 Crane Selection for Steel Frame Projects

Construction managers will have to ensure that appropriate crane type and of required capacity is selected and utilized. Besides selection, placement, working radius as well as scheduling of crane has to be planned. Steel construction utilizes cranes for lifting heavy structural members. Crane rentals are very expensive so planning, scheduling and appropriate size selection are very critical. AISC has developed a detailed PowerPoint for learning crane selection, crane use optimization, lift evaluation and crane placement for steel frame buildings. The PowerPoint is available at the AISC website [12]. Literatures of major crane manufacturers are available at those websites [13–16].

106.1.12 OSHA Steel Erection Rules and Site Safety

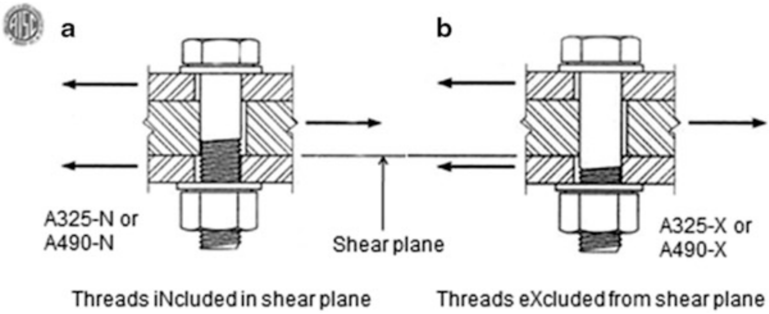
Occupational **S**afety and **H**ealth **A**dministration, OSHA, a federal agency in the US studied 673 fatalities of ironworkers . in detail. OSHA constituted a committee, **S**teel **E**rection **N**egotiated **R**ulemaking **A**dvisory **C**ommittee, **SENRAC**, to develop rules for protection of ironworker at steel frame construction projects. The rules took effect in 2001 and cover all area of steel frame construction projects, such as, site layout, site specific erection plan and construction sequence, hoisting & rigging, structural steel assembly details, column anchorage, beams & columns, open web steel joists, systems engineered metal buildings, falling object protection, fall protection and training. Violation of these rules result in severe penalties that run into hundreds of thousand of dollars for contractors. Author has developed a PowerPoint ***OSHA Steel Erection Rules*** and is available at *ajayshanker.com* If additional information is needed the OSHA website [17] can be used to find needed information.

106.1.13 Design and Selection of Columns and Braced Column



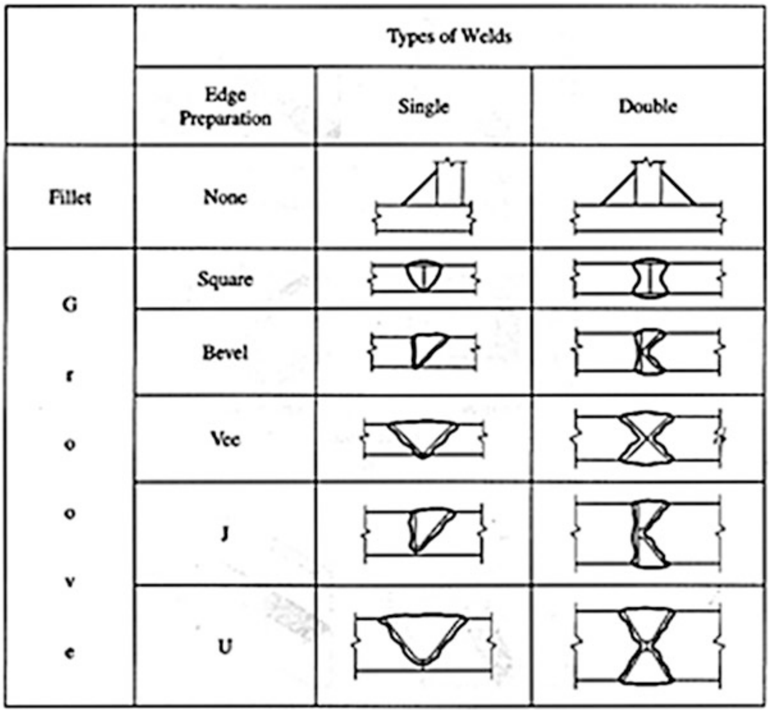
Construction students should know about shipping size, splicing, lifting holes and web plates to receive the floor beams. A good knowledge to identify shear and moment connections for floor beams is also needed. A mathematical exercise to show column capacities for different column heights and end conditions is also important. Other issues related to holes on perimeter columns for safety cables, painting and welding, material specifications are also important. Author has developed a PowerPoint ***Design and Construction of Steel Columns*** and is available at *ajayshanker.com*.

106.1.14 Bolted Connections: High Strength Bolts



Construction management students will supervise field operations such as bolting and welding. It is extremely important that they know all issues related to structural bolts, such as, specifications; failure modes shear tension bearing block-shear; strength reduction if threading is in shear plane, installation procedures for bearing and slip critical bolts, bolt spacing for constructability, standard and slotted holes, bolts in single or double shear etc. As most structural failures only occur at connections and connections are supervised by CM students a good understanding of all aspects of bolted construction is important. Author has developed a PowerPoint ***Bolted Connections*** and is available at *ajayshanker.com.* AISC has also made available PowerPoints ***Bolting and Welding and Connections*** and Bracing *at the AISC website* [7].

106.1.15 Welded Connections, AWS Weld Symbols and Details



Welding is another field process that CM students should know in detail. Steel frame construction is increasingly done by using fillet welded moment connections for connecting floor beams to columns. Students should have expertise in reading shop drawings that show various weld symbols, weld sizes, lengths and specifications of electrodes. CM students should know types and uses of groove, butt and plug welds. Author has developed a PowerPoint ***Weld Symbols*** and is available at ajayshanker.com. The PowerPoints published by AISC and mentioned in previous Bolted connections also have slides for welding. American Welding Society, The AWS website [18] is the main resource repository for the latest in welding industry. The website also has many publication that are free downloads.

106.2 Conclusions

This is an informational paper with the primary purpose to help instructors engaged in teaching structural steel to construction management students. The paper provides many resources that author has used over the past 20 years while teaching structural steel at Rinker School of Construction, University of Florida, USA.

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Chapter 107
Developing Students' Intercultural Competence

Patrick Zou and Liz Shek-Noble

Abstract This paper explores the efficacy of online e-learning environments for developing students' intercultural competence (IC) in the context of Australian higher education. It begins by defining the key attributes and prescriptors of IC, and argues that Taylor's theory of perspective transformation (Adult Educ Quart 44:154–174, Int J Intercult Rel 18(30):389–408) is the most plausible explanation for why and how people become interculturally competent. E-learning is put forward as a platform for developing students' IC, due to its interactive and multimodal approach to learning. Last, the paper outlines several strategies for developing students' IC in an e-learning context. We recommend a bi-directional approach whereby students *and* lecturers work to become more knowledgeable and flexible towards other cultures. The findings of this paper will contribute to existing literature on IC by demonstrating how online e-learning environments can help to develop positive attributes of flexibility, curiosity, openness and acceptance of diversity in students. Although the paper uses Australian higher education as its example, the findings should be applicable to higher education in a global arena.

Keywords Higher education • E-learning • Flexibility • Intercultural competence • Perspective transformation

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_107,

107.1 Introduction

As businesses, educational institutions and technological production are internationalised, it is crucial to develop skills and attitudes that will assist in negotiating the complex interaction between one's culture and that of another. It has become necessary to draw on different pedagogical approaches in universities, as foreign students comprise a significant portion of their enrolment and commencement numbers. For example, in the 2010 calendar year, the number of enrolments of international students in Australian universities was 619119, and the number of commencements 329352 [1]. In fact, there is potential to grow to a mind-boggling 10 million enrolments within 10 years through online platforms [2]. From these statistics alone, it is clear that Australian higher education standards must take into account the culturally-relative nature in which people learn, communicate with one another and interact with various technologies.

The purpose of this paper is to develop strategies to assist students in achieving intercultural competence in an online e-learning environment. As is the case with Fantini's observation [3] that in a business context 'success in a global marketplace depends, to a large degree, on their employees' ability to deal in the international arena', it is equally important to develop intercultural competence in students at a tertiary level of education.

This paper will be divided into three sections: the first section will outline the various traits an individual must develop to become interculturally competent. The second section will discuss various strategies that explain how one becomes interculturally competent and will provide suggestions for its practical application in an online e-learning environment. Ultimately, this paper argues that the changes triggered in the interculturally competent student can be explained through the theory of *perspective transformation*. Perspective transformation will hence provide the 'conceptual framework for investigating how intercultural competency is acquired' [4].

107.2 The Traits and Prescriptors of Intercultural Competence

Although there is no definitive definition of intercultural competence, it is generally agreed that it is a process involving a shift in inter- and intra- personal orientation, where an individual's attitude to a target culture prompts compelling changes in perception, both towards the target culture and the individual's own native culture. This is what Fantini [3] calls the '"double-edged" nature of the intercultural experience', or what Engeström defines as 'expansive learning' ([5, 7], cited in [8]).

107.2.1 Intercultural Competence and Knowledge Transmission

According to Engeström [5–7], intercultural competence must always involve a reciprocal and active process of knowledge transmission. Incorporating this active learning approach will assist in negotiating three domains of knowledge: '(a) *individual knowledge*, (b) *individual and/or collective knowledge* and (c) *collective knowledge*.' (Cited in [8]) Here it is evident that intercultural communication fosters a mutually beneficial relationship for not one, but three different groups: the individual interacting with a target culture; the group knowledge this individual acquires and passes onto other sojourners, and the collective knowledge that the host culture attains about the visiting individual's own society.

Perhaps equally important to intercultural competence is the self-reflexive knowledge gained by the individual, since the term 'intercultural' also 'reflects the view that foreign language students need to gain insight both into *their own culture* and the foreign culture' (Kramsch [9], cited in [10]; emphasis added). The process of gaining insight into not only another culture but also that of our own does require, however, a host of already-existing, but not necessarily sophisticated, attributes inherent in the individual. Such attributes, leading to a capacity 'to perform *effectively* and *appropriately* when interacting with others who are linguistically and culturally different from oneself' (Fantini 2006, quoted in [11]) are not merely limited to sociolinguistic and content-specific competencies relating to the taboos, language, worldviews and norms of a given culture [15]. Rather, the learning that occurs as a result of the intercultural encounter succeeds when speakers can build a relationship between their own and another culture with a flexible outlook in mind. This is, according to [12], the ability 'to accept that [cultural] difference and see the common humanity beneath it' (quoted in [10]).

107.2.2 The Traits and Communicative Competencies of the Interculturally Competent Person

In a learning environment, the traits of an interculturally competent person are geared towards educationalism, that is, learning enough about a culture to move past an initial 'cultural shock' when encountering an unfamiliar language for the first time. Moving past this initial 'cultural shock' involves a deeper understanding of the complex intertwinement of language and culture. In exposing oneself to the different customs, social expectations and communicative uses of language in a culture, students can move beyond a simple polarisation of culture characterised in an 'us' versus 'them' mentality, and as a result of this multi-layered experience, 'knowledge of and respect for other cultures may be developed' (Stier [13, 14], cited in [15]). Respect for and knowledge of another culture in this educational context requires one to develop communicative competence and thereby overcome their ethnocentrism. Communicative competence, as outlined by [16], can be delineated into four competencies: grammatical, sociolinguistic, discourse and strategic (cited in [17]).

Whilst it is undoubtedly important to develop communicative competence in these four categories, intercultural competence is reliant on more than a speaker's dexterity in the language of a target culture. In order to be interculturally competent, one must also have certain positive behavioural characteristics that predispose them to gaining insight into another culture's customs, worldviews, and habits. We claim that positive behavioural characteristics such as flexibility and openness are crucial to the process of becoming interculturally competent.

107.2.3 Positive Behavioural Characteristics of Intercultural Competence

Davis and Cho [18] argue that two key prescriptors of an interculturally competent person are openness and flexibility. An open-minded person will 'have cognitive flexibility in adapting new ideas' and display a 'willingness to change' [18], whereas flexibility in attitude 'permits individuals to adapt to one other's behavior appropriately (Ting-Toomey 1999, cited in [18]). For if intercultural competence describes a person's level of *adaptive capacity* (Taylor 1994a) when confronted with an alien or partially familiar culture, openness and flexibility are fundamental to the process of adapting one's behavioural patterns as well as cultural stereotypes. This in turn reduces 'culture shocks' (Kim 1991, cited in Davis and Cho [18]) and prompts new forms of thinking and self-expression.

Other attributes which aid the process of becoming interculturally competent focus on the affective dimensions of being non-judgemental and empathetic toward another culture. These affective dimensions are what [19] regard as a degree of 'third-cultural perspective' (quoted in [4]) and assist in the ability for the individual to communicate effectively, create interpersonal relationships and deal with psychological stress (Hammer et al. [19], cited in [4]). Ultimately, intercultural competence is achieved with these aforementioned traits and dimensions in mind.

107.3 Perspective Transformation as an Explanation for IC

Stepping beyond superficial curiosity towards a foreign culture requires the individual to take 'into account the everyday lived experience of diverse cultures [as] represented by students and their families.' [20] It is essential to account for the *process* by which people achieve intercultural competence, in order to develop a theoretical framework for fostering intercultural competence in an online e-learning environment. The trigger in mindset prompting the individual to become inter- rather than mono- culturally oriented in his/her worldview can be explained by the theory of *perspective transformation*.

107.3.1 The Theory of Perspective Transformation

For Taylor [4], perspective transformation is a valid explanation for the learning and growth individuals experience in the process of becoming interculturally competent. Becoming an interculturally competent person involves a process 'whereby the stranger develops an adaptive capacity, altering his or her perspective to effectively understand and accommodate the demands of the host culture' [4]. The manner in which individuals are able to alter their perspective of a target culture can be explained by way of a gradual shift 'in the internal conditions of individuals as they participate in extensive intercultural communication activities' (Kim and Ruben 1988, quoted in [25]). With more frequent and prolonged immersion in a host culture, leading to in-depth communication (verbal and non-verbal), and participation in everyday life activities, the individual begins a process of revising their meaning structures or perspectives relating to that culture. For whereas the individual initially interprets events through 'the lens of his or her meaning perspective (world view)' [25], there is a gradual transition towards embracing a heterogeneous rather than homogeneous outlook towards the world and the customs, beliefs, and activities of its inhabitants. Intercultural competence development is therefore a lengthy and ongoing process due to the never-ending stimulus thrust onto the participant from within an already familiar culture, and one experienced for the first time. As Fantini [21] says, intercultural competence development will occasionally involve 'periods of regression or stagnation, and normally [will have]. . . no end point.'

107.4 E-Learning as a Platform for Achieving IC

Having accepted *perspective transformation* as a plausible explanation for how participants acquire intercultural competence, it is necessary to build a platform for encouraging intercultural competence. With the increased use of online e-learning in higher education, for example, MIT and Harvard University are offering free online e-learning courses where 100,000 students are enrolled from more than 100 countries (The Australian 2012), our discussion will focus on how e-learning may be used as a platform for achieving IC. Davis and Cho's case study [18] of intercultural competence involved a transatlantic group of students and faculty across six universities (Iowa State University, University of Florida, University of Virginia, Institution of Education in the University of London, Aalborg University, and University of Barcelona). Their plan was to develop a community in education technology to serve 'as a bridge to introduce new cultures, knowledge and people to students' [18].

The International Leadership in Education Technology (ILET) was selected in 2001 in Europe and the USA to create an intercultural learning environment involving these six universities. The ILET project had three strategies to develop intercultural competence: 'a sojourn abroad, a Summer Academy, and an online Reading Group' [18]. The findings of Davis and Cho's research into the online Reading Group were positive. In a fully text-based and online environment, students felt they were encouraged to 'become more flexible to unfamiliar situations and be open to new people and their ways of thinking and expressing themselves' [18]. It was reported that in an online rather than face-to-face learning context, the reading group environment 'broadened most students' research interests and positively opened their minds to new ideas, discussion, and knowledge', albeit not improving their academic performance [18].

Similarly, Liaw in 2006 studied the efficacy of e-learning environments for developing intercultural competence. Liaw's findings [10] showed that reading articles on various topics and subsequently discussing one's observations on them in an online forum granted opportunities for English as a Foreign Language (EFL) students to use insights into their own cultural and social practices as guiding principles for EFL learning. As such, the students were 'compelled to better understand their own and their counterpart's cultural views', and subsequently 'challenge their sense of self and their cultural identity and worldview' (Hager 2005, quoted in [10]).

Two other reference tools that enhanced intercultural competence through communication in the target culture included providing an online dictionary and a bilingual concordancer to use when reading and writing responses to online discussion [10]. Zahar et al. [22] have found bilingual concordancers useful in increasing the vocabulary of participants in a target culture, specifically if contextual clues are provided (cited in [10]). Furthermore, online dictionaries expand the participant's lexicon by providing contextual inferences (Fraser 1999, cited in [10]). In order to assess the relative success of reference tools and technology (quizzes, forums, concordance, comprehension tasks) for intercultural competence in an online e-learning environment, a multidimensional mode of assessment is recommended. Multidimensional assessment comes in the form of tests, interviews, and surveys, with the types of assessment being expert, reciprocal, peer, or self-evaluative. Ultimately, multidimensional assessment is an important way of measuring, both qualitatively and quantitatively, the level of intercultural competence that is achieved.

107.5 Strategies for Achieving IC

Whenever a model for achieving IC is proposed, it is necessary to be aware of one's audience so that its implementation matches up with the needs of participants. As McLoughlin and Oliver [23] summarise, 'educational resources must take account of cultural variables and recognise the specific learning needs, preferences and styles of learners'. An important consideration for lecturers when implementing their model for achieving intercultural competence is how the educational values held by students will affect their receptivity to intercultural learning. For this reason, we recommend a bi-directional rather than uni-directional approach to achieving IC.

107.5.1 A Bi-directional Approach to Achieving IC

Outlined within the syllabus will be clearly defined values, as they relate to intercultural cooperation *and* educational objectives relevant to an Australian context. This is to acknowledge the fact that different cultures have different presentation styles, and that explicit statements regarding the educational values and objectives of a particular course 'helps them [students] better adjust' to this new discourse [24].

We strongly assert that developing intercultural competence should be a bi-directional rather than uni-directional process where it is not only important to foster this form of learning in students, but also in their teachers and instructors. We agree with Taylor [20] that teachers need metaphorically to 'enter their students' households and communities as "learners," seeking to understand the ways in which people make sense of their everyday lives'. In reality, what this means is that a survey will be conducted at the beginning and end of the semester, and include questions concerning the preferences students have towards various modes of learning, and whether they use social networking sites such as *facebook* and *myspace* for both educational and recreational purposes. Furthermore, as IC involves a process of self-reflexive knowledge, where students note changes made to their perspective, attitudes and respect towards other cultures and that of their own, an end of semester self-evaluation report will be administered. This self-evaluation report will take the form of a before-and-after style, where students rate how certain prescriptors relating to IC have changed as a result of the course, and whether they have been prompted to learn about other cultures more due to their interaction with foreign students.

107.5.2 Group Work as an Essential Component of Intercultural Cooperation

Online group work should be encouraged and comprised of students from both local and international backgrounds. Students will also have an opportunity to develop leadership skills such as delegation of duties and conflict resolution as inflected by their growing knowledge of different cultures. Collaborative approaches to learning have proven to be beneficial, since they enable 'groups to combine expertise and distribute control for parts of the task [to affirm]... learner control' [23]. Online dictionaries and bilingual concordancers will also be available when breakdown in communication for international students occurs. Additional support in the form of bulletin boards and individual email correspondence with tutors and course coordinators will also be available.

107.5.3 Making Your Language Accessible and Comprehensible for Local and International Students

From the perspective of a lecturer, one way of taking into account cultural variations in cognition and communication is by considering the role of language in serving as a gateway to intercultural learning, by making known through verbal and non-verbal means the complex values and customs of a particular group. Yet the levels an individual has relating to their grammatical and sociolinguistic competence in a particular language varies. Since it is not easily determined the level of ability native and ESL learners have in English, it is necessary for the lecturer 'to express content simply and precisely in English-language internet-based learning courses' [24]. This would mean using conventional and straightforward syntax and adopting a style of writing that would avoid idiomatic and overly figurative language.

107.6 Conclusion

In this paper, we argued that an interculturally competent person possess positive character traits of flexibility, open mindedness, awareness, and an appreciation for diversity in thought and action. Nevertheless, in order to become interculturally competent, the individual must undergo a transformation of perspective, since it is 'the precondition to change' one's worldviews and cultural stereotypes [25].

In order to develop a theoretical framework for fostering intercultural competence in an online e-learning environment, this paper has considered two case studies [10, 18] where multimedia technology has been utilised with the intention of monitoring and encouraging communication between the host and target culture. With the positive recommendation of using online technologies for developing IC in the studies by Davis and Cho [18] and Liaw [10], the authors of this paper outlined a bi-directional model of learning in an online context. It was argued students become more interculturally curious (and later competent) when they participated in online group work comprised of both local and international students, as this would incite discussion regarding their life experiences and preferences for learning. Lecturers, in understanding the relative levels of comprehension and communication confidence international students have when using

English, should write the objectives and aims, as well as the learning contents of their courses in a style which uses conventional syntax, simple grammar, and literal rather than figurative language. Ultimately, the findings of this paper contribute to the existing literature on IC by demonstrating how online e-learning environments can help, through a transformation of perspective process, to develop positive attributes of flexibility, curiosity, openness and acceptance of diversity in students, all of which are essential to the process of becoming interculturally competent.

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Chapter 108
The Internationalisation of UK's HE in Construction Department: The Success Factors of Exporting Education to China

Gang Wu and Sammy Chung

Abstract Compared with other major institutions in society, higher education institutions in the past were perceived as very international institutions in the European countries because there was a neo-colonial dimension of higher education (Teichler 1999). Students from many developing countries are willing to study abroad because higher education systems in their countries are incomplete and cannot offer them sufficient resources and quality studying. This paper introduces that the advantages of UK's higher construction education lie in both its teaching approaches and the links with professional bodies, then Analyses the market demand of Chinese construction higher education, finally Discusses the success factors of exporting UK's construction higher education to China

Keywords Internationalisation • High education • Construction department

108.1 Introduction

From 1980s, the rapidly growing global economy encourages the exchange of university's faculty and students and the trend of internationalising university's curricula [1]. Simultaneously, since governments try to reduce public expenditures

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Financially supported by Guangdong Higher Vocational Education Research Institute Fund: GDGZ09010, and Shenzhen Polytechnic Research Fund: 2209s3080002.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_108, © Springer-Verlag Berlin Heidelberg 2014

as a result of the global monetarist doctrine, university funding seems to be cut inevitably [2, 3]. Universities have to adopt output-based schemes to be effectiveness (focusing on outcomes and results and managing change better) and efficiency (doing more with less and value for money) [3]. Due to the lack of sufficient domestic higher educational capacity and pressure of funding shortage, UK's higher education institutions were fuelled to enroll overseas students from developing and transitional countries. Like other higher education departments in UK, the construction department should resolve those common problems by developing international business as a part of strategy.

With the booming economy, China is eager to employ intellectuals who are equipped with advanced knowledge and technologies. Due to the historical reasons and the impacts of economy transformation, Chinese construction industry has been suffering the shortage of skilled professionals. However as the domestic higher education for construction lacks advanced teaching system and learning method, i.e. problem-solving and group discussion, it cannot satisfy the requirements of construction industry, especially large projects. Therefore, there is a huge market for UK's construction higher education institutions (HEIs) to help overcome this problem in China. Owing to the complex and dynamic nature of China's society, it is important for UK's construction HEIs to understand the market demand and factors influencing the success of exporting construction higher education to China.

This paper aims to identify the success factors of exporting UK's construction higher education to China. In order to achieve the aim, the following objectives are envisaged to accomplish:

– Identification of the forms and organisation of internationalisation in higher education.
– Identification the advantages of UK's construction higher education.
– Analysis of the market demand of Chinese construction higher education.
– Discussion of the success factors of exporting UK's construction higher education to China

108.2 The Forms and Organisation of Internationalisation in Higher Education

108.2.1 Rationales and Motivations for Internationalisation

Due to the supply and demand, Higher education become a part of the globalisation process and can no longer limit to national context. In order to seek for knowledge abroad, where the highest quality is offered, the majority of international students come from 'developing' countries, and most of them go to 'developed' countries [4]. In fact, there's a progressive movement on this area decades ago. According to United Nations Educational, Scientific and Cultural Organization (UNESCO) [5], the number of international students has nearly tripled since 1980 and has increased by 50 % since 1998. In 2004, 2.5 million higher education students studied abroad. With the increase of student mobility, the higher education institutes in industrial countries needs to clearly understand the trend, opportunities and challenges resulting from the internationalisation. Prior to discuss the Chinese construction higher education market for UK higher education institutes, it is important to take a brief review of internationalisation including its forms and organisation.

In the recent years, internationalisation often appeared in the education papers and journals. It is commonly used interchangeably with globalisation. Globalisation can be thought of as the catalyst while internationalisation is the response, albeit it a response in a proactive way [6]. The working definition of internationalisation is the process of integrating an international / intercultural dimension into the educational business [7]. It is not only focused on orienting to countries or nation states, but includes the different cultural / ethnic groups within a country. As globalisation is the flow of technology, economy, knowledge, ideas etc. across borders, it is important to integrate internationalisation into higher education. In order to clarify the rationale of educational internationalism, Knight and Wit [6] identified four reasons to internationalise, which are: political reason, economic reason, academic reason, and cultural reason.

108.2.1.1 Political Reason

In political rationale, the internationalisation of education will benefit foreign policy on national security and peace among nations. For some countries, it can strengthen and promote their national identity. The exchange of cultural, scientific and educational knowledge between countries can benefit the communication and diplomatic relations. Therefore, the internationalisation of education is an important political rationale at the national level.

108.2.1.2 Economic Reason

In economic rationale, countries are more focused on their global competitiveness in scientific and technology areas. Therefore, the best way is to improve and maintain this competitive edge by developing a highly skilled and knowledgeable work force and through investing in applied research. In the job market, it is important to identify competencies for new graduates to function in an international work environment. In the past decades, exporting education products was one of the strategies to most of the institutions in order to survive.

108.2.1.3 Academic Reason

Based on academic rationale, internationalising the higher education sector could help the achievement of international academic standards for teaching and research. Although there are concerns regarding the uniformity and homogeneity that can result from the excessive emphasis on internationally recognised standards, enhancing the international dimension of teaching, research and service can add value to the quality of higher education systems.

108.2.1.4 Cultural/Social Reason

In terms of cultural and social rationale, some countries which attempt to preserve and promote national culture consider internationalisation as a way to respect cultural diversity and counterbalance the perceived homogenising effect of globalisation. The graduates' intercultural understanding and communication are seen as one of the strongest rationales for internationalising the teaching/learning experience of students in higher education.

108.2.2 Types of International Programmes

There are two types of international programmes. One is recruiting foreign students to study in the 'developed countries', and the other is developing collaborative links or partnership with one or more HEIs overseas to establish accredited courses. Recruiting foreign students is a straightforward method that enables eligible overseas students to study under the same circumstance as local students. The teaching and learning quality for overseas students can be easily controlled and improved. The higher education institute can efficiently observe the studying and living problems of overseas students, and then making appropriate adjustment or amendment. However, the overseas recruitment is confined with some limitations including the language barriers, culture impacts, requirements for enough studying and living facilities and the overseas students' economic abilities. Comparing with recruiting overseas students, establishing collaborative links with overseas partners can rapidly expand the international influence and reputation of HEIs. The universities can franchise the overseas institutes to offer their degrees and other qualifications. The overseas students take the accredited courses in their own country, or complete the first year and sometimes second year of the degree programme before they go abroad to achieve the degree. Establishing overseas-validated-courses (OVCs) requires less resource than directly recruiting overseas students. However, it is important for HEIs to select appropriate overseas partners and develop effective teaching and learning quality assurance system. An inappropriate collaborative partner or inferior teaching and learning quality would ruin the institutes' international reputation and programme rapidly.

In summary, the globalisation enables the rapid growth of international programmes in the higher education. A HEI that wants to achieve success in the internationalisation should enhance its own intercultural abilities, develop effective organisation and select appropriate programme.

108.3 The Advantages of UK's Construction Higher Education in the Internationalisation

Like other higher education provisions, the UK's construction higher education needs to take advantage of internationalisation to resolve the shortage of domestic students and the reduction of university funding. Due to the continuing improvement, UK's construction higher education has established international reputation for its flexible and practical teaching approach, and close relationship with professional bodies.

The UK's construction higher education focuses on developing student's professional skills and problem-solving abilities. Problem-based teaching approach is usually applied in the construction provisions. Students are encouraged to use their prior knowledge and search for new knowledge or further information to solve a series of problems or scenarios [8]. During the problem-based learning, students have the opportunity to gain experience from real construction projects (e.g., site visits) as part of their professional training. Moreover, students are usually required to work in a group to develop their collaborative and cooperative ability in the team-working. Such a problem-based teaching approach enables students to acquire professional knowledge/skills and fosters them to be more flexible and adaptable in their future careers in industry.

In addition to the valuable teaching approach, the close relationship with professional bodies ensures the updated useful teaching contexts. Most of UK's construction higher education departments have the accredited courses by relevant professional bodies, i.e. Royal Institution of Chartered Surveyors (RICS), Royal Institution of British Architects (RIBA), Chartered Institute of Building (CIOB) etc. Those professional bodies can effectively control the accredited courses by regular monitor, ensuring the teaching contexts can satisfy the industry's requirements in practice. Students who take those accredited courses can develop basic knowledge and practical skills for their future careers, and will be allowed to proceed to the further professional training and full membership of the relevant professional bodies.

In general, the UK's construction higher education applies a student-oriented teaching approach, encouraging student's active learning, professional skills development and practical problem-solving abilities' enhancement. As developing countries have high demand of construction graduates with advanced professional knowledge and practical problem-solving abilities, the above two advantages enable the UK's construction higher education to be attractive in the international higher education market.

108.4 The Market Demand of Importing Construction Higher Education from Developed Industrial Countries to China

With the rapid development of economy, many changes have been taken place in Chinese construction industry. In order to realise the urbanisation and modernisation in the whole country, China needs a large amount of skilled construction practitioners who should equip with professional theories, advanced knowledge and problem-solving abilities. However, due to the transformation of economy system and the deprivations of Culture Revolution, the Chinese construction industry has been suffering the acute shortage of skilled personnel, especially at middle management level [9, 10]. As the key to solve the shortage of skilled practitioners lies in the development of construction, especially the higher education for construction industry [10], there is a high market demand of importing higher education for construction from developed industrial countries. The following part will discuss three major factors contributing to the high market demand of importing higher education for Chinese construction industry.

108.4.1 Industry's Requirements

Chinese construction industry, as one of five major sectors of the economy (agriculture, construction, transportation, commerce and other industry) plays an important role not only in China's economy but also in society with massive employment and considerable economic contribution [11, 12]. In recent years, the booming of China's economy is driving a variety of capital works projects including residential and commercial property, transportation, environmental protection and energy. Furthermore, projects surrounding the 2008 Olympics and the 2010 Shanghai Expo create huge changes for Chinese construction industry. However, with China's entry to World Trade Organisation (WTO) in 2001, China's massive construction market has opened to foreign companies. Chinese construction industry is confronting more and more challenges and competitions from globalisation.

Notwithstanding great improvements has been achieved in Chinese construction industry with the reform of economy in China since 1980s, Chinese construction industry is notorious with its low productivity and poor management system, which impair the sustainable development of the whole industry. The underpinning reason of the two weakness of Chinese construction industry is the lack of skilled professionals, such as designer, supervisors and engineers. Chinese construction industry is suffering both a numerical shortage of skilled professionals and a qualitative shortfall [13]. Although the number of construction professionals is big, their number is very small while comparing with the total employment in the industry. Around 76 % of the total employment in Chinese construction industry is from the rural labour force (*ibid.*). In addition, a number of construction professionals lack of advanced management knowledge and skills because of pitfalls in their education background. Most of those professionals didn't take higher education so that their knowledge is obsolete. As the lack of quality skilled professionals has resulted in many quality and safety problems because of shoddy workmanship and deficient management, there is a huge demand for eligible professionals in urban planning, architecture, construction project management, construction management, land management, and facilities management. Since the industry requires more efficient management information and control systems with more effective cost control, construction planning, resource allocation, value management and risk management, life-cycle appraisal, safety management and quality assurance systems (*ibid.*), it is envisaged that there would be a huge market demand of advanced technological and managerial knowledge in Chinese construction industry.

108.4.2 Higher Education's Requirement

Due to the historical reason, China's higher education system lagged behind the economic growth and market demand. Since 1993, reforms have been carried out in China's higher education system in order to resolve inefficient administrative system, unreasonable course design, unbalanced distribution of education and waste of education resources [14]. Likewise, the construction higher education in China has been improved significantly in teaching, staffing, research, financial management, and international cooperation [15]. However, the obsolete teaching approach in China's higher education hindered the effective transmission of knowledge and technologies. In China, student learning in higher education focuses on constructing a foundation of scientific knowledge, preparing professional caliber students, exploring professional theories and having students participate in practice [16]. Students usually learn basic construction knowledge in the first and second years, undertake coursework across multiple disciplines in the third year and carry out professional practice activities, including a final year project in the fourth year [15]. The separation of theory learning and professional practice goes against the development of construction students' professional knowledge and problem-solving abilities. In order to improve the teaching quality, foster students' flexibility and adaptability in future career, and enhance the competitive advantages, China' higher education for construction need to improve its teaching system.

108.4.3 Professional's Requirement

As mentioned before, the Chinese construction industry requires a large amount of skilled professionals. In order to assist practitioners in developing professional knowledge and practical skills, China established a qualification certificate system in 1993 [13]. Upon to date, there are ten different professional qualifications in

Chinese construction industry. The applicants for those professional qualifications have to pass relevant exams and then can become registered professionals. In addition, the registered professionals need to attend annual training course to update knowledge and acquire new technologies in the industry. With China's entry of WTO, Chinese construction professional bodies are keen to cooperate with overseas professional organisations such as CIOB, RICS and RIBA, helping their members obtain overseas qualifications [12]. In order to establish a mutual recognition mechanics with overseas professional bodies, the Chinese construction professional bodies need to update their examination systems and training schemes. Furthermore, the cooperation between Chinese and overseas professional bodies encourages the higher education accreditation. Therefore, the development of Chinese construction professional bodies fosters the rising demand of importing sophisticated construction higher education to China.

108.5 The Success Factors of Exporting UK's Construction Higher Education to China

Considering the market demand of advanced technologies, eligible graduates and skilled professionals in Chinese construction industry, UK's construction higher education institutes can make use of two types of education exports to recruit Chinese students and develop accredited courses with Chinese construction higher education institutes. In order to help UK's construction HEIs achieve success in Chinese construction higher education market, the followings factors should be taken into account at the inception of developing international programmes in China.

108.5.1 Geographic Factor

China has adopted an unbalanced regional development policy since its reform and opening up in the 1980s. Based on the policy, the coastal provinces and three municipalities including Shanghai, Tianjing and Beijing acquired the priority of development. A large amount of state capital was invested in those areas, which became growth centres. The construction industry in those economy developed areas is growing rapidly and requires a large amount of skilled professionals. Although the higher education market in those areas is well-fledged, the competition is keen. Majority of higher education institutes in those areas have already established international links with western higher education institutes. In order to make success in those areas, UK's construction high education institutes should highlight the close link with UK's prestigious professional bodies. The courses accredited by those professional bodies would attract considerable students who want to become eligible construction professionals in their future careers.

Apart from the economy developed areas, the western part of China is becoming a potential international higher education market due to China's west development strategy launched from 2000. The west development strategy focuses on promoting the social and economic progress of China's central and western areas. Due to huge investments (1 trillion RMB, equals to 100 billion sterling pounds) in infrastructure and construction works and the policy of retention talent flowing to richer provinces, there is a large market for UK construction higher education institutes in central and western areas of China. As the local HEIs lack of international exchange opportunities, establishing collaborative links with them could help UK's construction HEIs establish reputation and develop market share rapidly.

108.5.2 Partner Factor

It is obvious that no foreign HEI can work independently but always needs the connection with ad local HEI or consultancies. In order to establish sustainable international programme, UK construction HEIs should carefully select local partners who are capable of assisting in student enrollment and organising collaborative programmes or courses. UK's construction HEIs can get help from China Education Association for International Exchange, which is a China's nationwide not-for-profit organisation conducting international education exchange. In addition, the Chinese Ministry of Education regularly updates a list of accredited consultancies or institutes which are considered as eligible to conduct international education exchange work.

108.5.3 Language Factor

Language is an important factor in establishing collaborative courses with local higher education institutes. Although English is a compulsory course of Chinese students from primary to tertiary education level, it is still difficult to deliver lecture to Chinese university students in English. Moreover, it would be more difficult to use English as the medium of instruction for Chinese construction practitioners. Considering the language barriers, UK's construction HEIs can apply a bilingual teaching method in the collaborative courses. The lecturers from UK should cooperate with local lecturers who can work as an interpreter or assistant in the classroom and help translate teaching materials into Chinese. The bilingual teaching method can help Chinese construction students and professionals understand the teaching contents unambiguously and rapidly. Simultaneously, Chinese lecturers can also learn the problem-based and student-centred teaching approach in practice.

108.5.4 Quality Factor

As mentioned before, the competition in Chinese international higher education market is keen. In order to expand the market share in China, UK's construction HEIs should establish mechanism as and systems that can assure quality teaching and learning. Considering the difference between Chinese and UK's construction situation, major attention of teaching and learning quality could be given to the following dimensions:

- Curriculum design: the curricula should focus on liaising advanced construction technologies with Chinese construction industry.
- Pedagogical design: the problem-based teaching approach and professional skill training should be applied in all modules.
- Staff selection/training: the UK's and Chinese staffs should have good communication ability and can cooperate with each other effectively and efficiently. In addition, it is necessary to organise relevant training programmes, workshops or seminars to improve staffs particular teaching skills.
- Resource provision: In order to effectively develop students' practical skills, it is important to provide students with real equipments, especially some surveying equipments as teaching aids.

108.5.5 Placement/Internship Factor

The main reason that Chinese students select to study abroad or attend the collaborative course is to not only learn the advanced knowledge and technologies but also acquire working experience in western countries. UK's construction HEIs can attract more students in China if they can facilitate them to find placement/internship opportunities during studying or after graduation.

108.5.6 How to Measure Success?

Based on the above factors, something needs to be maintained or accepted in order to eliminate any failure. (1) As long as the current policies and system in China remain unchanged, (2) A continuation of large amount of state capital investing in the higher education sector, (3) Ministry of Education continually monitor their accredited consultancies which are considered as eligible to conduct international education exchange work, (4) UK HEI prepare to accept that teaching in bilingual teaching method in the collaborative courses without affecting the quality or the standard (5) Reconsider on preparing a curriculum to suit the global demand.

The successful measure can be justified by the development of the programmes and number of students engaged on it.

108.6 Conclusion

With the trend of globalisation, the internationalisation of higher education has become an effective method for western HEIs to offset the shortage of domestic students and government funding. This paper briefly reviewed the reasons of internationalisation of higher education, introducing the four approaches in the organisation of higher education internationalisation and two types of exporting higher education. Following the analysis of the advantages of UK's construction higher education, three market demands of exporting construction higher education to China was identified. Based on the advantages of UK's construction higher education and Chinese market demands, five success factors for UK's construction HEIs to expand the market in China were discussed. However, due to the constraints of time and resources, the lack of first-hand investigation material limited in-depth analysis and discussion. The future research could focus on investigating some real international projects in China to identify the problems and bring practical suggestions for UK's construction HEIs.

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Part X
Green Construction Materials and Construction Waste Recycling

Chapter 109
The Conceptual Model of the Design for Construction Waste Minimization Based on System Dynamics

ZhengDao Li, XiFu Wang, and PengPeng Li

Abstract Construction waste minimization has caused widespread concerns in research field worldwide. Many literature indicate that the architectural designer should conduct waste minimization design to reduce construction waste to a proper level. Based on questionnaire and interview survey, the study identifies the main factors affecting the minimization level of waste at the design stage. Based on above key factors, with the help of VENSIM system dynamics software, this study builds the conceptual model of design and management for construction waste minimization. The model composes four subsystems, namely architectural design, waste generation, waste disposal, and waste performance assessment. Upon the conceptual model, the research reveals the interaction mechanism of the main factors that affect the level of waste minimization at the design stage, which make architectural designers better understand the impact and significance of the design planning on construction waste minimization.

Keywords Construction waste • Minimization • Conceptual model • System dynamics

109.1 Introduction

With the continuous development of the urbanization and transformation of the old buildings, large amount of construction wastes generated from construction and demolition have increasingly serious impact on people's ordinary life. Statistics show that the annual construction waste in China accounted for 40 % of the total municipal waste [1]. The amount of construction waste from the removal of building in China is more than 200 million tons each year, and the construction waste

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_109,

generated from the new buildings is approximately 100 million tons [2]. Meanwhile, these construction wastes consume a lot of construction materials which are a waste of valuable natural resources and occupy scarce land resources when they were disposed in the landfill. More seriously, some components of these wastes also contain toxic substances, endangering the survival of humans and sustainable development of the surrounding environment [3]. Therefore, how to strengthen the management of construction waste minimization, and improve the level of construction waste minimization becomes a problem which is urgent to be resolved.

"The design for construction waste minimization", that is construction waste reduction in the design phase, can be defined as that in the design stage of the construction project, the waste could be reduced through refining architectural design and formulating material management planning, and using advanced construction techniques to eventually achieve resource conservation and environmental protection. Many literature point out that a large number of the construction waste is generated due to lack of considerations on material use, construction techniques and so on in the design phase. The research about construction waste minimization should focus on the design phase, to reduce the generation of construction waste at the source [4–6]. However the issues of "The design for construction waste minimization" did not arouse enough attention among the domestic research scholars who generally believe that the construction waste is mainly generated from the construction phase caused by improper construction [7, 8]. Meanwhile, in the practice, some architects cannot understand clearly the important impact of their design planning on the construction waste minimization.

Through questionnaire survey, this paper adjusts and summarizes the main factors that affect the minimization level of construction waste in the design stage. Based on these key factors, with the help of VENSIM System dynamics software, this study builds the conceptual model of design and management for construction waste minimization. Upon the conceptual model, the research reveals the interaction mechanism of the main factors that affect the level of waste minimization at the design stage, which make architectural designers better understand the impact and significance of the design planning on construction waste minimization.

109.2 The Main Factors That Affect the Design for Construction Waste Minimization

109.2.1 Survey Questionnaire

On the basis of intensive literature review, this paper investigated the factors that affect the minimization level of construction waste at the design stage. Questionnaire is shown in Table 109.1.

Table 109.1 Questionnaire (partly)

F	Sub-Factor	Explanation	The impact of reduce construction waste				
			a	b	c	d	e
	Infection mortar	Reduce the artificial wet operations and mortar waste	1	2	3	4	5
technology	Temporary metal wall fences	Increase the number of recycling, reduce demolition waste	1	2	3	4	5
	......	....	...	...	...	...	...
	......	....	...	...	...	...	...
	Plaster infill walls	Instead of the traditional block wall, reduce site waste	1	2	3	4	5
	Precast floor	Instead of site concrete pouring, reduce concrete waste	1	2	3	4	5

Explanation: a-unimportant; b-less important; c-important; d-very important; e-extremely important

This research selected respondents from Class A Design Institute in Shenzhen to do the survey. Questionnaires are recovered immediately these respondents finish filling in. The number of questionnaires distributed was 223, and recovery rate is 84.7 %. Removing some invalid questionnaires, the total recovered valid number is 141 and valid response rate is 70.5 %. According to Moser and Kalton [9], this survey efficiency is within the effective range. The information of respondents is shown in Fig. 109.1.

109.2.2 Statistical Analyses

The paper uses the formula (109.1) to calculate the average importance level of each influencing factors. The average importance level is used to identify the important factors affecting the design for construction waste minimization.

$$u_h = \frac{1n_1 + 2n_2 + 3n_3 + 4n_4 + 5n_5}{1n_1 + 2n_2 + 3n_3 + 4n_4 + 5n_5} \qquad (109.1)$$

where u_h is the mean importance rating of an attribute and n_1, n_2, n_3, n_4, and n_5, represent the number of designers who rated the attributes as 1, 2, 3, 4 and 5, respectively.

Statistical *t*-test is adopted to verify the significance level of various factors. The specific calculation and verification process is as follows:

The null hypothesis H_0:u≦u_0 against the alternative hypothesis H:u > $u_{0,}$ and u is the population mean. The decision rule was to reject H_0 when the calculated t value was larger than t $_{(n-1,\ a)}$ as shown in formula (109.2).

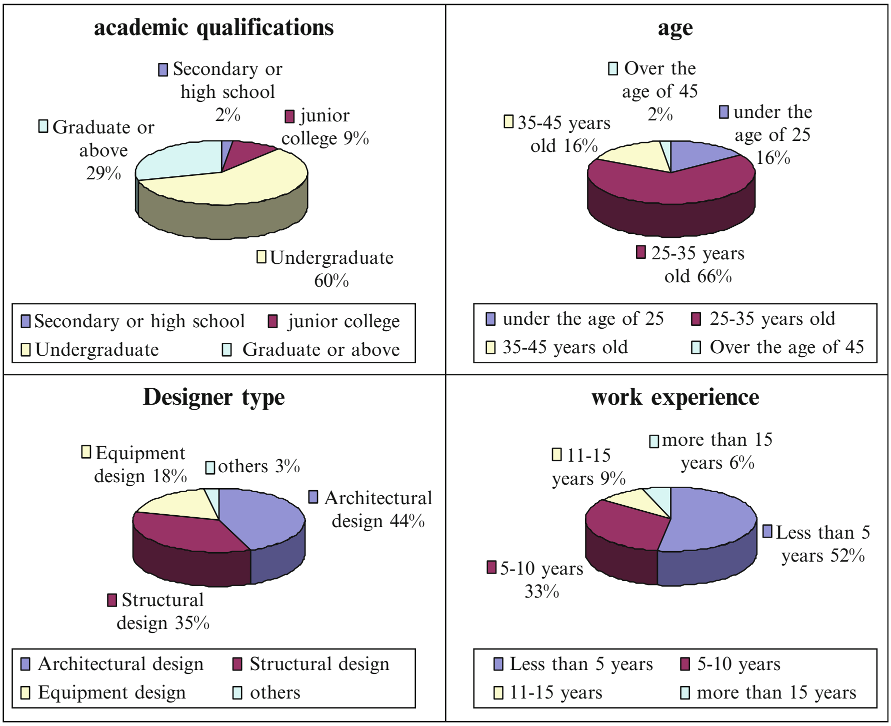

Fig. 109.1 Main situation of respondents

$$t = \frac{\bar{x} - \mu_o}{\frac{s_x}{\sqrt{n}}} > t_{(n-1,\alpha)} \tag{109.2}$$

where the random variable $t_{(n-1,\ a)}$ follows a Student's t-distribution with n−1 degrees of freedom, is the sample mean, S_x the sample standard deviation, n the sample size, and u_0 the critical rating above which the attribute was considered as most significant. In this study, all the attributes selected for statistical testing were considered as important factors. Hence, the statistical test sought to identify "more" and "most" significant attributes among them. Therefore, u_0 was fixed at 3, because, ratings above 3 represent "more significant" and "most significant" attributes according to the questionnaire design. The significance level, a was set at 0.05 following the conventional risk level. This implies that there was a 95 % certainty that the result was not due to chance. The probability of mistakenly rejecting the null hypothesis, or committing a Type I error was 5 % and the probability of accepting the null hypothesis when it was true was 95 %.

In this study, the sample size n namely the number of the total recovered valid questionnaires is 141. It was obtained that $t_{(140,\ 0.05)} = 1.655$. If the t value is larger than $t_{(140,0.05)}$ at 95 % confidence interval, the null hypothesis that the attribute was "less significant" or "not significant" only was rejected and the alternative hypothesis accepted. It was therefore concluded that the attribute was significant as a contributor to the design for construction waste minimization. However, if the t value of the statistical test of the mean ratings by the designers is smaller than $t_{(140,\ 0.05)} = 1.655$ at 95 % confidence interval, the null hypothesis that the attribute was "less signi6cant" or "not significant" only was accepted.

109.2.3 Survey Results

According to the data obtained by the data processing formulas in the previous section, the statistical results were shown in Table 109.2. The main factors with * is filtered out by *t*-test, meaning significance of these factors.

109.3 The Conceptual Model of the Design for Construction Waste Minimization

Based on these key factors, with the help of VENSIM System dynamics software, this study builds the conceptual model of design and management for construction waste minimization as shown in Fig. 109.2. The important variables are shown in Table 109.2- Survey results (A1–A3; B1–B6; C1–C7; D1–D9; E1–E4; F1–F6).

The interaction of the major factors which affect the design for construction waste minimization:

1. Sub-factors of external system → System improvement → External system influence → technology promotion effect → building technology → the total effect of minimization design. Building the various external systems promotes the improvement of the overall external system, which encourages the use of the waste reduction technologies, and ultimately enhances the total effect of minimization design.
2. Sub-factors of external system → External system influence → design promotion effect → building design → the total effect of minimization design. Building the various external systems promotes the improvement of the overall external system, which thereby affects the industry design rules, encouraging the designer to implement waste reduction design, and ultimately enhances the total effect of minimization design.
3. (Sub-factors of designers' behavior and attitude, Level of performance) → the promotion to attitude → behavior and attitude of designers → designers' ability → (Materials management plan, building technology, building design); Sub-factors of designer behavior and attitude and Level of performance have impact on the behavior and attitude of the designers, changes in behavior and attitude encourage the designers to implement more reduction design and enhance design capabilities, and ultimately affect the planning, design and technology adoption.

Table 109.2 Survey results

Factors	U Formula (1)	Variance S_x	t value (2)
A Building technology			
Infection mortar	2.8014	1.071	−2.2027
A1 Temporary metal wall	3.3050	1.035	3.4998 *
A2 Aluminum metal formwork	3.3617	1.002	4.2865 *
A3 Metal scaffolding	3.4043	1.069	4.4908 *
Plaster infill walls	2.9787	1.180	−0.2141
Precast floor	2.9220	1.299	−0.7133
Precast stairs	2.9574	1.236	−0.4089
Precast facades	3.0780	1.243	0.7456
Prefabricated internal wall	3.1418	1.119	1.5058
B Building design			
B1 Building component size fit	3.3333	1.026	3.8584 *
B2 The standardization of building components	3.5177	1.039	5.9155 *
B3 Modular design	3.4894	1.032	5.6282 *
B4 Reduce the temporary facilities	3.3759	0.982	4.5440 *
B5 Reduce design change	3.3901	1.164	3.9807 *
B6 Detailed design	3.4397	1.045	4.9989 *
C Materials management plan			
Estimated waste type	3.0496	1.023	0.5760
C1 Estimated waste numbers	3.1773	1.058	1.9909 *
C2 Clear recycling material type and numbers	3.4043	1.007	4.7671 *
C3 Clear waste sorting method	3.5390	1.072	5.9677 *
C4 Clear waste site management	3.4965	0.997	5.9110 *
C5 Planning of waste sorting and storage area	3.3759	1.039	4.2966 *
C6 Transportation of materials protection program	3.3050	0.956	3.7889 *
C7 Material procurement program	3.4255	0.980	5.1558 *
D External system			
D1 Laws and regulations of the design of waste reduction	3.4184	1.029	4.8275 *
D2 Enterprise regulations of the design of waste reduction	3.4539	0.960	5.6159 *
D3 Industry technical standards of the design of waste reduction	3.4894	1.080	5.3814 *
D4 Construction waste information management	3.4043	1.007	4.7671 *
D5 Waste reduction research investment mechanism	3.5106	0.961	6.3110 *
D6 Degree of integration of the norms and standards of architectural design and waste reduction technology	3.4752	1.032	5.4664 *
D7 The degree of refinement of the laws and regulations	3.4823	1.004	5.7021 *
D8 Strengthen the market-driven mechanism	3.5532	1.052	6.2459 *
D9 The supervision system	3.6241	0.990	7.4895 *
E Designers' ability			
E1 Professional competence	3.6028	1.139	6.2824 *
E2 Knowledge structure	3.6241	0.953	7.7786 *
E3 Work experience	3.8511	1.082	9.3408 *
Design operating environment	3.1277	1.127	1.3455
E4 Ability to obtain information and effective communication	3.6879	1.029	7.9378 *

(continued)

Table 109.2 (continued)

Factors	U Formula (1)	Variance S_x	t value (2)
F Behavior and attitude of designers			
F1 Saving resources and protecting the environment education	3.5319	1.004	6.2913 *
F2 Design waste reduction skills training	3.5035	1.004	5.9528 *
F3 Design waste reduction incentives	3.4539	1.216	4.4330 *
F4 Clear responsibilities for waste reduction	3.4823	0.968	5.9154 *
F5 Internal reduction culture	3.3901	2.756	1.6805 *
F6 Acceptance of the waste management industry	3.3759	1.073	4.1611 *

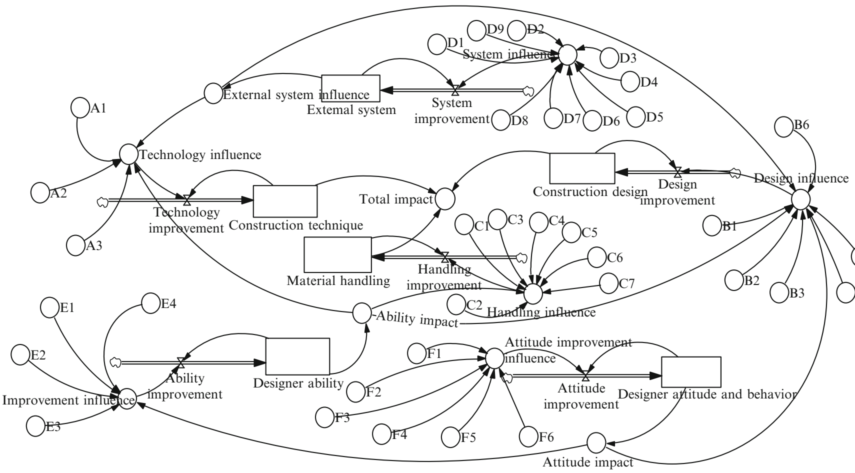

Fig. 109.2 The conceptual model of the design for construction waste minimization

4. (Sub-factors of external system, designers' behavior and attitude, designers' ability) → (Materials management plan、building technology、building design) → the total effect of minimization design. External system、designers' behavior and attitude、designers' ability are soft factors as a whole which affect the mandatory measures such as materials management plan、building technology and building design, and ultimately enhances the total effect of minimization design.

109.4 Conclusions

According to the survey, this study identifies the main factors affecting the minimization level of waste at the design stage and builds the conceptual model of design and management for construction waste minimization. This research reaches the following conclusions:

1. This paper investigated the factors that affect the minimization level of construction waste in the design stage from five aspects, namely building technology, building design, materials management plan, external system, designers' ability, behavior and attitude of designers. This can give waste managers a comprehensive understanding about the reason of waste, and lay the framework basis for the development of the evaluation model, finally provide an extremely useful reference for further research.
2. The concept model based on system dynamics can reveal the interaction mechanism of the main factors affecting the level of waste minimization at the design stage, which make architectural designers better understand the construction waste minimization of the design stage;
3. As part of the entire research about the assessment of construction waste minimization, this study only build a concept model; the framework need to be improved in future research and the validity need to be examined by empirical research.

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Chapter 110
A Model for Quantification of Construction Waste in New Residential Buildings

Jingkuang Liu, Yousong Wang, Bilei Yang, and Yiyong Lin

Abstract Construction waste management is currently a worldwide issue that concerns not only the on-site construction management level but also the sustainable development direction of construction industry. The quantification of construction waste volume, at the project stage, is essential for the building practitioners to properly plan and control its disposal. A detailed model is established to estimate the on-site volume of construction waste for new residential buildings. This quantification model has been developed by investigating 20 dwelling projects in Pearl River Delta of China. Based on the bill of quantities, two coefficients have been provided to estimate the wreckage volume and the packaging volume individually. Finally, a case study of residential building with masonry-concrete structure is demonstrated to illustrate the usefulness and effectiveness of the model.

Keywords Construction waste • Quantification model • Masonry-concrete structure • Dwelling projects

110.1 Introduction

As one of the major fixed asset formation sectors and cornerstone industries in the national economic system of China, the building sector is undergoing rapid development. Along with this, a lot of new construction and relocation projects produce huge quantities of construction waste; thus, on one hand, natural resources are not used intensively, on the other hand, the waste pollutes the ecological environment. At present, construction waste in China accounts for 30–40 % of total urban waste, and most of the construction waste, without undergoing treatment, are delivered to

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_110,

suburban or rural areas for disposal by means of open storage or landfill [1]. Thus construction waste not only incurs high transportation costs but occupies valuable land. In addition, the dust generated during transportation and in storage creates air pollution. The rapidly developing building sector urgently needs sound management of construction waste, but China is not conducting enough research on this issue [2]. Moreover, neither the central nor local governments have published any quantitative statistic data on construction waste. The functions of the government did not show and the monitoring efficiency is low. While the developers and contractors make few waste management plans, paying more attention on maximizing their own economic interests, making no consideration to control the production of construction waste, a lot of illegal dumping, all of which bring large treatment costs for the government [3]. Therefore, it is necessary to estimate the construction waste quantity of new projects through the scientific and reasonable methods in order to offer it in accordance to the relevant government management departments to assess construction waste recycling, make plans for expanding landfill sites, control the construction waste flowing and reduce illegal dumping. By adsorbing and integrating the previous research results, this paper sets up a model for quantification of construction waste in new residential buildings based on the survey data of Pearl River Delta of China. Finally, the paper provides new construction building for an example to estimate the on-site volume of construction waste with the quantification model.

110.2 Waste Quantification Procedure

110.2.1 Quantify Different Waste Streams Arising from the Construction Site

This current work presents a method to quantify different waste streams arising from the construction site. First of all, a classification system is needed.

The classification of waste item has referenced a relevant professional standard (List of construction engineering quantity pricing norms GB50500-2008) and the classification system is hierarchic, in which the list of construction wastes are divided into different levels, such as chapters and subchapters. The classification code of each item is formed by nine numbers. The numbers correspond to the main divisions of the Bill of Quantity (BOQ), called chapters, and the letters to the following divisions, called subchapters. For example, chapter 010101, earth works, and sub-chapter 010101001, earth transportation. The classification puts together similar materials, with the same measurement units.

110.2.2 Determine The Quantity of Each Item per Project (Q_i)

These values are obtained from the measurement of 100 typical Spanish dwelling projects surveyed (Table 110.1). These projects have been defined by the following five main characteristics:

- Project: new construction
- Number of floors: from 1 to 10 floors, one or two basement levels and stores or offices at ground level.
- Foundation: pile, reinforced concrete slab, reinforced concrete trench or pads.
- Structure: reinforced concrete or brick walls.
- Ceiling: inclined or horizontal.

Common characteristics are also identified in the majority of the 20 projects analyzed:240 × 115 × 53 mm standard bricks;Wall face plastering the lime and cement mortar;Aluminous gusset plate ceiling;400 × 400 mm porcelain polished tiles flooring surface;Ceramic wall tiles in kitchen and bathroom;Waterproof roof paving SBS modified asphalt waterproof coiled materials.

110.2.3 Estimation of Construction Waste Generation

Once the quantities (Q_i) have been determined by the surveys, the next step is to calculate the expected waste. In construction processes, tow sources of waste can be defined: wreckage and packaging waste. The wreckage volume refers to the losses, offcuts and breakage of materials during work completion, including the earth from the excavation works. The packaging waste includes material wrapping, cans, containers, pallets, etc. The proposed method allows the quantification of tow kinds of waste volumes associated with the tow sources of waste previously identified: the Apparent Wreckage Waste Volume(VAR_i)and the Apparent Packaging Waste Volume(VAE_i)[4]. These tow volumes derive from the Apparent Constructed Volume(VAC_i). The VAC_i is defined as the volume in cubic meters per square meter built of the item"i". The unit system is that traditionally used, and all data are represented in relative values that measure the quantity of each item in m, m^2, m^3, kg or unity per square meter built.

From the measurement of all the items identified in the building construction, the Apparent Constructed Volume is calculated using Eq. (110.1):

$$VAC_i = Q_i \times CC_i \tag{110.1}$$

Where VAC_i is the Apparent Constructed Volume for the item "i" in m^3/m^2, Q_i is the quantity of the item "i" in its specific unit (m, m^2, m^3, kg or unity)/m^2, CC_i is the conversion ratio of the amount of the item "i" in VAC in m^3/Q_i specific unit.

Table 110.1 Category list for C&D waste

Survey					
Project:		Location:		Starting date:	
Surface constructed:		Duration:		Building code:	
Code	Concept	Quantity	Code	Concept	Quantity
010101001	m^3.Excavation		030202001	m^2. Radiators	
010101002	m^3.Refill		030202002	m. Pipes	
010101003	m^3.Earthmoving transport		030202003	m. Circuits	
010101	Earth works		030202004	m. Derivations	
			030202005	u. Light points	
010401001	Kg. Concrete reinforcement		030202006	u. Sockets	
010401002	m. Pile		030202007	m. Ground connection	
010401003	m^2.Commodity concrete		030202008	m. Hot water pipe	
010401004	m^3.Concrete		030202009	u. Drains	
010401005	m^3.Cast-in-situ concrete		030202010	u. Tap	
010401006	m^3.Concrete foundation		030202011	u. Bathroom appliances	
010401	Foundation		030202012	u. Thermos/heaters	
			030202	Installations	
030801001	u. Catch basins				
030801002	m. Collectors		010803001	m^2.Acoustic insulation	
030801003	m. Down pipe		010803002	m^2. Thermal insulation	
030801	Water disposal		010803	Insulations	
010402001	kg. Structural steel		020101001	m^2.Tiling	
010402002	m^2. Concrete slab		020101002	m^2. Plaster	
010402003	kg. Steel reinforcement		020101003	m^2. Whitewash	
010402004	m^3Reinforced concrete		020101004	m^2. Screed	
010402005	m^3.Concrete column/beam		020101005	m^2. Floors	
010402	Structures		020101006	m^2. Ceiling	
			020101007	m. Finishing	
010301001	m^2. Concrete blocks		020101	Tiles	
010301002	m^2.Wall chambers				
010301003	m^2. Wall partitions		010503001	m^2. Steel frames	
010301004	m^2. Exterior bricks		010503002	m^2. Aluminum	
010301005	m^2. Interior bricks		010503003	m^2. Wood	
010301	Enclosures		010503004	m^2.Closet	
			010503005	m^2. Wood doors	
010701001	m^2. Horizontal roofs		010503006	m. Bannister	
010701002	m^2. Inclined roofs		010503007	m^2. Shades	
010701	Roofs		010503008	m^2. Safety bars	
			010503	Carpentry	
			020401001	m^2. Glass	
			020401	Glass	
			020507001	m^2.Exterior paint	
			020507002	m^2.Interior paint	
			020507	Paint	

This VAC_i can generate estimates on wreckage and packaging waste, depending on the kind of construction under development (new construction). Their respective volumes are calculated in Eqs. (110.2) and (110.3) using different transformation coefficients from the VAC_i.

In new construction projects, as far as the Apparent Wreckage Waste Volume is concerned, it is calculated from the VAC_i in Eq. (110.2):

$$VAR_i = VAC_i \times CR_i = Q_i \times CC_i \times CR_i \tag{110.2}$$

where VAR_i is the Apparent Wreckage Waste Volume for the item "i" in m^3/m^2, CR_i is the coefficient for the transformation of VAC in VAR (dimensionless), namely the generation rate of Wreckage Waste.

Moreover, in new construction projects, the Apparent Packaging Waste Volume is estimated from the VAC_i in Eq. (110.3):

$$VAE_i = VAC_i \times CE_i = Q_i \times CC_i \times CE_i \tag{110.3}$$

Where VAE_i is the Apparent Packaging Waste Volume for the item"i"in m^3/m^2, CE_i is the coefficient transformation of VAC in VAE (dimensionless), namely the generation rate of Packaging Waste.

The final step to estimate the waste volume (m^3) of a new construction project is to add the result of multiplying the Apparent Wreckage Waste Volume (m^3/m^2) and the Apparent Packaging Waste Volume (m^3/m^2) by the building surface (m^2).

Chinese government does not have enacted official statistics data. These coefficients, CC_i and CE_i, are obtained from Jaime Solis-Guzman [4] and the investigation data on construction waste in Pearl River Delta Region. CR_i are estimated from the attrition rate of building materials in the book "Standard quantity of Shenzhen building works consumed (2003)". In the next section some coefficient determinations are described.

110.3 Case Study

The following examples apply the quantification model to a new construction (Table 110.2). The example refer to a dwelling project with the following main group characteristics (Fig. 110.1): apartment building of four floors, a structure formed by reinforced concrete columns, beams and a pile foundation of less than 8 m deep and horizontal ceiling. The total surface of the building is 1,650 m^2.

In Table 110.2, the three conversion parameters (CC_i, CR_i and CE_i), applied when considering the construction of this dwelling project, can be observed. For example, in sub-chapter 010101001, Earthmoving transport, the item quantity for this specific type of construction is 0.20 m^3/m^2 constructed. The soil from the excavation is already defined in volume units, as cubic meters of loose soil, subsequently the conversion ratio CC_i is 1. The next coefficient listed, CR_i, is

Table 110.2 Estimation of the waste volume expected in a new construction project

Type: new construction building				Usage: Dwellings Floor numbers: 4 Total surface: 1,650 m^2							
Structure: Reinforced concrete				Roof: Horizontal				Foundation type: Piles up to 8.00 m			
Code	Concept	Q_i	CC_i [a]	CR_i [b]	CE_i [c]	VAC_i	VAR_i	VAE_i	m^3 Waste per m^2	m^3 Waste/1,650 m^2	Percentage
010101003	m^3.Earthmoving transport	0.21	1.0000	1.0000	0.0000	0.2100	0.2100	0.0000	0.2100	346.50	0.62
010401001	kg.Concrete reinforcement	5.12	0.0001	0.0204	0.0000	0.0005	0.0000	0.0000	0.0000	0.02	0.00
010401002	m. Pile	0.26	0.3200	0.0800	0.0000	0.0832	0.0067	0.0000	0.0067	10.98	0.02
010401004	m^3.Concrete	0.08	1.0000	0.0300	0.0000	0.0800	0.0024	0.0000	0.0024	3.96	0.01
010401003	m^3.Commodity concrete	0.02	1.0000	0.0134	0.0000	0.0200	0.0003	0.0000	0.0003	0.44	0.00
010401006	m^3.Concrete foundation	0.04	1.0000	0.0300	0.0000	0.0400	0.0012	0.0000	0.0012	1.98	0.00
030801001	u. Catch basins	0.02	0.3800	0.0500	0.0500	0.0076	0.0004	0.0004	0.0008	1.25	0.00
030801002	m. Collectors	0.06	0.0830	0.0600	0.0100	0.0050	0.0003	0.0000	0.0003	0.58	0.00
030801003	m. Down pipe	0.11	0.0140	0.0100	0.0200	0.0015	0.0000	0.0000	0.0000	0.08	0.00
010402002	m^2. Concrete slab	1.24	0.2800	0.0400	0.0200	0.3472	0.0139	0.0069	0.0208	34.37	0.06
010402003	kg.Steel										
reinforcement	13.42	0.0001	0.0200	0.0000	0.0013	0.0000	0.0000	0.0000	0.04	0.00	
010402005	m^3.Concrete column/beam	0.24	1.0000	0.0300	0.0000	0.2400	0.0072	0.0000	0.0072	11.88	0.02
010301001	m^2.Concrete blocks	0.84	0.0500	0.0360	0.1000	0.0420	0.0015	0.0042	0.0057	9.42	0.02
010301003	m^2.Wall partitions	0.86	0.0500	0.0560	0.1000	0.0430	0.0024	0.0043	0.0067	11.07	0.02
010301004	m^2. Exterior bricks	0.99	0.1400	0.0300	0.1000	0.1386	0.0042	0.0139	0.0180	29.73	0.05
010301005	m^2. Interior bricks	0.45	0.1400	0.0300	0.1000	0.0630	0.0019	0.0063	0.0082	13.51	0.02
010701002	m^2. Inclined roofs	0.68	0.1800	0.0610	0.0300	0.1224	0.0075	0.0037	0.0111	18.38	0.03
030202003	m. Circuits	0.83	0.0002	0.0100	0.5000	0.0002	0.0000	0.0001	0.0001	0.14	0.00
030202004	m. Derivations	0.16	0.0003	0.0100	0.5000	0.0000	0.0000	0.0000	0.0000	0.04	0.00
030202005	u. Light points	0.12	0.0012	0.0100	1.0000	0.0001	0.0000	0.0001	0.0001	0.24	0.00
030202006	u. Sockets	0.23	0.0012	0.0100	1.0000	0.0003	0.0000	0.0003	0.0003	0.46	0.00
030202007	m.Ground connection	0.13	0.0006	0.0100	0.5000	0.0001	0.0000	0.0000	0.0000	0.07	0.00

030202008	m. Hot water pipe	0.32	0.0006	0.0100	0.0000	0.0002	0.0000	0.0000	0.0000	0.00	0.00
030202009	u. Drains	0.06	0.0140	0.0100	0.2000	0.0008	0.0000	0.0002	0.0002	0.29	0.00
0302020010	u. Tap	0.08	0.0038	0.0000	1.0000	0.0003	0.0000	0.0003	0.0003	0.50	0.00
030202011	u.Bathroom appliances	0.07	0.1830	0.0200	0.2500	0.0128	0.0003	0.0032	0.0035	5.71	0.01
030202012	u. Thermos/heaters	0.01	0.2600	0.0000	0.0500	0.0026	0.0000	0.0001	0.0001	0.21	0.00
010803002	m^2.Thermal insulation	0.78	0.0360	0.0100	0.0000	0.0281	0.0003	0.0000	0.0003	0.46	0.00
020101001	m^2.Tiling	0.52	0.0320	0.0398	0.5000	0.0166	0.0007	0.0083	0.0090	14.82	0.03
020101002	m^2.Plaster	1.84	0.0290	0.0300	0.0000	0.0534	0.0016	0.0000	0.0016	2.64	0.00
020101003	m^2.Whitewash	4.12	0.0250	0.0300	0.0000	0.1030	0.0031	0.0000	0.0031	5.10	0.01
020101004	m^2. Screed	0.86	0.0830	0.0500	0.0500	0.0714	0.0036	0.0036	0.0071	11.78	0.02
020101005	m^2.Floors	0.12	0.2100	0.0300	0.1000	0.0252	0.0008	0.0025	0.0033	5.41	0.01
020101006	m^2.Ceiling	0.14	0.0510	0.0500	0.2000	0.0071	0.0004	0.0014	0.0018	2.95	0.01
020101007	m. Finishing	0.15	0.0190	0.0500	0.1000	0.0029	0.0001	0.0003	0.0004	0.71	0.00
010503001	m^2. Steel frames	0.12	0.0530	0.0000	0.0500	0.0064	0.0000	0.0003	0.0003	0.52	0.00
010503005	m^2. Wood doors	0.18	0.0530	0.0600	0.1000	0.0095	0.0006	0.0010	0.0015	2.52	0.00
010503007	m^2.Shades	0.10	0.0620	0.0200	0.0500	0.0062	0.0001	0.0003	0.0004	0.72	0.00
020401001	m^2.Glass	0.16	0.0120	0.0500	0.5000	0.0019	0.0001	0.0010	0.0011	1.74	0.00
020507001	m^2.Exterior paints	0.26	0.0053	0.0500	1.5000	0.0014	0.0001	0.0021	0.0021	3.52	0.01
020507002	m^2.Interior paints	0.57	0.0052	0.0500	1.5000	0.0030	0.0001	0.0044	0.0046	7.58	0.01
	Total					1.7988	0.2715	0.0693	0.3076	562.33	1.00

[a] Data obtained from Jaime Solis-Guzman [4] and the investigation data on construction waste from Pearl River Delta Region of China
[b] Data obtained from the book "Standard quantity of Shenzhen building works consumed (2003)"
[c] Data obtained from Jaime Solis-Guzman [4] and the investigation data on construction waste in Pearl River Delta Region of China

Fig. 110.1 Dwelling construction where the quantification model is applied in the case study

1 since all the earth excavated is sent to the landfill. Finally, CE_i is 0 because the soil needs no packaging.

A second example in Table 110.2, sub-chapter 010503005, wood doors, the item quantity in the project analyzed is 0.18 m^2/m^2 constructed. In this sub-chapter, the item measurement unit is m^2,and to translate it into a constructed volume, CC_i is 0.05 m^3/m^2,which is due to the fact that a typical door width is 5 cm. A similar analysis is performed for every sub-chapter. The following coefficient, CR_i, is 0.02. This value is obtained from the attrition rate of building materials in the book "Standard quantity of Shenzhen building works consumed (2003)". Finally, CE_i is 0.10 since the door packaging is approximately10 % of the door volume.

By multiplying the Apparent Wreckage Waste Volume and the Apparent Packaging Waste Volume of each item by the building surface (1,650 m^2), the expected waste volume can be estimated in the new construction analysis. To sum up, Table 110.2 predicts 562.33 m^3 total wastes, 346.50 m^3 is excavated soil and 215.83 m^3 is mixed waste (including packaging). Calculations showed a waste generation of 0.34 m^3/m^2 (Soil is considered) for the new construction projects and generate the biggest volume are soil, concrete and bricks. The soil is part of group 10101003, earthmoving transport, the concrete is part of several groups in chapters 010401 (10401004,10401003,10401006) and 010402 (10402002,10402005) and the bricks belong to chapter 010301 (10301001,10301004,10301005). These three items represent about 80 % of the total waste volume.

The soil can easily be reused for refill on the same construction site or for other work. The concrete and bricks can also be used as refill for pipelines, roads or walking tracks at the same site, or treated to be reused on a different site.

110.4 Conclusions

The rapid development of China's urban economy brings a lot of new projects. However, most construction waste from these new projects is illegally dumped without treatment or control, which leads to environmental pollution and destruction. In order to avoid more damage to the environment and encourage the development of sustainable construction industry, the government of China should set up a comprehensive legislation system to specificate the production and management of construction waste from the design phase to the construction and completion phase. All participants of construction projects are obligated to go through "Reduce, Reuse, and Recycle" procedures, participate in building waste planning, implementation and control. In order to realize the construction waste control goal, it is necessary to measure construction waste [5].

This paper established a quantification model of construction waste which is easy to understand and convenient to use. For the last 2 years the model has been tested at the dwelling projects in Pearl River Delta of China and has proved to be 85 % accurate in its predictions. The calculation method of this model is simple and the sorting code number is similar to the codes of construction quantity bill. Developers can budget the treatment costs of construction waste by estimating the volume of possible construction waste. When waste operation is being market, the government could try to give developers appropriate compensation by prompting them to dispose the construction waste coming from the construction site. In addition, accurate forecast of the construction waste volume can not only help to control the waste better during building, but also help to raise the construction management level in the building area. Therefore, the forecast of the construction waste volume is significant [6]. What should be emphasized is that this paper used the investigation data on construction waste from the Pearl River Delta Region and foreign researchers' experience data due to a lack of government promulgated statistical data. At present this quantification model mainly aims at the lower masonry – concrete structure, and it still need to add other construction waste quantification models of high-rise steel reinforced concrete structure. Therefore, the model needs further modification and confirmation in order to be appropriate for other areas, not only the residential projects but also some construction projects of wider range, such as office, industrial building and hospital etc.

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Chapter 111
What Affects Implementation of Green Buildings? An Empirical Study in Hong Kong

Vivian W.Y. Tam

Abstract This paper examines the factors affecting the implementation of green buildings for the local construction industry. Questionnaire surveys and structural interviews were conducted to investigate the economical and social factors in the implementation of green buildings. From the survey results, the industry strongly believes that green building implementation is environment-friendly and can improve social values to the consumers. However, material costs, construction and transportation for green materials and green building features are more expensive than those for the conventional buildings. Four major factors affecting the existing limited implementation of green buildings were also discussed. Recommendations to improve the implementation of green buildings were also explored. This study can bring insights locally and around the world on how green buildings can be implemented to achieve environment-friendly, long-term cost saving and being recognized by the society and the consumers to reduce difficulties and burden encountered in the implementation.

Keywords Green building • Implementation • Hong Kong

111.1 Introduction

The implementation of sustainable development has been set up by the Hong Kong government since 2003 [1]. The Chief Executive of the Hong Kong Special Administrative Region, Ir. Donald Tsang, stated that to confront increasing demand of 'greener' environment, it is logical for 'green building' to be developed as a competitive constructional market in Asia. A green building is a structure that is designed,

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_111,

built, renovated, operated, or reused in an ecological and resource-efficient manner to incorporate energy efficiency, water conservation, waste minimization, pollution prevention, resource-efficient materials, and indoor environmental quality in all phases of its life [2–9]. The appearance of a green building will be similar to any other buildings [10,11]. However, the difference is in the approach, which revolves round a concern for extending life spans of natural resources, and providing human comfort, safety and productivity ([12,13]; Indian [8,14]).

Some of the salient features of a green building are [12,15–18]: (i) minimal disturbance to landscapes and site condition; (ii) use of recycled and environment-friendly building materials; (iii) use of energy efficient and eco-friendly equipment; (iv) quality of indoor air quality for human safety and comfort; and (v) effective control and building management systems.

There are a few construction-related environmental assessment tools in the market, such as the Building Research Establishment Environmental Assessment Method (BREEAM) [19], the Hong Kong Building Environmental Assessment Method (HKBEAM) [20–22] and the Leadership in Energy and Environmental Design (LEED) [23]. The BREEAM is a tool for surveyors and engineers to evaluate building life-cycle costs. Through the 'Eco-labelling' system, buildings are rated as excellent, very good, good and pass. The system mainly focuses on ecological and global effects of construction activities, such as carbon dioxide quantity emitted with less emphasis on issues like management and construction methods. The HKBEAM is a classification system in which buildings are divided into four categories according to their environment-friendliness: excellent, very good, good and fair whereas the LEED is a software tool used to measure environmental performance of a building site at an operational level; that is, technical information on site concerning daily environmental performance. A criticism of LEED is that it mainly concerns with technical aspect of environmental performance with much less emphasis on the management side.

Although there are many construction-related environmental assessment tools available in the market, there are limited studies in providing guidance on how to implement green building effectively. There are many researches working on how green building can help reduce energy consumption. Green buildings consume only 27 % of energy compared with the conventional buildings as suggested by a China building Code [15]. Using solar systems for green buildings, more than 70 % of the total energy can be saved [24]. Approximately, it was also found that the performance of hybrid air-conditioning systems is 44.5 % higher than conventional vapour compression systems at a latent load of 30 %, and this can be achieved by 73.8 % at 42 % latent load [25]. However, there is no evidence to believe that green buildings are more comfortable, including aesthetics, serenity, lighting, ventilation, acoustics and humidity [13]. Indeed, the only difference between the green buildings and conventional buildings was that occupants of the green building were more likely to perceive their work environment as warm, and occupants who felt warm were more likely to describe their environment as poor [13].

The previous researchers had investigated reduction of energy consumption for green buildings, development of water conservation systems and sustainable tools for quantifying success on sustainability and green buildings. There is a lack of research, however, on possible environmental, economic and social factors negatively contributing to the implementation of green buildings in the local construction industry. This paper thus aims: (i) to examine the factors affecting the implementation of green buildings in the local construction industry; and (ii) to recommend measures to improve green building implementation.

111.2 Research Methodology

To achieve the objectives of this paper in examining the factors in terms of economic and social factors in implementing green buildings in the local construction industry, a questionnaire survey was conducted. Factors affected on economic and social issues were highlighted from the previous studies [26–30] and selected for the use in this paper in the questionnaire survey. The questionnaire (Pilot Questionnaire) was first sent to ten practitioners. Face-to-face interviews were followed to receive comments and feedback to further improve the readability and suitability of the questionnaire. There are only minor amendments made in the wordings and better understanding of the questionnaire survey from the Pilot Questionnaire. The final questionnaire was sent to 300 parties including contractors, consultants, developers, governmental departments, and environmental professional associations who have experience in the implementation of green buildings. A total of 145 responses have been received with the response rate of about 48.3 %. However, three of the questionnaires were not properly completed and only 142 questionnaires are valid.

Data collected from the experimental work was analysed using the Statistical Package for Social Sciences (SPSS) Version 18.0 for Windows. Before the data was analysed and used for discussion, it is important to validate their reliability. Reliability analysis studies properties of measurement scales and individual items of the data. The reliability analysis procedure calculates a number of commonly-used measures of scale reliability and also provides information about the relationship among individual items in the scale. The data will not be useful if its reliability is low, which indicates that the data may wrongly be collected. One of the most popular reliability statistics is Cronbach's alpha [31] which determines the internal consistency or average correlation of items in a survey instrument for gauging its reliability [32]. The alpha parameter ranges from 0 to 1, in which 0 means completely unreliable and 1 means perfectly reliable [33]. A score of more than 0.5 is an acceptable reliable value. Cronbach's alpha can be computed using Eq. 111.1 [34]:

$$\alpha = \frac{k\overline{\mathrm{cov}}/\overline{\mathrm{var}}}{1 + (k-1) \times \overline{\mathrm{cov}}/\overline{\mathrm{var}}} \quad \text{or} \quad \frac{k\bar{r}}{1 + (k-1)\bar{r}} \text{ (if the items are standardized to have the same variance)} \tag{111.1}$$

where k is the number of items in the scale, $\overline{\mathrm{cov}}$ is the average covariance between items; $\overline{\mathrm{var}}$ is the average variance of the items; and $\bar{r}$ is the average correlation between items.

To determine the relative ranking of factors, scores were transformed to agreeance indices using Eq. 111.2:

$$RAI = \frac{\sum w}{AN} \tag{111.2}$$

where w is the weighting given to each factor by the respondent, ranging from 1 to 5 in which '1' is strongly disagree and '5' strongly agree; A is the highest significant of agreeance, in this study $A = 5$; N is the total number of samples; and RAI is the relative agreeance index, $0 \leq RAI \leq 1$.

After receiving the questionnaire responses, nine respondents from different business sectors agreed to participate in further individual interviews for reflective argumentation of the questionnaire results with two governmental officials, two building developers, one environmental consultant, three building contractors and one member of an environmental professional association. The interviews were intended to gather further comments; elaboration and interpretation on the results obtained from the questionnaire.

111.3 Results and Analysis

The reliability of the survey results is very high with the reliability in economic factor, social factor and overall of 0.934, 0.865 and 0.907 respectively. This forms a strong evidence to show that the data is highly reliable, which validates the below discussions.

111.3.1 Economic Factor

Table 111.1 summarises the survey results on economic factor. "Using energy efficient systems can perform an increase in initial building cost" obtained the RAI value of about 0.74 from the survey results. An interviewed environmental consultant noted that energy efficient systems have a higher initial investment cost

Table 111.1 Summary of survey results on economic factors

	Agreeance (in %)					
	1 Strongly disagree	2	3	4	5 Strongly agree	RAI
Using energy efficient systems can perform an increase in initial building cost	0	0	47	38	15	0.74
Green materials are difficult to buy it locally and additional cost may be required for transportation	0	8	31	46	15	0.74
Materials used for constructing green building features cost more than that for constructing the conventional buildings	0	8	38	46	8	0.71
Installing green features will increase total construction cost	0	23	23	39	15	0.69
Green design will increase design fee	0	8	54	23	15	0.69
Designing green buildings are more time consuming than designing the conventional buildings	0	31	38	23	8	0.62

than the conventional system, thus construction cost will also be increased. However, the interviewee also stated that long-term cost for energy efficient systems is lower than that for the conventional systems, which include less maintenance cost and longer service life.

"Green materials are difficult to buy it locally and additional cost may be required for transportation" and "Materials used for constructing green building features cost more than those for constructing the conventional buildings" measured the RAI values of about 0.74 and 0.71 respectively from the survey results. An interviewed building contractor explained that green materials normally required more preparation processes and procedures for the production activities than the conventional materials. Treatments may also be required for the production processes. Another interviewed contractor noted that some green materials are not locally available which will significantly increase the material cost. Therefore, it is quite understandable that green materials cost more than the conventional materials, which builds up one of the major barriers for the industry in the implementation of green buildings.

"Installing green features will increase total construction cost" measured the RAI value of about 0.69 from the survey results. An interviewed building contractor noted that adopting green building features for residential buildings costs more than adopting commercial buildings. One of the main reasons for this is that suppliers of green materials and energy-efficient systems for commercial buildings are readily available which increases cost due to the limited supply for residential buildings.

"Green design will increase design fee" and "Designing green buildings are more time consuming than designing the conventional buildings" obtained the RAI values of about 0.69 and 0.62 respectively from the survey results. These two statements surveyed designing issues in regarding to green building features. From the interview discussions, an interviewed designer noted that green building

Table 111.2 Summary of survey results on social factors

	Agreeance (in %)					
	1				5	
	Strongly disagree	2	3	4	Strongly agree	RAI
Green building are more environment-friendly than the conventional buildings	0	0	0	28	72	0.94
Awareness for green building by the society is better than before	0	0	0	62	38	0.88
Buildings with green building features are more attractive to the consumers than the conventional buildings	0	0	54	31	15	0.72

designs cost a bit higher than the conventional designs as the designers need research on the building environment, including directions, weather patterns and temperatures. By understanding the building environment, natural lighting and natural ventilation can be effectively facilitated for green buildings. Therefore, designing green buildings may have higher design fee and take longer time than designing the conventional buildings.

111.3.2 Social Factor

From the survey results in Table 111.2, "Green buildings are more environment-friendly than the conventional buildings" obtained the RAI value of about 0.94. From the interview discussions, the interviewees all agreed that green buildings are undoubtedly environment-friendly. They noted that constructing green buildings is the trend around the world, which can extend life cycle, reduce waste generation and achieve sustainable performance. An interviewed contractor highlighted that the existing practice is an initial implementation or a trial period for green buildings. The government needs to input sufficient resources, standards and specifications to help implement green buildings in the local construction industry. An interviewed developer also stated that the government should first implement green building practices for all governmental projects.

'Awareness for green building by the society is better than before' obtained the RAI value of about 0.88 from the survey results, which includes about 38 % and 62 % of the respondents strongly agree and agree with the statement respectively. It is noted that respondents are more aware of green buildings in the society than ever before. An interviewed environmental consultant highlighted that green building development in the market is growing quite rapidly in recent years. Another interviewed contractor explained that this may due to the increasing number of residential projects incorporating green building features in their design and construction activities.

"Building with green building features are more attractive to the consumers than the conventional buildings" obtained the RAI value of about 0.72 from the survey results. The respondents agreed that buildings with green building features are more attractive than the conventional buildings. One of the interviewed developers highlighted that the attraction from green building features is evident and they believed that it could help improve building values. The interviewed consultants also agreed that local developers are eager to adopt innovative designs and green elements in the housing development.

111.4 Discussion

Based on the above discussions, the following measures are recommended to improve the implementation of green buildings in the local construction industry. The experience from this study can also be effectively implemented in other countries.

- The government needs to initiate the implementation of green buildings for all projects and to clearly highlight benefits and difficulties which may be encountered to the industry. This can significantly build up the industry confidence in green building implementation at the initial stage.
- A clear guideline or standard on the implementation of green buildings with detailed procedures is necessary to reduce possible uncertainties for designers, architects and clients in the implementation.
- Suppliers should provide a list of available resources, including recycled materials and green building features to the industry. Storage locations for the relevant materials and features are also required to build awareness in the industry of material availability, transportation cost and required time before designing green buildings. A central database system is recommended to collect all available resources.
- The government can mandatorily require the implementation of green buildings for all commercial buildings at the initial stage to initiate the importance of green buildings, as the materials and resources for commercial buildings are more well-developed than other building types. Other building types can gradually be implemented after the success of the commercial buildings. Incentives should also be provided for the initial implementation of green buildings.

111.5 Conclusion

This paper examined economical and social factors affecting green building implementation for the local construction industry. Questionnaire survey and structured interviews were conducted. From the survey results, the industry believed that implementing green buildings can help improve the economic and social issues in the local construction industry. However, the industry highlighted that design, material, construction and transportation cost for green buildings are higher than those for the conventional buildings which creates the major burden for the implementation. Incomplete integration within and among projects, lack of experience, knowledge and standards on the implementation of green buildings, lack of life cycle costing knowledge, insufficient time and funding were the four major factors affecting the existing limited implementation of green buildings. Recommendations to improve the existing implementation of green building were also suggested.

Acknowledgements The author would like to thank Mr. Ming-Fai Li for conducting the survey.

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Chapter 112
Modeling Effective Construction Waste Management Through Causal Loop Diagrams

Hongping Yuan, Jianli Hao, and Shaokai Lu

Abstract Previous studies failed to investigate construction waste management system from a holistic perspective. To fill the research gap, this study examines the relationship of three measures of performance (economic, environmental, and social) that underlie the key variables of construction waste management practice through causal loop diagrams. The key variables involved in the causal loop diagrams are identified by a thorough review of existing literature. The interrelationships underlying all the variables are analyzed in detail to formulate a series of causal loop diagrams. The causal loop diagrams are efficient in depicting the interactions between these variables. This study contributes to the body of knowledge by formulating major variables affecting the effectiveness of construction waste management in a construction site from a holistic point of view. The underlying interrelationships among these variables can be well unveiled through a detailed analysis of the causal loop diagrams. The causal model comprising the causal loop diagrams provides a vehicle based on which quantitative model to assess effects of management measures on effective construction waste management can be developed.

Keywords Effectiveness • Construction waste management • Causal loop

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_112,

112.1 Introduction

In line with the increasing acceptance of sustainable development as an important mission [1], the construction industry has recognized the need to alleviate its adverse impact on the environment and the consequent importance of waste management. Thus management for waste in the construction sector (generally termed 'construction waste') has attracted widespread attention and become a recognized discipline in its own right. Many methods for managing construction waste have been developed, such as establishing a waste management plan, adopting prefabrication, conducting on-site waste sorting, and using precise construction methods. However, there is a lack of a tool to help the industry understand and evaluate to what extent the application of such methods are effective. Without such a tool, it is difficult to assess the effectiveness of construction waste management practices and subsequently improve them.

Previous studies associated with construction waste management (CWM) have concentrated their efforts on examining CWM systems from a static point of view, without considering the relationship of interrelated variables involved in the systems. Therefore, to better understand, assess and improve the effectiveness of CWM, a systematic approach that is capable of dealing with the complexities of CWM systems is required. In this study, the relationships among various CWM activities were considered from a systematic perspective. The major influence of variable interactions on the whole system could be described with causal loop diagrams because it portrays only the key behaviors of the system. Through identifying essential variables affecting the effectiveness of CWM, a conceptual model was developed to describe their causes-and-effect relationships in a CWM system. The model offers a way to integrate a series of causality activities within a CWM system by considering the interactions of each activity rather than a simple stimulus–response action.

112.2 Effectiveness of Construction Waste Management

A diversity of industries including the construction sector have been taking actions to promote both research and practice in each of the sectors for embracing sustainable development principles. However, the literature to date determines that when performing CWM, economic performance is still the foremost objective while environmental and social performance are of lower priority [2]. This contrasts sharply with the principle of sustainable construction, which is defined as "a holistic process aiming to restore and maintain harmony between the natural and the built environment, and create settlements that affirm human dignity and encourage economic equity." [3]. Since effective CWM is one integral process for the attainment of sustainable construction, it should not only emphasize the economic performance, but also highlight associated social and environmental performance.

Therefore, *effectiveness of CWM* for this study was defined as: "the degree to which objectives are achieved when implementing CWM; where the objectives mainly concern how to simultaneously promote the economic, environmental and social performance of CWM activities in the project." Thus, major variables that influence the effectiveness of CWM can be identified from three aspects accordingly, i.e. economic, environmental, and social performance.

112.3 Causal Loop Diagrams

The causal loop diagram is a conceptual tool which reveals a dynamic process in which the chain effects of a cause are traced, through a set of related variables, back to the original cause (effect). It aids in visualizing how interrelated variables affect one another. Normally, such a diagram consists of a set of nodes representing the variables connected together. The relationships between these variables, represented by arrows, can be labeled as either *positive* or *negative*.

112.3.1 Causal Loop Diagram of Economic Performance

It has been found in literature that there are nine variables affecting economic performance of CWM, including cost of waste collection, sorting and separation, cost of waste reuse, cost of recycling, cost of waste transportation from construction site to landfills, cost of disposing of waste at landfills, penalty paid due to illegal dumping of waste, revenue from selling waste materials, saving in waste transportation cost from construction site to landfills, and saving in cost for disposing of waste at landfills. By connecting these variables based on their interrelationships, the causal loop diagram of economic performance subsystem which contains 16 feedback loops in total is established (Fig. 112.1). Among the feedback loops, three are positive (i.e. R1, R2 and R3) and the other thirteen are negative (i.e. B1 to B13). All interrelationships among these feedback loops are expounded as follows.

In the feedback loop R1 of the subsystem of economic performance, suppose that there is an increase in the amount of illegally dumped waste, this indicates a decrease in the volume of collected waste on the construction site, which results in less waste to be sorted for further processing. Subsequently, the smaller amount of sorted waste reflects fewer efforts of the local government for waste reduction. Since regulation is one of the effort clusters for promoting waste reduction, fewer efforts of the local government to reduce construction waste will cause less actions of the government to strengthen waste reduction regulations. Consequently, loose waste reduction regulations allow more waste dumped in inappropriate places, instead of being disposed of at landfills. Therefore, this feedback loop is a reinforced loop. Positive feedback R2 only contains two variables. In the feedback loop, a larger amount of construction waste which is dumped illegally causes

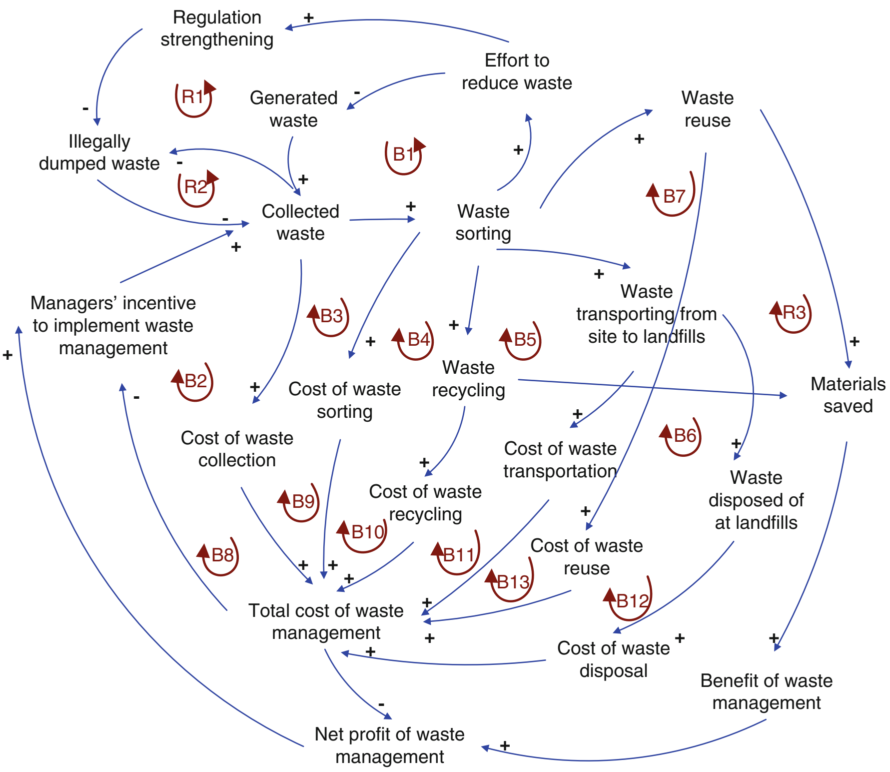

Fig. 112.1 Causal loop diagram of economic performance

a smaller volume of waste to be collected on the construction site, and then the smaller volume of collected waste indicates more waste will be disposed of improperly, rather than in regulated landfills. This is also a reinforced feedback loop. In feedback loop R3, the variable *managers' incentive to implement waste management* will reinforce itself through the feedback. Firstly, an increase in managers' incentive to conduct waste management will result in more waste to be collected, which correspondingly leads to more waste to be sorted. When more waste is sorted, more waste can be reused. Subsequently, a larger amount of construction materials can be saved through waste reuse, which brings more benefits by managing construction waste. An increased benefit of waste management indicates more net benefits will be gained from implementing waste management, which finally intensifies managers' incentive to carry out waste management.

In the feedback loop B1, the variable *effort to reduce construction waste* affects itself through a balanced feedback loop. More efforts devoted to construction waste reduction result in a smaller amount of waste generation in the construction project. Less waste generation means that less waste can be collected. Similarly, the smaller volume of collected waste will lead to less waste to be sorted. Consequently, less effort will be needed to minimize construction waste. In feedback loop B2, an increase in managers' incentive to implement waste management will cause more waste to be collected, and thereby increasing the cost required for waste collection. The increased cost of waste collection will then increase the total cost of waste management. Finally, the increased total cost of waste management will undermine managers' incentive to conduct waste management in the project. Hence, B2 is a negative feedback loop. The interrelationships of feedback loop B3 are similar to those in feedback loop B2. The only difference is that causal loop B2 is related to waste collection, while B3 is associated with waste sorting. The interrelationships of feedback loop B4 is similar to those in B2 and B3. It is a negative feedback loop and mainly concerns the cost of waste recycling and its impacts on managers' incentive to implement CWM. Feedback loop B5 involves six variables that will have a negative influence on managers' incentive to implement waste management. Suppose that there is an increase in managers' incentive, the collected waste and waste to be sorted will both as a result increase. Then it is anticipated that the amount of waste transported from the construction site to landfills will increase and thereby increasing the total cost of waste management. At the end, the increased cost of waste management will weaken managers' incentive to implement waste management. By adding two variables – *waste disposed of at landfills* and *cost of waste disposal* – to negative feedback loop B5, a new feedback loop B6 can be formulated. In B6, an increase in managers' incentive to implement waste management will lead to an increased amount of waste disposed of at landfills. More waste entering landfills will result in a higher cost for waste disposal and undoubtedly raise the total cost of waste management. Consequently, managers' incentive to conduce waste management will be attenuated. In feedback loop B7, any variable (such as *managers' incentive to implement waste management*) will affect itself in a negative way through a series of feedback loops. For example, an improvement in managers' incentive to implement waste management will raise the amount of waste to be collected and subsequently leads to more waste to be sorted and reused. Then the total cost of waste management will be augmented due to the increased cost of waste reuse. Finally managers' incentive will be undermined due to decreased net profit of implementing waste management. The feedback loop B8 is to some extent similar to the feedback loop B2 of this subsystem. In feedback loop B2, the total cost of waste management influences managers' incentive to implement waste management directly. In feedback loop B8, however, the total cost of waste management firstly influences the net profit of waste management negatively, and finally managers' incentive to implement waste management will be positively affected by the net profit of waste management. Similarly, by adding the variable *net profit of CWM* to the feedback loops B3, B4, B5, B6 and B7, feedback loops B9, B10, B11, B12 and B13 can be formulated respectively.

112.3.2 Causal Loop Diagram of Environmental Performance

It is found in literature that there are five variables influencing environmental performance of CWM, including land consumption due to waste landfilling,

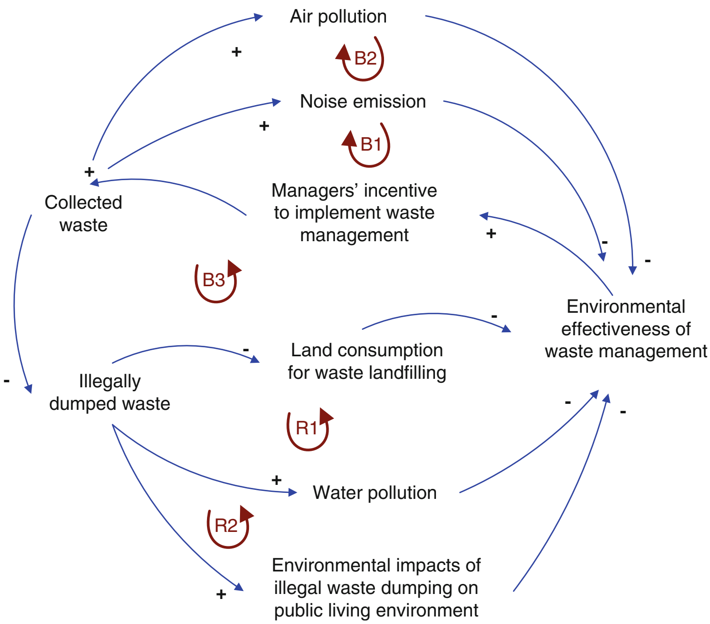

Fig. 112.2 Causal loop diagram of environmental performance

water pollution, noise emission, air pollution, and environmental impacts of illegal waste dumping on public living environment. By constructing these variables in line with their interrelationships, the causal loop diagram of the subsystem of environmental performance which involves five feedback loops in total is formed (Fig. 112.1). Among the feedback loops, two are positive (R1 and R2) and the other three are negative (B1, B2 and B3).

It is noted from feedback loop R1(see Fig. 112.2) that a change in any variable within the causal loop will eventually affect itself positively. For example, an improvement in managers' incentive to implement waste management will raise the amount of collected waste, which then decreases the amount of illegally dumped waste. Afterwards, the less illegally dumped waste will cause less pollution to water, and then less water pollution indicates a more effective environmental performance of waste management. At the end, the higher environmental effectiveness of waste management will stimulate managers' incentive to conduct CWM. By replacing the variable *water pollution* with the variable of *environmental impacts of illegal waste dumping on the public living environment* in feedback loop R1, a new feedback loop R2 can be developed. The causal relationships among R2 are similar to those in loop R1.

Feedback loop B1 contains four variables. A change on any variable will affect itself in a negative way. For instance, a larger amount of collected waste will cause more noise emission during the waste collection process. More noise emission indicates a lower environmental effectiveness of waste management, which to some extent reduces managers' incentive to implement waste management.

Eventually, the lower incentive to conduct waste management will lead to a smaller volume of construction waste to be collected in the project. Feedback loop B2 has similar causal relationships as the feedback loop B1, while the only difference is to replace the variable of *noise emission* with the variable of *air pollution*. It depicts how impacts of air pollution influence the environmental effectiveness of CWM. The feedback loop B3 is also negative. In this causal loop, an increase in managers' incentive to implement waste management will contribute to waste collection and results in more collected waste. As a consequence, a smaller amount of waste will be illegally dumped, which implies more land resources will be occupied for construction waste landfilling. Afterwards, more land consumption for waste landfilling leads to a lower environmental effectiveness of waste management. Finally, the lower environmental effectiveness will undermine managers' incentive to conduct waste management.

112.3.3 Causal Loop Diagram of Social Performance

It has been identified in literature that there are eight variables affecting social performance of CWM, including practitioners' awareness to manage waste, provision of job opportunities, physical working condition, impacts on long-term health, safety of workers in conducting CWM, public satisfaction about CWM, impacts of illegal waste dumping on the social image, and public appeal for regulating illegal waste dumping. By building these variables based on their interrelationships, the causal loop diagram of the subsystem of social performance which contains six feedback loops in total is established (Fig. 112.3). Among the feedback loops, one is negative (i.e. B1) and the other five are positive (i.e. R1, R2, R3, R4 and R5). The behavior of the whole system is determined through the dynamic interactions of these feedback loops.

By referring to feedback loop B1, it can be seen that a larger amount of waste dumped illegally will raise the public appeal for regulating illegal waste dumping behavior, which enhances the conduct of waste management. The amount of waste dumped illegally will finally be minimized to some extent due to the enhancement of waste management.

In the positive feedback loop R1, a change on any variable will affect itself in a reinforced way. For example, an increase in practitioners' initiative to manage waste will contribute to the social effectiveness of waste management. The higher social effectiveness of waste management will then increase public satisfaction about waste management, which at last stimulates practitioners' initiative to manage waste. This means that an increase in practitioners' initiative to manage waste will lead to an improvement in public satisfaction about waste management. Feedback loop R2 describes the interrelationships between *new job opportunities* and *conduct of waste management*. On one hand, the implementation of CWM provides more new job opportunities for the entire society; on the other hand, the employment of more people for the work can in turn better facilitate the conduct of

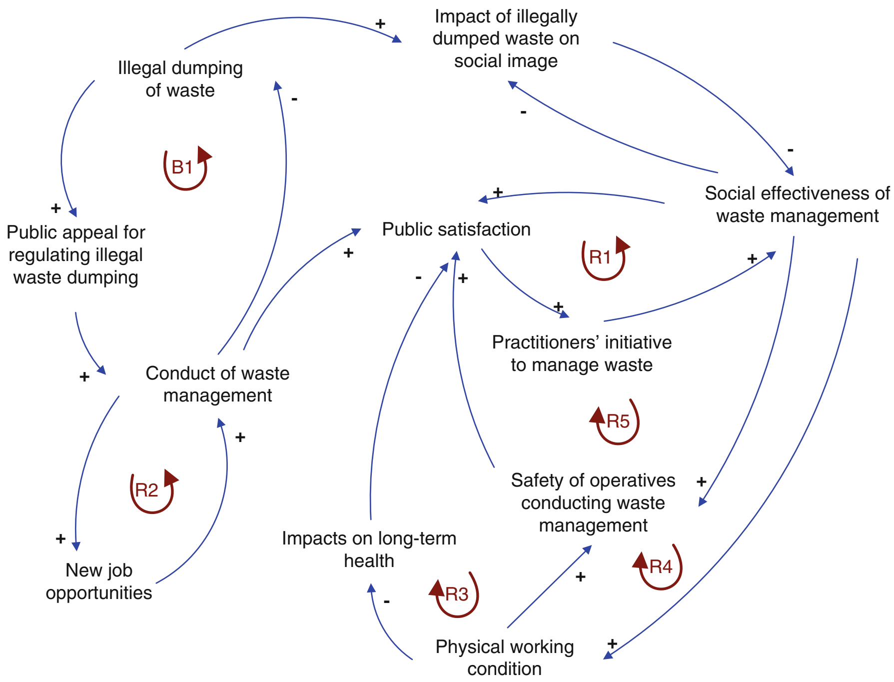

Fig. 112.3 Causal loop diagram of social performance

CWM. In the positive feedback loop R3, it can be observed that the physical working condition will influence impacts of waste management activities on the long-term health of practitioners involved. Better physical working condition will make the workers suffer fewer impacts on their long-term health. If practitioners have to work under a worse condition that brings adverse impacts to their long-term health, the public satisfaction about waste management will be relatively lower. Then the public satisfaction will affect practitioners' initiative to manage waste positively; that is, if the public satisfaction is higher, practitioners will be more active in engaging in waste management activities. The increase in practitioners' initiative to manage waste can help improve the social effectiveness of waste management. Consequently, the higher social effectiveness of waste management contributes to a better working condition for performing waste management. Some of the causal loop relationships in feedback loop R4 are the same as R3, the difference is that physical working condition will affect the safety of operatives in waste management, and then the safety of operatives will contribute to the public satisfaction about waste management. A change on any variable within this causal loop will influence itself positively. In the causal loop R5, the behavior of the feedback loop will be reinforced by a change on any variable. For example, an improvement in the safety of operatives will promote the public satisfaction with CWM, which then contributes to practitioners' initiative to manage waste.

Afterwards, a higher social effectiveness of waste management can be achieved through the enhancement of practitioners' initiative. Finally, the higher social effectiveness contributes to a safer environment for operatives to implement waste management.

112.4 Conclusions

To analyze the economic, environmental and social performance of CWM collectively, this paper presented a step-by-step account of the development of a causal model, which is capable of being used to qualitatively analyze the effectiveness of a CWM system. According to outcomes of a literature review, 22 major variable (i.e. nine related to economic performance, five in relation to environmental performance and eight with regard to social performance) influencing CWM are identified. In line with the underlying interrelationships among the variables identified, the economic, environmental and social performance of CWM system is described and explained respectively by using a series of causal loop diagrams. Further research can be directed to quantitative investigations into the effectiveness of CWM systems by converting the causal model developed in this study into quantitative simulation models that can run in real-time.

Acknowledgments This study was supported by the Fundamental Research Funds for the Central Universities (Project no.: SWJTU12CX115) and the NSFC (Project no.: 70902037, 71090402).

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Chapter 113
Exploring a Long-Term Mechanism of Construction and Demolition Waste Recycling: A Case of Chongqing

Qiong He, Shiying Shi, and Mingming Hu

Abstract Based on the analysis of costs and benefits on the construction waste landfill and recycling in Chongqing, the paper focus on discussing three possible environmental and economic policies for establishing long-term mechanism of the construction and demolition waste recycling: disposal charges, recycling subsidy and government purchasing recycling product. The results show that the direct costs of waste recycling will be higher than the landfill, and increasing waste disposal fees may be incentive to reduce waste generation, but it must rely on strict law enforcement, because it increase the risk of illegal landfill; financial subsidy to recycling center is not a long-term policy, because it cannot stimulate technological innovation and cost savings; reasonable government purchasing has a immense potential for improving the application of recycling products by guiding the construction market. The government purchasing should be the most concerned measure for establishing a long-term mechanism of construction and demolition waste recycling.

Keywords Construction and demolition waste • Cost-benefit analysis • Chongqing • Environmental economic policies • Recycling

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_113,

113.1 Introduction

In recent years, China has enjoyed exceptionally rapid economic growth, achieving a GDP growth of up to 8 % annually. However, in parallel with this rapid economic development has had a serious environmental impact on China's environment, partly because the tremendous amount of waste generated by environmentally unfriendly construction activities, such as earth excavation, civil works, site clearance and formation, demolition activities and building renovation [1]. Wang et al. [2] found that the amount of solid waste produced by construction and demolition works is more than three million tons in China, and more recently Wang et al. [3] found that most of construction and demolition waste (C&DW) were disposed in landfill, having consumed about 6,000 acres of lands. Worse still, With the acceleration of urbanization development and large-scale urban renewal, according to the forecast, China's new residence areas will increase three billion stere, meanwhile, consume about 40 % of cement and steel, and five billion tons of C&DW will be produced till 2020 [3]. The majority of that waste has not been well processed, which has caused serious resource degradation and environmental problems [1]. Under this circumstance, effective management of C&D waste in China's fast-developing construction sector [4], especially making C&DW reduction, recycling and harmless [5] is urgently needed. So far, many experts and scholars pay more attention to the research on solid waste issues, including conserving resources, waste reuse, reclamation, harmless and waste disposal. In addition, numerous papers have been published to discuss construction waste management problems, and try to study those issues in a different light, such as economy, society, technology, regulation, etc. [6–10]. However, most of the existing researches are qualitative discussion and short of systemic and quantitative think for C&D waste, from source control to marketization of renewable product [11], particularly investigating into building a long-effect mechanism of C&D waste recycling.

Even though there has some research on C&D waste conducted in China's several developed cities, including Beijing, Shanghai, Shenzhen and Hong Kong, little attention has been paid to the management of C&D waste in other regions. As China is such a big country with many different levels of economic development, the studies made in one region may not be suitable for others, that's to say, those disposal measures of C&D waste employed in one region cannot be simply applied to other regions regardless of their contextual differences [12]. In that case, by focusing on Chongqing as a typical city of rapid development of economy in China, its C&D waste management is improving, findings are more likely to be relevant to other economically underdeveloped regions of China. The remainder of the paper comprises four parts. The next part provides a general description for the environmental economic policies and its status quo of application, identifies the factors of cost and benefit for waste disposal based on the questionnaire and interviews, and outlines the research methodology used for calculating the of cost and benefit for waste disposal. The third part introduces the Chongqing's status of construction and demolition waste management and its planning. The forth part analyses and discusses the different policies' influence for waste disposal, and the last part draws conclusions.

113.2 Management and Planning of the Construction and Demolition Wastes in Chongqing

In 2007, the Coordinated and Balanced Development between Urban and Rural in Chongqing was set up. The urban construction would further speed up, and the production of construction wastes would grow rapidly in the future. Based on the waste disposal goal of recycle, reuse and reduce, "The Distribute Programming of Construction Wastes in Chongqing District" was issued in April, 2008. The program planned that seven resources comprehensive disposal centers and 19 construction waste landfills would be established in 2020, when the construction wastes would be fully integrated in the disposal center, and 80 % of them would be recycled after sorting and reusing. The total processing capability of treatment centers attained up to 3.2 million tons per year, and the service time was 12 years. However, there are many recycling products appeared including building standard bricks, hollow blocks, concrete aggregates and maintenance materials of municipal facilities (pavers, road edge bricks, asphalt concrete pavements, etc.). The detailed recycling project was shown in Fig. 113.1. According to the Chongqing's status of C&D waste management and its planning, the approaches of waste disposal are trimmed in Fig. 113.2.

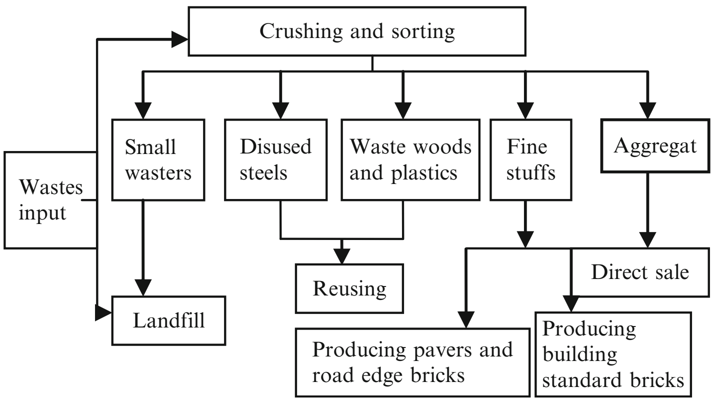

Fig. 113.1 The detailed recycling project of construction wastes in Chongqing

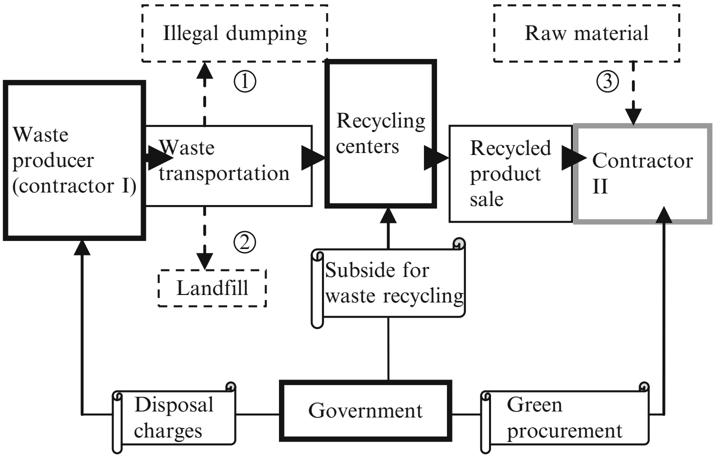

Fig. 113.2 The analysis framework of environmental economic policies on waste recycling

113.3 Research Methodology

Many policies to manage the C&D waste have been proposed, ranging from reducing waste in source, reusing and recycling waste, to landfilling; their goals are minimizing resource consumption and alleviating environmental pollution [12]. However, Vivian W.Y. Tam [5] think that these policies in practice are not as effective as its original intention, which demonstrated by substantial evidence; and lacking of economic incentives is the major factor affected C&D waste management activities. In other words, all parties involved may support the waste reusing or recycling when they get more benefits from conducting C&D waste reusing or recycling than the cost they covered. Therefore, so far the environmentally friendly and long effective management policies have not been high on the agenda. In that case, research into cost-benefit analysis of C&D waste recycling is of great importance to enable us to find answer for the question of which policies is effective to improve C&D waste recycling[12].

The cost-benefit analysis is the foundation to understand the motivation of actors and judge the potential effectiveness of environmental management policies. This research is not the first to analyze the cost and benefit of C&D waste recycling, some attempts on this topic have been already made [5, 8, 14, 12, 13]. This paper aims to build a long-effective mechanism through analyzing the cost and benefit of relative subjects (waste producer, recycling firm and government) under some environmental economic policies. The novelty of this study mainly lies in two aspects: the first is to analyze some laws and regulation that are in relevant to waste management, sum up and build the framework of environmental economic policies of waste recycling; the second is to investigate all essential activities that are in relevant to the cost-benefit of C&D waste disposal; the second is employment of the cost-benefit approach, which can not only involve various activities but also calculate their cost and benefit under different policies. According to previous studies that adopted systematic procedures for the cost-benefit analysis [4, 11, 15], this study takes the procedures as following.

113.4 Identifying and Analysis the Factors of Cost and Benefit

113.4.1 Factors of Cost

[Collection and transportation]: the main part of construction waste collection and waste transport is the producer or the removal contractor of CDW. Currently, Chongqing construction waste collection is basically a hybrid approach, that directly transport mixed CDW to landfills without any treatment, and as required to pay admission fees. Therefore, the cost in the collection phase is composed of waste collection cost, transportation costs and admission fees.

[Illegal Dumping]: At present, construction waste management is in poort situation in Chongqing. The planning of Waste disposal site and charge mechanism is unreasonable ,resulting in the contractor's transportation costs and time costs are high; Thus, contractor is lack of waste recycling motivation, willing to take the risk of the law sanctions using illegal dumping nearby. As long as the contractor is not found, he will save the cost of transport and disposal. If legal system is strong, construction waste disposal charge is lower, recycled product has healthy market, the waste disposal company will make policy adjustments according to the cost-effectiveness (such as reduce admission fees, give subsidies to the contractor). Thus waste producers would refuse illegal dumping of construction waste due to the cost reduction of their own, that is, the acts of illegal dumping construction waste is light gradually.

[Simple landfill]: This is a legitimate approach. NOW If the construction site is close to legal simple landfill field, the contractor will transported waste to the landfill field. Contractors sent waste to the legal field and pay admission fees, so, the direct cost of waste disposal which is paid by contractors includes transportation costs and admission fees.

[Waste resource]: According to the " Conditions and procedural requirements for construction waste disposal in Chongqing" and "Construction Waste disposal field distribution planning in Chongqing," we can see that the Chongqing l Government will attach importance to environmental protection industry, increase more investment in environmental protection and promote recycling industry of construction waste in the next 5 years; then, all construction waste will be transported to waste recycling disposal center after collected in the site. Combining field research with experts interviews, we know that the costs of construction waste recycling disposal include separation costs in site, resource disposal costs, landfill costs of remaining waste, producing costs of re-product.

Table 113.1 Formulas of costs and benefits

Key players	Function	Formulas	Remarks
Waste producer or contractor	Waste collection	Labor costs: $C_{11} = C_C$	C_C: Labor costs of waste collection in site
	Simple landfill	Transport costs $C_{13} = Tr * D_S$	Tr: Unit transport Cost, D_S: The transport distance
		Payments for landfill $C_{14} = C_S$	C_S: Payments for landfill
	Comprehensive	Transport costs $C_{15} = D_{21} * Tr$	D_{21}: The transport distance, Tr: Unit transport Cost
	Disposal	Payments for comprehensive disposal $C_{16} = C_r$	C_r: Payments for comprehensive disposal
Waste recycling enterprise	Waste	Costs $C_{21} = 0.8 * C_0 + 0.2 * P_F$	C_0: costs for comprehensive disposal P_F: Discounted price of Landfill land
	Reuse	Revenue of sale $B_{21} = P_1 + P_2$	P_1: Price of reusing bricks P_2: Price of reusing concrete aggregates
		Revenue of comprehensive disposal $B_{22} = C_r$	C_r: Payment for comprehensive disposal
Government	Procurement and Subsidy	Green procurement C_{P1} Subsidy C_{P2}	C_{P1}: Cost of procurement C_{P2}: Subsidy

113.4.2 Potential Benefit Factors

According to "The Edict of Construction Wastes Disposal Condition and Procedure in Chongqing", the construction wastes requested for payment of fees before landfilling, which was round profit in wastes comprehensive disposal. At present, the new housing was about 23 million m^3 per year in Chongqing, and which consumed about 5.04 million m^2 of bricks, 23 million tons of sands and 34.5 million tons of stones. If the government stipulated that 15 % reusing products should possess in the new purchasing construction materials of public projects, more than 1.1 million m^3 of reusing bricks and 1 million tons of concrete aggregates should be needed. In addition, the fees of project procurement was about 690 million yuan including concretes, bricks and blocks, which was another round profit in construction wastes comprehensive disposal. Therefore, the payment of fees before landfilling and reusing construction materials were the main benefits for the wastes comprehensive disposal. And the modeling for the comprehensive disposal costs and benefits was shown in Table 113.1.

According to field survey of cdw disposal site, the nine main city zones of Chongqing, the environment sanitation expert interview, literature consult and electronic materials research, gain relevant data such as transport distance of cdw recycling center, the unit cost of transportation, admission fees of cdw landfill, admission fees of recycling disposal, secondary disposal costs of illegal dumping, disposal costs of recycling center and market price of recycled products, and so on, that is summarized in Table 113.2.

Table 113.2 Survey data

Items	Parameter definition	Remarks
Total wastes (t)	Q: Total wastes produced in Chongqing district	$Q = 3.20$ million tons (according to site investigation and the Feasibility Study Report for Comprehensive Treatment Project of Construction Wastes in Chongqing District)
Transport distance (Km)	D_S: The transport distance of simple landfill	$D_S = 20$ km (according to the Location Planning for Simple landfill of Construction Wastes in Chongqing District and Instruction for Simple landfill of Construction Wastes in Chongqing District)
	D_{21}: The transport distance of comprehensive disposal site	$D_{21} = 15$ km (according to the Feasibility Study Report for Comprehensive Treatment of Construction Wastes in Chongqing District)
Waste collection costyuant^{-1}	C_C: Labor costs of waste collection in site	$C_C = 0.47$ yuant^{-1} (according to site investigation and the Fixed Price of Construction Project in Chongqing District, 2008)
Unit transport distance cost (yuant^{-1} km^{-1})	T_r: Unit transport distance cost	$Tr = 3.36$ yuant^{-1} km^{-1} (according to site investigation and the Fixed Price of Construction Project in Chongqing District, 2008)
Payments for landfill (yuant^{-1})	C_S : Payments for landfill	$C_S = 2.5$ yuant^{-1} (according to the Regulation of Paid services Charges on Environmental Health in Chongqing District)
	C_r: Payments for comprehensive disposal	$C_r = 25$ yuant^{-1} (according to the Feasibility Study Report for Comprehensive Treatment Project of Construction Wastes in Chongqing District)
Payments for comprehensive disposalyuant^{-1}	C_0: costs for comprehensive disposal	$C_0 = 64.9$ 7yuant^{-1} (according to the Feasibility Study Report for Comprehensive Treatment Project of Construction Wastes in Chongqing District)
Discounted price of landmillion yuan per hectare	P_F: Discounted price of land	$P_F = 2.4$ million yuan per hectare (base on the Open Transfer Notice about Construction Land Transactions in the Rural Area in Chongqing, and assumed that 1 ha land can hold 0.15 million tons construction wastes)
Price of reusing product (yuanm^{-3}, yuant^{-1})	P_1: Price of reusing bricks P_2: Price of reusing concrete aggregates	$P_1 = 260$ yuanm^{-3}, $P_2 = 45$ yuant^{-1} (according to site investigation and the Feasibility Study Report for Comprehensive Treatment Project of Construction Wastes in Chongqing District)
Quantity of reusing product m^3,t	Q_1: Quantity of reusing bricks Q_2: Quantity of reusing concrete aggregates	$Q_1 = 1.09$ million m^3, $Q_2 = 0.95$ million tons (according to the "Concrete Solid Brick" (GB/T21144-2007), "Concrete

(continued)

Table 113.2 (continued)

Items	Parameter definition	Remarks
		brick"(JC943-2004), "Ordinary concrete small hollow block"(GB8239-1997), "Test methods and quality standards for ordinary concrete sand"(JGJ 52-92) and " Test methods and quality standards for ordinary concrete gravel or pebbles"(JGJ 53-92), assumed that water-cement ratio is 0.28, the concrete aggregates (<5 mm) per 1 m^2 concrete is 650 kg and aggregates (>5 mm) per 1 m^2 concrete is 1,125 kg)

113.4.3 Data Survey

113.4.3.1 Analysis and Discussion the Influences of Different Policies on the C&D Waste Disposal

According to the information in Fig. 113.2, the heavy line represents the major approach of realizing waste reclamation, involving waste producer (construction contractors I), waste recycling enterprise (Integrated disposal center), the user of building materials (construction contractors II). The dotted line stands for the complete way of waste recycling, (1) when the law enforcement is lax, the contractor I is likely to be dump waste illegally. (2) C&D waste is likely to be sending to landfill when the cost of bringing the waste to the recycling centre exceeds the cost of landfilling. (3) While recycled product have not an advantage over primary materials in quality, image and price, which potential client (construction contractors II) may use raw material, it results in no market space for the recycled product. Therefore, in order to promote the scale development of waste reclamations, government should take measures to achieve those results, including keeping the waste recycling enterprise sustainable running and encourage waste producer to take C&D waste to the recycling center. For this purpose, government can adopt three kinds of environmental economic policy, which is disposal charges, subsidies for waste recycling and government green procurement system. However, Different policies have distinct influence on the recycling effects, even grave discrepancy. it's essential to analyze and assess the waste management policy, choosing the relative effective strategy. Detailed analysis as follows:

(a) *Government green procurement system*
In the guide of public environmental interests, Government should take environmental protection effect into based on Improving procurement quality and efficiency. They should take measures to develop the markets for recycled materials, ensure the sustainability of recycling enterprise.

In terms of the calculation in Table 113.2, recycling enterprise could keep running by benefiting from selling the recycled materials, but some stable material source is necessary for the sustainable operation of recycling enterprise. However, construction contractor send C&W waste to landfill as a result of lower landfilling cost, which result in stagnating production due to shortage of recycling material. In that case, for the sake of improving competitiveness, recycling center could reduce the gate fees C_{r1} ($0 \leqq C_{r1} \leqq 19.3$), alleviate contractor's burden caused by recycling and encourage waste producer send all of C&D waste to recycling center for disposal, keep the recycling enterprise going concern.

(b) *Subsidies for recycling disposal*

Re-production is lack of competitiveness in the economy compared to the raw product. The environmental protection industry needs to be supported from the country's financial policy and requires the government to take measures to guide actively the pr-production market and to encourage users to accept re-production [16]. However, the subsidies policy does not guide the pre-production market through directly green purchasing of public programs, but give financial subsidies to CDW recycling disposal companies to maintain its normal operation; and promote recycling products to take part in fair market competition.

In this environment of the policy, the most incomes of CDW recycling disposal business come from owing to sales revenue of re-production is very small and almost neglectful [14, 17, 18]. At present, admission fees of the CDW landfill is lower, charges of recycling disposal companies is higher, and contractors tend to choose low disposal cost; the recycling center reduces admission fees or subsidizes the contractor for encouraging the contractor to support CDW recycling and transport actively waste to the recycling center, so that waste recycling center has more competitive advantage.

(c) *Disposal charges*

In order to ensure the practicality of the findings, under this circumstance, a precondition is that government can not subsidizes the recycling firm, and don't recommend public project to procure recycled aggregates. But a promise was given to recycling center that may adjust the disposal fee scale in order to achieve breakeven. Recently, with the increasing amount of C&D waste, the limited landfill imposed some restrictions on landfilling. So as to relieve the land demand and facilitate a feasible approach to the C&D waste management, government could utilize economic tools (tax, subside, charge) and legal means (punish, casual inspection, supervision) to raise the cost of landfilling, reduce the cost advantage over landfill, compel waste producer to support reclamation.

However, due to immature market of recycled product and no supportive policy, recycling center has to increase the fee scale for maintaining the business management. Moreover, according to market fairness, the cost of the contractor implementing recycling shouldn't exceed the cost of landfilling, otherwise, recycling approach don't work. Based on the information in Tables 113.2 and 113.3, the critical value of recycling gate fees is estimated, that is 55.18 RMD per ton. However, waste

Table 113.3 The cost-benefit calculation of related subject

Subject	Participation activities	Cost-benefit calculation	Total (ten thousands RMB)
Waste producer	Waste collecting	cost$C_C * Q$	150.4
	Landfill	Transportation cost : $Tr * D_S * Q$	21,504
		Gate fees$C_S * Q$	800
	Recycling	Transportation cost$D_{21} * Tr * Q$	16,128
		Gate fees$C_{r1} * Q$	06,176
Recycling enterprise	Waste recycling	Cost$(0.8 * C_0 + 0.2 * P_F) * Q$	17,656.32
		Benefit$Q_1 * P_1 + Q_2 * P_2$	32,576.5
		Gate fees$C_{r1} * Q$	06,176
Government	Government procurement	CostC_{P1}	0

Record:0≦Cr1≦19.3

Table 113.4 A cost matrix of participating subject under different policies (ten thousands RMB)

Subject policy	Green procurement	Subside for waste recycling	Disposal charges
Producer	$16{,}278.4 \leq C_{A1} \leq 22{,}454.4$	$16{,}278.4 \leq C_{A2} \leq 22{,}454.4$	$C_{A3} \geq 33785.6$
Recycling center	17,656.32	17,656.32	17,656.32
Government	0	$11{,}480.32 \leq C_P \leq 17{,}656.32$	>0

Record: CA1,CA2,CA3 represents contractor's cost under three policies;CP represents government's cost under the policy of subside for the recycling

producer cover almost waste disposal cost, this factor may inspire them to take actions to reduce cost. If waste producer reduce waste output by management technology innovation or on-site recycling, the marginal cost of waste disposal may be decreased.

In conclusion, according to the different influence of waste recycling caused by three kinds of environmental economics policies, a cost matrix involving government, recycling enterprise, waste producer, is sum up in Table 113.4.

113.5 Conclusions

The reusing of construction wastes was an important measure in the environment friendly and resource-saving society. Moreover, it was the key link in pollution control standards for solid waste collection, storage, disposal and recycling [19]. The sustainable development of construction wastes reuse was achieved by the government green procurement, policy constraints and economic incentives comprehensively. However, the development of wastes reuse would be hindered in the long term, as charges of construction wastes disposal maybe induce much more illegal wastes landfill. Furthermore, the subsidies for waste producers were unhelpful to wastes reuse, which may induce contractors ignoring wastes management in site and the increase of construction wastes. But, reasonable government green procurement is the most promising policy option to establish long-term mechanism of construction wastes reuse.

Acknowledgment The research work of this paper is supported by the two projectsNo. CDJXS11031120 Supported by the Fundamental Research Funds for the Central Universities and National Social Science Foundation of China NO.11CJY040.

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Part XI
Other Themes

Chapter 114
Government Financial Subsidies in the Influence of Public Housing Under the PPP Financing Model

Yongfang He and Bing Li

Abstract While China's develop into a social benefit society,affordable housing problem of large salary population become more attention to the authorities. In order to solve this problem,the government has issued a series of policy to expand the construction of economically affordable housing. However, the movement has been blocked because of construction fund shortage in many cities. Academic researchers suggest that introducing PPP models is one of the conventional ways for obtaining alternative finance to develop public housing. The purpose of this study is to analyze the relationship between the governmental financial subsidies and various influencing factors of public housing based on PPP model. This article first provides the favorable conditions that the governments adopt PPP model for the construction of public housing. Benefit models of the public and private sector's was developed based on economics theories. They were analyzed by game theory to find out how governmental financial subsidies influence the welfare of the private and public sectors. Research results demonstrate the government financial subsidies can not only increase the benefit of the private sector, but also increase the benefit of the government through providing extra amount of public housing. It is hoped that this study can provide some useful information for the governments in considering PPP model to develop public facilities.

Keywords PPP • Governmental financial subsidies • Public housing

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_114, © Springer-Verlag Berlin Heidelberg 2014

114.1 Introduction

In recent years, Chinese government enacted a series housing policy like *the economically affordable housing management procedures* and *public housing management method of the lowest income family* to solve the low-income people's living problems [1]. The results are significant in many cities. However, a new problem arises in these cities from the "sandwich layer", who is accounted for about 20–40 % of the urban population, consists of city salariats and graduated employee. They do not meet the conditions of cheap rented housing, and can't afford buying economy applicable house either. As the saying, they become the main sacrifices of high housing prices [2].

In March 2009, the Premier Wen Jiabao first brought forward the key word of "positive development of public housing" in his government report. While Under-secretary Qi Ji from Ministry of Housing and Urban-rural Development proposed a clear framework on speeding up the construction of public housing [3]. In June 2010, The Ministry of Housing and Urban-rural Development and other seven departments drafted working paper of *guiding opinion in speeding up the development of public housing*, requested local authorities propelling the construction of public housing through a series of measures.

Academic researchers suggest that introducing PPP models is one of the conventional ways for introducing private capital into develop public housing, Marsh [4] and Lawrence [5] analyzed Canada and the United States's public rental house project. And Steveb [6] also analyzed the policy guidance of low-rent housing price changes. Yok-shiu [7] and Aimin [8] study investment, affordable housing, pricing, management of low-rent housing in China, and forecast such the future development of China's affordable housing. Bjom and John [9] thought macroeconomic policies on housing policy have very big effect. These include a region's economic condition, social security level, and so on. Liu Chaoji [10] analyzed Shenzhen public rental housing in the operation mechanism, and advised taking experience of the United States, Hong Kong and other developed countries to solve these problems. Then Cheng Li [11] argued that problem of China's public rental housing safeguard way existing in the development of a single, financing difficulties and management mechanism. Li Xiuhui [12] suggest that low rent housing construction introducing BOT mode become an innovation trend combined on his paper. Tian Yilin [13] first proposed conforms to our country national condition the PPP model of housing security system. Wang Qiankun [14] put forward the low rent housing construction introduced PPP mode to solve construction financing difficulty for the past few years. Those academic researches promoted the development of public housing.

However, the main reason hindering development of the construction of public housing is insufficient funds. The government is expected to invest 1.3–1.4 trillion to build 10,000,000 sets of construction of affordable housing over the next few years, [15] but public housing is, the most serious shortage of funds, as shown in Table 114.1.

Table 114.1 Affordable housing government financing needs [16]

Year	Plans to build (thousand sets)	Expected to complete (thousand sets)	Capital demand (billion Yuan)	Capital source (billion Yuan)	Financial deficit (billion Yuan)
2011	8,000	4,300	607.2	162.2	445.0
2012	8,000	6,800	773.4	186.8	586.6
2013	10,000	8,450	798.6	214.7	583.9
2014	10,000	9,500	832.8	246.3	586.5
2015	10,000	10,000	868.8	282.1	586.7

Table 114.2 2011 deposits and its growth rate in China [18]

Index	Amount (billion)	Growth (%)
Savings deposit	826,701	13.5
Household deposits	351,957	15.5
RMB	348,046	15.7
Non financial enterprises deposits	313,981	9.5
Loan	581,893	15.9
Short-term loan	217,480	21.8
Medium and long term loans	333,747	11.8

China's public housing construction funds sources mainly including special fund,public financial allocation, land revenue etc. [17]. If the required public housing capital totally relies on the government budget, it will give government heavy financial burden. However there are many "idle funds" in our country belong to town dwellers. According to the National bureau' statistics in national economic and social development, there are 82.7 Yuan and foreign currency balance deposits in financial institutions in 2011, as shown in Table 114.2. Therefore, it provides a basic condition of enough private capital for the government to introduce private involvement for public housing construction.

114.2 PPP Financing Mode of Public Housing

PPP (Public – Private – Partnership)is a widely used concept across different fields. Wang Hao [19] in his paper *the PPP definition and classification* stated wide PPP is that the government establishes various kinds of cooperative relations with the private sector to provide public products or services. And the narrow PPP models refers to "with a common goal of all parties, through constructing the cooperation network of the liability share and benefits sharing and related supervision mechanism, so that it can reach goal more efficient". It is well known that modern PPP financing mode was put forward firstly by the British government, and then the United States, Canada, France, Germany, Australia, New Zealand and Japan and other majority western country. The United Nations, world bank, OECD, the

European commission and other international organizations or community are pro the idea of PPP and promoted PPP experience in a worldwide.

In China, the Hong Kong industrial Co. LTD and Shenzhen special zone government joint together to construct of Shenzhen Shajiao B power plant at first by using BOT financing models in 1988. Next, Liabin B successful application opened the new situation of China's public private cooperation. From then on, the PPP model has been widely used to water, roads, metro infrastructure construction. It is not only for the government to solve the money problem, also provides a more professional services.

Currently, for the government, introducing private capital can help to alleviate the government financial pressure. Government can use effective preferential policies to attract private funds and guarantee the construction of the male rent of long-term and effectiveness. The government in order to guarantee completing construction of public housing in PPP mode smoothly, and at the same time make sure that the private sector can earn money. Then attract more private sector involved in the construction of public housing. The government has two kinds of incentive policy: (1) Public housing exempts from Land tax, Stamp duty, business tax and house property tax. (2) The government give two kinds of compensation for public housing [5]. The government offer rent of public housing below market price; [12]. The private sector charge market rent fee and government press a month to rent subsidies to support low-income families. This paper will discuss the second type rent compensation methods, which is called Build-Subsidize in Operation-Transfer.

114.3 Government and Private Sector Stackelberg Game Theory in PPP Mode of Public Housing

In a PPP project, government and the private sector are two important stakeholders. The government financial subsidies can be proposed as dynamic game between these two important stakeholders. Based on this assumption, this paper begins related research between government and the private sector with the two different game views. When deciding into PPP, the government and the private sector meet Stackelberg game conditions. This means that the government dominated in the game, and already considered fully reaction function of the private sector.

First, this paper assumes that the private sector and government play a two stage dynamic game, and their action orders are as follows:

1. The government decides paid-in land transfer fund w and franchise term t;
2. The private sector based on the above government's decision to determine rental prices.

Obviously, Stackelberg game equilibrium is a seed game refining Nash equilibrium, the game is a complete and perfect information dynamic game, so it can use reverse induction solution method.

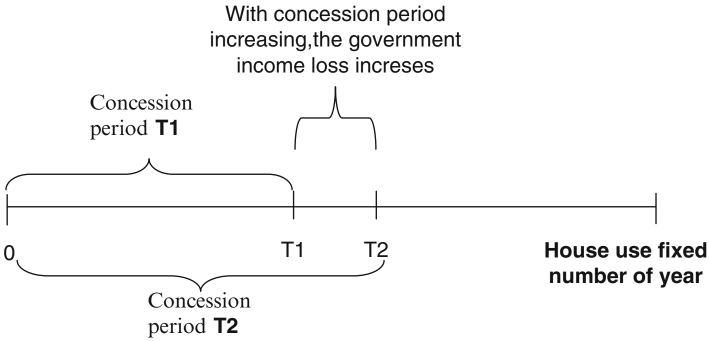

Fig. 114.1 Concession period against government of future revenue

Second, this paper also assumes that Public housing market is a completely competitive market. The demand for public housing is $Q = (\phi - \beta P_r)$, $(\phi > 0, \beta > 0)$. The private sector determines its fees for rent $\boldsymbol{P_r}$ and $\boldsymbol{P}$ is the government to price subsidies. C_m is the unit land for the government expenses and the cost of land requisition. δt is the government supervision fee in the concession period, increasing with the length of the concession period (T2-T1). $C(t) = \alpha t^2$ is that the government's revenue (after house transfer) losses will be decrease with the concession period increases (As Fig. 114.3 show). The assumption $\boldsymbol{I}$ is the private sector investment and $C(I)=kI^{\gamma}$ is the maintenance operation cost.$\pi$is the profit of private sector and $\boldsymbol{J}$ is the profit of government (Fig. 114.1).

114.3.1 In a Government Financial Subsidies Model, Expected Profit for Both Parties are Expressed as

$$\pi = [\phi - \beta(P_r - P)](P_r - w) - I - kI^{\gamma} \tag{114.1}$$

$$J = [\phi - \beta(P_r - P)](w - C_m + \delta t - P) - C(t) \tag{114.2}$$

114.3.2 Stackelberg Game Model Under the Leadership of the Government

To find out the optimal solution of land grant fee, rent, concession period under government leader, it is calculated in the following process.

First, derivate of the variable π to independent variable $\boldsymbol{P_r}$: $\dfrac{\partial \pi}{\partial P_r} = 0$, then $\phi - (Pr - P)\beta - (Pr - w)\beta = 0$.

$$\mathrm{P_r} = \frac{\phi + \beta w + P\beta}{2\beta} \tag{114.3}$$

The price increase as the government rent fee increases when the governmental benefit maximization. Then put $\boldsymbol{P_r}$ into function (Eq. 114.2)

$$Max \prod\nolimits_J = \left[\phi - \beta\left(\frac{\phi + w\beta}{2\beta} - P\right)\right](w - C_m + \delta t - P) - \alpha t^2 \tag{114.4}$$

Third, first derivative of the variable $\boldsymbol{J}$ with respect to independent variable $\boldsymbol{w}$ and $\boldsymbol{t}$:

$\frac{\partial \prod_J}{\partial w} = 0,\ \frac{\partial \prod_J}{\partial t} = 0$ can get the optimal solution of $\boldsymbol{w}$ and $\boldsymbol{t}$.

$$w* = \frac{\left(4\alpha - \beta\delta^2\right)\phi + 4\alpha\beta C_m + \left(4\alpha - \beta\delta^2\right)\beta P}{\beta\left(8\alpha - \beta\delta^2\right)} \tag{114.5}$$

$$t* = \frac{(\phi - \beta C_m + \beta P)\delta}{8\alpha - \beta\delta^2} \tag{114.6}$$

Last, putting $\boldsymbol{w}$ into $\boldsymbol{P_r}$, can get $\mathrm{Pr}* = \frac{\left(6\alpha - \beta\delta^2\right)\phi + 2\alpha\beta C_m + \left(6\alpha - \beta\delta^2\right)\beta P}{\left(8\alpha - \beta\delta^2\right)\beta}$

In conclusion, the (w*, t*, Pr*) is the optimal solution of this game refined Stackelberg game equilibrium.

Under the government subsidies, putting the optimal price $\boldsymbol{P_r}$ into demand function,and can get the market measured quantity:

$$Q* = \frac{2\alpha(\phi - \beta C_m + \beta P)}{8\alpha - \beta\delta^2}$$

Viewpoint 1: $\frac{\partial w*}{\partial P} > 0,\ \frac{\partial t*}{\partial P} > 0,\ \frac{\partial \mathrm{P_r}*}{\partial P} > 0,\ \frac{\partial w*}{\partial P} > 0$, If government pay direct financial subsidies $\boldsymbol{P}$ to public housing, then:

1. The increase of the land grant fee can lead to the increase of the rent.
2. The financial subsidies of the government directly related to the length of the concession period. The government gives the private sector the more subsidies, the shorter the concession is. If the government increased subsidies, it can reduce the concession period.
3. The government giving finance subsidies makes rental prices increase in certain circumstances, but also can then gradually restore to its original levels. The explanation is two views.

Viewpoint 1:This paper assumes that the tenant is very sensitive to public rents. A little change in the price would cause the public demand for rent changes greatly. If the government gives subsidies in this time, it can push the demand of public

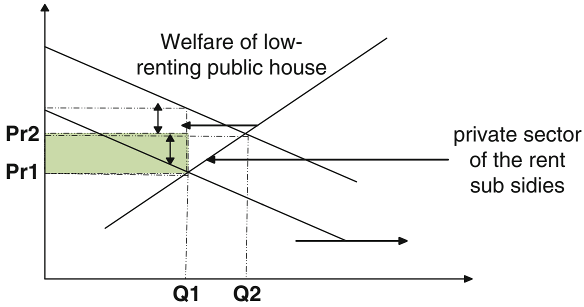

Fig. 114.2 The lessee and the private sector to share the government subsidies

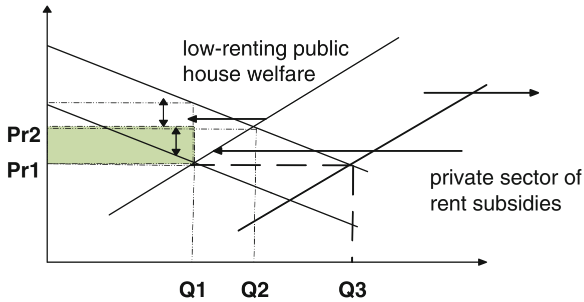

Fig. 114.3 The lessee and the private sector to share the government subsidies

housing, and make quantity of public housing moving right from the curve $\boldsymbol{Q}_1$ to curve $\boldsymbol{Q}_2$.As a result, the number of public housing expands, and makes more "sandwich layer" returns. It also make rent improve from $\boldsymbol{P}_{r1}$ to $\boldsymbol{P}_{r2}$, and let the private sector to gain an extra income (As shown in Fig. 114.2). Continuity, this will attract more and more of the private sector involved in construction of public housing under the PPP models, lead to the supply function curve of the private sector move right (As shown in Fig. 114.4). Then the tenants rent fall down again. Furthermore, the number of public housing grows from $\boldsymbol{Q}_2$ to $\boldsymbol{Q}_3$. Therefore, when the government issues finance subsidy policy, not only the public and private department, but also the government is the beneficiaries, enjoy the "win-win".

Viewpoint 2: when $\frac{\partial Q*}{\partial \mathrm{P}} = \frac{2\alpha\beta}{6\alpha - \beta\delta^2} > 0, \alpha > 0, \beta > 0, \alpha > \frac{\beta\delta^2}{2}$ If the government subsidies P increases, the private sector also may be willing to increase the supply of public housing, and also will be to participate in the construction of public housing and have certain incentive to attract private sector participation (Fig. 114.3).

Finally, the benefit of government departments and private sector respectively is:

$$\pi = \frac{\alpha(\phi - \beta C_m + \beta P)^2}{(6\alpha - \beta\delta^2)\beta} - I - kI^\gamma \tag{114.7}$$

$$J = \frac{4(\phi - \beta C_m + \beta P)^2\alpha^2}{(6\alpha - \beta\delta^2)\beta} \tag{114.8}$$

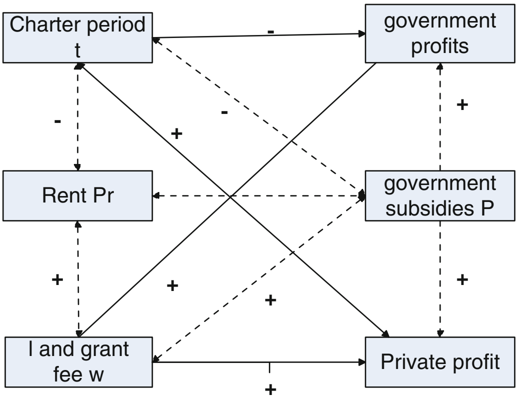

Fig. 114.4 Relation map of the factors in public housing

Viewpoint 3: When P = 0, profit of the private sector is $\pi' = \frac{(\phi-\beta C_m)^2\alpha}{\left(6\alpha-\beta\delta^2\right)^2\beta} - I - kI^\gamma$ and the benefit of government departments is $J' = \frac{4(\phi-\beta C_m)^2\alpha^2}{\left(6\alpha-\beta\delta^2\right)^2\beta}$, then $\pi > \pi', J > J'$. It can be concluded that, if the government give the direct financial subsidies tenants ***P***, it results that:

1. The private sector will make more profits because of the government's financial subsidies.
2. The government's social benefits will be increased at the same time.

From the graph, though the rent rose at first, but it will decline afterwards. But the quantities of public housing expand and lead to profits of private sector increase. The government's social benefits will increase with expansion of supply of public housing, more and more private sector investment into the construction of PPP rent. Therefore, the government may also take the financial subsidies to attract private sector participation.

114.3.3 Summary

As shown in Fig. 114.4, a relation graph can be concluded that four factors, concession period, rental price, land grant fee and government finance subsidies, have direct or indirect influences on the benefit of stakeholders of public housing project. The solid line show dominant relationship and the dotted line represent implicit relationship.

114.4 Conclusion

The aim of this paper is to analyze the relationship between the governmental financial subsidies and various influencing factors of public housing within PPP environment. This article firstly explores some favorable conditions that the governments adopt PPP model for the construction of public housing. Benefit models of the public and private sector's was developed based on input-output theories. The formulas were analyzed by game theory to find out how governmental financial subsidies influence the welfare of the private and public sectors. Research results demonstrate the government financial subsidies can not only increase the benefit of the private sector, but also increase the benefit of the public sector by providing extra amount of public housing.

The first conclusion of this article is that the government increasing financial subsidies will bring more rental revenue to the private sector and possibly, increase government price in land leasing. And the increase of government finance can make more the private companies join into the construction of public housing, expanding the number of public housing for more people. Therefore, the government subsidies can increase benefit of the government and social benefits by providing extra amount of public housing. So the government financial subsidies have a "win-win" effect to the private sector and the government.

The revelation of this paper is that government can take effective incentive mechanism, subsidize in building-operation-transfer model, to improve the private sector initiative. The government participation has influence on social benefits; local authorities should choose the best financing model to increase social benefit to meet the needs of the people. However, the governmental financial subsidies should have a ceiling; otherwise, it may produce versus effect on public benefit.

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Chapter 115
Research Trend of Collusion in Top Construction Journals

Yun Le and Ming Shan

Abstract Collusion is a stubborn negative phenomenon in construction industry, calling scholars to conduct continuous research in recent years. In this paper, a comprehensive analysis on 24 collusion publications in eight top construction journals in the duration of 1999–2011 was performed, including Automation in Construction, Building and Environment, Building Research and Information, Construction Management and Economics, Journal in Engineering, Journal of Construction Engineering and Management, International Journal of Project Management, Engineering, Construction, and Architectural Management. Distribution of collusion publications in years and journals was concluded in this paper. It was also found that scholars from Hong Kong, Australia, U. K., and Netherlands had conducted certain research on collusion issue in construction industry, meanwhile scholars from developing countries were also focusing on this topic. Typically, scholars with much contribution on this research topic were listed out with a proper scoring method. Research interests illustrated from these collusion articles were also identified into five categories, which may imply the future research direction on this topic.

Keywords Collusion • Construction industry • Review • Research trend

115.1 Introduction

Collusion is a negative phenomenon existing in the construction industry of both developing countries [1, 2] and developed countries [3]. Allen et al. [4] defined collusion as 'a secret understanding, especially for a fraudulent purpose, contrary to the principles of free competition, which benefits only the parties to the collusive

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_115, © Springer-Verlag Berlin Heidelberg 2014

agreement at the expense of those not privy to the arrangement.' Scholars have conducted continuous study on this issue in recent years, which means that some research results have been published in the construction journals publicly. However, research content and research method of collusion topic that scholars are concentrating on is distinct. Therefore, it is significant and necessary to summarize the research trend of collusion in construction industry among these academic journals. Hence, this study aims to address the following questions:

- What was the coverage of collusion topics during the period of 1999–2011?
- What did the writers contribute to the collusion publications during the period of 1999–2011?
- What were the research interests on collusion topic in these collusion publications during the period of 1999–2011?

115.2 Search Methodology

Research achievements published in the top journals can represent the mainline study level and interest on the issue [28]. With this assumption, eight top international academic journals on construction management from Chau's ranking list [5] were selected as the search source, they were *Automation in Construction (AIC), Building and Environment (BE), Building Research and Information (BRI), Construction Management and Economics (CME), Engineering, Construction and Architectural Management (ECAM), International Journal of Project Management (IJPM), Journal of Construction Engineering and Management (JCEM), Journal of Management in Engineering (JME).*

To study the research status in recent years, duration of search was defined from 1999 to 2011, as well as the search keywords were defined as "**collusion**" OR "**collusive**" in the "title/abstract/keyword" field of the search engine. Initial quantity of papers obtained through search in last eight top journals was 60, whereas the results still included some unwanted publications, which happened to meet the search keywords but do not really discuss about collusion in construction industry. Therefore, with the refinement based on the content of "title/abstract/keyword", 24 papers close to discussion on collusion in construction industry were obtained exactly as the analyzing objective articles.

To conclude the research contribution from each country or institution, it is necessary to rank and analyze the scholars quantitatively. Howard et al. [6] advocated a more accurate formula which had been adopted to identify the research trend of science education, to reflect the actual contribution of each individual writer in a multiauthored paper (115.1 Formula), where n = number of writers of the paper, and i = order of the specific writer. Given that each paper has a score of one point, a detailed score matrix for writers is shown in Table 115.1.

Table 115.1 Score matrix for multiauthor papers

	Order of specific writer				
Number of writers	1	2	3	4	5
1	1.00				
2	0.60	0.40			
3	0.47	0.32	0.21		
4	0.42	0.28	0.18	0.12	
5	0.38	0.26	0.17	0.11	0.08

Although this study could not provide an exhaustive analysis on collusion in construction industry with this search methodology, it will be helpful to achieve research mainline on this issue.

$$score = \frac{1.5^{n-i}}{\sum_{i=1}^{n} 1.5^{n-i}} \tag{115.1}$$

115.3 Discussion

115.3.1 Distribution of Collusion Papers in Top Construction Journals

As a stubborn problem existing in construction industry for a long time, collusion has attracted many scholars all over the world to try to settle this negative phenomenon. With the state of Table 115.2, it could be found out that more and more achievements have been obtained with the scholars' persistent effort since 2007, which imply that the study on this issue will boom in next few years.

Top construction management journals also never ignore the issue of collusion in construction industry. As shown in Table 115.3, regardless of theme concentrated in each journal is automation in construction, informatization in construction industry, construction management, or project management, research achievements on the collusion topic have been collected in these top journals.

Especially the two journals from U.K., CME and BRI, famous for theoretical research on construction management issues, have paid much attention on the collusion topic, articles recorded in those two journals occupied 62.5 % of all the 24 articles, it illustrates that more and more scholars are trying to settle this problem with theoretical method.

115.3.2 Writer's Contribution to the Papers

As previously mentioned, by applying the score matrix as delineated in Table 115.1, the score of a specific writer in a multiauthored paper can be calculated, therefore

Table 115.2 Distribution of publications in date

Date	99	00	01	02	03	04	05	07	08	09	10	11
Quantity	2	2	1	1	2	2	1	4	2	4	1	2

Table 115.3 Distribution of publications in journals

Journal	AIC	BE	BRI	CME	ECAM	IJPM	JCEM	JME
Quantity	1	2	5	10	2	2	1	1

Table 115.4 Research origin of collusion papers published

Region/Country	Institute/University	Researchers	Papers	Score
Hong Kong	2	13	6	6
Australia	2	5	4	3.12
U. K.	3	6	3	2.49
Netherlands	2	2	2	2
South Africa	3	3	3	1.57
U. S. A.	2	4	2	1.53
Taiwan	2	4	2	1.47
China	1	4	1	1
Canada	1	1	1	1
Italy	1	2	1	1
India	1	2	1	1
Nigeria	1	2	1	1
Zambia	1	3	1	0.82
Total	22	51	24	

the country origins of collusion publications could be also ranked with accumulation of scores. As shown in Table 115.4, many researchers in Hong Kong, Australia, U. K., and Netherlands conducted much study on collusion phenomenon in construction industry, they had got much more scores than other regions. Especially researchers from Hong Kong (the Hong Kong Polytechnic University and City University of Hong Kong typically) contributed most on the study of collusion topic, both the occupied ratio of researchers and papers attained 25 %, this is understandable because Hong Kong is a place with interaction between western culture and eastern culture, where scholars always have more consideration on the collusion issue with distinct angles.

It is also worth noting that many scholars conducted collusion research with typical empirical analysis in developing country, i.e. China, India, South Africa, Zambia, and Nigeria. This is believed that large quantities of construction projects are being performed in these countries, meanwhile the severity of collusion phenomenon existing in these countries' construction industry has brought much negative influence, with the most possible reason of deficiency on law and industry institution.

Statistics described in Table 115.5 show that main researchers involved on collusion issue could be classified into four categories in geography, they are scholars from Hong Kong, Netherlands, South Africa, and Australia, and

Table 115.5 Main researchers involved on collusion issue

Researchers	Score	Papers	Cited	Region/Country	Affiliation
C. M. F. Ho	2.32	3	16	Hong Kong	HKPU
A. G. Dorée	1	1	51	Netherlands	UT
Martin S.	0.98	3	72	Australia	QUT
Paul Bowen	0.89	2	10	South Africa	UCapeT
Anna Z. F.	0.72	2	44	Australia	QUT
Charles Vee	0.6	1	28	Australia	QUT
Robert Pearl	0.5	2	10	South Africa	UKN
T.S. Liao	0.47	1	38	Taiwan	NTU
Linda Fan	0.47	1	16	Hong Kong	HKPU
Henry Suen	0.47	1	14	Hong Kong	CUHK

HKPU represents Hong Kong Polytechnic University, *UT* represents University of Twente, *QUT* represents Queensland University of Technology, *UCT* represents University of Cape Town, *UKN* represents University of KwaZulu Natal, *NTU* represents National Taiwan University, *CUHK* represents City University of Hong Kong

furthermore, most of them happen to concentrate their research interest on collusion forms and ethic management in construction industry. Among them, Christabel Man-Fong Ho from the Hong Kong Polytechnic University published three papers on these top journals with the ranking first for individuals, the research team constituted by Martin S., Anna Z. F., and Charles Vee from Queensland University of Technology analyzed collusion phenomenon in angle of ethics in a series of papers, A. G. Dorée provided us a classical paper about collusion in Dutch construction industry which has been cited for 51 times, Paul Bowen and Robert Pearl also analyzed the same issue in South Africa which has provided a template for developing countries.

It could be asserted that achievements from last scholars could represent the highest research level on collusion issue in the period from 1999 to 2011.

115.3.3 Research Methods in Collusion Publications

Through the comprehensive review of these published papers, some similarities are observed especially in the research methodologies. A common research methodology adopted by researchers comprises of four key stages, namely, (1) topic identification; (2) data collection; (3) knowledge processing; and (4) validation process. The stage of "topic identification" is usually achieved via a comprehensive literature review search from journals, conference proceedings, books, reports, and articles etc. [1, 2, 7–9].

After the "topic identification", the second stage of study would typically be "data collection." This stage is often carried out via recognized techniques, such as empirical investigations [9–11], and questionnaire surveys [1, 2, 8, 12–17].

The third stage of "knowledge processing" is normally studied via techniques including statistics analysis [8], theoretical analysis [18, 19], this stage will deliver the initial findings of the research.

In the fourth state of "validation process", researchers always bring about some conclusions and recommendations from research achievements [17, 20].

115.3.4 Research Interests in Collusion in Construction Industry

Based on the analysis on papers obtained from search, five categories are identified for the research interests of collusion papers, including (1) description on collusion forms; (2) collusion tendering; (3) theoretical analysis on collusion; (4) practitioners' attitudes on collusion; (5) prevention strategies. The research contents could be concluded as following:

- **Description on Collusion Forms**: various forms of collusion have been identified from questionnaire surveys or empirical investigations by researchers [1, 2, 11, 13, 16, 17].
- **Collusion Tendering**: some scholars conducted research on collusion existing in tendering phase of construction, concentrating on selection criteria for contractors, unbalance bidding, and project costs, etc [10, 24, 25, 26]
- **Theoretical Analysis on Collusion**: Krisen et al. [21] and Said [22] performed theoretical analysis on decision making in ethical dimension, as well as pre-emptive mechanism avoiding improper benefits grabbed by contractors.
- **Practitioners' Attitudes on Collusion**: attitudes from practitioners including owner, contractor, supervisor, and quantity surveyor on collusion in construction industry are investigated by scholars [8, 9, 12, 15, 27].
- **Prevention Strategies**: Bologna and Nord [7], Henry et al. [19], Sohail and Cavill [23], and Sichombo et al. [14] brought about various prevention strategies for collusive behaviors concentrating on technical auditing, accountability, legislation, as well as culture influence.

115.4 Conclusion

It could be concluded from the summary of these papers that researchers from Hong Kong, Australia, South Africa, Netherlands, and U. K. contributed most on the study of collusion in construction industry. Most of the top construction journals have collected collusion publications continuously; typically CME and BRI from U.K. paid much attention on this topic.

Research interests in this field are distributed into five categories, including (1) description on collusion forms; (2) collusion tendering; (3) theoretical analysis on collusion; (4) practitioners' attitudes on collusion; (5) prevention strategies. Whereas status could be identified that researchers conducted more study on description of collusion forms than the solution to this negative phenomenon, however it also implies the future research direction of collusion topic in construction industry.

Acknowledgments The writers gratefully acknowledge the National Natural Science Foundation of China (Project No. 71172107) for providing funding to support this research effort. The writers would also want to acknowledge Hu Yi from Hong Kong Polytechnic University, as well as Dr. Ke Yongjian from the National University of Singapore.

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Chapter 116
A Reference Value Analysis of Macao's Public Construction Works Laws for Mainland China

Wenjie Yang and Yan Zhang

Abstract The construction laws play a very important role in regulating the behaviors of all participants throughout the construction process. Previous studies on the effectiveness of the construction project management mainly put emphasis on the effect of the specific lines in the construction laws. This paper comparing the construction project laws adopted in mainland China with the public construction law of Macao, analyzes the legal process in two legal systems respectively to discuss the relationship between rights and obligations in the management process. Based on the results of the comparison, their advantages and shortcomings have been demonstrated. The primary problems of the construction management in mainland China is the ambiguousness in specifying rights and responsibilities and defectiveness in management process, to this end, a reference value analysis of the Macao's public construction laws is introduced to get the process improved. At last, the Hong Kong-Zhuhai-Macao bridge project, as a study case, has been selected to assess the improvement effectiveness, four suggestions comprising establishing quality management system, staying on the progress schedule, project improving payment procedures, and clarifying the liability in construction process were put forth. This research is also trying to propose some useful advices and give reference to analyze the management of the public construction works in China.

Keywords Construction law • Hong Kong-Zhuhai-Macao Bridge • Public works

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_116,

116.1 Introduction

Public projects are the survey and design of the public constructions contracted by national or local government and other public bodies, generally including projects relevant to social interests and public safety, and projects that have or partly have state-owned funds or financed by governmental departments. Public projects are usually characterized as having large-scale, long construction period, high capital investment, and great social impact. In China, the public works also have the characters of huge-amount investment and complex management process. Without a strong control, there will be a variety of problems in project management and implementation [1–5].

- The governmental projects have no clear legal person, so the responsibility of management is ambiguous, let alone staying perfectly on budget.
- There is no special law to regulate the public projects in mainland China, and project teams are always set up casually. Therefore, the management efficiency is very difficult to be improved. Full-scale management position in every institutions results in repeated allocation of resources and aimless in management.
- There are a lot of financial gaps at the beginning of project and overruns of cost and time in performance. Additionally, the survey, design, and construction are usually carried out at the same time.

Numerous studies have been concentrated on the subject of solving public construction management problems, two primary issues have been discussed most: related laws and regulations, and management effectiveness. Researches on improving management effectiveness usually gave solution in a systematic vision [6, 15], however, their studies was always too abstract to be applied in real construction projects due to the complexity of the management system. Studies on completing related laws and regulations were usually focused on the specific lines of the laws and regulations [7, 8], which are lack of a more systematic and comprehensive understanding of the construction law system. Obviously, the construction laws have regulated the whole management process of the project, clarified the relationship between rights and obligations in construction process, and standardized the management process and providing guidance to behaviors of the constructors. In this case, studying the entire management process of the construction laws, describing completely the management process in a one-page diagram, and comparing different processes in different law systems is a reasonable idea to solve the problems in construction management.

116.2 Comparative Analysis of Management Process Between Macao and Mainland China

Macao, after returning to China in 1999, still retains her independent legislation power. The Macao government had introduced the Public Works Contraction Law [9] to manage public works construction, considering its special meaning.

In mainland China, construction projects are regulated by related laws such as the Bidding law [10] and the Construction law [11, 14, 16]. Nevertheless, there are so many differences in the legal system between Macao and mainland China. It is meaningful to analyze the reference value of one another.

116.2.1 Management Process of Public Works Construction in Macao

The process of construction laws, included a large quantity of information and complex interaction, runs throughout the overall construction activity and even beyond that. To describe the process information completely, the primary steps are listed vertically, the detailed processes are described laterally, and key procedures are highlighted by outline border. The management process of public works construction in Macao can be characterized according to the Public Works Contraction Law, as shown in Fig. 116.1.

The Public Works Construction Law of Macao is based on the Portugal legal system, and the public constructions are operated by commercial principles and managed in business patterns which are universally adopted in developed countries. In order to maximize the market's role in allocating, and to create an environment for free competition, the government only has to control the operation of public construction through appropriate macro-control according to the market dynamics. The advantages are illustrated as follows:

- The owners have a clear and independent legal personality, so they are able to manage the project to better meet their own interests in the process of project.
- To ensure a comprehensive public supervision of great possibility, the information is completely available, and process is transparent throughout the bidding, which contributes to safeguarding the fairness of the bidding process.
- Standardized contract withdrawal mechanism, and balanced relationship between the owners and contractors, reasonably allocates the risks of the project.
- The functions and rights of the supervision engineer have been clearly defined, the rights to monitor the contract performance, working plans, engineering drawings and modifications are fully granted. The cost of project is better controlled thanks to detailed payment procedures.
- There are strict and clear definitions in contract and working plan alternation, price departs from quantity is achieved based on the bill of quantity.

The weak supervisory of the government is the main inadequacy, without a clearly defined of malpractices and penalties, the impartiality of the bidding and contract performance depends mostly on public oversight and self-regulation. Members of the tender board are designated by the owner, which improved the bidder's competitiveness, but also resulted in bidding collusion, bribery and other illegal behaviors, even the owner, bribed or threatened, may also flout the public interests [12].

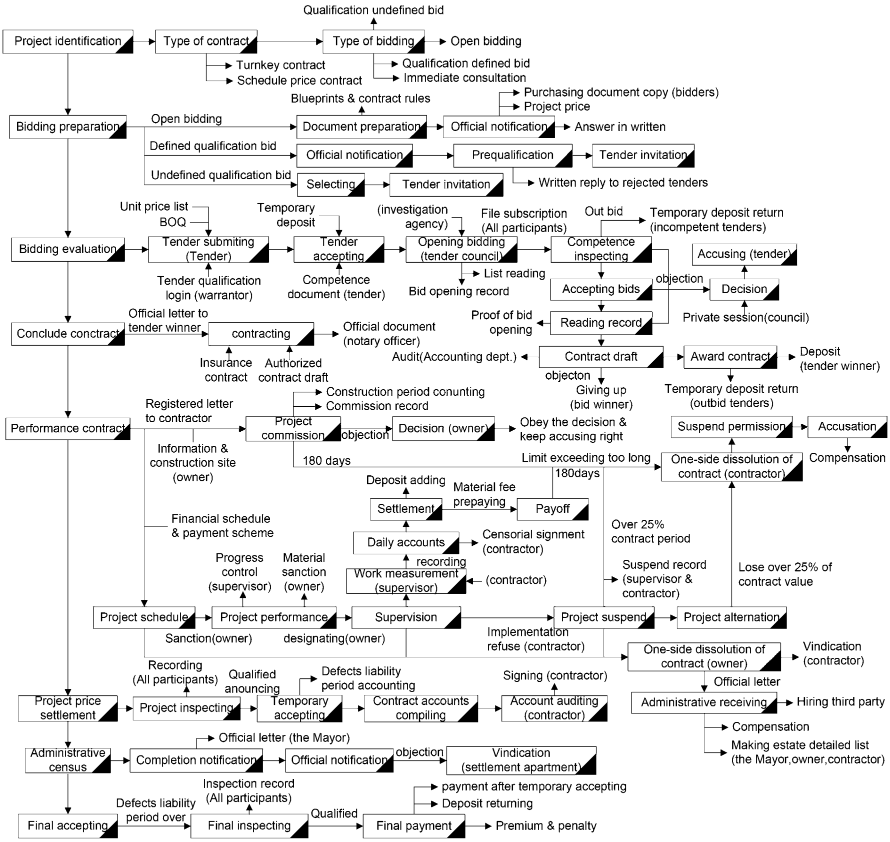

Fig. 116.1 Management process diagram of Macao public works construction

116.2.2 Management Process of Public Works Construction in Mainland China

There is no special law for public construction in mainland China, thus the management process should have concerned all related construction laws, and the process can not only apply to public construction but also to all the other construction activities. Since different laws have varied application scope, the application rage of the management process in this paper is confined by the minimum scope of all the laws related. The management process is presented in Fig. 116.2, without the processes in shading with red letters.

Generally speaking, the management process maintained in mainland China is more rigorous, many illegal activities are clearly defined and regulated by severe penalties. Compared with Macao, government plays a more important role in supervising the construction performance. The development of neutral bodies,

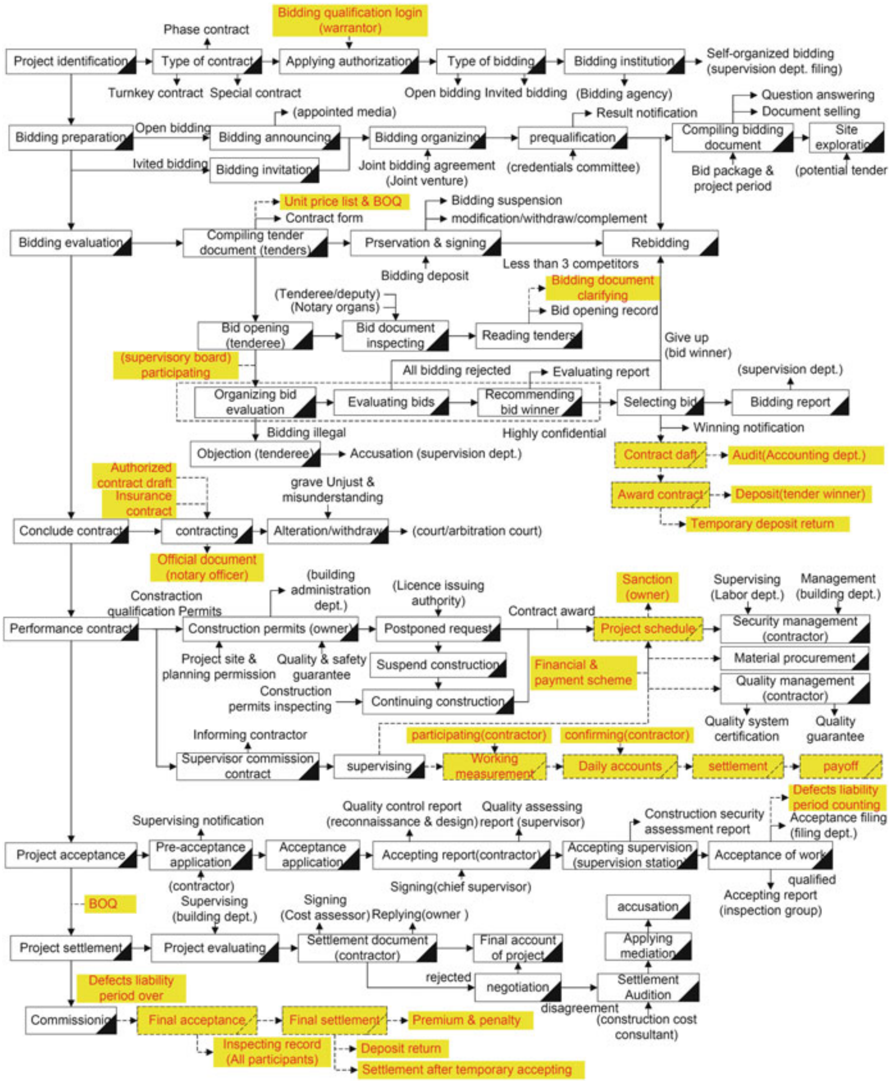

Fig. 116.2 Comparison diagram of management process of mainland public works construction

such as the tendering agency, the credentials committee and the bid evaluating committee, are conducive to the formation of a construction trading center, which contribute to the bidding fairness. However, the governmental supervision administration has responsibility in every single process in the project, which inevitably resulted in cumbersome procedures, and management inefficiency. What's more, corruption can be fostered by incorrectly empowerment. The disadvantages are:

- The functions and rights of the supervision engineer have not been clearly defined, and the working schedule cannot be well implemented because of lack of strict process review. The metrological functions are not standardized, and accounting needs more reliable foundation to work as a clear basis for payment.
- The contract is hard to alternate. The project has no detailed and accurate bill of quantity, project alternation always without a clear specified process, and having no process management to ensure the project on schedule and on budget.
- There's no process control in quality management, no awareness of quality control in covert projects, no effectiveness in implementation of quality management system, and no systematic quality management concept.

116.2.3 Reference Value Analysis for Mainland China

From the comparison above, there is a tendency for the public works construction law of Macao to manage the public projects in market principles and solve them in an economic manner. However, the laws of mainland China ensure an orderly and fair process through the administrative management and supervision. Their effectiveness also differs: Liberal market environment will bring about healthy free competition, but also may induce people to pursue benefit regardless of its legality, strict supervision is able to ensure the legitimacy of the management process, but also is able to make the project out of schedule and budget by an overstaffed bureaucracy and to give rise to corruptions by incorrectly empowerment.

A well performed public works project should guarantee a healthy free-market competition, but also have effective supervision to promote the continuous of free competition. Therefore, by a reference value analysis of public construction laws in Macao, the ameliorative management process of mainland China is suggested as Fig. 116.2, and several proposals are given as follows:

- Bidding: Transparency of the bidding process is to be promoted, and supervised by specialized administrative supervisor. To establish and improve the public participation system, the government should provide more information available to the public and more approaches for their participation in bidding.
- Quality management: The process quality control is tightened, and rigorous project review is conducted in a phased manner to put an end to invisible quality problems. Improving the functions of supervisor in quality management, making detailed record of quality assessment and problem solutions are the ways to form a unified and standardized quality management system. Establishing contractor database, considering the credit data of the contractors in the bidding evaluation, and introducing the guarantee mechanism for the tenders is also suggested.
- Schedule management: To establish reasonable and comprehensive process management procedure, it is supposed to make detailed and exhaustive working

plans by strict process review and scrupulous arrangements, and improve the supervision engineer's function on working schedule management.

- Cost management: The metrological function of the supervisor engineer would be better off if the settlement and payment procedures were based on the bill of quantity, and the financial schedule and payment scheme were connected with project schedule to improve the payment procedures.
- Contract disputing management: Establishing the review mechanism of project alteration, and improving implementation and payment processes in project alternation are the proposal ways. The alternation should be reflected in the bill of quantity and working schedule, so the contract disputes are reduced by well-defined responsibility of progress and fund operation.
- Overall management: the insurance mechanism of the project is improved by including the major project alternations in the insurance coverage, to introduce market mechanism to solve project alternation problems.

116.3 Case Study of the Hong Kong-Zhuhai-Macao Bridge

The selected case of this research is the management process of the Island & Tunnel Project of Hong Kong-Zhuhai-Macao Bridge Joint Venture of China Communications Construction Co., Ltd. To understand the characteristics of the management process and performance effectiveness, a comprehensive investigation has been conducted to the department of engineering, contract and planning, quality, general affairs, and etc. The island & tunnel project includes a huge immersed tube tunnel and two deep-sea artificial islands, is 7,440.546 m in length, and 63 months of contract period. The project is the largest target amount of transport infrastructure project in China, in the price of 13.1 billion yuan, and the most difficult part of the bridge. The bridge is the dash line indicated in Fig. 116.3, and the project is the part between two read points, which are the artificial islands.

The project has features of normal public works, but also has characteristics of corporative construction and management, design-build contract, as well as restrictions of complex navigation environment and time limitation. To meet the requirement of huge-scale and complex project like this, the joint venture has developed also a large-scale and complicated organization to conduct the management. In order to standardize the management organization and system, the Compilation of design-build Contract Management System for Island & Tunnel Project of Hong Kong-Zhuhai-Macao Bridge [13] are established by the project management department to manage the project. Relevant documents of HSE, quality and inspection management is separately compiled to regulate the project procedures. The management processes is sorted out and shown in Fig. 116.4.

As the project is a design-build contract, the actual period of construction blueprints determination is longer, and compiling of the bill of quantity is slower. The biggest obstacle in developing the working plan and cost control is the frequent

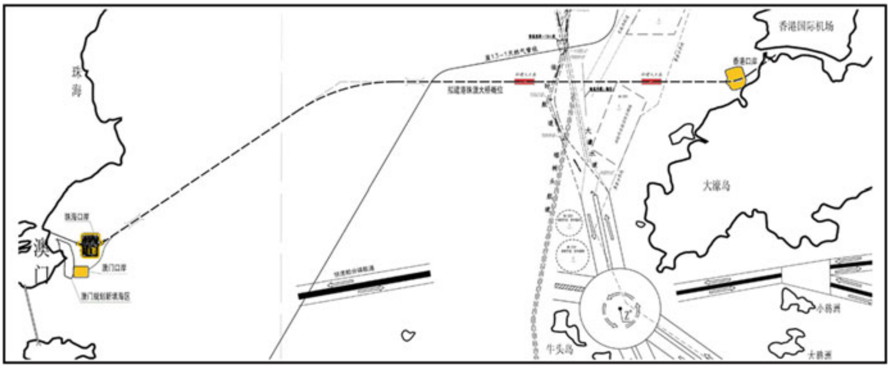

Fig. 116.3 General layout of the Hong Kong-Zhuhai-Macao bridge

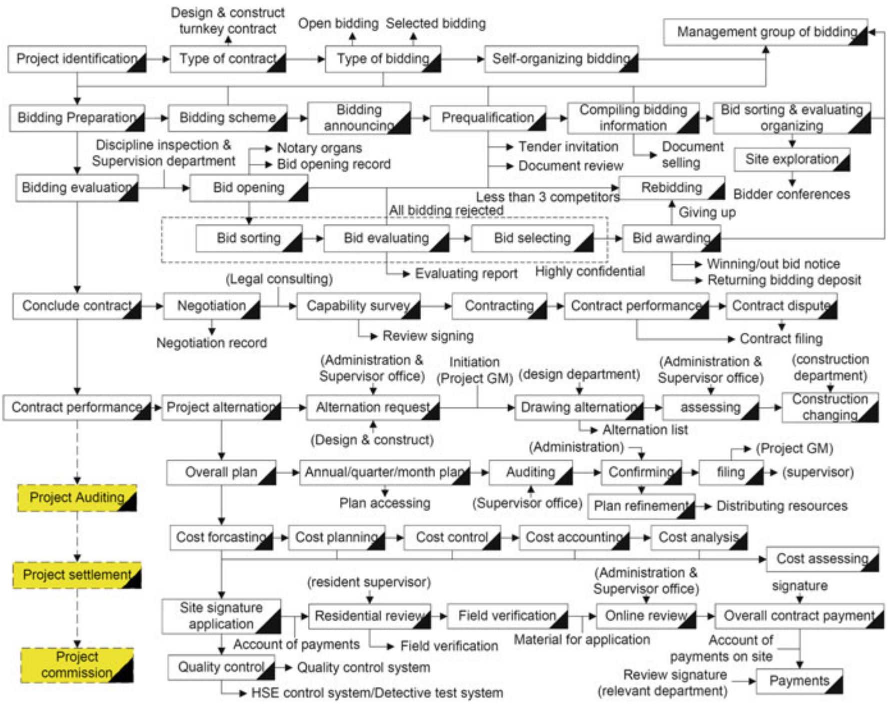

Fig. 116.4 Management process of the Island and Tunnel Project of Hong Kong-Zhuhai-Macao Bridge

alternation of the blueprints. The management measurements and their performance of the project are concluded as follows:

- Schedule control: A three phased planning management system has been introduced, including master plan, annual/quarterly plans, monthly/specific

plans, to gradually refine the implementation of the schedule and ensure feasibility and rationality of the plans. The key nodes and the overall schedule of the project are currently well controlled recently.
- Cost control: A two-stage management system has been established, where the entire system is separated into two parts: the project management department and the design division/working area. The cost management is optimized via PDCA cycle for continuous improvement. Currently, an independent cost management, differs from the owner, is conducted by the management department to get a budget control refinement and has achieved their expectations.
- Quality management: The concept of "primary quality & secondary quality" is carried out, and a two-stage management system just like the cost control is introduced to specify and deepen implementation of the quality management system. Quality management has recently achieved the overall quality target, of first time passing rate at 90 % by self-test and 95 % by supervision-test.

Generally speaking, the project management system currently adopted, based on the management system of the China Communication Construction Company, borrowed ideas from the management models of Hong Kong and Macao, and absorbed experience from outstanding international consulting firms, is relatively an integrated, effective and scientific management system. The project is in the good management of quality, cost, schedule, and contract disputes so far, however, the project is still in its early stage, the current management system is still facing a lot of challenges with technical promotion and further progress of the project.

116.4 Conclusions and Recommendations

In short, the imperfection of the construction law system is an important reason leading to the problems of public works management. It is necessary to study the overall process of the laws when discussing the problems of construction projects. This paper firstly compared the overall public works construction management process of existing law system of Macao and mainland China, to describe various characteristics of the construction management in different legal systems from a different perspective, and then clarified the relationship between rights and obligations of various participants involved, and proposed a reference value analysis to improve the construction law system and management system for mainland China.

By the comparison of management processes in two legal systems, it is concluded that the legal process of construction projects in mainland China is required to be reinforced, such as supervision function, payment procedures, project alternation process. The concrete improvements are proposed from aspects of quality, schedule, cost, and contract disputes. The Hong Kong-Zhuhai-Macao Bridge, as a case study, has been selected to assess the effectiveness of the improvement, four suggestions have been put forth: establishing quality management system to strengthen the quality process control, staying in process schedule by strict execution and review of working plan, improving payment procedures by pricing based on the bill of quantity, and clarifying the liability of quality, schedule, financing, and contract disputes.

A balanced management among quality, process, financing, and contract dispute in the construction process should be conducted, which means, the management should firstly maintain a strict process control in quality management, so as to resolve contract disputes, and control the project on schedule and budget.

Focusing on the problems prevalently exist in regulation efficiency, the authors recommend the government to establish a comprehensive supervisory system. The projects are mainly supervised by the construction management department, and supplemented by financial and administrative department, as well as the owner and intermediary organizations. The national and local people's congress should play an essential role in validating, approving, supervising and auditing of the projects in order to achieve construction and supervision separation.

This paper, however, is attempted to adopt a more comprehensive and innovative method to analyze the process of construction laws, and propose suggestions for improvement, which are then examined in a case study. It is proved that this analysis method is able to be applied to similar improvements in both legal processes and management processes, and provide valuable reference for future analysis of similar problems. However, the feasibility of various measurements in this paper remains to be further examined especially by public construction projects.

Acknowledgement The authors express their appreciations to each member of the Project Management Department for Island & Tunnel Project of Hong Kong-Zhuhai-Macao Bridge Joint Venture of China Communications Construction Co., Ltd. Special gratitude goes to TAO Weili, HAN Chao, LI Zhi, and LIU Gang for their eager help and sincere advices.

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Chapter 117
Financial Distress Early Warning Model for Listed Real Estate Companies of China Based on Multiple Discriminant Analysis

Yang Li, Hong Zhang, and Shuo Huang

Abstract This paper uses annual financial statement data of 99 listed real estate companies from A-share market, adopts multiple discriminant analysis to modify a Z-Score baseline model, and establishes a financial distress early warning model applicable to listed real estate companies in China. The findings indicate that the average accuracy of the financial distress early warning model reaches higher than 90 %, which is greatly improved from the previous Z-score baseline model. In the context of deepening adjustments in Chinese real estate industry, this model not only provides a reference indicator for business managers and market investors, but also helps policy makers timely evaluate the potential financial risks in real estate industry.

Keywords Financial distress • Early warning model • Multiple discriminant analysis • Listed real estate company

117.1 Introduction

The term financial distress (or financial failure in some literature) has different meanings, depending on the context. In a broad sense, financial distress can be used to indicate any condition when the business operation and financial circulation of a company fails to proceed normally or stagnates due to internal and external factors. To be specific, the financial distress of a company is a process, typically represented by persistent losses, events of default and insolvency, and finally corporate bankruptcy.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_117, © Springer-Verlag Berlin Heidelberg 2014

Real estate business, different from the general manufacturing industry, is characterized by large capital investment, long recovery cycle, high debt ratio and etc. In this instance, real estate enterprises in this capital-intensive industry are sometimes confronted with tense capital chain due to slow property sales, and thus leading to the financial distress. In 2008, under the influence of global financial crisis, a lot of property developers suffered from the capital pressure went bankruptcy, leaving the construction in a shutdown state (called as Làn Wěi Lóu in Chinese). The recent example is Top 10 Chinese property developer Greentown China (HKG: 3900). In September 2011, because of the corporate real estate trust business, Greentown triggered the investigation from China Banking Regulatory Commission and then the stock market worried about its tight capital chain. In 1 week from Sep. 22 to Sep. 27, the share price dropped by more than 30 %. The evidences above have preliminarily indicated that the financial distress in the real estate company has its own characteristics. As a consequence, how to establish a financial distress early warning model applicable to listed real estate companies has become the common issue to be solved for both academics and business managers in China.

The research on financial distress early warning model emerged in the 1960s. The application of financial statement analysis in the early warning model at the early stage is univariate models based on the single financial ratio, such as the ratio of cash flow to total debt [1]. Soon after, multivariate models were established with the multiple discriminant analysis (MDA) method, which drove financial distress early warning research into the period of the Z-Score model and its derivative models such as ZETA [2, 3]. Then, other nonlinear statistical techniques are introduced in financial distress prediction, such as Logit [4] and Probit methods [5]. The hybrid model integrated with the MDA and Logit method was also constructed to achieve the longer prediction length [6]. In China, the financial distress analysis and its early warning models developed rapidly along with domestic security market and accounting system. The F-score model (Failure Score Model) was established on the basis of Z-score model by adding the new variable to reflect the variant cash flow [7]. Similarly, with the application of MDA method to modify the Z-score model, another derivative model (referred as Z_0 model hereinafter) was proposed, and its predictive accuracy for financial distress is higher based on 120 listed companies randomly selected from A-share market [8].

Existing literature on financial distress early warning model mostly focuses on all listed companies, so the distinctive business model and the accounting feature in real estate companies is omitted in these models, which could be inapplicable. This paper attempts to make contributions by extending the financial distress research to real estate companies and furthermore with the application of the MDA method, the prediction accuracy for financial distress in real estate companies can be improved.

The remainder of the paper is structured as follows: Sect. 117.2 evaluates the prediction accuracy of two general models based on the financial statement of listed real estate companies from the A-share market, and recognizes the better one as the baseline model. Sect. 117.3 establishes a financial distress early warning model through the modification of the baseline model with the MDA method. Conclusions are presented finally in Sect. 117.4.

117.2 Baseline Model Selection Based on Predictive Accuracy of Financial Distress

Based on the predictive accuracy for financial distress, we can evaluate and compare two different early warning models, including the traditional Z-score model and its derivative Z_0 model applied for Chinese listed companies.

117.2.1 Basic Assumptions

In order to conduct the comparative research, we need distinguish financially distressed companies from listed companies in healthy financial state. Therefore, some basic assumptions need to be made to identify the judging rule and the forecast time limit for financial distress.

1. Take the ST firm[1] designated as the judging rule for financial distress
   According to the China Securities Regulatory Commission (CSRC) regulation of the special treatment mechanism, a listed company shall be classified as an ST firm if the audited results of the most recent two fiscal years show that it has suffered a loss. Simply speaking, all the ST firms are in terrible or abnormal financial situation, and thereby the use of special treatment as the judging rule for financial distress is reasonable for listed real estate companies in China which is also supported by previous researchers [7, 8].
2. Set the time limit of the financial distress early warning model as 5 years
   The aforementioned literature indicates that, the longest time of the early warning model for financial distress is 5 years. In other words, based on the data of a listed company in the financial year T, the early warning model is just capable to predict its financial situation before the year T+5. When the time limit exceeds 5 years, the forecast accuracy of financial distress sharply drops down as the year increases [6]. In this instance, the time limit of the early warning model is set as 5 years in this paper.

117.2.2 Sample Companies

According to the industry classification standard defined by the CSRC, we select 99 real estate companies listed on A-Share market as the sample. At the end of 2011, 99 listed real estate companies consist of 9 ST firms and 90 non-ST firms. Given that the predictive power is restrained within 5 years for early warning

[1] The term "ST", short for special treatment, is a unique delisting mechanism in China introduced by the China Securities Regulatory Commission (CSRC) in 1998.

Table 117.1 Descriptive statistics (unit: billion *yuan*)

Variables	Max	Min	Mean	MSE
Total asset	49.920	0.045	3.838	6.087
Total debt	32.466	0.038	2.502	4.171
Cash flow	26.246	−3.644	1.099	2.976
Net profit	2.423	−0.866	0.115	0.315
Retained earnings	5.234	−1.109	0.272	0.815

models according to previous research [2, 8], the basic dataset is sourced from the financial statement of the fiscal year 2006. In order to evaluate the predictive accuracy for listed real estate companies, the 99 companies are divided into two groups as ST and non-ST, containing 9 and 90 companies respectively. The descriptive statistics of the whole sample is provided in Table 117.1.

117.2.3 Baseline Model Selection

In order to assess the predictive accuracy of financial distress early warning model, the discriminant accuracy matrix is constructed, as shown in Table 117.2.

Table 117.2 describes a matrix used to assess the discriminant accuracy. H_1 and H_2 represent the number of correct discriminant samples; M_1 denotes the number of Type I error, which misclassifies ST firms as non-ST firms; M_2 denotes the number of Type II error, which misclassifies non-ST firms as ST firms. The sum of H_1, H_2, M_1 and M_2 represents the total sample. The ratio R that the sum of H_1 and H_2 accounts for the total sample can be sued to assess the model accuracy of the early warning, as below.

$$R = (H_1 + H_2)/(H_1 + H_2 + M_1 + M_2) \times 100\,\% \tag{117.1}$$

Following the discriminant analysis standards of Z-score model, the Z scores of ST firms should be less than 1.81, and that of non-ST firms should be larger than or equal to 1.81. In the case of Z_0 model, the value of ST firms should be less than 0.5, and that of non-ST firms should be larger than or equal to 0.5. Therefore, we can calculate the discriminant accuracy for each model based on the sample data of listed real estate companies, and the matrix is listed separately in Tables 117.3 and 117.4.

From Table 117.3, the discriminant accuracy of Z-Score model for listed real estate companies in China is $R_1 = (5 + 48)/(5 + 48 + 4 + 42) = 54\,\%$.

From Table 117.4, the discriminant accuracy of Z_0 model for listed real estate companies in China is $R_2 = (8 + 60)/(8 + 60 + 1 + 30) = 76\,\%$. By contrast, the accuracy of early warning for financially distressed real estate companies using Z_0 model is higher than using Z-score model. Accordingly, we use Z_0 model as the baseline model, and modify it with the financial statement of sample companies, and thus establish a financial distress early warning model applicable to listed real estate companies in China.

Table 117.2 Discriminant accuracy matrix

	Predictive grouping	
Actual grouping	ST firm	Non-ST firm
ST firm	H_1	M_1
Non-ST firm	M_2	H_2

Table 117.3 Discriminant accuracy analysis based on Z-score model

	Predictive grouping	
Actual grouping	ST firm	Non-ST firm
ST firm	5	4
Non-ST firm	42	48

Table 117.4 Discriminant accuracy analysis based on Z_0 model

	Predictive grouping	
Actual grouping	ST firm	Non-ST firm
ST firm	8	1
Non-ST firm	30	60

117.3 Financial Distress Early Warning for Listed Real Estate Companies

117.3.1 Early Warning Setup with the MDA Method

The baseline Z_0 model applies the MDA method in its modeling process, we follow this methodology to modify Z_0 model in line with the financial characteristics of listed real estate companies. The composition of Z_0 model is listed as in Eq. (117.2).

$$Z_0 = 0.517 - 0.460\ X_1 - 0.388\ X_2 + 9.320\ X_3 + 1.158\ X_4 \tag{117.2}$$

The definition and the calculation of each independent variable X_i ($i = 1, 2, 3, 4$) in Eq. (117.2) are described in Table 117.5.

In general sense, higher Z_0 value indicates for healthier financial situation of the company, and further results in lower possibility of having the financial distress. Then, we modify the Z_0 model with the MDA method, in the following steps:

1. Select predictive variables and group variables
   Select X_i ($i = 1, 2, 3, 4$) contained in Z_0 model as the predictive variables and define the group variable as 1 and 2, respectively for ST firms and non-ST firms. The descriptive statistics of two groups are listed in Table 117.6.

   From Table 117.6, we can find that, except the variable of capital/debt ratio (X_1), the average values of the rest predictive variables in non-ST firm group are greater than the ST firm group. Thus, it can be concluded, non-ST real estate companies perform better than ST companies, in terms of long-term, short-term solvency, current and accumulative profitability, and the sample data is to some extent proved to be appropriate.

Table 117.5 Definition and calculation of each variable in Z_0 model

Variable	Definition	Calculation
X_1	The long-term solvency of corporate capital	X_1 = total debt/total asset
X_2	The short-term solvency of corporate capital	X_2 = cash flow/total asset
X_3	The current profitability of corporate capital	X_3 = net profit/average total asset
X_4	Accumulated profitability of corporate capital	X_2 = retained earnings/total asset

Table 117.6 Descriptive statistics of predictive variables in two groups

Group	Variable	Mean	Standard deviation	Sample size
1	X_1	1.32	1.35	9
	X_2	−0.24	1.15	9
	X_3	−0.13	0.47	9
	X_4	−1.74	2.51	9
2	X_1	0.78	0.17	90
	X_2	−0.14	0.45	90
	X_3	−0.06	0.07	90
	X_4	−0.42	0.55	90

2. Test the significance of the discriminant function
By testing the eigenvalue of the discriminant function and its variance ratio, we can evaluate the explanation power of the discriminant function (see Table 117.7).
Seen from Table 117.7, the number of the function is one and its eigenvalue is 0.585. The variance ratio (to what extent total variance can be explained) reaches 100 %, which reflects the discriminant function has strong explanation power for the sample data. In the MDA method, the significance test is also required, as shown in Table 117.8. Wilks' λ is 0.231, $\chi 2$ statistics is 43.785, demonstrating the overall significance of the discriminant function.
3. Calculate coefficients in MDA function
The coefficients in the MDA function are listed in Table 117.9.
Based on the coefficients listed in Table 117.9, the specific form of financial distress early warning model can be given as in Eq. (117.3).

$$F = 0.236 - 0.178\ X_1 + 0.195\ X_2 + 0.610\ X_3 + 1.139\ X_4 \tag{117.3}$$

To clarify, the definitions of predictive variables in Eq. (117.3) are exactly the same as in Eq. (117.2).
4. Determine the discriminant standard
After reaching the early warning model, we need further determine the discriminant standard for financial distress. Based on Fisher's linear discriminant model [2, 9], the mean values of both groups can be calculated as F_1 and F_2. The mean values of non-ST firm group and ST firm group are 0.254 and -2.260 respectively. According to the symmetry classification rule, the turning point F^* is the average value of F_1 and F_2, so F^* is computed as $F^* = (F_1 + F_2)/2 = -1.0$.

Table 117.7 Eigenvalue and variance ratio of the MDA function

Function No.	Eigenvalue	Variance ratio	Accumulated ratio	Typical coefficient
1	0.585	100.0	100.000	0.608

Table 117.8 Significance test of the MDA function

Function	Wilks' λ	χ^{2-} stats	Dof	Sig.
1	0.231	43.785	5	0.000

Table 117.9 MDA function coefficients

Independent	Predictive coefficient
X_1	−0.178
X_2	0.195
X_3	0.610
X_4	1.139
Constant	0.236

Table 117.10 Predictive accuracy of discriminant analysis model

	Predictive grouping	
Actual grouping	ST firm	Non-ST firm
ST firm	8	1
Non-ST firm	1	90

Following the discriminant standard, we can substitute the financial statement of listed real estate company into the early warning model denoted as Eq. (117.3). If the score F is greater than –1.0, the company is financially healthy under normal status. On the contrary, if the score F is less than or equal to –1.0, the company is classified into financially distressed company under poor financial status.

117.3.2 Reverse Test Using Sample Data

By substituting the original sample data into Eq. (117.3) to calculate F values, we can re-group the sample companies based on the discriminate standard (see Table 117.10).

Table 117.10 shows that, the predictive accuracy of financial distress for listed real estate companies reaches $R = (8 + 90)/(8 + 89 + 1 + 1) = 98\,\%$, and improves by 22 % compared with the Z_0 model (76 %). The result here indicates that the early warning model modified based on the MDA method can provide more accurate prediction for listed real estate companies than Z_0 model.

The model robustness is very important for financial distress prediction. In sought to test the robustness of our model, we use 2007 financial statement of the

Table 117.11 Robustness test based on predictive accuracy

	Predictive grouping	
Actual grouping	ST firm	Non-ST firm
ST firm	8	1
Non-ST firms	3	87

same 99 listed real estate companies, re-calculate its predictive accuracy, the result as shown in Table 117.11.

Seen from Table 117.11, the predictive accuracy $R = (8 + 87)/(8 + 87 + 1 + 3) = 96\,\%$. Thus, it can be concluded that, this model keeps its high accuracy for financial distress, and the robustness is testified.

117.4 Conclusions

This paper provides a financial distress early warning model applicable to listed real estate companies in China, by using the multiple discriminant analysis method to modify a baseline Z_0 model. The model established in this paper has provided higher forecast accuracy for financial distress than other models. In the context of deepening adjustments in real estate industry and fast-changing global economy, the model can help business managers and market investors to recognize the potential financial risks in listed real estate companies, so as to take actions at the earlier stage to prevent from running into the bankruptcy or considerable losses.

This paper is mainly focused on the application of financial distress early warning research to analyze the listed real estate companies in China. However, the specific mechanism of the financial distress generating in real estate companies is not completely covered in this paper, the government policy on property sales, for instance. The research in the future can make in-depth explorations into this issue based on the characteristics in real estate business model, financial operation and accounting system, so as to further improve the applicability of the financial distress early warning research in real estate companies.

Acknowledgement We are grateful to the research support from the National Natural Science Foundation of China (No. 71073096).

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Chapter 118
Research on Negotiating the Transfer Price for T0T Project Financing Mode Based on Game Theory

Weichao Li

Abstract This paper extends the transfer-operate-transfer (TOT) concession model (Liu et al. 2002) to a new method for identifying a concession period by using bargaining-game theory. Transfer price is one of the most important decision variables in arranging a TOT-type contract, and there are few methodologies available for helping to determine the value of this variable. The previous model presents an alternative method by which determined are the win-win price level to furnish theoretic basis on which to form and decide the transfer price and TOT projects. Nevertheless, a typical weakness in using the previous model is that the model cannot recommend a specific time span for concessionary. This paper introduces a new method called TOT bargaining concession model to enable the identification of a specific concession period. The two parties concerned in engaging a TOT contract in the model are the investor and the government and their bargaining behavior is the key factor in the model.

118.1 Research Background

As we all know, TOT (transfer- operate- transfer) is a new kind of financing mode through the sale of existing assets for Incremental funding [1]. This approach is the use of private capital to operate infrastructure projects. This is an effective mode of exploiting private capital to operate infrastructure. The main objective of TOT financing model is to revitalize the stock assets and to improve the efficiency of operation of the project.

Infrastructure industry is characterized by the huge investment, long construction period, and comparative low rate of return. So in the mainland of China, the construction and operation of the infrastructure are conducted by the government,

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_118,

which leading to a state of low efficiency and monopolization [2]. So the private reform of the infrastructure in China is imperative. Now the most popular private participation in the infrastructure is the BOT. A build-operate-transfer contractual arrangement provides a mechanism for governments to use private finance and management skill. But in the mainland of China, we must consider the regime of state ownership and a lot of existing state-owned infrastructure. So the TOT model has more merits in the private participation.

118.1.1 Mitigating the Investing Risk

The foreigner invest the infrastructure must face a host of examine and approve, which increase the investment risk. But the TOT model makes the foreign enterprise and civil enterprise have more opportunity to participate the infrastructure industry. Adopting the TOT model, the investors avoid design and construction of the infrastructure, in which stage there are a lot of uncertain factors. But in the TOT model, the investors are just responsible for the running of the existing infrastructure [3].

118.1.2 Motivating the Operator

The revenue of the investors is associated with the operating efficiency of the infrastructure, which can take full advantage of the infrastructure and contributes the social welfare. Due to the less professional running of the government, the private participation can alleviate the fiscal burden or increase the tax income for the government.

118.1.3 Keeping the Property of State

After the concession period, the assets of the project free return to the government to keep the property of state, which is very significant to regulate and control the infrastructure [4]. So TOT is a comprise method that not only can induce the private capital to the infrastructure but also subtly avoid the ideology constraint.

The determination of the transfer price is the key factor of the model, as the price of the transfer directly affects both the investor's and the concerned government's interests. In general, a lower transfer price is more beneficial to the private investor. But if the price is too low, it will cause the loss of state assets. The debate is centered on the transfer price. What types of transfer prices are reasonable?

On the other hand, if the transfer price is too high, the investor will either reject the contract or be forced to increase the service fees during the operation of the project in order to recoup the investment and make a certain level of profit. Consequently, the risk burden of a higher transfer price will be shifted to the public who use the facilities. In a recent development, Liu et al. (2002) introduced the interest allocation model for helping identify a concession period interval, by adopting a method whereby the basic interests of the both sides can be protected. This article attempts to identify the transfer price under the aim to achieve a win-win for the TOT project, even though the different targets under the transfer pricing decision. The negotiation for this period is, in fact, a bargaining process. This paper examines this bargaining process by using bargaining-game theory to assist in identifying a specific transfer price.

118.2 Research Method

118.2.1 Existing Model

This research is the extension to an existing model, the TOT interest allocation model, introduced by Liu et al. (2002), which is based on the rationale that the transfer price in procuring a TOT-type project shall protect the basic interests of both the government concerned and the private investor.

Suppose the construction period of a infrastructure is T, the investment of the government is P_0 (for simple, P_0 is all invested at the first year), the average net revenue is L'_k (k = 1, 2, … , m) before transferring the project. After running m years, the project is transferred to the private investor. The concession period is n, the transfer price is P, supposed to be paid at the beginning of the concession period. After the end of the concession period, the government gets the infrastructure back, the residual value is M_0. For the government take high risk during the construction of the project, its rate of return is i_1, similar with the industry benchmark rate of return.

So when the government transfers the project, the NPV (net present value) of the government is

$$NPV_1 = \sum_{t=T+1}^{T+m} \frac{L'_1}{(1+i_1)^t} + \frac{P}{(1+i_1)^{T+m}} + \frac{M_0}{(1+i_1)^{T+m+n}} - P_0 \qquad (118.1)$$

Suppose that the government always operate the project by itself, the average net revenue is L_j (j = 1, 2, … , n), so the NPV of the government is:

$$NPV_2 = \sum_{t=T+1}^{T+m} \frac{L'_1}{(1+i_1)^t} + \sum_{t=T+m+1}^{T+m+n} \frac{L_1}{(1+i_1)^t} + \frac{M_0}{(1+i_1)^{T+m+n}} - P_0 \qquad (118.2)$$

The concession period of the private investor is n, during which the average net revenue is R_j (j=1, 2, ... , n). Even though the private investor do not have to take the risk of the construction, but his capital cost is higher than the government. The private rate of return i_2 is higher than i_1. The NPV of the private investor is:

$$NPV_3 = \frac{1}{(1+i_2)^{T+m}}\left(\sum_{t=1}^{n}\frac{R_1}{(1+i_2)^t} - P\right) \quad (118.3)$$

Then we can analyze the transfer price through the quotation. When the $NPV_1 = NPV_2$, we got the price P'_1. At the moment, the invest revenue of the efficiency raise is all distribute to the private investor. The government does not get any benefit, so it will have no enthusiasm to transfer the assets. When the $NPV_1 = NPV_3$, we got the price P'_2. The benefit from the TOT model is distribute to both side on average, by which the private investor lose his enthusiasm. To make both side satisfied, the appropriate transfer price should between P_1 and P_2, namely $P = \alpha P'_1 + (1-\alpha)P'_2$, $0 < \alpha < 1$ α is the interest weight that α is more bigger, the private sector gets more interest.

I think the last analysis distribute the interest from the view of both parties. In the following bargaining model, the interest will be distribute interest through the situation of the negotiation without considering the sunk cost.

118.2.2 Basic Principles of Bargaining Theory

Research in bargaining and game theory has already experienced a long history. Among the early contributors to the study in this field were Nash [5], Raiffa [6], and Harsanyi [7]. Bargaining theory deals with the situations where people interact rationally with each other, assuming that an individual's action depends essentially on what other individuals may do. The theory is commonly used to describe the situation similar to where a chess player thinks about all issues that may arise logically in the game [8]. Muthoo [9] opined that a bargaining situation is a situation in which two players have a common interest to cooperate but have conflicting interests over exactly how to cooperate. Muthoo [9] further opined that bargaining is any process through which the players try to reach an agreement. This process is typically time consuming and involves the players making offers and counteroffers to each other. There are a large number of analytical models examining bargaining process (for example, Nash 1950a, 1951; [6, 7, 9–13]). These models are based the following major assumptions: Rational Behavior, Information Sharing, Bargaining Payoff, Bargaining Cost and Time Value [14].

118.3 Negotiating for a Specific Concession Period in Committing a TOT-Type Contract

The benefit the government gets is :

$$NPV_1 - NPV_2 = \frac{1}{(1+i_1)^{T+m}}\left(P - \sum_{t=1}^{n}\frac{L_1}{(1+i_1)^t}\right) \tag{118.4}$$

The benefit the private investor gets is $NPV_{3.}$
The economic benefit arising from the transfer is B:

$$B = NPV_1 + (NPV_1 - NPV_2) = \frac{1}{(1+i_1)^{T+m}}\sum_{t=1}^{n}\frac{R_1 - L_1}{(1+i_1)^t} \tag{118.5}$$

Of course, the transfer can be accepted by both sides when the

$$P1 = \sum_{t=1}^{n}\frac{L_1}{(1+i_1)^t} < P < \sum_{t=1}^{n}\frac{R_1 + L_1}{(1+i_i)^t} = P2,$$

$$P = \beta P_1 + (1-\beta)P_2, 0 < \beta < 1$$

The parameter β in the TOT interest allocation model is the bargaining focus. The β presents a numerical interval, suggesting that any value P within the interval is an effective concession solution that can protect the basic interests of the both sides. The two players (the government concerned and the private investor) will need to negotiate for a specific value within the interval through a bargaining process. According to the principles of bargaining theory discussed previously, each side will wish to gain maximum benefit. The two players will bargain until they reach to a point where both sides will receive some benefits that are more than or at least equal to their basic expectations. This bargaining process can be illustrated in Fig. 118.1.

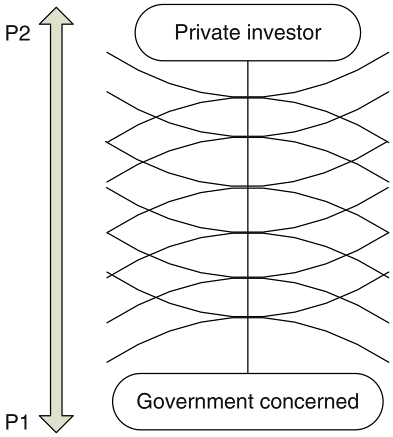

Fig. 118.1 The profile of the utility gains by the government concerned and the private investor

118.4 Bargaining Process of Identifying the Transfer Price

In a typical bargaining exercise, it is demonstrated that there is a little advantage to the player who offers first [14]. The following discussions consider two scenarios where the first round offer is given respectively by the government concerned and the investor.

The government makes an offer first. Let Q_g denote the maximum payoff and q_g for the minimum payoff that the government can receive if the government's offer is accepted in the first round of bargaining. And let Q_p and q_p denote respectively the maximum and minimum payoffs that the investor can receive from his counteroffer if he rejects the government's offer. While making the offer, the government will consider the possibility that the investor may reject the offer and initiate a bargaining. In order to reduce the chance of a further bargaining, thus saving the cost of time value, the government should make a reasonable offer by analyzing simultaneously the investor's position. If the offer is not attractive to the investor, according to the rule of rational behavior, the investor will reject the offer and propose a counteroffer. However, to propose the counteroffer, the investor will bear the bargaining cost f_p and the cost of time value (by applying the discount rate γ_p); thus, he can get a minimum payoff $\gamma_p q_p - f_p$ and a maximum payoff $\gamma_p Q_p - f_p$ [15]. Therefore, the government's best strategy is to make a first-round offer that can allow the investor to gain a similar range of payoffs to what the investor would gain from his possible counteroffer.

As discussed previously, the total benefit from operating a TOT infrastructure during a project's economic life is measured by B, and this benefit will be shared between the government and the investor. Accordingly, using the government's best strategy will allow it to get a minimum payoff $B - (\gamma_p Q_p - f_p)$ and a maximum payoff $B - (\gamma_p q_p - f_p)$. Nevertheless, as assumed, the government expects a maximum Q_g and a minimum q_g payoff from its first-round offer strategy. Therefore, the above discussions lead to the formulation of the following inequalities:

$$Q_g \leq B - \left(\gamma_P q_p - f_p\right) \tag{118.6}$$

$$q_g \geq B - \left(\gamma_P Q_p - f_p\right) \tag{118.7}$$

To look at this scenario further, assume that the investor does make a counteroffer. By using a similar analogy to that applied above, the investor should propose a reasonable counteroffer by analyzing carefully the government's position. In this case, the government may make a further counteroffer, and if it does, the government will bear twice the bargaining cost (namely $2f_g$) for producing the first offer and the further counteroffer. The government will also bear the cost of time value (by applying the discount rate γ_g). Therefore, the government can get a minimum payoff $(\gamma_g q_g - 2f_g)$ and a maximum payoff $(\gamma_g Q_g - 2f_g)$ if it makes a further counteroffer. Having realized this possibly further counteroffer by the government, the investor's best strategy is to make an offer that allows the government to gain a similar range of payoffs to what the government can gain if bargaining continues to the next round. As a result, the investor can get a minimum payoff $B - (\gamma_p Q_g - 2f_g)$ and a maximum payoff $B - (\gamma_p q_g - 2f_g)$. Considering that the investor expects a maximum Q_p and a minimum q_p payoff, the following inequalities can be formulated:

$$Q_p \leq B - \left(\gamma_g q_g - f_g\right) \tag{118.8}$$

$$q_p \geq B - \left(\gamma_g Q_g - f_g\right) \tag{118.9}$$

By applying Eqs. (118.6) and (118.7) to Eqs. (118.8) and (118.9) respectively, the following results can be obtained:

$$Q_g \leq \left[\left(1 - \gamma_p\right)B - 2\gamma_P f_g + f_p\right] \Big/ \left(1 - \gamma_P \gamma_g\right) \tag{118.10}$$

$$q_g \leq \left[\left(1 - \gamma_p\right)B - 2\gamma_P f_g + f_p\right] \Big/ \left(1 - \gamma_P \gamma_g\right) \tag{118.11}$$

As Q_g denote the maximum payoff and q_g for the minimum payoff for the government t, the inequalities (118.7) and (118.8) lead to the following:

$$Q_g = q_g = \left[(1 - \gamma_P)B - 2\gamma_P f_g + f_p\right] \Big/ \left(1 - \gamma_P \gamma_g\right) \tag{118.12}$$

Therefore, the consequence of the bargaining is that the government will receive an extra payoff Qg or qg, and a upper boundary of transfer price will be P_u .

So the government can get the benefit:

$$\left[(1 - \gamma_P)B - 2\gamma_P f_g + f_p\right] \Big/ \left(1 - \gamma_P \gamma_g\right)$$

Namely,

$$\frac{1}{(1+i_1)^{T+m}}\left(P_u - \sum_{t=1}^{n} \frac{L_1}{(1+i_1)^t}\right) = \left[(1 - \gamma_P)B - 2\gamma_P f_g + f_g\right] \Big/ \left(1 - \gamma_P \gamma_g\right) \tag{118.13}$$

By examining the situation that the investor makes an offer first, the same procedure may be easily adapted to obtain inequalities for private investor:

$$Q'_p \leq \left[\left(1 - \gamma_g\right)B - 2\gamma_g f_p + f_g\right] \Big/ \left(1 - \gamma_P \gamma_g\right) \tag{118.14}$$

$$q'_p \leq \left[\left(1-\gamma_g\right)B - 2\gamma_g f_p + f_g\right] \Big/ \left(1-\gamma_P\gamma_g\right) \tag{118.15}$$

As Q_g denote the maximum payoff and q_g for the minimum payoff for the government t, the inequalities (118.14) and (118.15) lead to the following:

$$Q_g = q_g = \left[\left(1-\gamma_g\right)B - 2\gamma_g f_p + f_g\right] \Big/ \left(1-\gamma_P\gamma_g\right) \tag{118.16}$$

Therefore, the consequence of the bargaining is that the government will receive an extra payoff *Qp* or *qp*, and a lower boundary of transfer price will be P_L.

So the private investor can get the benefit:

$$\left[\left(1-\gamma_g\right)B - 2\gamma_g f_p + f_g\right] \Big/ \left(1-\gamma_P\gamma_g\right)$$

namely,

$$\frac{1}{(1+i_2)^{T+m}}\left(\sum_{t=1}^{n}\frac{R_1}{(1+i_2)^t} - P_L\right) = \left[\left(1-\gamma_g\right)B - 2\gamma_g f_p + f_g\right] \Big/ \left(1-\gamma_P\gamma_g\right) \tag{118.17}$$

Referring to Eqs. (118.13) and (118.17), the new transfer price interval is derived as $(P_{L,}\ P_u)$, When the bargaining process continues, further new intervals can be formed by repeating the above analytical process. The interval will gradually converge on a specific point, for example, after *n* times of bargaining, and there should be an equation at this point. $P_L = P_u$

Nevertheless, in the application, it is difficult to find a perfect converging point. By using δ, any point within the converging interval (P_L, P_u) that is derived from *i* times of bargaining is considered an agreeable concession period if the following criterion can be met:

$$(P_u - P_L)/B = \delta \tag{118.18}$$

118.5 Application of BOT Bargaining Concession Model

A power plant was built in 1990 and was put into operation in 1994. The project total investment was 3.2 billion yuan. In 1999, the power station was conducted the TOT model. The TOT contract stipulates: the concession period of 20 years, promise tariff of 35 cents/kWh, the production benchmark of 6.6 billion kWh/year, residual values of 1.28 billion yuan (40% of total project 3.2 billion investments).

For the traditional power industry, the industry's benchmark rate of return is 12 %, so take i_1 as 12 %; the tariff of the project site is generally 0.30 yuan/kWh and the cost of power generation in general is 0.24 yuan/kWh; the tax rate of power generation is for 15 %. Supposed the transferee request the return on investment was 15 % (i_2 = 15 %); due to the high efficiency of the privatization of enterprises, the cost of power generation reduced to 0.134 yuan/kWh. Tax rate of power generation is still 15 %.

Net cash flow before and after the transfer based on the above data, is calculated:

$$\begin{aligned} \mathrm{R_i} &= (0.35\ \mathrm{yuan/kWh} - 0.134\ \mathrm{yuan/kWh}) \times 6.6\ \mathrm{billion\ kWh} \times (1-0.15) \\ &= 1.221\ \mathrm{billion\ yuan}\ (\mathrm{i} = 1, 2, \ldots, 20) \end{aligned}$$

$$\begin{aligned} \mathrm{L'_k} = \mathrm{L_j} &= (0.3\ \mathrm{yuan/kWh} - 0.24\ \mathrm{yuan/kWh}) \times 6.6\ \mathrm{billion\ kWh} \times (1-0.15) \\ &= 0.337\ \mathrm{billion\ yuan}\ (\mathrm{k} = 1, 2, \ldots, \mathrm{m}; \mathrm{j} = 1, 2, \ldots, \mathrm{n}) \end{aligned}$$

Referring to Eq. (118.1), $\mathrm{NPV_1} = -14.74$

Referring to Eq. (118.3), $\mathrm{NPV_3} = 21.57 - \frac{P}{(1+0.15)^9}$

When the objective function is $\mathrm{NPV_1} = \mathrm{NPV_2}$, solve the equation to gain $P'_1 = 2.515$ billion yuan. When the objective function is $\mathrm{NPV_1} = \mathrm{NPV_3}$, solve the equation to gain $P'_2 = 7.037$ billion yuan.

In the bargaining model,

$$B = \frac{1}{(1+i_1)^{T+m}} \sum_{t=1}^{n} \frac{R_1 - L_1}{(1+i_i)^t} = 2.381$$

the following assumptions are used: $\mathrm{f_g} = \mathrm{f_p} = 2$ million yuan ; $\gamma_\mathrm{g} = \gamma_\mathrm{p} = 0.98$; and $\delta = 10\ \%$.

$$\frac{1}{(1+i_1)^{T+m}} \left(P_u - \sum_{t=1}^{n} \frac{L_1}{(1+i_1)^t} \right) = \left[(1-\gamma_P)B - 2\gamma_P f_g + f_p \right] \Big/ \left(1 - \gamma_P \gamma_g \right) = 1.154,$$

$\mathrm{P_u} = 5.717$ billion yuan

$$\frac{1}{(1+i_2)^{T+m}} \left(\sum_{t=1}^{n} \frac{R_1}{(1+i_2)^t} - P_L \right) = \left[\left(1-\gamma_g\right)B - 2\gamma_g f_p + f_g \right] \Big/ \left(1 - \gamma_P \gamma_g \right) = 1.154,$$

$\mathrm{P_L} = 5.919$ billion yuan

$$(\mathrm{P_u} - \mathrm{P_L})/\mathrm{B} = (5.919 - 5.717)/2.318 = 8.7\% < 10\%$$

The above calculation suggests that the transfer price range is (5.717, 5.919) yuan.

118.6 Conclusions

In the TOT project, the government wants a higher transfer price so that he can recoup his initial investment. But the private investor procures a lower transfer price to decrease his investment. In the transfer price determining process, we can firstly identify the price range that the government concerned and the private investor both get interest. What is the ultimate transfer price in the range is related to the different bargaining parameter of both sides. Then we could exploit the bargaining model the paper discussed to find a more precise price. We can conclude that the bargaining model of TOT transfer price supply a model that can estimate the transfer price precisely.

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Chapter 119
Strategy Selection of the Government in Monitoring the Quality of the Economical Housing Project: Based on the Research on the Economical Housing Market in Xi'an

Donglang Yang and Qiaowei Fu

Abstract Economical housing, with the double nature of commodity and protection, is a kind of policy housing that is built in accordance with a reasonable construction standard through the government provides preferential policies, limited to the dwelling size and selling price. Based on the status of quality monitoring of the economical housing project in China, This paper set Xi'an economical housing market for example, through researching on it to further elaborate the problems of traditional quality monitoring and control system of economical housing in actual operation and necessity for the government to transform quality monitoring and control strategy of economical housing. Finally, this paper find out the key and a valid path that promote real estate developers to change from "adapt to economical housing project quality supervision" to the "autonomous to assure" through analyzing behavior decision-making process of government and real estate developers in economical housing quality monitoring and control with the help of the game model. This can provide ideas to enhance the efficiency of monitoring the quality of China's economical housing project and to update the regulatory model of economical housing project.

Keywords Economical housing • Project quality • Supervision strategy

119.1 Introduction

119.1.1 Background and Literature Review

In recent years, with the speeding up of industrialization and urbanization, more and more people go from the countryside to cities, then, economical housing construction scale expands unceasingly. For quality supervision, our country executes a kind

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_119,

of management mode that the construction and administrative department under the state council is responsible for the national economical housing, the local people's government at or above the county level or the real estate construction administrative departments is responsible for economical housing management in their own administrative areas. According to their duties and the division, the development and reform, price, censorial, finance, land resources, tax and financial management departments from the people's government at or above the county level implement supervision and management in the areas of responsibility.

Although the supervision system in the economical housing development and the construction process played a very important role, this kind of supervision model is still the government-led economical housing project quality control system. With quality problems emerge in endlessly, for example, HuiZe garden district of chenzhou. This research has important meaning in improving the economical housing which is the biggest local economical housing project in hunan province, appear ceiling transverse rupture and other serious engineering quality problems, something originally is good for the people drew more controversy, make traditional government-led economical housing project supervision and management model come under suspicion, therefore, in the present situation, the comprehensive analysis in the government-led economical housing project supervision system in our country and control system of the enterprise's own, especially the government actually should take which way and from which respect for economical housing project supervision and management project quality supervision efficiency, balancing different interest demands between business and government.

There is not so much research about economical housing project quality supervision. Liang Jing [1] did some research on the quality question of economical housing from the perspective of positioning failure of government function, points out that the real estate development enterprise is directly responsible for the construction and sales of the economical housing. Developers and enterprise, to a certain extent, as equal market economic body, their starting point of all activities are based on profit. The government's regulatory absence caused that there is no obvious price difference between economical housing and commodity house, poor quality and so on a series of problems. The government should be responsible for making up for the shortage of market mechanism, not substitute market. In the implementation process of economical housing policy, improper implementation, to intervene to market too deep, too broad scope, away from the normal government function are also harmful to the normal operation of the market mechanism [1]. Hu Hailin et al. [2] did some research on the quality control problems from the perspective of economical housing construction investment and points out that the low cost of economical housing project decides to low profits of the parties. As a contractor, suppliers, reducing cost and pursuing the biggest profits is always its target. If we do not finish good quality control, this will lead to lower the quality of projects in the event. If you don't do well in beforehand control, once appear quality problem, it will influence making a room, so that the sales very likely [2].

119.1.2 Research Framework

The government is the macroscopic guide and the supervisor in the process of the enterprise's economical housing project quality control and management, enterprise is the microcosmic body and direct performer [3].

In the current government-led economical housing project quality supervision control system, the enterprise passively accept and implement rules and regulations, management measures made by the government, at the same time, the enterprise form its own economical housing quality control system based on this. The paper will define this as "adaptive economical housing project quality supervision" mode. Along with the expansion of economical housing market in our country and constantly complicated development environment, this kind of traditional government mandatory regulation method already do not adapt to the development of economical housing market – regulatory effect is not good. Real estate development enterprises shall undertake its own responsibility of economical housing project quality control, strict self-discipline, to construct the enterprise-led quality assurance system, improve the efficiency of quality control, this paper will define such supervision model as "independent economical housing project quality supervision" pattern, set xi'an economical housing market as an example, through the case investigation, further elaborates on the existing problems that appear when the traditional supervision system is in the actual operation and the necessity of transforming function for the government, at last, through the Game model to analyze the behavior decision-making process of government and enterprise in economical housing quality supervision and control, and then, find out an effective way that realize the government's regulatory strategies selection.

119.2 Economical Housing Market Case: The Traditional Quality-Control System

119.2.1 Research Results of Xi'an Economical Housing Project Quality: The Necessity for Government to Change Regulatory Strategy

A set of regulatory system is effective or not is not how much system is establishment – a complete system, if cannot be put in good implementation, its effectiveness is zero, might even be a negative value. To set xi'an economical housing market as an example, the article adopt the qualitative research method – make an on-the-shot investigation into the actual effect of economical housing development and construction and residents satisfaction in the present government-led economical housing project control system. The specific methods: selected 15 economical housing projects in xi'an (Feng yun lan wan, xuanwu garden, Oriental courtyard and so on), and then selected 1 owner in every project randomly as interview object, encoded each object, and then depth interview, through the interview, we got some information about the economical housing quality. The results show that, during the 15 owners, there are 8 owners are not satisfied to the purchasing experience. For example, NO.1 owner said that the construction quality of economical housing is very poor, the wall have crack; The specific is shown in Table 119.1.

We can draw the conclusion that we must put more attention to economical housing project control, otherwise, it will bring more economic and social problems.

Table 119.1 Interview results about xi'an economical housing quality problem

Quality problem type	Project	Construction area(m^2)	Average selling prices (yuan/m^2)	Owner said
Design quality	Natural courtyard	175,084	3,100	NO.6 "all the windows in the stair are fixed, have no ventilation in summer, the houses are not north-south transparency"
	Chang an yiju	210,000	2,600	NO.10 "Across the street is the construction of substation, which will have great influence on the resident – electromagnetic radiation within 500 m"
Construction quality	Feng yun lan wan	300,000	3,700	NO.1 "I'm on building 18, our house had just finished decoration more than a week, I found that sitting room and the other two rooms all have a long crack on the wall"
	Tang Du warm springs garden	145,000	2,600	NO.8 "Seeing the cracks in the balcony, I feel horrible and also concerned about it, such a heavy cement down from here, is no laughing matter"
	oriental courtyard	80,000	2,987	NO.4 "The contract of economical housing project – oriental courtyard written expressly elevator for joint venture elevator, but now for domestic 'Montgomery' brand"
After-sales service quality	Xuanwu garden	49,000	2,912	NO.3 "Our district is a family-based management, does not satisfy the contract conditions to make a room, and we can't ask for it, so long as the owner asked about this matter, developers will be very angry, like the appearance of the fight"

(continued)

Table 119.1 (continued)

Quality problem type	Project	Construction area(m^2)	Average selling prices (yuan/m^2)	Owner said
	Big garden	170,000	2,250	NO.14 "I bought 53 # economic room of big garden in 2008, in the contract, the date that pay for room on is December, 2008, but by December 2009, no news, no one answer the phone also"
	Daniel century splendid	500,000	3,600	NO.15 "the entrance of each unit stays a dump, decorate garbage, life rubbish what all have, fly all over the place"

119.2.2 The Existing Problems on Present Quality Supervision Model

1. The relative displacement of the regulation target between the central government and local government. The enterprise follow the general guidelines made by the central government in development and construction of economical housing, and then implement by local governments according to the local actual situation. For the central government, the main goal of implementing economical housing construction is to solve the housing problem of the low-income family and to promote harmony and development of the whole society; The state set development and the construction of economical housing as the content of local government performance appraisal, so for local government, it will pay more attention to short-term benefits and construction quantity of the economical housing, neglect economical housing quality supervision. In the process of economical housing's development and construction, the local government is the main supervision.
2. The regulatory system are not perfect. The existing economical housing project supervision system is mostly for project application that is market access supervision before the project construction, to project construction period, the quality supervision and management system is in deficiency. This leads to just value the project application etc. of the early work, once the application is successful, in the process of project construction, the real estate developers do not pay attention to the quality guarantee. Especially for inferior quality problem, there is no more concrete processing and control measures to develop and implement.
3. The power rent-seeking phenomenon is seriously, the regulatory system become a mere formality. Although our country's supervision mechanism has been

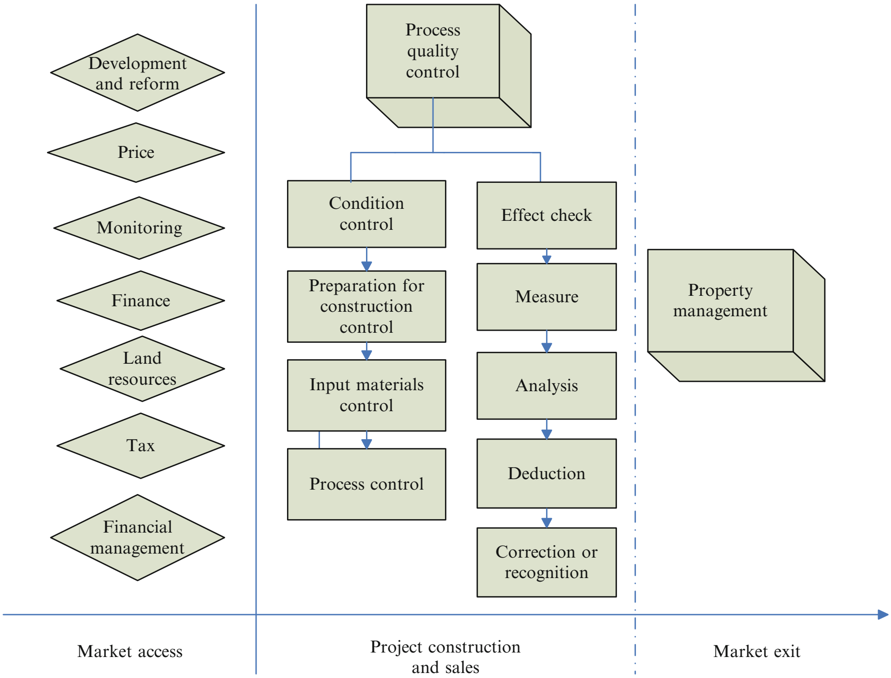

Fig. 119.1 Real estate developers' own project quality control system

relatively systematic and diversified, the government behavior which is out of control is not getting good control, more and more money-power trades bring unqualified developer into the housing market, and disturb the order of the economical housing market, then make the economical housing supervision system stay in an almost state of vacuum.

119.2.3 Economical Housing Project's Own Supervision Mode

The government formulated economical housing layout and construction system, price making, sales management system, listed trading system, supervision and management system, and so on, but these are basically made by the government, the market is responsible only for concrete implementation, which contributed to the formation of the real estate developers' own project quality control system (see Fig. 119.1), this system emphasizes "control", that is, to build passively and not independently under the government's instruction and guidance [4].

In this passive environment, relative to the commodity house, enterprise's idea for economical housing project quality control has been in serious distortion.

1. Excessive cost control. Following the principle of small profit, the economical housing sales execute government guided-price, and it cannot be altered casually. Undoubtedly, this will increase the investment risk. Because of the nature of rational economic man, in order to seek more interest, real estate developers must control cost strictly. For example, the survey found, economical housing project often choose construction team whose price is low.
2. Ignore quality supervision. Economical housing's small profit and the supervision of government to economical housing quality is not in place, especially now, living demand and investment demand inflate constantly, there is no difficult in economical housing sales. Many of those factors commonly cause that the economical housing developers don't care about project quality basically.
3. Lack of service management. The after-sales services of economical housing much couldn't keep up with others, the survey found, the economical housing owner once discover quality problem, developers cannot give a very good solution mostly, and bad attitudes.

119.3 The Game Analysis

119.3.1 Model Assumption

In this model, the participant are rational, that is to say, they are pursuing their own best interests; The information is not complete, that is, the game both parties have no accurate understanding to each other's characteristics, action rule and the utility function [5].

1. Game player and its action. This paper mainly studies the game between the government and enterprise, so there are two participants – the government and enterprises. For the government, there are two strategies, one kind is to stick to traditional regulatory model, the government leading, namely the adaptive control. Another kind is to reduce government intervention, encourage enterprises to consciously assume quality supervision, namely the independent regulation. And the economical housing development enterprises also have two options: positive execution and passive resistance in this regulation mode.
2. Utility function. The utility functions of participants are not only affected by their own actions, but also by the action with each other. The utility mainly depends on three factors: the profits when the economical housing quality improved, including both public revenue and the enterprise's private gains. The second is the costs that must be input to strengthen the supervision and management of economical housing. The third is risk cost that is punished when implement illegal operation.

119.3.2 The Game Model of Government-Enterprise About Economical Housing Quality Supervision

1. The construction of comprehensive strategy game model. In the economical housing project supervision, the government and enterprise, as the participants of the game, have their own strategies, each strategy choice has its own cost that must undertake and profits. As shown in Table 119.2.

   According to the analysis above, we can draw the Game matrix between the government and enterprises, as shown in Fig. 119.2.
2. Game model analysis

   In the model, the government's mixed strategy is (p, 1−p), that is, the probability for government to adopt adaptive regulatory is p, independent regulatory is 1−p; Similarly, enterprise's mixed strategy is (q, 1−q), namely, the probability for enterprise to adopt positive quality control is q, passive resistance is 1−q.

In the game, when the player is not clear about other player's actual strategy selection, his strategy is uncertain, for this, people can predict their benefits only by the way of calculating expected return.

The government's expected return for:

$$\begin{aligned}\mathrm{U1}\ (\mathrm{p},\mathrm{q}) = {} & (\mathrm{c}-\mathrm{h}-\mathrm{e})\mathrm{pq}+(\mathrm{c}-\mathrm{e})\ (1-\mathrm{p})\mathrm{q}+(\mathrm{d}-\mathrm{h})\mathrm{p}(1-\mathrm{q}) \\ & +(-\mathrm{s}-\mathrm{e})(1-\mathrm{p})(1-\mathrm{q})\end{aligned} \tag{119.1}$$

Similarly, enterprise's expected return for:

$$\begin{aligned}\mathrm{U2}\ (\mathrm{p},\mathrm{q}) = {} & (\mathrm{e}+\mathrm{r}-\mathrm{g})\mathrm{pq}+(\mathrm{r}+\mathrm{e}-\mathrm{g})\ (1-\mathrm{p})\mathrm{q}+(-\mathrm{d})\mathrm{p}(1-\mathrm{q}) \\ & +\mathrm{e}(1-\mathrm{p})(1-\mathrm{q})\end{aligned} \tag{119.2}$$

In the formula (119.1), for partial derivative of p:

$$\frac{\partial U}{\partial P} = d+s+e-h-(d+s+e)q \tag{119.3}$$

Make formula (119.3) = 0, draw: $\mathrm{q} = 1-\dfrac{h}{d+s+e}$

In the formula (119.2), for partial derivative of q:

$$\frac{\partial U}{\partial Q} = r-g+(e+d)p \tag{119.4}$$

Make formula (119.4) = 0, draw: $p = \dfrac{g-r}{e+d}$

We can conclude that when the government supervise with the probability $p=\frac{g-r}{e+d}$, the enterprise take a positive quality control with the probability $\mathrm{q} = 1-\frac{h}{d+s+e}$, both sides receive the largest utility – reach the balance of interests.

Table 119.2 The costs and benefits of government and enterprise in the game

The government		Enterprise	
Letters	Items	Letters	Items
h	Supervision and examination expenses	g	The required fee when actively implement quality management according to the government's request
c	Public interest brought when the enterprise control quality positively	r	Brought extra private gains because of standard management
e	Support fund every year	d	Punishment capital that the enterprise pay when it passively resist government's quality management, then discovered by the government
d	Punishment capital that the enterprise pay when it passively resist government's quality management, then discovered by the government	e	1. Support fund every year 2. Support fund the government deduct when enterprise Passively resist on government quality management, and then discovered by the government
s	The government loss when the government implement independent supervision, enterprise did not cooperate with		

		enterprise	
		Positive execution	Passive resistance
The government	Adaptive supervision	(c-h-e, e+r-g)	(d-h, -d)
	Independent regulatory	(c-e, r+e-g)	(-s-e, e)

Fig. 119.2 The game matrix government and enterprise

The government has all kinds of measures that require the enterprises to carry out, but these policies may not conform to the enterprise's actual situation, so, in the whole process of policy implementation, the enterprise just accept passively, caused the enterprise's own regulation enthusiasm is not high, and the regulation efficiency is low.

According to the results of the Game model of comprehensive strategy, in order to improve the probability of the enterprises to actively carry on quality control, we can reduce h (supervision and inspection fees, which means to reduce the number of inspection), improve d (punishment capital that the enterprise pay when it passively resist government's quality management, then discovered by the government), e (the support capital the government provide to every year), and the proper enlargement of s (the government loss when the government implement independent supervision, enterprise did not cooperate with).

119.4 Conclusion

We Comprehensively concluded that the government should gradually reduce unnecessary intervention on real estate development enterprise, but adopt market regulation means to incentive and promote enterprise's own strengthen to economical housing quality supervision, enhance the pertinence and effectiveness of the government and enterprise both in economical housing quality supervision and control and finally achieve a goal that the supervision system change from the government-led "adaptive supervision" to enterprise-led "independent regulatory".

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Chapter 120
A Combination Forecasting Model for Fast Cost Estimating in Civil Engineering

Xun Liang

Abstract This paper tries to make a model based on fuzzy mathematics, Grey model and regression model, exploring methods to estimate the project cost quickly. Firstly, the similar projects are found by the similarity measures in the fuzzy mathematics. Secondly, Grey interconnects degree helps to find the main factors affecting the project cost. Finally, these main factors establish the regression equation. This model is applied to analyze data from the construction projects cost in Guangzhou, indicating the effectiveness and practicality of the model. By comparison with the single models, the civil engineering cost is estimated quickly and accurately, while the combined model improves the limitations of a single model, accuracy and reduce the prediction errors.

Keywords Fuzzy mathematics • Grey model • Regression model • Civil engineering • Fast cost estimating

120.1 Introduction

The investment in the civil engineering mostly has a large amount, so that accurate forecasting cost estimation is concerned for the scale and the design of the project, which will be helpful for the implement of the civil engineering. Cost estimating of the project is based on data of preliminary design and quota which are still rough in the early design phase. Although the similar construction cost can be reference resources, each building is different from the others. So it is hardly to get the accurate engineering quantity without detailed design drawings in the early design stage. Thus, the cost of the project is hardly determined which is based on the quantity and quota.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_120,

In the end, accurate fast cost estimating methods are wildly discussed, including Grey Model [1, 2], Fuzzy Mathematics [3], liner regression analysis [4] ,case-based reasoning method [5], Neural Network [6], and so on. These methods had good effects on different application scope. Grey model has the accuracy only on the basis of the similarity of the constructed engineering. Fuzzy mathematics method has to be subjective with the quantity of the key elements including membership degrees and adjustment factor in the Exponential Smoothing, while these values are determined by the experts. Liner regression analysis does not need to look for similar projects; however the independent variables are so different for the author that we cannot get the appropriate model by now. Case-based reasoning method needs large amount of the constructed engineering. A lot of constructed engineering has to train Neural Network method, so the method requires a large computer memory and calculation time.

This paper tries to combine different models into a new model, which will be applied in wilder scope and easier used.

120.2 Establishing the Fast Cost Estimating Model

120.2.1 Choosing the Constructed Engineering Similar to Planned Engineering

Based on same structure type (frame structure), this paper uses the Fuzzy recognization method to calculate the Fuzzy degree and closeness degree between the constructed projects and the planning ones, and choose the larger constructed projects which have closeness degree to be the reference resources to the planning projects [7, 8].

Firstly, the characteristic elements are determined. The elements which influence the cost of the projects includes the structure type, foundation type, apartment layout, storey height, plies, bay, finishing, and so on. If the project has *m* characteristic elements, these data make the characteristic index set *T*, written as $T = \{t_1, t_2,\ t_3 \ldots\ldots t_m\}$ [9].

Then, the membership degree of these characteristic elements is calculated. The corresponding membership degree is determined in the [0,1] scope using the statistical method, that the element with value 1 is the most difficult construction with highest cost, and the other degrees are established compared to that element. That is, the more difficult, more complicated, longer and harder constructions have higher degree. Thus, the fuzzy relation coefficient table for the characteristic elements of the unit square cost is established [10].

Thirdly, calculate the closeness degree of the constructed and planning engineering [11]. If the planning construction is B and the constructed engineering is $A_1, A_2 \ldots$ A_n, corresponding characteristic index $T = \{t_1, t_2,\ t_3 \ldots\ldots t_m\}$, the membership degree vector set is $\{\mu_{Ai}(t_k) | i = 1, 2 \ldots n; k = 1, 2, \ldots m\}$, then the closeness degree of B and A_i is

$$\alpha(B, A_i) = \frac{\sum_{k=1}^{m} \left(\mu_B(t_k) \wedge \mu_{A_i}(t_k)\right)}{\sum_{k=1}^{m} \left(\mu_B(t_k) \vee \mu_{A_i}(t_k)\right)} \tag{120.1}$$

In which,

α: closeness degree
μ: membership degree
m: number of characteristic element
i: number of projects

Finally, according to the order of the degree, the constructed projects with largest degrees are found to be the similar ones to the planning projects, and the next phase starts.

120.2.2 Grey Relation Analysis to Get the Key Elements Influencing the Engineering Cost

The elements influencing the engineering cost are lot. The grey correlation degree calculation excludes the minor influence factors and gets the major influence ones, which simplifies the model and avoids the multiple linear problems to a certain extent [4, 12].

If y is the cost of the project (independent variable), x_1, x_2,. . .x_n are dependent variables of the engineering parameters. Firstly, analyze the correlation degree r_i, given r_0, when $r_i < r_0$, deleting the x_i from the explanatory variables, which has weak relation with the independent variable, to simplify the model. If the rest p explanatory variables are x_{i1}, x_{i2},..x_{ip}, analyze the grey correlation degrees $r_{ij,ik}\left(i_j, i_k = i_1, i_2 \ldots ..i_p\right)$ between these dependent variables. Given r_0', if $r_{ij,ik} \geq r_0$', regarding x_{ij} and x_{ik} as the same kind of variables. So those rest variables are divided into several smaller categories, while one representative factor is chosen from each category to make the new model [13].

120.2.3 Establishing the Model

From the analyses above, we have found the key elements for the engineering cost, based on the grey correlation degree, in the closest constructed projects based on the closeness degree analyze. Last, using the excel software to establish the linear regression model to get the project cost.

120.3 Examples of Calculation

120.3.1 Collecting the Data for Analyze

For all the buildings here are frame structure, the characteristic parameters of the buildings are the foundation (t_1), masonry (t_2), exterior finishing (t_3), interior finishing (t_4), surface finishing (t_5) and floor (t_6). If the academic building is the planning project, the others will be the constructed projects (Table 120.1). According to the Guangzhou construction cost information about the per square cost of the different elements, the cost per square of prestressed concrete pipe (D = 500 mm) is 718 Yuan, which is the most valuable, so the value of it is 1. The values of other types of foundations with lower cost are then determined to be from 0 to 1 with the comparison to this biggest one. Finally, the experts' opinions are concerned and the final membership degrees are as the Table 120.2

120.3.2 Calculating the Closeness Degree Between the Constructed Project and the Planning Project

Make the Zadeh expression for the projects as following (take A_1,A_2,A_3,A_4 for examples)

$$T_{A_1} = \frac{1}{t_1} + \frac{1}{t_2} + \frac{0.1}{t_3} + \frac{0.1}{t_4} + \frac{0.3}{t_5} + \frac{0.833}{t_6}$$
$$T_{A_2} = \frac{0.6}{t_1} + \frac{1}{t_2} + \frac{0.1}{t_3} + \frac{0.1}{t_4} + \frac{0.3}{t_5} + \frac{0.833}{t_6}$$
$$T_{A_3} = \frac{0.5}{t_1} + \frac{1}{t_2} + \frac{0.1}{t_3} + \frac{0.1}{t_4} + \frac{0.3}{t_5} + \frac{0.833}{t_6}$$
$$T_{A_4} = \frac{0.8}{t_1} + \frac{1}{t_2} + \frac{0.1}{t_3} + \frac{0.2}{t_4} + \frac{0.3}{t_5} + \frac{1}{t_6}$$

According to the closeness degree formula (formula 13.1.1), the degrees between A_1 and A_2 are

$$\sum_{k=1}^{m} \left(\mu_{A_1}(t_k) \wedge \mu_{A_2}(t_k)\right) = 1 \wedge 0.6 + 1 \wedge 1 + 0.1 \wedge 0.1 + 0.1 \wedge 0.1 + 0.3 \wedge 0.3 + 0.833 \wedge 0.833$$
$$= 0.6 + 1 + 0.1 + 0.1 + 0.3 + 0.833 = 2.933$$
$$\sum_{k=1}^{m} \left(\mu_{A}(t_k) \vee \mu_{A_2}(t_k)\right) = 1 \vee 0.6 + 1 \vee 1 + 0.1 \vee 0.1 + 0.1 \vee 0.1 + 0.3 \vee 0.3 + 0.833 \vee 0.833$$
$$= 1 + 1 + 0.1 + 0.1 + 0.3 + 0.833 = 3.333$$
$$\alpha\left(A_{1,}A_2\right) = \frac{2.933}{3.333} = 0.88$$

Table 120.1 The characteristic parameters description

Building type	Code	Foundation t_1	Masonry t_2	Exterior finishing t_3	Interior finishing t_4	Surface finishing t_5	Floor t_6	Building area (square meter)	Unit square cost (Yuan/square meter)
Academic building (frame structure)	A_1	Prestressed concrete pipe pile D = 500 mm,	Gas concrete	Ceramic tile	Plastering	Abrasive brick	cs	8,500	1,984.4
	A_2	Independent foundation	Gas concrete	Ceramic tile	Plastering	Abrasive brick	5	7,742.2	1,798.1
	A_3	Strip foundation	Gas concrete	Ceramic tile	Plastering	Abrasive brick	6	2,609.7	769.38
	A_4	Prestressed concrete pipe pile D = 400 mm,	Gas concrete	Ceramic tile	Ceramic tile, plastering	Abrasive brick	6	10,904.2	1,437.76
	A_5	Independent foundation	Sand lime brick	Ceramic tile	Ceramic tile, plastering	Abrasive brick	4	1,725	1,055.33
	A_6	Artificial digging hole pile	Foam concrete	Ceramic tile, reflection glass curtain wall	Ceramic tile, plastering	Abrasive brick	6	6,030	1,541.86
Student's dormitory	A_7	Prestressed concrete pipe pile D = 400 mm,	Gas concrete	Ceramic tile	Plastering	Abrasive brick	6	9,800	2,040.04
Office building	A_8	Independent foundation	Sand lime brick	Ceramic tile, reflection glass curtain wall	Ceramic tile, emulsion paint	Stone	6	4,116	1,180.29
Comprehensive building	A_9	Prestressed concrete pipe pile D = 400 mm,	Gas concrete	Stone, reflection glass curtain wall	Plastering	Abrasive brick	5	2,147.8	2,112.84
Administration building	A_{10}	Prestressed concrete pipe pile D = 400 mm,	Gas concrete	Stone, reflection glass curtain wall	Stone	Stone	5	6,639	1,945.37

Table 120.2 Characteristic parameters fuzzy coefficient

Code	t_1	t_2	t_3	t_4	t_5	t_6
A_1	1	1	0.1	0.1	0.3	0.833
A_2	0.6	1	0.1	0.1	0.3	0.833
A_3	0.5	1	0.1	0.1	0.3	1
A_4	0.8	1	0.1	0.2	0.3	1
A5	0.6	0.6	0.1	0.2	0.3	0.667
A_6	0.5	0.5	0.6	0.2	0.3	1
A_7	0.8	1	0.1	0.1	0.3	1
A_8	0.6	0.6	0.6	0.3	1	1
A_9	0.8	1	1	0.1	0.3	0.833
A_{10}	0.8	1	1	1	1	0.833

Similarly,

$$\begin{aligned}\alpha(A0_1, A_3) &= 0.81\\ \alpha(A_1, A_4) &= 0.87\\ \alpha(A_1, A_5) &= 0.66\\ \alpha(A_1, A_6) &= 0.57\\ \alpha(A_1, A_7) &= 0.9\\ \alpha(A_1, A_8) &= 0.52\\ \alpha(A_1, A_9) &= 0.74\\ \alpha(A_1, A_{10}) &= 0.54\end{aligned}$$

It is easy to see that the similar engineering to the planning one are A_6,A_1,A_3,A_2,

120.3.3 Establish the Cost Estimating Model

Taking the unit square cost as the independent variable *y*, calculate the grey correlation degree between y and x_i (Table 120.3).

The results are

$$r_1 = 0.724, r_2 = 0.5, r_3 = 0.5, r_4 = 0.5, r_5 = 0.5, r_6 = 0.5$$

Given $r_0 = 0.4$, so these 6 dependent variables are all explanatory variables to *y*. Then, calculate the grey correlation degree between these dependent variables $r_{ij'ik}$. Given $r_0' = 0.7$, the results are

$$r_{24} = 0.75, r_{15} = 0.6$$

So the six dependent variables can be divided into following categories

$$\{x_1, x_5\}, \{x_2, x_4\}, \{x_3\}, \{x_6\}$$

Table 120.3 The data of the similar engineering and the planning one

	Foundation	Masonry	Exterior finishing	Interior finishing	Surface finishing	Floor	Unit square cost
Code	x_1 (Yuan/ square meter)	x_2 (Yuan/ square meter)	x_3 (Yuan/ square meter)	x_4 (Yuan/ square meter)	x_5 (Yuan/ square meter)	x_6	y (Yuan/ square meter)
A_1	718	784	102	47	155	5	1984.4
A_2	463	781	116	60	106	5	1798.1
A_3	347	800	80	24	83	6	769.38
A_4	549	817	1,034	142	124	6	1437.76
A_6	588	766	122	26	97.66	6	2040.04

Table 120.4 Key explanatory variables

	Foundation	Masonry	Exterior finishing	Floor	Unit square cost
Code	x_1 (Yuan/square meter)	x_2 (Yuan/square meter)	x_3 (Yuan/square meter)	x_6	y (Yuan/square meter)
A_1	718	784	102	5	1984.4
A_2	463	781	116	5	1798.1
A_3	347	800	80	6	769.38
A_4	549	817	1,034	6	1437.76
A_6	588	766	122	6	2040.04

The results suggest that x_1 is high related to x_5 and x_2 is high related to x_4, which means they can be representative for each other. So the six variables becomes four key explanatory variables $(x_1, x_2,\ x_3,\ x_6)$ (Table 120.4).

Using Excel software with those data to establish the linear regression equation for unit square cost

$$y = 1.116x_1 - 28.26x_2 + 0.97x_3 - 327.36x_6 + 24880 \tag{120.2}$$

The coefficient of determined r is 0.999, which suggests the regression effect is good.

Finally, we use the equation to calculate the cost and compare the practical results to get the residential errors (Table 120.5).

120.4 Conclusions

The example calculations show that fuzzy mathematics recognition can select the most similar constructed ones to the planning project quickly, from the large amount of constructed projects, which reduces the reference cases for fast calculation. While the membership degree is the base of the recognition, the accurate judgment of this degree needs a lot of cases to support, which means quantification

Table 120.5 The results comparing with the practical cost

Code	Practical cost	Estimating cost	Residential error
A_1	1,984.4	1,989.747	−5
A_2	1,798.1	1,803.4	−5
A_3	7,69.38	775.0255	−6
A_4	1,437.76	1,445.519	−8
A_6	2,040.04	2,045.682	−6

of them is difficult. The grey coefficient degree can get rid of the factors having minor effects on the cost, choosing those factors which have major effects. This analyzes needs reasonable threshold value to estimate the key factors, which is not discussed in this paper. Linear regression method avoids weights of the influence factor problems, and is combined with first two methods to get a good equation. This thought has certain significance for the fast cost estimation in the civil engineering.

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Chapter 121
Universities Capital Construction Project Cost Estimation Method for Practical Research in Decision-Making Stage

Renwei Pen, Xun Lian, Xuemiao Wu, and Daohui Liao

Abstract At present ordinary universities in China at decision-making stage of infrastructure projects have no fixed practical calculation methods for project cost estimation. In this article, various project cost estimation methods are used for theoretical analysis and research, for instance, the combination of the estimate index method and the similar engineering budget method, to practically calculate the project investment cost estimated value of Guangdong ordinary universities' planning student dormitories.

Keywords University • Infrastructure projects • Project decision-making • Investment estimation

The construction engineering cost at project decision-making stage is the determination of reasonable investment estimation. Some traditional commonly used investment estimation methods are: the production capacity index method, the estimate index method, the similar project budget method [1]. Recently, there are some new methods of study: the gray system theory model method [2–5], the fuzzy mathematical evaluation model method [6, 7], combination of grey system theory and fuzzy mathematics [8, 9], combination of case reasoning and fuzzy mathematics [10], the linear regression method [11], the neural network to [12, 13], etc.

The grey system theory applies to analyze those small or incomplete information. It's research objects are systems with small sample, poor information and uncertainty. It is worked mainly through known information generation, development, extraction of valuable information to get correct understanding and exact

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_121,

description of the operating pattern of system, and get scientific prediction based on them. The most common model is GM (1, 1) model.

Using the theory of fuzzy mathematics, six characteristic elements (labor, materials, machinery, comprehensive fee, spreads and indirect cost) corresponding to the main characteristics of the vector (area and cost) to build an engineering project are chosen. According to the expert evaluation method, a few membership functions tables of existing buildings and proposed buildings are built, the close degree between the proposed construction project and the built construction project is calculated, and then the nearly choice principle is used to find the closest built project. After that, exponential smoothing method is applied to establish the evaluation model, and estimate the engineering project cost.

Case reasoning and fuzzy mathematics combination method uses a basic thought about separation of quantity and price to calculate main material consumption of the target house. Nine characteristic factors involved include: building area, worth area, width, eaves high, roofs, depth, foundation bearing capacity, seismic intensity, wall thick. Through calculation of similar house close degree, some most similar cases are found, and then the average value of these cases is used as the estimation value of the target house.

Linear regression method is a method that chooses several typical engineering to have multiple regression analysis, use factors such as building acreage and height as independent variables and cost as dependent variable, to calculate project cost estimation.

When using the factor analysis and RBF neural network combination constructing model to do the calculation, we select indexes like construction and installation price index, structure, basic types, building acreage, underground layer number, to the upper number and building height, then determine most of them as training and the remaining as verifying in dozens of sample. In case training, through the factor analysis we find three principal components, and then have a RBF network design and simulation, at last, use Matlab environment to set up network.

At present, infrastructure investment estimation of China's province-owned universities has no fixed practical calculation method, most of which are based on past experiences and estimated costs of recent similar projects cost. Since there has no scientific consideration of factors such as price difference correction, adjustment and rising construction period prices, the error of estimation is large and the estimation is often lower than the actual settlement accounts. New method which is researching recently has smaller error, but it takes a large amount of engineering practice and design scheme data, and has more mathematics theory calculation. Due to this, there is no clear design scheme in project engineering decision stage, and enough engineering design data cannot be generally gotten, so the practical application has some limitations.

According to China's province-owned universities characteristics, we try to use a practical estimation method of combination of budget index method and similar engineering budget method to calculate the estimated cost of conventional engineering.

121.1 The Structure of the Construction Project Cost

121.1.1 Construction Engineering Cost Structure and Characteristics

Construction engineering cost is usually referred as a project construction cost (expected or actual) expense. It is formed by the construction and installation costs, equipment, work, appliances purchase expenses and other expenses.

The characteristics of the engineering cost valuation are single valuation, multiple valuations and branches combination valuation.

121.1.1.1 Single Valuation

Because of the oneness of architectural design, construction engineering generally cannot be priced singly by the state or company. It can only be priced by special programs (preparing estimation, estimation, budget, contractual price, settlement price and final determination settled cost etc.).

In compiling project proposal and feasibility study stage (engineering decision stage), generally we can estimate cost according to ruled investment estimate index, similar project cost material and current equipment material price, combining them with engineering practice.

121.1.1.2 Multiple Valuation

Construction project shall be priced severally from rough to subtle according to different project construction stages:

1. Put forward project proposal, feasibility study stage → investment estimation;
2. The preliminary design stage → design the total budget;
3. Technology design stage → amend total budget;
4. The construction drawing design stage → construction drawing budget;
5. Engineering bidding stage → the contract price;
6. Contract implementation stage → the clearing price;
7. Completion acceptance stage → the final accounts of the completed project.

This paper research the first time of investment estimate valuation.

121.1.1.3 Branches Combination Valuation

It is referred as dividing the project (such as the construction project down into individual engineering, then down into the unit engineering, division engineering), and pricing it according to combination of engineering formed.

Unit engineering construction drawing budget usually uses relevant fixed unit price and cost standard according to division or general component project for its calculation. This method is known as unit appraisal method.

Besides we can also use project budget norm, collecting and computing labor, materials, construction machinery number and amount that unit engineering or single project need, and then multiplied by local price at that time to get direct engineering cost, finally calculating indirect cost and profit tax according to fee standard. This method is called real method.

121.1.2 Project Static Cost

Usually building installation fees, equipment fees, instruments fees, sum of other costs and general reserve fees are treated as static cost. It refers to when making expected cost (sum of estimation, the floorboard of the cost estimates and the budget), calculating instantaneous cost on the basis of the construction element unit price of a benchmark year or month.

Static cost estimate has no fixed formula. In real work, as long as there is a component of the project cost data, we can use all sorts of methods to estimate.

When time of making static cost estimation is far away from the start time, we must use the year before the start year as the benchmark year, and adjust the static cost according to recent price indexes. Otherwise the benchmark role will be lost and the accuracy of the estimated cost will be influenced.

121.1.3 Engineering Dynamic Cost

It refers to the sum of investments that a construction project is expected to require, including static cost, the rising price of risk factors, the need to increase the investment and interest payments which are expected to require.

Estimation of the cost of the dynamic mainly includes the investment amount which may increase according to price change, interest and fixed asset investment direction regulating tax. It should be on the standard of investment funds in static use plan as the basis for calculating amount above all kinds of changes, not with the static cost of years for calculation.

121.2 Construction Engineering Cost Valuation Basis

121.2.1 Fixed Cost

It refers to the consumption of the necessary amount of society which finishing the appointed single construction content in human, material and financial resources that needs for. In China, it has the fairness, authority, and belongs to the voluntary economic indicators. After legal standard procedure, we also can make it has statutory force within the specified range.

121.2.2 Cost Index

It reflects comprehensive general requirements of human, material and financial resources that specific individual engineering requires. It has a greater generality, bounteous degrees and error range, and belongs to the reference of economic indicators, such as budget index, investment estimation index, and index of 10,000 RMB Yuan.

Among them, the investment estimate index is a fixed amount which is used in the project proposal of feasibility study stage for investment estimation, and calculation of project cost. It is very brief, often by independent individual engineering or completed engineering projects for the calculation object, and its feasibility study stage outlined degree matches outlined degree. Its main function is to provide the basis for project decision-making and investment control.

121.2.3 Fees Fixed Amount

It generally uses one (or more) independent variable as computing basis to reflect special charges (should be variable) social necessary work or the percentage of the standard. It is a special form of quota.

121.2.4 Basic Unit Price

It is the sum of unit price of labor, materials, machinery and equipment, work, and tools consumed in construction project.

121.2.5 Construction Engineering Cost Index

It is the index that tells the relative change trend and degree of different period project cost, and is an important tool of dynamic study cost. Generally price index should be made according to main elements respectively, and then we get project cost index by collecting.

121.2.6 The Stability of the Engineering Cost Basis

Bill calculation rules is stable which can keep for years. Work, materials, machine quota consumption have elative stability, and can maintain from 5 to 10 years.

On the other hand, basic unit price, the cost of the project construction, and the construction cost index etc. change fast, they only have stable time of about a year, so always needed to be adjusted.

121.3 Investment Decision Stage Construction Project Cost Estimation Method

121.3.1 Project Post Estimation Method of Traditional

121.3.1.1 Production Capacity Index Method

It is a method to estimate the cost of aiming project amount according to production capacity and investment of completed construction project of similar device, and scale of production capacity of planning construction project device. This law shall not be applied to civil engineering projects of universities.

121.3.1.2 Estimate Index Method

When the preliminary design depth is not enough, and cannot accurately calculate the amount of sectional works, as long as the project technology is more mature, and the project has similar structure estimation index to use, we can use this method.

Budget index refers to consumption standard and cost index of labor, materials, machines of branch engineering or unit engineering which are more comprehensive than budget norm.

121.3.1.3 The Similar Project Budget Method

It refers to using unilateral budget cost of past similar projects to estimate proposed construction project's cost.

When this method is used to estimate project's cost, the difference between the proposed projects structural characteristics and the similar projects structure characteristics should be amended.

The difference of artificial man-days unit price, material price, mechanical budget number unit price, other direct and indirect cost rate between the proposed construction project region and similar project region should be amended using the K difference correction coefficient.

The investment estimate aiming project cost = aiming project construction area $\times$ similar engineering cost unilaterally $\times$ K.

K is the project and the difference between the coefficient similar engineering. The following is steps and methods for calculating:

1. Calculation similar projects, the settlement of labor, the cost of raw materials, machinery fee and other fees and the indirect cost directly in all project total cost of the proportion of the. With its percentage points respectively said: Pi % $(\mathrm{I} = 1, 2, 3, 4, 5)$.
2. The proposed construction project with similar calculation in project area in artificial cost unit price ①, the cost of unit price ②, machine fee unit price ③, other direct fee rate ④ and indirect cost rate ⑤ the differences between coefficient: $Kj =$ proposed projects area (j) unit price/similar project area unit price (j) $\times$ $\%(\mathrm{j} = 1, 2, 3, 4, 5)$.
3. Differences coefficient calculation, $K = P_1\ \% \times K_1 + P_2\ \% \times K_2 + P_3\ \% \times K_3 + P_4\ \% \times K_4 + P_5\ \% \times K_5$.

121.3.2 New Practical Estimation Method: Estimate Index Method, Combined with Similar Engineering Budget Method of

With lack of design project data at infrastructure project decision-making stage, this method aggregates the advantages of estimate index method and similar engineering budget method, considers cost index and dynamic cost, and reduces estimation error. And the calculation is simple and practical. At the same time it avoids problems that other new methods have, such as more practical design data is needed or calculation is complex.

121.3.2.1 Calculation Steps

1. Collect cost information of recent similar and relevant all kinds of constructions.
2. According to own university's engineering structure and current decoration standard, adjust and amend adjustment existing cost estimate index.
3. Through adjustment of labor, materials, mechanical unit price, compile own university's recent (such as year 2010) all kinds of project cost estimation index (unilateral cost).
4. Count and analyze recent years' fluctuations of local labor, materials, mechanical unit price, and predict the next 3-5 years fluctuations trend of labor, materials, mechanical unit price.
5. According to own university's recent all kinds of project cost estimation index and fluctuations trend of estimation of labor, materials, mechanical unit price in next 3-5 years, calculate planning new project's investment estimation (unilaterally investment and total investment).

121.3.2.2 Workout Own University's Project Cost Estimation Index

According to actual situation of China's province-owned universities, we choose certain method to reasonably determine cost estimation index of own university's conventional buildings, and then we can estimate the dynamic cost amount of the proposed new project.

Cost estimation index of building project often use m^2, m^3 or m of completed building or structure as the calculating unit. Because of the fluctuation of the constant price, artificial man-days unit price, materials, and machinery unit price keep rising, cost index subsequently changes. For this reason, estimating index needs to use separation of "consumption" and "unit price" method, according to the main resources consumed standard of different buildings and structure types of unilateral construction area. Then according to local artificial man-days unit price, material price, mechanical budget number unit price and indirect cost fees standard at the time of calculation to calculate the applicable estimate index. Then according to the following formula, estimate the cost of aiming project:

$$\begin{aligned}\text{The estimate cost of aiming project} = {} & \text{the architectural area of the aiming project} \\ & \times \text{corresponding estimate index}\end{aligned}$$

When estimating cost with estimate index method, if there are parts of differences between the structure characteristics of the proposed construction project and estimated indicators, we should first amend estimate index, then use the amend estimate index to estimate cost.

121.3.2.3 Compute Project Cost Index

Construction project cost structure index should be worked out follow certain levels:

1. Firstly should workout input products price index, including all kinds of materials, artificial and mechanical number and price index;
2. Secondly calculate expense index (including artificial cost index, and materials index, machine fee index) base on input products price index;
3. Thirdly further collect cost item index (namely direct cost is index, indirect cost index);
4. Lastly according to above indexes, workout project cost index.

All levels of indexes can be calculated by Sent type comprehensive price index formula and its deformation calculation formula, namely:

$$K_P = \sum P_1 q_1 / \sum P_0 q_1 \ or\ K_P = \sum P_1 q_1 / \left(\sum P_1 q_1 / K_i \right) \tag{121.1}$$

In the formula,

K_P – price index;
P_1 – data of the price of the period;
q_1 – the amount of during the data;

P_0 – base period price data;
K_i – price subentry coefficient.

Because of the uniqueness of the fabrication engineering, even in the same kinds of engineering, there are differences, according to the social average of consumption and cost measure proportion, the method to solve the problem is weight (set weight type): choose one or several typical examples of engineering (relative stability) with representative characteristics in same kind of fabrication engineering, strictly censor, review and analyze normal consumption level, reasonable construction standards and construction method, and eliminate the abnormal factors as a measure of price index weight basis. Then put information such as price data of basis period which equals to the reporting period and consumption of example engineering into the formula.

Price index of equipment and instrument has many kinds, variety and specifications, so choose those which has large amount, high price, and the dosage changes more to collect purchasing quantity and the unit price for statistics, and then press the following formula for calculation:

$$\text{Equipment and instrument, price index} = \sum(\text{the reporting period in equipment tools, equipment unit price} \times \text{during the purchase quantity}) / \sum(\text{foundation period of the equipment tools, equipment unit price} \times \text{during the purchase quantity})$$

Engineering construction other expenses which have various content and a proportion of relatively modest, don't be prepare for other cost index.

Construction engineering cost index = (the reporting period in construction and installation investment + the reporting period in equipment tools, equipment investment + the reporting period in other expenses investment)/[(the reporting period in construction and installation investment/construction and installation price index) + (the reporting period in equipment tools, equipment investment/equipment and tools price index) + (the reporting period in other expenses investment/other cost price index)]

Project cost index can be predicted with finding provinces' project cost information documents at that time, or calculating the cost difference between similar engineering projects of a year in the past and now.

121.3.2.4 Determine the Dynamic Cost

The increased investment for price change, namely the reserve fee of price difference can be calculated generally by the formula below:

$$V = \sum K_t\left[(1+i)^t - 1\right] \tag{121.2}$$

In the formula,

V – the price of reserve;
K_t – year plan for using the investment amount (by using the capital construction project schedule that);
i – the price change rate (according to project cost index of the accumulation of information analysis);
t – 0,1,2, . . ., n;
n – construction period of years.

121.4 Specific Calculation Example

Now we use an example of an university's student dormitory investment estimation to illuminate an alternative practical cost estimate calculation method in project decision-making stage.

121.4.1 Composition of the Total Investment in the Project Construction

According to current investment estimation range of China's ordinary universities' infrastructure department, we do not have to consider the fixed assets investment direction regulating tax, the construction period of interest, circulating fund:

The first part is fabrication project cost (equipment cost generally applied by other departments);

The second part is other cost of project construction (mostly calculated using the first part as the base), including:

1. Land use fee and transfer compensation (do not have to consider in old school campus construction projects);
2. Construction management fee: specifically include ① construction department management fee (1 %), ② agent management fee of government investment projects (2 %), ③ bidding agent service charge (1 %), ④ supervision fee of project construction (about 2.5 %), ⑤ construction drawing technology application fee (0.5 %);
3. Project prophase consulting fee (0.5 %);
4. Engineering survey design fee (average about 3.5 %);
5. Engineering project evaluation headscarf fee (about 1 %);
6. Engineering insurance fee (0.5 %);
7. Facilities construction fee $(1080 \times 5\ \% = 54\,\text{yuan/m}^2)$;
8. Basement of air defense stuff construction fee (2 %);
9. Termites prevention and cure fee (3.5 yuan/m^2);

10. High reliability and temporary power supply expenses by electricity charges $(240\,\text{yuan/KVA}, 0.053\text{KVA/m2}, 240 \times 0.053 = 13\,\text{yuan/m}^2)$.

The third part is reserve expenses, including basic reserve fee (5 %), price increasing reserve fee (3 %, or calculate and determine as below).

121.4.2 Unilaterally Investment Cost Estimation

121.4.2.1 Calculation of the First Part of Expenses

1. It is known that one university's unilateral settlement cost of similar student dormitory engineering is 1,200 yuan/m^2 (civil engineering unilateral cost is about 1,000 yuan/m^2).
2. Make sure main material consumption index of civil decoration engineering (reference in 2005 in Guangzhou area construction engineering technical and economic index [14] adjustment). (see Table 121.1)
3. Third quarter of 2004 [15], fourth quarter of 2010 [16] material unit price and price adjustment civil engineering calculation. (see Table 121.1)

   Artificial cost difference of adjustment calculation (can take other direct expenses, scene funds, indirect expenses, planning profits and taxes): $226.86\ \text{yuan/m}^2 \times [1 + (12.67 + 0.28 + 4.17 + 3.42)\ \%] = 226.86 \times 1.2054 = 273.46\ \text{yuan/m}^2$.
   Market material price difference of adjustment calculation (can take planning taxes): $146.04\ \text{yuan/m}^2 \times (1 + 3.42\ \%) = 151.03\ \text{yuan/m}^2$.
   Total price difference is: $273.46 + 151.03 = 424.49\ \text{yuan/m}^2$.
   Price increasing range is: $424.49 \div 1000 = 0.424$, which is about 42.4 % of the original unilateral civil engineering cost.

4. If installation project has no detailed material index, we can consult material unit price and the increasing range after price difference adjustment, consider the installation work material price and price adjustment range are 42.4 %, too.
5. A headscarf project cost from 1,200 yuan/m^2 in 2005, amend and adjust to $1200 \times (1 + 42.4\ \%) = 1709\,\text{yuan/m}^2$ in 2010.

121.4.2.2 Calculation of the Second Part of Cost

1. According to the actual situation of Guangdong province-owned universities infrastructure department, the construction unit management fee (1 %), and the government investment projects acting system management fee (2 %) temporarily should not be considered.

Table 121.1 Students dormitory engineering price difference calculation table

Serial number	Every 100 m^2 building area — Index of material — Name	Number	Unit	Third quarter of 2004 guided price (RMB yuan)	Fourth quarter of 2010 guided price (RMB yuan)	Calculate price difference (RMB yuan)/100 m^2 (Unit price difference × index)
1	Artificial	428.04	mandays	33	86	$(86 - 33) \times 428.04 = 22686$
2	Pipe pile D = 400	34.92	m	79	124	$(124 - 79) \times 34.92 = 1571$
3	Reinforced	4.71	t	3387.66	4,874	$(4874 - 3387.66) \times 4.7 = 7001$
4	Concrete products (C30, pumping)	34.27	m^3	308	325	$(325 - 308) \times 34.27 = 583$
5	Cement	6.43	t	362.37	490.21	$(490.21 - 362.37) \times 6.43 = 822$
6	18 mm thick waterproof plywood	20.1	m^2	43.15	34.99	$(34.99 - 43.15) \times 20.1 = -64$
7	Turnover materials	1.98	m^3	1209.18	1272.91	$(1272.91 - 1209.18) \times 1.98 = 126$
8	Lime	0.61	t	144.84	229.50	$(229.50 - 144.84) \times 0.61 = 52$
9	Medium sand	2.27	m^3	46.92	52.02	$(52.02 - 46.92) \times 2.27 = 12$
10	Gravel10~20	0.33	m^3	58.14	69.36	$(69.36 - 58.14) \times 0.33 = 4$
11	Suggested brick	3.54	$one thousand	190	305	$(305 - 190) \times 3.54 = 407$
12	Lightweight concrete small block 390 × 190 × 190	0.74	$one thousand	3,100	2323.04	$(2323.04 - 3100) \times 0.74 = -575$
13	Wear-resisting brick 500 × 500	0.3526	$one thousand	8072.37	8470.17	$(8470.17 - 8072.37) \times 0.3526 = 140$

14	Prevent slippery brick 300 × 300	0.058	$one thousand	2586.94	2668.54	$(2668.54 - 2586.94) \times 0.058 = 5$
15	Exterior wall glazed pottery 45 × 95	66.94	m^2	51.48	71.04	$(71.04 - 51.48) \times 66.94 = 1309$
16	Ceramics 200 × 300	36.16	m^2	48	59.76	$(59.76 - 48) \times 36.16 = 425$
17	Fire doors	1.96	m^2	436	650	$(650 - 436) \times 1.96 = 419$
18	Splint adornment door	14.39	m^2	210	380	$(380 - 210) \times 14.39 = 2446$
19	Aluminum alloy push-pull window	10.12	m^2	187.26	194.16	$(194.16 - 187.26) \times 10.12 = 70$
20	Modified asphalt coil	14.75	m^2	18	40	$(40 - 18) \times 14.75 = 325$
21	Ordinary emulsion paint	40	kg	23	13.65	$(13.65 - 23) \times 40 = -374$
	Total					Artificial cost difference is 226.86 yuan/m^2 Market material price difference is 146.04 yuan/m^2

2. Calculate other expenses:

$$1\ \% + 2.5\ \% + 0.5\ \% + 0.5\ \% + 3.5\ \% + 1\ \% + 0.5\ \% + 2\ \% + 0.4\ \%$$
$$= 11.9\ \%, 54 + 3.5 + 13 = 70.5\ \text{yuan/m}^2.$$

121.4.2.3 Calculation of the Third Part of Cost

Basic reserve fee (5 %),
Increasing price reserve fee (calculate and determine as below):

From 2004 to 2010, in 6 years, material unit price increase range is about 42.4 % from calculation above, converse to yearly material unit price increase range: $(1 + x)^6 = 1.424$. Which is $1 + x^{1/6} = 1.424$, get $x = 0.06 = 6\ \%$ per year.

121.4.2.4 Calculation of Students' Dormitory Unilateral Total Investment in 2010

$$1709 \times (1 + 11.9\ \% + 5\ \%) + 70.5 = 2068\ \text{yuan/m}^2$$

121.4.2.5 Estimation of Planning Similar Project Unilateral Investment

According to China's current construction procedure, large and medium-sized project construction period is 3-5 years. If use average of 3 years to calculate reserve of increasing price, the new project's unilateral investment should be:

$$1709 \times \left[11.9\ \% + 5\ \% + (1.06)^3\right] + 70.5 = 1709 \times 1.36 + 70.5$$
$$= 2395\ \text{yuan/m}^2$$

In which cost is for: $1709 \times (1.06)^3 = 1709 \times 1.19 = 2034\ \text{yuan/m}^2$

121.5 Epilogue

Through analysis and research above, under the condition that lack of design project data in infrastructure project decision-making stage, in order to fully consider dynamic cost, improve the calculation precision, and simplify calculation, China's province-owned universities can use practical estimation method that combine province-owned budget index method and similar trial project budget method to calculate new planning ordinary projects' investment estimate amount.

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Chapter 122
Spatial Analysis and Spatial House Price Index Construction: Evidence from Chengdu Housing Market

Lei Xin and Siqi Zheng

Abstract Accurate estimation of prevailing housing prices is important for both business and research investigation of housing and mortgage markets. Quality-adjusted house price indices have already been constructed using traditional hedonic models. These hedonic models don't incorporate the spatial structure in housing data sets. In this article, we argue that spatial structure is more important in the precision and accuracy of resulting price estimations. The housing sales data we employ have been actually observed in Chengdu housing market in 2010. We examine the spatial relationship using the Global and Local Moran's I statistics of the hedonic residuals. As the data sets show spatial structure, we illustrate the importance of spatial autocorrelation in both the specification and estimation of hedonic models, and then apply the spatial model in estimating zone level price index. We also assess the accuracy of both models, and conclude that considering spatial relationship in the spatial hedonic model is significant, since the spatial hedonic model is more accurate in estimating housing prices.

Keywords Spatial • Hedonic • Price index

122.1 Introduction

As important and sensitive signals in real estate market [1], accurate estimation of prevailing housing prices is important for both business and research investigation of housing and mortgage markets. Domestic and foreign scholars have been devoted in exploring the method of estimation of housing price, and there is a consensus in the literature that an economic approach based on hedonic models is the most suitable one for constructing cross-section quality-adjusted house price indices.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_122,

While these hedonic models do not incorporate the spatial structure in housing data sets, the accuracy and precision of the house price indices are affected by the assumption of the independent random error terms in conventional hedonic models. With the development of Geographic Information Systems in recent years, hedonic models always include some spatial variables such as distance to CBD, distance to the nearest key school and so on. However, this is not enough, because house prices data sets are spatially correlated for two main reasons. First, neighborhoods tend to be developed at the same time, so neighborhood properties have similar structural characteristics such as dwelling size, ages, design features and so on. Second, neighborhood residential properties share locational amenities. For example, neighborhood children have access to the same key school. These relationships cannot be explained only by including few distance variables, and lead to omitted variable problems.

To solve these problems, we develop spatial econometrics methods to improve conventional hedonic function to make the estimation of house indices more accurate and precise.

In the next chapter, after brief description of the data set, this study examines the residual spatial autocorrelation in a conventional hedonic model estimated by OLS.

Chapter 3 gives a brief overview of the methodology this study employs and put forward procedure to build the spatial-time house prize index.

The last chapter draws some conclusions, and puts forward the future research directions.

122.2 Conventional Hedonic Models and Spatial Dependence

122.2.1 The Data

This article examines spatial autocorrelation in hedonic house price equation using houses transaction data sets from Chengdu from 2006 to 2010. The primary source of the data is the Chengdu Urban\Rural Real Estate Administration, it takes charge of all the properties in Chengdu, and has a registration system which records all the transactions of new-built properties within the city, so the data we have is a whole sample. The total number of residential transactions is 468908. This data contains information on each residential property's structural characteristics, and also the address which will help us to calculate some spatial variables such as distance to the CBD by means of ArcGIS. However, because of the limitation of hardware facilities, we are not able to estimate the spatial models based on the whole transaction data sets, so we employ the building level model for this paper's research, which could be treated as single-family properties, the detailed description is provided in Table 122.1.

Table 122.1 Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
totmoney	468,908	580,320.3	326,655.2	51,935	8,521,812
fno	468,908	12.40954	7.980126	1	55
bed	468,908	2.239258	0.78595	0	9
live	420,652	1.916387	0.292914	1	5
bath	365,231	1.389584	0.536658	1	9
presale	468,908	0.031207	0.173876	0	1
d_cbd	468,908	6,965.343	2,972.921	198.11	18,407.27
d_sub	468,908	4,488.117	2,903.033	41.95	16,409.71
d_school	468,908	1,449.122	1063.354	24.09	6,344.26
d_park	468,908	1,684.519	986.3093	49.01	6,607.47

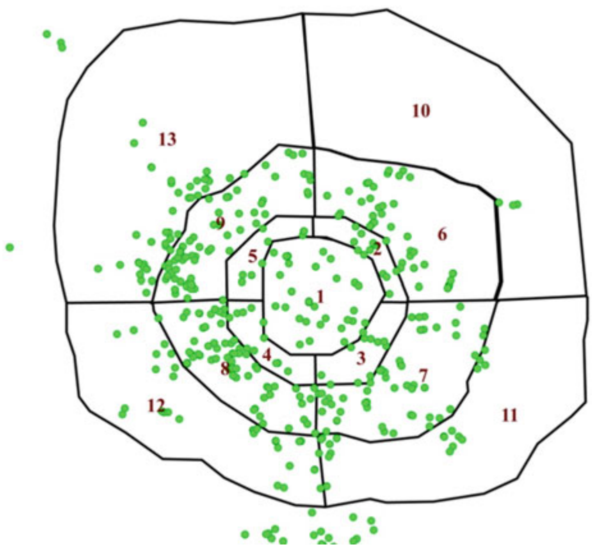

Fig. 122.1 The zones and property transactions

Besides the property data, we divide the central city area into 26 zones (Fig. 122.1) based on the ring roads and the orientation, and the zone is the spatial unit within which we employ the price index.

122.2.2 Conventional Hedonic Models

The generally accepted house price model is hedonic model. And it explains the house price in terms of its own characteristics, the model form is:

$$P = f(\beta S + \gamma L) + \varepsilon$$

Table 122.2 OLS estimation results

Log(*HP*)	(1)	(2)
Log(size)	1.284***	1.192***
	(268.95)	(23.77)
Log(floor)	0.0350***	0.068***
	(32.26)	(4.13)
bed	−0.0827***	−0.043**
	(−47.57)	(−2.01)
live	−0.0566***	−0.003
	(−16.53)	(−0.22)
bath	0.0284***	0.030*
	(13.65)	(2.30)
presale	−0.0516***	−0.147***
	(−6.92)	(−4.69)
d_cbd	−0.142***	−0.122***
	(−52.32)	(−4.17)
Sub_dummy	−0.00646***	−0.005
	(−6.26)	(−0.15)
d_school	−0.0305***	−0.038***
	(−20.61)	(−2.72)
D_park	−0.0291***	−0.019
	(−16.85)	(−1.23)
Constant	8.910***	8.790***
	(371.42)	(35.01)
Observations	63840	619
R^2	0.820	0.733

$^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$

Where P is the units' price; ε is the residual of the function; while S denotes the structural characteristics which are summarized by Sirmans et al. (2003), and the top ten variables are age, square footage, garage spaces, lot size, bedrooms, bathrooms, air conditioning, full baths, swimming pool, and basement; and L is the locational attributes which include distance to CBD, distance to school, police, crime rates and so on. It is worthy to note that the model will be estimated by OLS method.

The structural variables this study develops are almost in Table 122.1, including room area, bedrooms, living rooms, bath rooms, floor level, distance to CBD, distance to the nearest subway station, distance to the nearest key school, and distance to the nearest park and so on. Also, because of the correlation between distance to CBD and distance to the nearest subway station, we use the sub_dummy (value equal to 1 when distance to the nearest subway station less than 800 m; else equal to 0) instead.

We set data sets in 2006 as an example to introduce our models. First we employ two hedonic models including the transaction data and the building level data, and the estimation results are shown in Table 122.2 above.

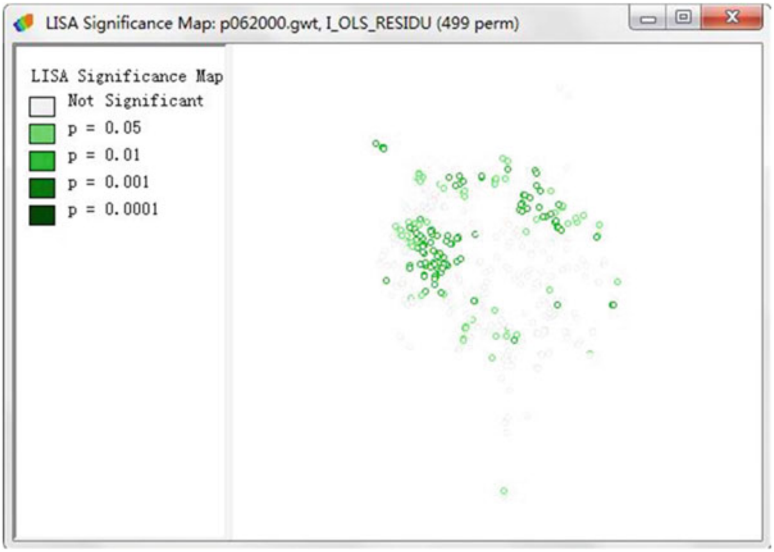

Fig. 122.2 The local Moran's I statistics of the hedonic

Model (1) is the house-level regression, and model (2) is the building level regression. It seems there is a big difference between these two estimations. Because almost all the variables in the model (1) are significant, while some in model (2) are not, and R^2 in model (1) is larger than that in model (2). However these two models are the same in nature, and the two estimation results' correlation coefficient is 0.9998. The difference shown before is because of the sample size. So it is reasonable to employ the building level model instead.

As mentioned before, if the residuals of the conventional hedonic model show spatial autocorrelation, the underlying assumptions of the OLS methods will be violated. Here we employ the global and local Moran's I statistics put forward by Anselin [2] to detect the spatial relationship in the residual of conventional hedonic model. The global Moran's is 0.1043. As Anselin mentioned, the ratio shows spatial positive correlation when the ratio is greater than zero. Furthermore, as shown in Fig. 122.2, the local Moran's I statistics also appear significant. Therefore, the spatial correlation indeed affects the accuracy and precision of the OLS estimation.

122.3 Spatial Hedonic Models

122.3.1 Model Selection

Based on the previous analysis, the hedonic house index is not that precise because of the spatial correlation. The development of Spatial Econometrics makes it possible to solve the problem. The two main types of models proposed by Anselin [2] are the spatial lagged model and the spatial error model:

Spatial lagged model:

$$\begin{aligned} & y = \rho W y + X\beta + \varepsilon \\ & \varepsilon \sim N(0, \sigma^2 I_n) \end{aligned}$$

Spatial error model:

$$\begin{aligned} & y = X\beta + \xi \\ & \xi = \lambda W \xi + \varepsilon \\ & \varepsilon \sim N(0, \sigma^2 I_n) \end{aligned}$$

Both these models consider spatial correlation, while the spatial lagged model can reveal the relationship among the samples by means of W, while the spatial error model cannot, so in this study, we prefer the spatial lagged model.

122.3.2 Spatial Weight Matrix

In the spatial lagged model, the weight matrix is rather important, so that the structure form of W affect the estimation of the model. Considering the data sets, the weight between samples is determined by the two-point's distance. Anselin put forward two types of spatial weight of distance: distance band and k-nearest neighbors. Because our whole data set is department samples rather than single-family, and the spatial model requires the matrix to be symmetrical, the distance band is a better choice.

How much the band affects the estimation needs further research. In this article we set a 2,000 m [5, 7] band as a sample according to experience. The initial weight is 1 between the point and its neighbors within the band, and the others are 0. Then after rows standardization, we finally obtain the spatial weight matrix. We perform this calculating process on GeoDa.

122.3.3 Estimation Results

Before estimating the model, we should verify the method. The spatial model is estimated with the Maximum Likelihood Method. The estimation result is presented below (Table 122.3):

As the same of the hedonic model, Global Moran's I is 0.0131, ten times smaller than the conventional hedonic model results. Also, the map of local Moran's I is shown in Fig. 122.3. Clearly, the results is consistent with our expect ations, the significant samples are reduced sharply.

Table 122.3 ML estimation results

Log(*HP*)	Coefficient	t-stat
Log(size)	1.131***	23.26
Log(floor)	0.063***	4.00
bed	−0.029	−1.44
live	−0.003	−0.24
bath	0.018	1.43
presale	−0.156***	−5.19
d_cbd	−0.169***	−5.86
Sub_dummy	−0.033	−0.97
d_school	−0.023	−1.70
D_park	−0.017	−1.11
W_log(*HP*)	0.358***	6.77
Constant	5.897***	13.44
Observations	619	
R^2	0.753	

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

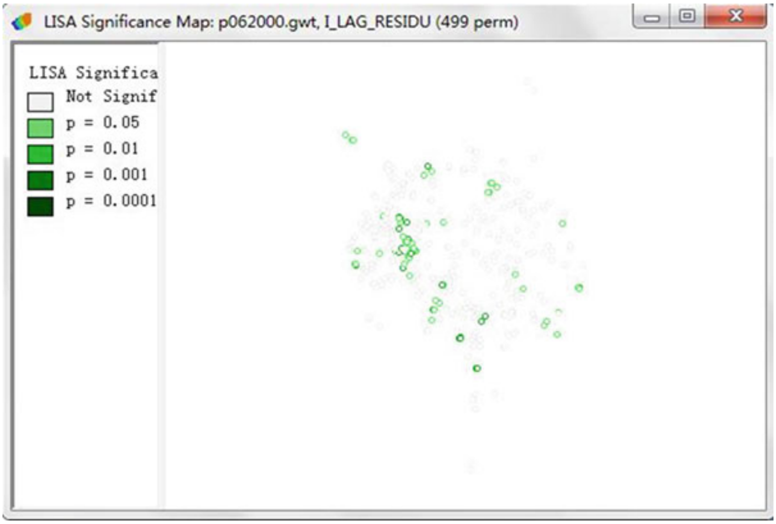

Fig. 122.3 The local Moran's I statistics of the spatial model

To examine the accuracy of the models, root mean square errors (RMSE) are used here like Tsutsumi et al. [3]:

$$RMSE = \sqrt{\frac{\sum \varepsilon_i^2}{n-1}},$$

The Conventional hedonic model result is 0.2376, and the spatial model is 0.2368, the *spatial* hedonic model is little more accurate.

So, from estimation of the conventional hedonic model and the spatial model, the coefficients of the variables shows variation. Almost all the variables related to the architectural attribute such as the building area, bedrooms, living rooms, bath rooms are smaller than the spatial models. But the variables of the location attribute did not change consistent.

As a whole, although the accuracy the two models differ slightly, the coefficients shows larger variation, so the spatial model is a better choice to build the house price index. And the zone_dummy spatial model estimation results are shown below. As the same with the results above, almost all the variables related to the architectural attribute are smaller than the spatial models. But the variables of the zones did not change consistent (Table 122.4).

This article employs the coefficient of the zone dummy to represent the variation of house prize within Chengdu [6]. And there are two steps, first from the spatial lagged model, we obtain the zone dummy coefficient, employing the function $ZI_n = \exp(\beta_n)$ to turn the coefficient into zone index in 1 year; and then we use the hedonic model with the year dummy to catch the time variation of the price, with this we adjust the zone index into the spatial-time index, shown in Fig. 122.4.

The results do accord with the actual realistic settings, the indices in 2008 is decreased because of the economic crisis. And the zones near the CBD show higher index.

Table 122.4 Zone_dummy models estimation results

Log(HP)	(1)	(2)
Log(size)	1.143***	1.116***
	(22.81)	(22.90)
Log(floor)	0.069***	0.067***
	(3.98)	(3.99)
bed	−0.035*	−0.027
	(−1.65)	(−1.31)
live	0.008	0.004
	(0.52)	(0.25)
bath	0.022	0.018
	(1.62)	(1.39)
presale	−0.135***	−0.135***
	(−4.26)	(−4.43)
Z2	0.047	0.018
	(0.65)	(0.25)
Z3	−0.253**	−0.243**
	(−2.18)	(−2.18)
Z4	−0.335***	−0.330***
	(−2.60)	(−2.67)
Z5	−0.042	−0.081
	(−0.58)	(−1.16)

(continued)

Table 122.4 (continued)

Log(HP)	(1)	(2)
Z6	−0.006	−0.054
	(−0.04)	(−0.32)
Z7	−0.135	−0.178**
	(−1.61)	(−2.23)
Z8	0.176	0.092
	(1.63)	(0.88)
Z9	0.151**	0.058
	(1.99)	(0.78)
Z10	0	0
Z11	−0.265***	−0.240***
	(−3.99)	(−3.74)
Z12	−0.222***	−0.206***
	(−3.51)	(−3.38)
Z13	−0.181***	−0.218***
	(−3.17)	(−3.95)
Z14	−0.143**	−0.181***
	(−2.32)	(−3.05)
Z15	−0.099	−0.144**
	(−1.64)	(−2.45)
Z16	−0.094	−0.179***
	(−1.49)	(−2.87)
Z17	−0.096*	−0.170***
	(−1.79)	(−3.19)
Z18	−0.314***	−0.274***
	(−3.37)	(−3.05)
Z19	0	0
Z20	0	0
Z21	−0.132*	−0.207***
	(−1.78)	(−2.87)
Z22	−0.430***	−0.462***
	(−3.60)	(−4.02)
Z23	−0.205***	−0.317***
	(−3.15)	(−4.71)
Z24	−0.209***	−0.254***
	(−2.91)	(−3.63)
Z25	−0.139***	−0.216***
	(−2.25)	(−3.52)
Z26	0	0
w_logvalue		0.286***
		(4.47)
Constant	7.665***	4.137***
	(39.14)	(5.11)
Observations	619	619
R^2	0.749	0.758

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

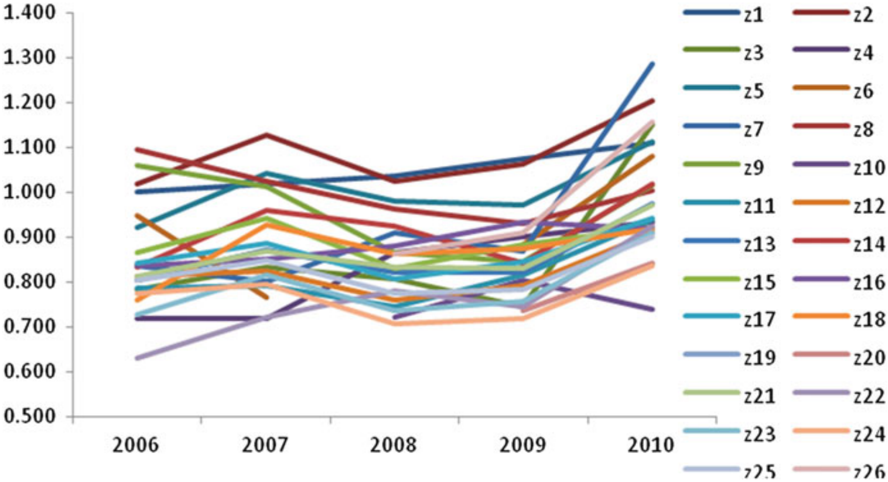

Fig. 122.4 Spatial-time house prize index of Chengdu

122.4 Conclusions

This article applies spatial econometrics method on hedonic model, estimates 26 zones house indices in Chengdu, and makes the house index estimation more accurate and precise.

This study demonstrates that the spatial structure in the data sets affects the analysis of the house market, and applying spatial models is a better choice for measurement purposes.

Future research should focus on the choice of the distance bond and the rapid estimation of large samples based on Matlab programs [4].

Acknowledgements This research is supported in part by the National Natural Science Foundation of China (No. 70973065), Major project of National Social Science Foundation of China (No. 09&ZD042) and Tsinghua University Initiative Scientific Research Program.

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Chapter 123
Identification and Structural Evolution of Real Estate Enterprises' Growth Ability

Xiayan Lin

Abstract How strengthen growth capacity in real estate enterprises which accumulate capital and production experience in former stage is an important research issue in the field of real estate. Based on installing real estate enterprises' value chain, it studies the identification and structural evolution of real estate enterprise's growth capacity. Research results indicate that real estate enterprise's growth capacity includes: market regulation, organizational management, external operation, creativity and entrepreneurship. In the different periods of enterprises growth circle, different growth capacities have different effects on enterprise's growth, which reflects the relationship between real estate enterprise's capacity and growth dynamics.

Keywords Real estate • Growth capacity • Identification • Evolution

123.1 Introduction

The last 30-year development and maturity of real estate industry have generate cyclical overheating in industrial investment and demand. The government strengthens macro-control of real estate by reforming real estate industry land supply pattern, adjusting the structure of land supply, improving the difficulty of corporate finance and increasing the construction of affordable housing, changing industrial environment and historical circumstance.

According to the country statistical database web, there are 85,218 real estate enterprises involving all kinds of property development qualifications all over the country up to the end of 2010,in which there are 3,685 state-owned enterprises, 3,685 collective enterprises, 3,671 Hongkong-Macao-Taiwan enterprises and 2,052

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_123,

foreign-capital enterprises. The number of enterprises present the swift growth, but it still show the industry trait such as small, scatter, weak and so on. Especially, quoted company's account for 1.4 % real estate enterprises. It is difficult to growth for most real estate enterprises. In 2011, the office of Housing and Urban of Shanxi checked up real estate enterprises and logged off development qualification of 333 real estate enterprises that had no new development projects, which would extinct soon due to inconformity to the qualification. It is clear that real estate enterprise growth is another important research issue apart from some real estate problems, such as real estate market, real estate micro-control and construction of affordable housing.

123.2 Review of Literature

According to different backgrounds, the research of enterprise growth theory can be divided into four stages: the classical theory of enterprise growth represented by Adam Smith; the neo-classical theory of enterprise growth of Marshall; the enterprise growth theory represented by Schumpeter's innovative ideas on the behalf of the enterprise growth theory which ranges from classical economics and modern theory of enterprise growth, Penrose's theory of internal enterprise growth and Coase's boundary theory represented the modern theory. Endogenous growth theory of enterprise development issues holds a dominant position in the study.

The papers studying enterprises growth in recent years have witnessed significant growth. However, most of them examined "general" enterprises without special considerations given to real estate enterprises. Some scholars have pointed out that there was no enterprise growth strategy and model that could be in the common use. They also pointed out that we should study enterprise growth according to different trades and kinds. Different enterprises may have different growth circumstances, so study specified trade can analyze problems and reflect trade's innate characters more clearly, accurately and directly. But most of the research of trades focuses on hi-tech enterprises, middle and small enterprises, family enterprises and new-created enterprises and so on, while few focus on real estate's growth problems. The main relevant researches of real estate enterprise's ability are competitive ability and key ability. Wang Hong-wei et al. [1] divided key ability as ranks from real estate enterprise growth and value chain angles and divided real estate enterprise's key ability into enterpriser ability, market ability, combination and integration ability and learn ability [1]. Sen-feng and Yue-lai [2] refined the strategy of real estate creating value and the source of sustaining competitive advantages, and divided real estate enterprises' key competitive ability into strategy planning ability, resources integration ability and creativity ability [2]. The different scholars didn't make an agreement on the elements of real estate enterprise ability.

123.3 Installing Real Estate Enterprise's Value Chain

Real estate enterprise is the integration of resources. Resources cover in every link of enterprise's value chain and ability is the bonding dose of value-appreciation link, and the function of ability embodies all the value-appreciation links. Value chain as a tool can recognize real estate enterprise's growth ability and analyze effectively the main functional link of enterprise's engaging in growth management, and explain how a series of activities compose an assembly to set up enterprise growth.

The concept of value chain is raised by American scholar Porter in1985. With Porter's value chain and value system theory to analyze the managing course, the scope and feature of operating activities of real estate enterprise can form the internal and external value-chain model of real estate enterprise. Generally, real estate enterprise's operating is divided into five periods, including invest planning period, project reporting and former preparing period, construction period, marketing period and tenement managing period. The five periods also can be regarded as operation procedure: market investigation – product scheme and feasibility research – getting land-using rights – finance planning – designing construction – marketing and selling – tenement management. According to porter's value chain-creating theory, value activities' strategy and importance conclude the value activities which are similar in technology using, functions and purposes into one link. The essay divides the value activities of real estate enterprises into investigation and planning, resource obtaining, project designing, project implement, market selling and tenement managing. Supporting value procedure caters to many real estate enterprise's projects, including enterprise's infrastructure, manpower-resource management, information management, finance management and purchase management.

The connection of the value activities exists not only in the internal value chain of the real estate developers, but also in the value chains among the enterprises and the external complementary enterprises related. Although, during the course of the development of the real estate, the enterprise's strengths leading to the different boundaries of the corporations are different, it is impossible for them to participate in the development of each section directly. Mostly, they make the program function by choosing outsourcing in partial sections, bringing the specialist agencies in the real estate developers' value chain, integrating and mobilizing the external resource. The success of the real estate project development depends on the work quality of each nodal company in the external value chain and the cooperation among them, as well as the coordination between nodal companies and the real estate enterprise. Though the internal value chain of the real estate enterprise does not exactly correspond to the functional departments of the companies, the exchange of the capital flow, information flow and logistics, between the real estate enterprise and the related complementary enterprise can be achieved by the relevant departments setting internally to complete the corresponding service nodes. Thus the external three flows can be integrated into the internal enterprise. Through the

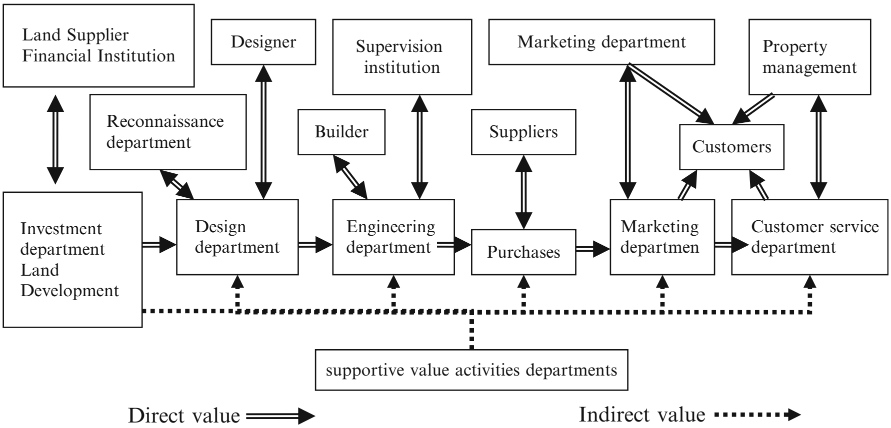

Fig. 123.1 External value chain model of the real estate enterprise

pattern of the integration from inside to outside, the real estate enterprises are organically combined with other enterprises, and their internal value chain is reconciled with external enterprises. The appreciation is coalesced to the real estate project. As illustrated in Fig. 123.1.

123.4 Discernment of Real Estate Enterprise Growth Ability

Real estate enterprise is integrated business resources, whose growth ability hides in its ability of resource allocation. The problems resource allocation should mainly solve are “What to do?”, “How to do?”, “Who do you for?” The absence of any one of these aspects will negatively affect the enterprises’ growth.

Therefore, from the following four aspects the real estate enterprise growth ability can be analyzed: (1) The real estate enterprise should work out the range and orientation of the resources usage in accordance with the present resources condition and environment of the enterprise. If the enterprise wants to diversify business, it will relate to the matter of industry orientation; if the enterprise wants to do core business, the matter of product positioning can be referred. Before the enterprise invest the land parcel, it is necessary for enterprise to survey, study, analyze and evaluate the regional market environment and predict the development trend of the area in the project, and therefore the type, content and scale of the investment project can be targeted. The ability is regarded as the Marketing Grasp force in this paper. This kind of ability is an adaptable ability which is endowed by the integration of the market opportunities and enterprise resources. This is the beginning of the resource allocation. If the issue is not properly handled, it may cause the enterprise to fall into the trap of the market opportunity and be dominated by the invisible hand in resources allocation, then lose the optimal combination. (2) The enterprise should form the matching productivity through organic combination of enterprise resource drawing on the direction of the resource allocation and relative rules, principles and ways. The ability first requires the technical efficiency of the resource allocation, the enterprise is asked to continually break the top limit and gain an edge in the process of growing up. Therefore, the real estate enterprise must master the innovation capability to achieve the technical efficiency which is difficult to imitate. The innovation capability reflects the ability to refresh enterprise and environment dynamically, speaking a lot of the growth advantages compared with the enterprise's competitors. (3) The allocation efficiency of real estate enterprise calls for institutional guarantee. Institutional competence manifests itself in the organization and management ability of the enterprise. As showed earlier, in the construction of the real estate enterprise value chain, the value chain of real estate development project has seen several functional divisions which create value for the enterprise directly or indirectly. They create value jointly. So the organization and management ability is needed not only in the innovation activities of the enterprise functional divisions, but also in the coordination of the lengthways and transverse functional divisions. The organization and management ability itself is an intellectual activity to integrate the limited resources effectively. (4) The value chain of real estate's external complementary enterprises is an essential part of the project value chain. For this reason, various supplier of the real estate enterprise participate in the process of real estate project development's benefit distribution, they are regarded as the direct benefit distributors of the enterprise. The benefit between these suppliers and the real estate enterprise are cheek by jowl. The real estate enterprise occupies the core status throughout these enterprises or departments. It should build up a close strategic cooperative partnership with them. Hence, the external operations capabilities are one of the real estate enterprise growth abilities. (5) The project development of the real estate enterprise usually takes the form of project management team. The team combines with the other production resources can achieve better coordination efficiency of the production resources. But the enterprise internal resources are not the only need in the development of real estate item, it also demands the cooperation between many external enterprises and departments, these abilities are not evenly distributed among the teams and individuals. The facts that the growth of so many excellent real estate enterprises in our country prove that the dominative entrepreneurship has an inestimable effect in the process of the real estate enterprise's growth.

123.5 Cycle Evolution of the Real Estate Enterprise Growth Ability Structure

The characteristics of the life cycle of the real estate market, products and technology will enlarge the size of the real estate enterprise. And under the influence of the industry dynamics, it will cause the interaction of the organization's life cycle.

Therefore, the growth ability of the real estate enterprise in different stages has different levels of growth strength.

During the period of starting the real estate enterprise, the most important influencing factors are the two links of the product output and resources input which lies in the both ends of the enterprises' value chain. In the early stages of the growth, firstly, the real estate enterprise usually focuses on launching product accepted by the consumers on a regional market, then transplants the mature mode verified by the existing market to the next project, expands the visibility in the regional market gradually. Market capacity is very important to the enterprises that are new to the real estate industry. Determining the direction of management, the real estate should avoid the hot projects which are concerned in the industry, and select the products which have been easily neglected by other enterprises and have a certain economic benefits, and give play to the new enterprise flexibility and the advantages of the strong adaptability to help to close the gap of the market demanding and supplying. According to the origin of the value chain, compared to big enterprises, the newly-opened real estate enterprises are obviously weak in acquiring all kinds of production factors and resources such as land, capital, and talents, and so on. On the one hand, not only the "Invitation for Bid, Auction and Listing" system raises the enterprises' bar to participate in the land market, especially in recent years, some local governments have been enthusiastic in selling land at large scale at one time. Large-scale land selling and high-set bidding conditions make many medium-sized and small enterprises that are at the early stage of the growth stay in the disadvantages in the bidding. In recent years, the country has continuously increased its land market regulation. The Level 1 land market is suffering strict restriction on land supply, and land resource also has become the bottleneck in enterprise development. In the other hand, there exists financial difficulties due to such problems: the less registered capital of new real estate enterprise, the weak development foundation, the lack of financing conditions to direct access to the capital market to process at a large scale, the central bank raised lending rates constantly in recent years, and some problems of new real estate enterprise, such as low credit, insufficient assets for mortgage, the lack of effective guarantee, and so on. From the view of human resources, new real estate enterprises have some disadvantages: not perfected in all kinds of rules and system, not clear of development foreground, high employment risk, and hard to introduce professional talents. How to strengthen external operation is the new test that new real estate enterprises need to face. But most of the real estate enterprises newly founded are project enterprises, and many of the single project enterprises adopt individual management mode, which has high demand of entrepreneurs' ability. For entrepreneurs, they need to find out how to find and accurately identify and actively capture entrepreneurial opportunities, how to look for partners and production factors through the social network, and how to recommend and market the products of the enterprise to the society through various channels. These abilities all play an important role in the later stages of the development of real estate enterprise.

In the rapid growth period of real estate enterprises, the size and number of real estate projects growth fast, and the project area could be in the same city, may also be in different cities, so enterprises are not on a steady development stage. The specific management system of real estate falls behind the speed of its growth. These changes ask for new requirements to the original enterprise management and project management system. And to conduct organization structure changes by enterprise internal management is in an urgent need. Yang Bo, Qiang Mao-shan [3] have conducted empirical research on the project organization structure reform mechanism which is widespread processing by China's real estate enterprises. To the real estate development enterprises which regard project as the guidance, project characteristic changes of project number and distribution scope is the main environment and incentives of organization structure change [3]. Any reform has power and resistance forces inside, and implementing organization structure reform is the responsibility of entrepreneurs. Therefore, how entrepreneurs balance in all reform resistance from the interests redistributed by reform power and human resources adjust, just as the existing defective management mode, market competition pressure, project distribution amount and distribution scope, and how to implement the internal organization management changes, such entrepreneurs' abilities play an important role in rapid growth of real estate enterprises.

In the duration of the real estate enterprise growth, seen from the development of China's real estate enterprise practice, most of the enterprises are all along "deep city – trans-regional development – national management" such development route to reach the purpose of the enterprise expansion. Shanghai Greenland, Tianjin Teda, Wanda group and other large real estate enterprises have implemented the national strategic layout. Along with the increasing competition of real estate market and increasingly strengthened consciousness of consumer subject, the expansion of the estate enterprises should according to the characteristics of the industry and its own conditions, beginning from the attention of the market demand, clearing customer demand through abundant market research; developing corresponding products in a planned and specific way through the market segmentation. First comes to the choice of area, real estate enterprises have more significantly regional diversity than any other industries have. The economic, social, and cultural factors exit in economic circle ranges in every areas are different and such diversity result in the regional differences of real estate market environment. Second, the real estate enterprises need to make specific choice within the cities of the area. Third, the real estate enterprises need to make the choice of product development. Through the maturity of real estate markets, Consumers get more clear understanding about the concept of house products, and they require good performance, good quality of the building products. Consumers even have great knowledge about the environment and facility match of real estate products, also the service of house living. What kind of building products and what type of building products should real estate enterprise provide with, and in other cities' expanding process, should real estate enterprises choose copy type product development or non-copy type product development, such all need to decide by the enterprise market capacity [4].

With the mature of the real estate market, consumers will have better understanding on the concept of housing product, they will not only require housing products' internal performance, quality, and etc., and even have appropriate knowledge of housing products' set of various environment and facilities, and also service of the link from buying a house to living in it. what building products real estate enterprises will provide, what kind of building products they will provide, and while expanding in other cities, adopt a replicated product development or a non-replicated one, all of these need enterprises' marking capacity to make a choice [5].

While the business environment of real estate enterprises is becoming increasingly complex, and facing different development environment and various needs of consumers, every development project has its own unique policy requirements, and it will have some big or small differences on planning and designing of development program, marketing promotion, cost control, engineering construction, inspection record, housing occupancy, and organizational management, and so on [6]. Thus, real estate enterprise organization is increasingly large and its business activities are becoming more complex. Required organizational management capacity of real estate enterprise is also rising. The structure of the organization must form a reasonable structure of organization, functions and powers, also relationship of functions and powers. Without scientific authority and decentralization of authority or the decentralization is inappropriate and will lead company's policy channels and execution difficult to implementation. The project company's proper decentralization of authority and head office's reasonable control becomes a key for a development company to succeed in expansion. From the continued growth of China's real estate business practice, organization structure of many real estate enterprises is more likely the form of head office, regional company, and Project Company. But throughout the actual implementation, they often failed to establish clear responsibilities of the division of job, either completely controlled by the head office, taking care of all matters; or the regional company and the project company each doing things in its own way, organization and department overlapping, resulting in waste of resources. With the expansion of enterprises' scale, the accumulated knowledge of real estate enterprise is increasing gradually. For the internal of enterprise, it is needed to establish organizational structure which is good for the management of knowledge, set up enterprises' knowledge base, knowledge map, and knowledge management mechanism; for the external cooperation units, they need to build up knowledge alliances in achieving sharing of knowledge and the internalization of external knowledge, so as to promote internal organization management better. Real estate enterprises need to strengthen external operation ability, choose partners who possess the advantage of resources and build up strategic alliances.

How much potential of real estate enterprises for its continued growth is also lies on the innovative ability of the enterprises. Innovative real estate enterprises will focus on the changes in the market in full time, considering more about how to create better products to meet customers' dynamic needs, how to set up external network of the enterprise and maintain its leading position in the external network, how to organize and manage in the internal of the enterprise and optimize the allocation of resources, etc. According to Schumpeter's definition of entrepreneurs, the function of the entrepreneurs is to identify the productive factors, and then

Table 123.1 Characteristics of the strength and weakness of periodic structures of real estate enterprises' developing ability

Stage	Ability				
	Marketing mastery ability	Internal organization and management ability	External operation ability	Innovation ability	Entrepreneurs' ability
Start-up stage	+	–	+	–	+
Rapid growth stage	–	+	–	–	+
Continued growth stage	+	+	+	+	+

integrate them [7]. Entrepreneurs are those who concern about the enterprises' development and decision makers, they start and complete the innovation, and they are discoverers of the potential value of opportunity, owners of social relations, and organizers and managers of resources, and so on. Those functions of entrepreneurs decide that they still possess the leading position in the continued growing period of real estate enterprise.

Now the strength and weakness of ability in different developing periods are synthesized into Table 123.1.

123.6 Conclusion

Based on the above analyses, it argues that the developing ability of real estate enterprise is formed by marketing mastery ability, organization and management ability, innovation ability, external operation ability, and entrepreneurs' ability. Of course, influence position of these abilities in the process of an enterprises' growth is not the same. Entrepreneurs' ability is the leading ability of real estate enterprises' continuous growth, organization and management ability. While external operation ability is the basic ability of real estate enterprises' continued growth. Innovation ability and marketing mastery ability are the potential ability of real estate enterprises' continued growth. The leading ability plays an important guiding role for the real estate enterprises, and the basic ability maintains the normal operation of the enterprise, the supporting base of the enterprises' perform for leading ability and potential ability. The potential ability directly promotes the enterprises' growth. From the perspective of the enterprises' growth cycle, this paper further analysis structure evolution of real estate enterprises' growth ability. Usually, on the start-up stage, marketing ability, external network operative ability and entrepreneurs' ability play the leading role; on the rapid growth stage, internal organization and management ability and entrepreneurs' ability play the leading role; and on the continued growth stage, it is the action of all these five abilities that promotes real estate enterprise to develop continually.

Acknowledgement This paper received fund from "Social Science Research Project in Fujian Province Department of Education".

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Chapter 124
A Study on Farmers' Concentrated Living Under the Background of Urban-Rural Integration: A Case of Beiwujiayuan Community in Beijing

Xiao Wei and Changchun Feng

Abstract This essay focuses on the issue of Farmers' Concentrated Living under the Background of Urban-rural Integration taking a case in Beiwujiayuan Community in Beijing. On the basis of questionnaire and field study, the impact of concentrated living on the daily life of farmers are first described, such as the changes in family income, daily expenditure, house structure and house areas. After that, the author analyzes the degree of satisfaction and relevant factors with a statistical interpretation. Using Logistics regression, it is found how and to what extent those influencing factors have an effect on the general degree of satisfaction. Along with the analysis of regression results, the author probes into relative problems on this issue. In the end, main conclusions drawing from this essay and some targeting policy suggestions are presented.

Keywords Farmers' concentrated living • Urban-rural Integration • Degree of satisfaction • Logistic regression

124.1 Introduction

Since China's reform and opening up, rapid development have taken in urban society and rural landscape has also undergone great changes. However, the gap between urban and rural development level has significantly increased. To eliminate the urban-rural dual structure and realize rural-urban coordinated development is a long and arduous strategic task. According to the 5-year plan for 2011–2015, promoting new rural construction and guiding the rural residential settlement is regarded as a main task of Urban and rural integration development.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_124, © Springer-Verlag Berlin Heidelberg 2014

Under the Background of Urban-rural Integration, new rural construction across the country has made some progress. However, farmers' concentrated Living is brand new reform measure with little experience to follow. Therefore, there must be varieties of contradictions and conflicts in the implementation process. In the above context, a field research was conducted in Beiwujiayuan Community in Beijing and attention was paid on the status and problems of farmers' concentrated living.

124.2 Literature Review

Academia discussed the issue of farmers' concentrated living mainly from three levels: government, community and Individual. At the government level, some local governments forced farmers to leave their village and live in apartment driven by the interest of land appreciation [1]. Also it is common to find "formalism" and "face-saving projects" in concentrated living in which the appearance of community is attached more importance than quality and facilities [2]. Lack of public service facilities and poor property management are common problems at community level [3, 4]. Other literatures discuss problems of social security and cultural adaption after concentrated living from individual level [5–7].

124.3 Methodology and Data

In order to obtain first-hand information, 80 questionnaires were sent and structured interview were conducted in May, 2011. After that, overall satisfaction of concentrated living was described and logistic regression model was employed based on field research data.

In a total of 80 questionnaires sent out, 80 effective copies were retrieved and the effective rate of retrieve was 100 %. The questionnaire includes issues as follows: (1) Individual and family characteristic and their viewpoint of the importance of land; (2) Total family income changes, daily household expenditure changes, structure and floor area of settlements changes after concentrated living; (3) Satisfaction of relocation compensation and governments work; (4)Satisfaction of new community from different aspect and on the whole. The individual and family characteristics of respondents are described in Table 124.1.

Table 124.1 Individual and family characteristics

Ages			Gender		
$\leq$40 years	41–59 years	$\geq$60 years	Male	Female	
16.3 %	37.5 %	46.3 %	45.0 %	55.0 %	
Education level			Family scale		
Primary	Junior high school	High school and above	1–2 members	3–4 members	$\geq$5 members
53.8 %	30.0 %	16.3 %	23.8 %	43.8 %	32.5 %

124.4 Concentrated Living in Beiwujiayuan Community

124.4.1 General View of Beiwujiayuan Community

Beiwujiayuan Community is located in urban and rural copula between the fourth ring and the fifth ring of Beijing, which is an administrative part of Yuquan Area, Sijiqing town, Haidian District. Beiwujiayuan Community is a pilot project of farmers' concentrated living for people in Beiwu Village. There were 1,550 families, 2,967 farmers and 663 non-farmers living in Beiwu Village before Concentrated living Project. At the meantime, more than 25,000 of migrant workers living in Beiwu Village by renting houses here.

According to Urban Master Planning 1993 of Beijing, Beiwu Village is planned as green belt separation so that 251 ha rural land have been requisitioned by government. With no land to be planted, villagers had to earn income from renting house to migrant workers, which is called "Tile Economy".

124.4.2 Life Changes of Farmers After Concentrated Living

124.4.2.1 Family Income

Family income is not only the economic foundation of a family, but also reflects the key indicators of household living conditions. The influence of concentrated living can be largely reflected by the changes of family income.

According to the results of questionnaires, families that experienced income reduction account for the 47.5 % of 80 samples followed by no changes in income and households that earn more than before only account for 20 %. Before concentrated living, there were hardly any villagers farming in Beiwu Village since all of private plots have been requisitioned in the name of Green Belt Separation Project. As mentioned above, majorities of villagers made a living by renting houses and they could separate their spatial houses into several small cabins, from which they could get more rent. However, they could not rent houses as before since there are only three housing unit: 50, 80 and 90 m^2 so that there would be no flexibility in separating department any more. As a result, income of majorities of households has been declined seriously.

124.4.2.2 Daily Expenditure

Daily expenditure of a household reflects the cost of living, which is closely related to living conditions. In accordance with questionnaire results, more than half of households find that they expend more on daily consumption than before. The biggest changes, as the interview suggests, is reflected in the water charge.

Table 124.2 Changes in family income and daily expenditure

	Increased (%)	Declined (%)	No changes (%)	Others (%)
Changes in family income	20.0	47.5	32.5	0.0
Changes in daily expenditure	53.8	6.3	38.8	1.3

Table 124.3 Changes in architectural construction and living area

Concentrated living	Living in reinforced-concrete structured houses (household)	The average level of living area (m^2)
Before	38	199.7
After	80	183.2

With water supplied from well, villagers were charged only 60–70 Yuan per year for water consumption before concentrated living. After living in apartment, wells are taken over by a running-water company and villagers are charged more than 40 Yuan per month. In addition, every household have to pay for property management fees as they live in a community managed by a property company (Table 124.2).

124.4.2.3 Architectural Construction and Living Area

About 50 % households lived in brick-structure houses before concentrated living and all of the villagers live in reinforced concrete-structure building now, which means their living condition improves to some extent. As for living area, the average level declines. Some villagers built a second-floor house for more rents before concentrated living, which was regarded as illegal and not included in the replacement area. Also, many families live separately in several small apartments after concentrated living. They do not adapt to housing unit changes although living area are replaced by 1:1 in light of policy (Table 124.3).

124.5 Satisfaction Analysis and Empirical Results

124.5.1 Overall Satisfaction

According to questionnaire statistics, about 65 % of respondents are satisfied with concentrated living on the whole. However, the overall satisfaction is a comprehensive indicator. So it is necessary to analyze influencing factors from different aspects.

124.5.2 Modeling and Variable specification

Empirical method is used in this part in order to find out significant factors that influence overall satisfaction. A Logistic Regression Model is established as follows, in which the dependent variable stands for overall satisfaction: 1 means satisfied and 0 means unsatisfied.

$$\mathrm{Prob}\left(\mathrm{Y_{ij}}=1\right)=\frac{e^{a+\sum\beta_{ij}X_{ij}+u_i}}{1+e^{a+\sum\beta_{ij}X_{ij}+u_i}};$$

After logit transformation,

$$\mathrm{Logit}[\mathrm{Prob}(\mathrm{Y_{ij}}=1)];$$

$$\ln\left[\frac{\mathrm{Prob}\left(\mathrm{Y_{ij}}=1\right)}{1-\mathrm{Prob}\left(\mathrm{Y_{ij}}=1\right)}\right]=a+\sum\beta_{ij}X_{ij}+u_i;$$

in which, $1\leq \mathrm{i,j}\leq 24, \mathrm{Prob}\left(\mathrm{Y_{ij}}=1\right)$ is the probability of satisfaction; X_{ij} represent factors influencing overall satisfaction; β_{ij} are parameters to be estimated; u_i stands for error term.

Variables	Variable description	Expected influencing direction
age	Years	–
educ	Years of education	+
member	The number of family members	+
inc_up	inc_up = 1 if family income increases, inc_up = 0 in other cases.	+
inc_dwn	inc_down = 1 if family income decreases, inc_up = 0 in other cases.	–
exp_up	exp_up = 1 if daily expenditure increase, exp_up = 0 in other cases.	+
exp_dwn	exp_down=1 if daily expenditure decrease, exp_down = 0 in other cases.	–
area	Living area after concentrated living(m^2)	+
land	land = 1 if respondent think land is important, land = 0 if else.	–
move	move = 1 if respondent move voluntarily, move = 0 if he/she move reluctantly	+
cmpst	cmpst = 1 if respondent is satisfied with relocation compensation, cmpst = 0 if else.	+
gov	gov = 1 if respondent is satisfied with government's performance, gov = 0 if else.	+
quality	quality = 1 if respondent is satisfied with quality of new apartment, quality = 0 if else.	+
area_stsfy	area_stsfy = 1 if respondent is satisfied with living area of new community, area_stsfy = 0 if else.	+
strct	strct = 1 if respondent is satisfied with unit structure of new community, strct = 0 if else.	+

(continued)

(continued)

Variables	Variable description	Expected influencing direction
beauty	beauty = 1 if respondent is satisfied with appearance of new community, beauty = 0 if else.	+
shop	shop = 1 if respondent is satisfied with shopping facilities around new community, shop = 0 if else.	+
trspt	trspt = 1 if respondent is satisfied with transport facilities around new community, trspt = 0 if else.	+
doctor	doctor = 1 if respondent is satisfied with medicare facilities around new community, doctor = 0 if else.	+
school	school = 1 if respondent is satisfied with school facilities around new community, school = 0 if else.	+
env	env = 1 if respondent is satisfied with environment of new community, env = 0 if else.	+
squ	squ = 1 if respondent is satisfied with square and greenland in new community, squ = 0 if else.	+
leisure	leisure = 1 if respondent is satisfied with sports and entertainment facilities in and around new community, leisure=0 if else.	+
neigh	neigh = 1 if respondent is satisfied with the relationship between neighbourhood in new community, neigh = 0 if else.	+

124.5.3 Empirical Results

At first, Pearson's correlation coefficients indicate that "age" and "education", "move" "cmpst" and "gov" are highly correlated. Six models are used in logistic regression in order to avoid multicollinearlity.

Regression results are shown in Table 124.4. It is shown that goodness of fit of six models is desirable judging from 2Loglikelihood and Nagelkerke R^2. The extent and direction of influencing factors are summarized as follows.

Firstly, the quality, unit structure and living area of new apartment have significant influence of the overall satisfaction. It is suggested that higher satisfaction of building's quality and room structure and larger living area contribute to higher satisfaction on the whole at 95 % significant level. But the evaluation of building appearance is not a significant factor while building appearance earns the highest evaluation according to questionnaire statistics. Therefore we can conclude that building appearance is less of concern than factors closely relating to living conditions. More than 80 % interviewees complain about the sound insulation of walls, which affects not only daily routines but also relationship between neighborhoods. In addition, elevator power outage and pipes leaking are also regarded as quality problems of new apartment. Many villagers consider room structure design unreasonable, such as living room is much smaller than bedroom

Table 124.4 Regression results

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Age	0.887	–	0.077	–	0.054	–
Educ	–	0.191	–	0.179	–	0.037
Member	0.257	0.257	0.583	0.583	0.065	0.065
inc_up	2.834*	2.834*	1.783	1.783	2.779*	2.779*
inc_dwn	0.193	0.193	0.043	0.043	0.173	0.173
exp_up	0.391	0.391	0.445	0.445	2.664	2.664
exp_dwn	2.424	2.424	0.043	0.043	3.198*	3.198*
Area	2.016	2.016	0.009	0.009	1.032	1.032
Land	−2.267	−2.267	0.009	0.009	−2.527	−2.527
Move	–	–	5.132***	5.132***	–	–
cmpst	–	–	–	–	2.091***	2.091***
gov	3.759***	3.759***	–	–	–	–
Quality	2.597	2.597	2.536**	2.536**	2.908**	2.908**
Area_stsfy	0.083	0.083	0.327	0.327	0.035	0.035
strct	2.601***	2.601***	0.173	0.173	2.448**	2.448**
Beauty	1.713	1.713	0.254	0.254	0.106	0.106
Shop	0.389	0.389	1.717	1.717	0.111	0.111
trspt	0.008	0.008	0.681	0.681	0.233	0.233
Doctor	1.383	1.383	0.353	0.353	1.049	1.049
School	0.003	0.003	0.418	0.418	0.033	0.033
env	3.509***	3.509***	0.544	0.544	3.052**	3.052**
squ	0.14	0.14	0.333	0.333	0.218	0.218
Leisure	0.63	0.63	3.40	3.406	1.21	1.21
Neigh	2.466**	2.466**	3.692	3.692	4.574	4.574
−2Loglikelihood	42.402	42.402	37.289	37.289	32.906	32.906
Nagelkerke R^2	0.738	0.738	0.776	0.776	0.808	0.808

*, ** and *** represent for the confident level at 90 %, 95 % and 99 %, respectively

and it is too close to put sofa and TV at the same time in living room. In short, most basic conditions of new apartment contribute significantly to the overall satisfaction and "face-saving projects" seems to be a serious problem.

Secondly, environment in new community and relationship between new neighbors have significant impact on overall satisfaction at 95 % significant level and entertainment facility is another significant factor, which indicates that farmers pay more and more attention to interpersonal relationship and entertainment activities as living conditions improves. On the terms of neighbourhood, concentrated living is not only a process of spatial concentration but also social gathering process. Most villagers are glad that they can meet their old neighbors and friends in new community. Therefore it is a desirable pattern to allow villagers to live in original place which helps to maintain social ties between neighborhoods.

Thirdly, overall satisfaction is also significantly influenced by the attitudes toward land, moving voluntarily or reluctantly, degree of satisfaction towards compensation and government's performance. It is shown that the higher evaluation of land and reluctant moving contributes to lower satisfaction. About 60 % of respondents still attach great importance on land although all farm land has been requisitioned.

Relocation compensation is also one of significant factors at the significant level of 99 %. By contrast, the changes in family income and daily expenditure do not contribute significantly to overall satisfaction. It is inferred that the changes degree of income and expenditure seems rather smaller than the amount of relocation compensation up to millions Yuan in some cases.

Satisfaction of government's efforts in concentrated living is also important. It is thought that government's performance has detects of lack of openness and fairness. According to some respondents, some villagers, who have closely relationship with village committees, were distributed more compensation that others. This can be proved, based on the interview, by the fact that the criterion of compensation differs largely between households from 3,200 to 3,900 Yuan/m^2. In the aspect of openness, village committee never publicized compensation criterion or amount of compensation distributed to households. Worse still, relocation compensation was distributed as a package to villagers, who were rather confused with the detail and had no strong proof to argue with village committee.

124.6 Main Conclusions

Promoting farmers' concentrated living is the main direction of future rural development. Taking Beiwujiayuan Community as example, this paper mainly focuses on the problems of concentrated living. Important conclusions drawn by this research are summarized as follows.

1. In general, more than half of respondents are satisfied with concentrated living. However, the overall satisfaction is influenced by different factors and to different extent.
2. It is shown that the quality and room structure of new apartments are significant factors and contributes positively to overall satisfaction.
3. Relocation compensation and village committee's performance in the process of concentrated living process are rather important aspects, according to the results of Logistic regression.
4. It is also found that there are problems in this case study, such as poor building quality, improper structure design, lack of transparency in compensation distribution and so on.

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Chapter 125
Comparative Study on Chinese and U.S. Evaluation Standards for Green Building

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Abstract This study addresses the applicability of the national and international evaluation standards of green buildings to the green buildings in China. The Chinese and U.S. evaluation standards of green buildings were analyzed in detail. The Vanke Center that obtained the certificates of the U.S. LEED rating system and Chinese evaluation standard of green building (GB/T50378-2006) was introduced to specify the differences of the Chinese and U.S. evaluation standards of green buildings. The problems of the Chinese evaluation standard of green building were discussed, and some improvement suggestions were put forth.

Keywords Green building • Evaluation system • Energy saving • Sustainable development

125.1 Introduction

People have paid attention to their health and have higher demands for the building quality with the continuous improvement of people's material life. The urban residents are not satisfied with the early buildings because of high energy consumption and severe pollution. The construction of the green building in developed

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_125,

countries are earlier than in China, and there is the gap in the green buildings in China and abroad.

Green buildings not only can reduce material consumption, emissions of carbon dioxide, environmental pollution, protect natural resources and ecological environment, but also provide a more comfortable, healthy and efficient living environment. The green buildings will be a preferable choice in the future. Therefore, it is necessary to work out evaluation standards to evaluate the green buildings.

Since 1990s, some Western developed countries have made a number of green building evaluation criteria. The main rating standards include BREEAM (Building Research Establishment Environmental Assessment Method) in the UK, LEEDTM (Leadership in Energy and Environment Design) in the USA, CASBEE (Comprehensive Assessment System for built Environment Efficiency) in Japan, NABERS (the National Australian Built Environment Rating System) in Australia and SB Tool (Sustainable Building Tool) as an international project. With its transparent, simple and fair evaluation process, the LEED has been globally recognized. BREEAM has also been accepted and used in the construction area all over the world because of transparent evaluation process. CASBEE is mainly used in Japan. The Australian NABERS rating system has been gradually accepted by New Zealand. However, among these rating standards, LEED rating system is most widely accepted on the world [1, 2, 3].

The evaluation standard of green building was implemented in China on June 1, 2006. About 300 public and resident buildings have been obtained the certificates of the Chinese Green Building Evaluation Level authorized according to the evaluation standard of green building (GB/T50378-2006) [4]. However, some problems such as without geographical complexity and insufficient evaluation time have been found in implementation process. As a result, many developers in China would prefer to apply LEED certificate than the Chinese Green Building Evaluation Level authorization according to the evaluation standard of green building.

In this study, the evaluation standard of green building was compared with LEED rating system to find shortcomings and advantages for better implementing the Chinese evaluation standard.

125.2 Comparative Analyses

LEED is mainly applied to assess the building performance during its life cycle. In order to cover different building types into the system, LEED has evolved into different building assessment systems. LEED NC and LEED EB are the systems which come into practice in the early stage compared to other systems. The main categories include: Sustainable Site, Water Efficiency, Energy and Atmosphere, Material Resources, Indoor Environmental Quality and Innovative Design with LEED AP. LEED CI, just after LEED NC and EB, consists of Site selection, Water and energy saving, lighting and lighting control, building interior system and furniture, indoor environmental quality and discharge criteria. The integrated LEED system involves rating system, education, professional certification, resource support and third-party certification [2].

The evaluation standard of green building was developed based on the Chinese conditions and foreign rating standards such as LEED rating system and BREEAM. However, due to the lack of experience in the green buildings construction in China, this evaluation standard can not fully meet the needs of development of the Chinese green buildings. Compared to the LEED rating system, the evaluation standard of green building has not been widely recognized by the developers.

125.2.1 Similarity

Because LEED rating system is one of the reference standards when working out the evaluation standard of green building, two standards are similar structure and evaluation Indices such as outdoor environment, energy saving, water efficiency, materials and indoor environment.

125.2.2 Difference

125.2.2.1 Different Publishers

The evaluation standard of green building issued by the former Ministry of Construction is a recommended national standard. LEED rating system was issued by the U.S. Green Building Council which is a non-governmental agency. The U.S. federal and state governments encourage the developers to use the LEED rating system.

125.2.2.2 Different Application Procedures

The evaluation standard of green building stipulates the residential buildings and public buildings that apply the green building evaluation level authentication shall go through the quality acceptance and put the building into use over 1 year. Application of the LEED authorization is in the early stage of building life cycle, and the U.S. Green Building Council will track and understand the whole process. The application process of LEED rating system is very compact and the time for application process is clearly defined, it can greatly improve the efficiency, and each member can look at the information.

Table 125.1 Indicators of the evaluation standard of green building and LEED rating system

Evaluation standard of green building			LEED rating system		
Indicators	Score	Weight (%)	Indicator	Score	Weight (%)
Sustainable sites	14	22	Sustainable sites	14	20
Water conservation	5	8	Water efficiency	5	7
Energy and atmosphere	17	27	Energy and atmosphere	17	25
Materials and resources	13	20	Materials and resources	13	19
Indoor environmental quality	15	23	Indoor environmental quality	15	22
Operation management			Innovation and design	5	7

125.2.2.3 Different Evaluation Objects and Contents

The evaluation standard of green building is only used for evaluation of new residential buildings and public buildings. However, LEED evaluation buildings include new building, existing building, commercial interior decoration, community plan and development project.

Table 125.1 gives the indicators of the evaluation standard of green building and LEED rating system (2.2 NC). As can be seen, the former five indicators of two evaluation standards are the same or almost similar, and the weights are almost equal. Last indicator of the evaluation standard of green building is operation management, and last one of LEED rating system is innovative and design.

To classify the buildings as different grades, LEED rating system uses total score evaluation, and it does not ask the building to meet each of indicators. However, the evaluation standard of green building asks the building to meet both the necessary requirements and each indicator. Therefore, the evaluation standard of green building is strict than LEED rating system.

125.3 Case Study: Vanke Center

Vanke Center located in Yantian District, Shenzhen, Guangdong is a comprehensive building complex including function of apartment, hotel and office for Vanke Headquarters. The Vanke Center with an architectural area of 14,400 m^2 consists of green roof, photovoltaic power project with an installed capacity of 282. 06 kW and some innovative structures [5].

Vanke Center is the first project with LEED 2. 2NC Platinum certification and three stars of the Chinese green building evaluation level in China. It obtained a high score of 57 points, five points more than the score of LEED Platinum grade, the minimum standards for three stars of the Chinese green building evaluation is 46 points, Vanke Center obtained a high score of 49 points.(see Table 125.2). The Vanke center has cleared most of indicators of the evaluation standard of green building.

Table 125.2 LEED 2.2 NC score and clear indicators of evaluation standard of green building of Vanke Center

LEED 2. 2 NC			Evaluation standard of green building		
Indicator	Total score	Vanke Center score	Indicator	Required items	Vanke Center items pass
Environmental management	14	13	Land conservation	6	6
Water efficiency	5	5	Water saving	6	6
Energy and atmosphere	17	16	Energy and atmosphere	10	8
Materials and resources	13	5	Materials and resources	8	7
Indoor environmental quality	15	13	Indoor environmental quality	6	5
Innovation and design	5	5	Operation management	7	7
The score for Platinum	>52		Preference	14	10
Total score	69	57	Total score	43 + 14	39 + 10

125.4 Improved Measures

The following suggestions and measures were put forth in order to better implement the evaluation standard of green building.

1. Extending the evaluation scope

   The evaluation objects of the evaluation standard of green building are newly constructed resident and public buildings. The application scope of the Chinese evaluation standard should include the reforming projects of existing buildings, municipal engineering and large shopping malls.

2. Improve the operability

   The operability the evaluation standard of green building is not so good. The qualitative indicators account for 70 % and quantitative indicators are 30 % in the evaluation standard of green building, while LEED rating system has 70 % quantitative indicators.

3. Policy support

   The evaluation standard of green building is a recommended code, however, the governmental departments may give some policy guidance, such as requiring governmental invested projects must reach the requirements of the evaluation standard of green building, providing a degree of financial support to the green building owners and developers, dispensing with part of tax, allowing owners to benefit in the returning of the land remise fund, simplifying the approval procedures of the green building and accelerating the speed of declaration procedures.

4. Attention to operation of the market

   The evaluation standard of green building was issued and implemented by the government. Non-governmental institutions and companies have not positively take part in its implementation. The governmental departments should encourage the architectural society, non-governmental institutions involve in the evaluation work.
5. Life cycle assessment

   The evaluation time of the Chinese green building evaluation level is 1 year after the completion acceptance. The evaluation of the Chinese green building evaluation level does not consider the work in the early stage. The evaluation time should begin from the project start, and review construction process, operation results.
6. Open the evaluation process

   The evaluation process of the Chinese green building evaluation level is not open, and the appliers and citizens only know the evaluation results, and they do not know the evaluation process. The government should open the evaluation process.
7. Strengthening the professional training

   Professionals are essential factor for green buildings development. The professionals are short in China, therefore the professional training should be strengthened to promote green building development.

125.5 Conclusions

The evaluation standard of green building has been implemented for 6 years, some problems have been found. The main problems were analyzed in this study, and improved suggestions were put forth in order to better implement the evaluation work in China. The Vanke Center was discussed as a case study.

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Chapter 126
Analysis of the Value and Price of Real Estate and Concurrently on the Appraisal of Mortgage Value

Wen Wang

Abstract Research Purpose: This research seeks to probe deeply into the internal relation between the market value and market price of real estate to provide the basis of a scientific "definition of value". Research Methods: Documentation and logic reasoning were employed. Research Results: In the practice of real estate appraisal, the standards for "market value" are not applicable to all appraisal projects; and for the appraisal of a single object, the value standards vary with the purpose of the appraisal even under the same market conditions. Research Conclusion: In appraisals for the purpose of real estate mortgage, market value standards should be applied, particularly during periods of irrational advance of the real estate market; but in appraisals for the purpose of real estate transfer, market value standards may not be applicable because a determination of the actual market price is required, which may agree with or deviate from the market value.

Keywords Real estate • Value • Price • Appraisal

126.1 Introduction

What is the value of real estate? What is the relation between market value and market price of real estate? Is it the market value or the market price that is revealed in the appraisal of real estate? Are market value standards applicable to all appraisal projects? These questions have been puzzling the appraisal community in the Chinese Mainland. In actual operation, "market value" standards are always adopted without regard to the purpose of the appraisal. In appraisals for such varied purposes as real estate transfer, mortgage, enterprise reformation and compensation

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_126,

for residence demolition and relocation, the same standards are adopted for value definition. Whether this practice is reasonable, whether the value definition should be the same for different appraisal purposes and how to scientifically specify the "value definition" have become the problems that the appraisal community most urgently needs to solve.

Starting with an analysis of the connotations of the word value, this paper probes into the real meaning of value revealed in the appraisal of real estate, then differentiates and analyzes some ambiguous concepts emerging in appraisal practice, and puts forward preliminary advice for standardizing the "value definition".

126.2 Analysis of the Value and Price of Real Estate

126.2.1 What Is Meant by "The Value of Real Estate"

Of value theories, the most prominent are the Marxist labor theory of value, the Western marginal utility theory of value and Marshall's equilibrium theory of price. The Marxist labor theory of value reveals the essence of value and its core viewpoint is that man's living labor is the unique source of value; in the Western marginal utility theory of value it is argued that the commodity value depends on people's perception and evaluation of the goods' utility and is determined by the marginal utility of the commodity, and "marginal utility" is taken as the yardstick for measuring the quantity of value; and in Marshall's equilibrium theory of price it is argued that, with the other conditions being unchanged, the value of a commodity is jointly determined by the supply and demand of the commodity and this theory explains the value of commodity through equilibrium price.

The aforesaid value theories reveal different connotations of the word value and lay different emphases on their research. The Marxist labor theory of value lays emphasis on the research of the "essence of value" while the marginal utility theory of value and the equilibrium theory of price lay emphasis on analyzing the quantity of value, and they all have the significance of being used as reference for guiding the current practice of real estate appraisal. But in practical appraisal, the appraisers pay more attention to the currency manifestation of the real estate value, i.e. the value that can be realized under certain market conditions, or the exchange value. Therefore, the "value of real estate" dealt with in the appraisal is closest to the value definition in the equilibrium theory of price.

Then, in what state is the value revealed in the appraisal of real estate and what types does it have? In fact, the value revealed in the appraisal is the price that is most likely to be realized under certain market conditions. So, the value of real estate can be classified according to the market conditions. Generally, the real estate market can be classified as normal or abnormal. Accordingly, the value revealed in the appraisal of real estate can also be classified as normal market value and abnormal market value. Presently, they are respectively called "market value and non-market value" [2] in the field of real estate appraisal, which mean the same as the aforesaid terms. To avoid confusion and misunderstanding in wording, they are hereinafter referred to as "market value and non-market value".

For the concept of the market value of real estate, there exist many definitions at home and abroad. The definition of market value used by the US federal institutions in financial regulation is: "Market value is the most probable strike price of a piece of real estate sold in a competitive and open market, where such a market has all the conditions needed for fair trading, both the buyer and the seller have given deep consideration and received sufficient information before taking action, and it is supposed that the price will not be subject to abnormal pressure [1]." In the textbooks designated for real estate appraisers' qualification test in the Chinese Mainland, the brief definition of market value is: "Market value is the price most likely to be voluntarily agreed by and between rational and cautious trading parties, who aim for their self-interested motives and have sufficient time to learn about the trading object and understand the market quotation" [2]. Although these two definitions are not identical in expression, they are basically identical in connotation, that is, what corresponds to market value is the price formed under the conditions of normal market (open trading) by the buyer and the seller who have sufficient market information and conduct the trading in a voluntary and rational manner, and they especially emphasize the normal market conditions and rational trading.

Contrasting with market value, non-market value refers to all the other value types except market value, including quick liquidation value and irrational market value.

126.2.2 Relations Between Value and Price of Real Estate

With regard to the relations between price and value, the Marxist labor theory of value contains a brilliant exposition, that is, value is the foundation of price and determines price; price is the currency manifestation of commodity value and fluctuates with the fluctuation of value. Marx's value theory has the guiding significance for the correct understanding of the relations between value and price of real estate and these viewpoints have long been accepted by the people. But the questions remain, under different market conditions, what are the characteristics of the price manifested in different types of value? And, what on earth is the relation between market price and market value? I shall discuss these below.

1. Market Value and Long-term Equilibrium. According to the aforesaid definitions of market value, it is the price most likely to be agreed by and between both the buyer and the seller in voluntary trading under a series of supposed preconditions, that is, the "theoretical price" as often mentioned.

Whether the theoretical price exists in the actual market and whether it is the realizable price in the market or close to certain market price, to which the answer is affirmative. Then, in what state does the theoretical price correspond to the market price and when does the market price reflect the actual internal value of real estate?

The viewpoint that is universally accepted at present is that the market value corresponds to the equilibrium price. According to the Western theory of economics, the equilibrium price of real estate is the price formed when the market supply curve of real estate intersects with the market demand curve, that is, the price formed when the market demand quantity of real estate is equal to the market supply quantity. But it needs to be noted that market equilibrium can exist in several forms, namely, temporary equilibrium, short-term equilibrium and long-term equilibrium, and the prices in different cases of equilibrium are usually unequal. Then, to what equilibrium price does market value correspond? According to the aforesaid definitions of market value, the market value corresponds to the normal market conditions. This means only the price manifested when the market reaches the state of long-term equilibrium can really reflect the internal value of real estate. That is, market value corresponds to long-term equilibrium price.

2. Market Price and Temporary Equilibrium. Having made clear the connotations of market value and its corresponding relations with price, let us analyze the meaning of market price. The meaning of the market price of real estate is the common average price of certain pieces of real estate on the market and it is the abstract result derived from the great number of strike prices of such real estate [2]. So, market price also stands for the collective value judgment of market participants. But different from market value, the market to which market price corresponds includes both normal market and abnormal market; and the collective value judgment may be rational or may be irrational. When the market is in an abnormal state and the market participants are widely irrational, their collective value judgment will not reflect the internal value of real estate, and the market equilibrium at this time can only be temporary equilibrium and the market price corresponding to it will be the temporary equilibrium price.
3. Market Value and Market Price. From the above analysis, it can be seen that market value and market price are two concepts that interconnect with each other and differ from each other, and they respectively correspond to the prices of the real estate market in the long-term and short-term equilibrium states. Market price may tally with market value or may deviate from market value. When the main acts of participants in the real estate market are rational and real demand equals real supply, market price is close to its market value; but when the main acts of traders in the market are widely irrational or the market participants hold certain irrational expectations, market price will deviate from market value for a long period and to a great extent and its specific manifestation will be notably higher or lower than market value.

126.3 Analysis of Misunderstanding and Doubts in Actual Appraisal

126.3.1 Confusing Normal Market with Actual Market

In the appraisal of real estate, is the normal market price or the actual market price being appraised and how can one make the reasonable choice according to different appraisal purposes? These questions are not usually addressed in actual appraisal. For example, in the appraisal of land price, in whatever state the market is at the time of the appraisal, land price is invariably defined as the normal market price. But in fact, when the main market traders are generally in an irrational state at the time of the appraisal, the actual market price is not identical with the normal market price. Besides, in such case, it is not that the appraisal of all purposes should reveal their normal market prices. For example, an appraisal for the purpose of real estate transfer should take the actual market price as the standard because the actual market price stands for the price that is most likely to be realized under the market conditions at the time and tallies with the very purpose of the appraisal. The practice of confusing actual market with normal market in the appraisal can easily cause ambiguity in valuation.

126.3.2 Confusing Market Value with Market Price

In the appraisal practice in the Chinese Mainland, market value and market price are often inter-changeably used. In many appraisal reports, value is defined as the "market value of the appraised object under limited conditions", but what is actually appraised is the "market price". Even if the market is in an abnormal state at the time of the appraisal, the appraisal is still carried out according to the actual market price. In fact, when the market is in an abnormal state, market price may deviate from its market value and cannot really reflect the internal value of real estate. Therefore, when the market is in an abnormal state, if the appraisal is carried out without differentiating market value from market price, it will cause the appraisal results not to accord with the value definition.

126.3.3 Adopting the Same Standard for Transfer and Mortgage Appraisals

In actual appraisal, the appraisal purposes or the market conditions are usually not differentiated and the same standard is adopted for the value definition. For example, the market value standard is adopted for both transfer appraisal and mortgage appraisal. Is this practice reasonable? Let us first analyze which standard should be adopted in appraisal for the purpose of real estate transfer, market value or market price? As discussed above, what the appraisal for the purpose of transfer reveals is the price that is most likely to be realized under the market conditions at the time of the appraisal. Whether the market is in the normal state or in the abnormal state, it should be subject to the market conditions at the time. Therefore, in such a case, the value definition should be specified as appraising the market price of real estate, and it may not reflect market value.

But in appraisal for the purpose of mortgage, as the disposal of real estate assets occurs at some time in the future, there may be a rather long time interval from the time of appraisal. During this period, changes may occur in the conditions of the real estate market and there exist quite a few uncertain factors. To guard against the credit risks in real estate and on the principle of prudence, the value definition should be specified as appraising the market value of real estate, particularly when the real estate market is in a period of irrational advance at the time of the appraisal, the market value standard should be adopted rather than the price under the market conditions at the time. However, when the real estate market is in a period of recession and the market price is notably lower than market value, the market price should be appraised.

126.4 Conclusions

1. Market Value and Market Price Should not Be Used Inter-changeably. From the aforesaid analysis, it can be seen that market value and market price are two concepts that interconnect with each other and differ from each other. The market value of real estate refers to the price formed by the buyer and the seller in voluntary and rational trading under normal market conditions, and it corresponds to the price formed when the real estate market reaches the state of long-term equilibrium. If the market value standard is adopted in the appraisal, what the appraisal result corresponds to will be the normal market price. Even if the market is in an abnormal state at the time of the appraisal, it should also take the normal market conditions as the supposed precondition.

   The market price of real estate is the price of the appraised object that is most likely to be realized at a certain time under actual market conditions, and it corresponds to the temporary equilibrium price of the real estate market. As the actual market may be in a normal state and may be in an abnormal state at the time of the appraisal, market price may tally with market value but may also deviate from market value for a long period and to a great extent, and they should not be used inter-changeably.
2. Market Value Standards Are Not Applicable to All Appraisal Projects. In the appraisal of real estate, not all project appraisals seek to reveal the internal value and real value of real estate. In some cases, the client only requires the appraisal of the actual market price of real estate rather than market value. For example,

during a period of irrational advance of house market prices, a certain resident entrusts an appraiser to appraise his house property for the purpose of transfer. According to the appraisal purpose, the client requires appraisal of the price of the appraised object that is most likely to be realized in the trading under the current market conditions (abnormal market). In such a case, if the appraiser still carries out the appraisal according to market value standards, it will be notably lower than the actual market price and this obviously goes against the client's real purpose.

3. Value Standards Vary with Different Appraisal Purposes. Even for the same appraised object and under the same market conditions, the value definition may vary with different appraisal purposes. The most typical case is where, during a period of abnormal advance of real estate market prices, the value definition of the same appraised object may differ greatly in its transfer price appraisal and mortgage value appraisal. As discussed above, with regard to appraisal for the purpose of transfer, what the client is interested in is simply the current market price of the real estate rather than its internal market value. But the appraisal for the purpose of mortgage is different because the time of guaranty disposal is often inconsistent with that of the appraisal. During the intervening period, there may be great changes in the conditions of the real estate market. To guard against the credit risks of the bank and on the principle of prudence, the market value standards should be adopted in the appraisal.
4. Value Definition Determines Appraisal Thinking and Method Choice. It is universally recognized that, during a period of great fluctuation in the real estate market, especially when there exist bubbles in the market, the first choice of appraisal method should be the income approach and then the cost method, and the market comparison approach should be avoided as much as possible. In fact, this viewpoint may not be correct and the crux lies in how to choose the value standards in value definition, "market value" or "market price". If the market value standards are adopted in the appraisal, the aforesaid viewpoint is undoubtedly right. But if, according to the client's needs, what is appraised happens to be the price (such as transfer price) of real estate in the current market conditions, the aforesaid viewpoint may be questioned. Because what can best reflect the actual market price is still the price of comparable transactions that have recently occurred, as far as the appraisal of actual market price is concerned, the first choice should still be the market comparison approach rather than the income approach even in abnormal market conditions.

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Chapter 127
Maintenance of Public Schools Infrastructure in South Africa

Wilda Mojela and Wellington Didibhuku Thwala

Abstract Focusing on the dilapidated state of public schools' infrastructure in the East Rand, Gauteng Province of South Africa, this study presents findings on the reasons why public schools infrastructure is in a dilapidated state, various factors which contribute to the dilapidation and establishes ways in which the state of old and new infrastructure can be improved in an attempt to preserve and maintain a good state of public schools infrastructure. A detailed literature review of both South Africa and international literature was compiled on public schools infrastructure. A questionnaire was designed to collect data from nine schools in the East Rand. The field survey comprised of three Department of Education Officials, nine school principals, nine school teachers and nine school governing body members. There are several factors that lead to the state of dilapidation of public schools. The study provides a assessment of the conditions of public schools infrastructure. The paper further to identify the causes factors of public schools infrastructure dilapidation. The paper then presents the conclusion of the study.

Keywords Facilities maintenance • Dilapidation • Public schools infrastructure • Factors leading to dilapidation

127.1 Introduction

The primary purpose of a school is to promote equitable provision of an enabling school physical teaching and learning environment and a school in a dilapidated condition poses a challenge to the achievement of this goal [1]. Research indicates that better educational attainment and outcomes are achieved when the school

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_127,

environment is well maintained [1]. It is every country's high priority to ensure that its citizens are well educated. The dilapidated state of public schools infrastructure is a problem that is shared by most countries worldwide. Various studies have indicated that public schools infrastructure suffers from deplorable conditions and that seems to be a common notion [2–4]. A detailed study was undertaken by Filardo [5] to present the current condition of schools, their needs and challenges that schools face in keeping their infrastructure in a good condition in the USA. It can no longer be ignored that the condition and quality of buildings reflect public pride or indifference, the level of prosperity in the area, social values and behavior and all the many influences both past and present, which combine to give a community its unique character [6]. As a result policymakers, the government and common people worldwide have acknowledged that the dilapidated state of public schools infrastructure can no longer be ignored. Education Quality lawsuits lead to the 1998 Student First Act which established the School Facilities Board for building and improvement of school buildings in Arizona, USA [7]. Kenya has also established the School Infrastructure Improvement Plan (SIIP) which aims to provide direct funding to schools to carry out permanent infrastructure projects planned by community members.

127.2 Objectives of the Study

The main objectives of the study are as follows

- To access the conditions of public schools infrastructure
- To identify the causes factors of public schools infrastructure dilapidation

127.3 Literature Review

The National Infrastructure Maintenance Strategy drawn up by the Department of Public Works in conjunction with the CIDB (2007) states that a significant proportion of education facilities, particularly their mechanical and electrical equipment, are in a poor state of repair in South Africa. Furthermore, a study conducted by American Society of Civil Engineers (2005) found no improvement in the overall quality of school facilities since 2000. The majority of public schools infrastructure is in a dilapidated state and prevailing attitudes suggest that improvement of the state of public schools infrastructure will not be easy as most of the schools are old and have suffered years of neglect. Seventy percent of identified deficiencies in schools are a result of neglect [7]. Throughout the lifecycle of the school facilities, portions of funding intended for maintenance, have tended to be deferred or reassigned [2]. The most recent government statistics reveal that there are still many schools in South Africa that are without or have extremely poor basic infrastructure [8]. Astonishingly, detailed conditions and numbers do not exist but up to date numbers on spending exist [9]. Much still needs to be done to achieve national data on needs and detailed conditions of public schools infrastructure. The inability to properly maintain school facilities is also attributed to the problem that funds are usually based on the perceived needs and priorities of the districts and not the individual schools [10]. According to Ali [11], maintenance performance indeed suffers from inaccurate decisions made in cost allocation. He further says that existing building conditions and complaints received regarding building performance are critical in making maintenance decisions. Dilapidation of school facilities is also exacerbated by the fact that the local communities and the school districts are struggling to manage school facilities [5].

Although aspects of the poor quality of school infrastructure were evident in high performing schools as much as the low performing, it was noticeable that all the low achieving schools were particularly poorly maintained and neglected, in terms of the state of the classroom buildings, the furniture and the toilets [12]. Another study has indicated that dilapidated public school infrastructure is a result of mismanagement of funds, lack of stable and effective leadership at district level, intense overcrowding, deferred maintenance and neglect (Washington et al. 2003). There is also some mismanagement of resources as some schools had more furniture when others had none (Monyatsi 2005). Three main problems in Nigeria are lack of transparency and accountability in governance, under qualified staff and administration and tenous relationships between urban residents and local governments [13]. A study conducted by Moja (2000) improvement of infrastructure. The most pressing need in existing schools appears to be funding for mid-size refurbishment and repair projects such as partial replacement of roof, driveway surfaces, replacement of ceiling tiles, correction of hardware deficiencies and replacement of playground equipment [14]. Schools face challenges of keeping up with building maintenance, lifecycle replacements, new educational design and enrollment change [5].

127.4 Research Methodology

The investigation was based on secondary and primary data focusing on the factors which lead to the dilapidation of schools. The study started with the identification of dominant factors that lead to the dilapidation of public school's infrastructure through literature. A survey was conducted using structured questionnaires of 9 public schools in the East Rand, Johannesburg. Questionnaires were distributed to school principals, School Governing Body members, school teachers and District officials from the Department of Education. The use of past studies on the topic from various countries was utilized. Various factors that contribute to the dilapidation of public schools' infrastructure are identified from structured questionnaires. Data will be analyzed through the Statistical Package for Social Sciences (SPSS). The analysis was derived from structured questionnaires on why schools are in a dilapidated state, what factors lead to the dilapidation and establishing ways to improve the dilapidated state of public schools infrastructure. The questionnaire was designed to investigate reasons and factors why public schools infrastructure is in a dilapidated state and also to establish ways in which the dilapidated state of public schools infrastructure can be improved. The questionnaire was divided into three main parts. Part 1 related to general information of respondents, part 2 comprised of close ended questions while part 3 consisted of open-ended questions. A total of 30 questionnaires were administered and 27 were returned. The total of 27 respondents comprising of two Department of Education Officials, nine school principals, nine school teachers and nine school governing body members were interviewed from three townships in the East Rand, Johannesburg. A total of three public schools formed the sample from the study in each township. These townships were easily accessible to the researcher and have high numbers of infrastructural backlogs. Purposeful sampling was used to select the public schools and the type of respondents.

127.5 Research Findings and Results

Findings as shown in the above figure reveal that 81 % of the respondents noted that school infrastructure has existed for over 20 years. This affirms the notion that school facilities are often too old to be brought back to a good condition [4]. As shown in figure most of the schools are in a bad condition (Fig. 127.1).

Although there are other factors which contribute to the dilapidated state of public schools infrastructure, the findings reveal that overcrowding (88 % of respondents), vandalism (73 % of respondents), uneven distribution of funds (62 % of respondents) and lack of clear national standard policies (58 % of respondents) are some of the main factors which contribute to dilapidation besides inadequate funds (Fig. 127.2).

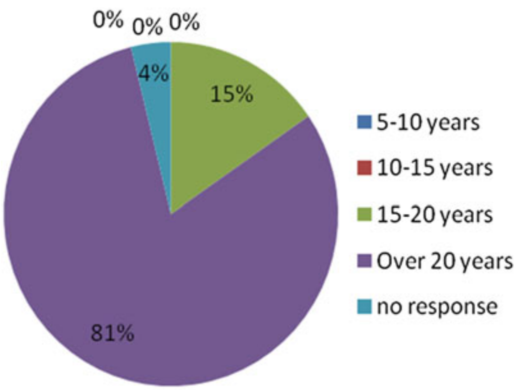

Fig. 127.1 Age of school

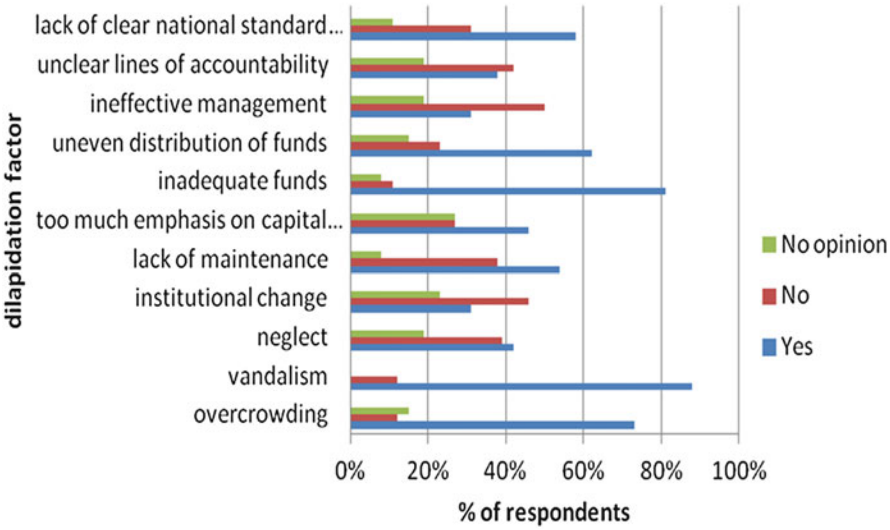

Fig. 127.2 School dilapidation factors

127.6 Condition of the School Infrastructure

The findings reveal that the condition of public schools infrastructure is ranked anywhere between very bad to good. Only 54 % of the respondents ranked their schools to be in a good condition and 34 % ranked their schools to be in a bad condition, with a further 8 % of respondents ranking their school to be in a very bad condition (Fig. 127.3).

127.7 Main Reasons for Poor Conditions of Schools

Six respondents believe that their schools in a bad condition due to deferred maintenance while another six respondents believe that their schools are in a good or very good condition because of the commitment of the school management. Four respondents noted that their schools are in a bad or very bad condition due to lack of maintenance and the other four noted that inadequate funds for maintenance is the reason for the dilapidation of their school. One respondent said that the reason why their school is in a good condition is due to the fundraising the school undertakes for maintenance works, one respondent said that their school is in a bad condition due to too much emphasis being placed on the tender process and vandalism (Fig. 127.4).

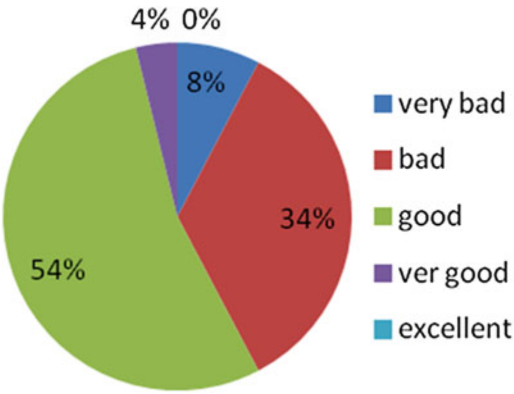

Fig. 127.3 Condition of school infrastructure

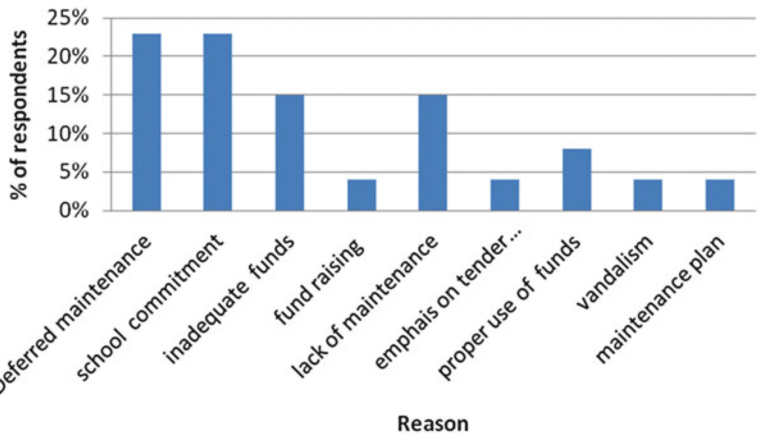

Fig. 127.4 Reasons for dilapidated condition of school

127.8 Frequency of Maintenance Works

Maintenance is not a norm in the public schools because only 8 % of the respondents noted that their schools always take up maintenance works. Only 46 % respondents noted that their schools often undertake maintenance works with 42 % noting that their schools rarely take maintenance works. Four percent never take maintenance works (Fig. 127.5).

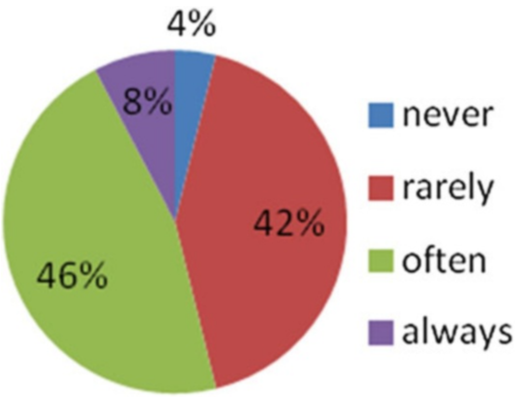

Fig. 127.5 Frequency of maintenance works

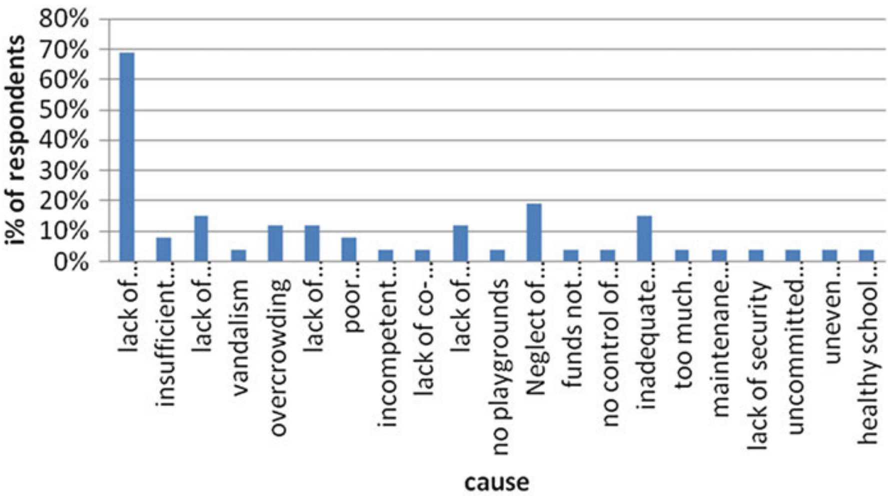

Fig. 127.6 Main causes of public schools infrastructure dilapidation

127.9 Main Causes of Public Schools Infrastructure Dilapidation

The figure above indicates that 69 % of the respondents believe that the main cause of public schools infrastructure dilapidation is the lack of maintenance. A further 29 % of the respondents noted that neglect cause the dilapidation of public schools infrastructure. This affirms the CIDB and the Department of Public Works conclusion as stated in National Infrastructure Maintenance Strategy that public infrastructure such as schools have suffered years of neglect and lack of maintenance (Fig. 127.6).

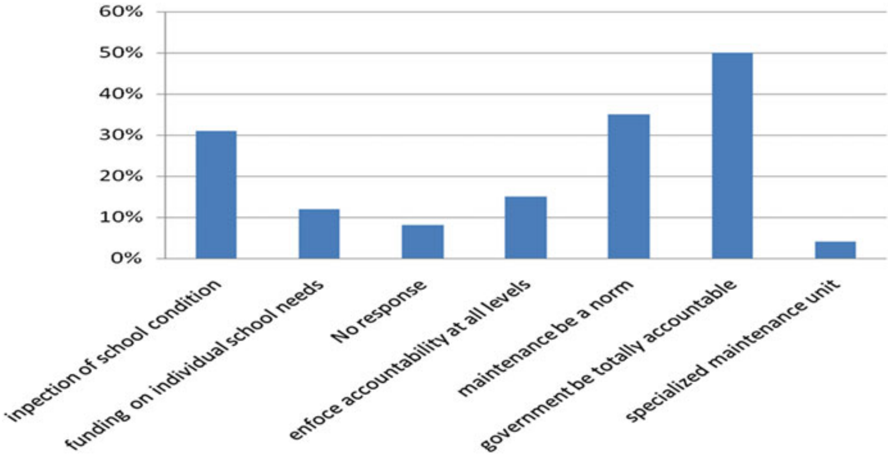

Fig. 127.7 Aspects that need to included in the maintenance framework

127.10 What Must Form Part of the Maintenance Framework

The findings reveal that the aspects that need to be included in the maintenance framework for public schools infrastructure are total government accountability for maintenance works (50 % of respondents), introduction of maintenance works as a norm (35 % of respondents), accountability for school condition be enforced at all levels (15 % of respondents), funding of schools be based on individual school needs (11 % of respondents) and the establishment of a specialized maintenance unit for schools (5 % of respondents) (Fig. 127.7).

127.11 Conclusion

The study has investigated why public schools infrastructure is in a dilapidated condition, identified factors which lead to the dilapidation and established ways in which to improve the dilapidated state of public schools' infrastructure. A significant number of schools are old and rarely undertake maintenance works for their infrastructure. Lack of maintenance has put the public schools infrastructure under a rapid rate of aging. The public schools infrastructure suffers from severe dilapidation because of a set of factors namely; vandalism, insufficient maintenance funds, uneven distribution of funds among schools, lack of clear national policies on the standard of public schools infrastructure, unclear lines of accountability at school level and district level, institutional change, ineffective management at school level, overcrowding, too much emphasis on capital works at government level, lack of community involvement, damage by learners, no control of funds by schools, lack of ownership by teachers, learners and the community, lack of commitment by some of the school management, lazy ground staff, no playgrounds for learners, mismanagement of funds at school level, too much emphasis on tender process, schools too old to be brought to good condition, lack of monitoring school conditions by districts and the lack of co-operation between school management.

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Chapter 128
The Relationship Between Construction Sector and the National Economy of Sri Lanka

Thanuja Ramachandra, James Olabode Bamidele Rotimi, and Raufdeen Rameezdeen

Abstract The causal relationship between construction and a country's economy has received much attention in the past. However, the results provide contrasting views on the nature of this relationship. This paper therefore investigates the direction of the causal relationship between construction and the economy of a developing country, Sri Lanka. It uses empirical data for selected economic and construction indicators for the period 1990–2009. The pattern of the causal relationship was determined using Granger causality test. The findings reveal that for all indicators except construction investment, national economic activities precede that of construction. The study therefore concludes and strengthens the body of knowledge on Sri Lanka that the causal relationship between its construction sector and national economy tend towards a uni-directional relationship with the national economy inducing growth in the construction sector and not vice versa.

Keywords Economy • Construction • Granger causality • Sri Lanka

128.1 Background

The construction industry encompasses a variety of activities and is a vital sector in any economy [1, 2]. Construction has a strong linkage with most of the other economic activities of a country [3–5]. It is considered to be an important partner

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_128,

in economic growth and mirrors the stage of economic development [3, 6, 7]. There are opposing views with regard to the relationships between construction and the economy of a country. One view is that construction causes the economy to grow as it creates physical facilities that are needed in the development of other productive activities [2, 8–10]. The opposing view holds that GDP causes the construction output growth [11–13]. Interestingly some other studies suggest a bi-directional relationship between different sub-sectors of the construction industry and the national economy [3, 14–16]. This paper believes that a better understanding of this lead/lag relationship requires more evidence from other countries. It is particularly necessary for developing countries because most of the previous studies used data from developed countries. This paper presents a test on the link between construction and the economy using empirical data from Sri Lanka. It is intended to extend knowledge on causal relationships and other general construction issues related to the case study country, Sri Lanka.

Sri Lanka is a developing country with a per capita income of US$2041 [17]. Sri Lanka has a strong construction sector which contributes significantly to its GDP. The total value of new construction is above 60 % of the total gross domestic fixed capital formation and the industry provides employment to around 7 % of the total labour force [18]. The construction industry in Sri Lanka is expected to grow steadily and systematically in the long run while being a significant and integral part of the economy [4].

128.2 Description of Methods

The study, on which this paper is based, uses Granger Causality Test to determine the above relationship. Granger Causality Test is an econometric technique pioneered by Granger and Newbold [19] which is applied to find relationships between economic variables. Granger causality uses regression to find the causal relationships between two variables, 'Xt' and 'Yt' [3, 11, 19]. The regression provides statistical evidence whether the current 'Y' value can significantly be explained by the past values of 'Y' and 'X'. Granger causality test considers two autoregressive (AR) models illustrated below:

$$\mathrm{Xt} = \sum \mathrm{á0iYt} - \mathrm{i} + \sum \mathrm{â0iXt} - 1 + \mathrm{ut} \tag{128.1}$$

$$\mathrm{Yt} = \sum \mathrm{á1iXt} - \mathrm{i} + \sum \mathrm{â1i\,Yt} - 1 + \mathrm{vt} \tag{128.2}$$

Where n is the maximum number of lagged observations included in the model and Ut and Vt are the random error terms for each time series. Where causality implies, X is Granger causing Y when á0i is not zero in Eq. 128.1. Similarly, Y is Granger causing X if á1i is not zero in Eq. 128.2. If both of these events occur, then feedback effects exist.

Testing causality involves using F-tests to ascertain whether lagged information on a variable Y provides any statistically significant information about a variable X in the presence of lagged X. If not, then “Y does not Granger-cause X.” There are four possible outcomes in a Granger causality test [20];

- No causal relationship between two variables,
- Unidirectional causality from X to Y,
- Unidirectional causality from Y to X, and
- Bidirectional causality (X causes Y and Y causes X).

Two sets of indicators are used in the current study. One set represents construction while the second national economy. Construction performance is measured using construction value added (CVA), value of construction in the total gross domestic fixed capital formation (CGDFCF), and construction cost indices (CCI). For the national economy, Gross Domestic Product (GDP), Gross Domestic Product Deflator (GDPD), Unemployment Rate (UE) and Balance of Trade (BT) were considered. Previous studies commonly used GDP as an indicator of economic growth, except [9] who used balance of payment and domestic prices. The indicators used for this study were based on constant prices for the period 1990–2009, and were obtained from published data by the Central Bank of Sri Lanka [18, 20, 21].

128.3 Results

Time series, especially economic data in level form is non-stationary and most statistical methods including Granger causality require the time series to be transformed to stationarity [19, 22]. Stationary could be detected using three methods: autocorrelation function (ACF), correlogram (Q-statistic), and the Unit Root Test. Among them Unit Root Test is widely used to detect and transform the series into stationary forms [22]. Unit root test provides several tests such as Dickey Fuller (DF), Augmented Dickey Fuller (ADF) and Phillips Perron (PP) for testing the order of integration [23, 24]. For the purpose of this study, Augmented Dickey Fuller (ADF) test is used following recommendations of past studies because the test considers the situation where the white noise error terms are correlated, which is an improvement of Dickey Fuller (DF) test [25]. Table 128.1 presents the critical

Table 128.1 Unit root test results for variables

	At level		At first difference		At second difference	
Variable	No trend and intercept	With trend and intercept	No trend and intercept	With trend and intercept	No trend and intercept	With trend and intercept
CV at 5 %	−1.9504	−3.5386	−1.9504	−3.5386	−1.9504	−3.5386
GDP	4.4199	1.6445	−0.4968	−3.9661	−9.0553	−9.1952
GDPD	3.2519	3.0933	2.0211	−0.6578	−5.2603	−6.0771
BT	6.0741	4.1637	−4.2139	−6.2124	–	–
CVA	2.9577	0.2734	−0.8241	−2.8046	−7.8325	−7.7790
CGDFCF	4.4524	0.1212	−3.1690	−6.1378	–	–
CCI	1.4116	−0.5006	0.5475	−1.5328	−2.7339	−2.7542

Table 128.2 Causality between GDP^2 and CVA^2

	GDP^2 does not cause CVA^2		CVA^2 does not cause GDP^2	
Lag length	F statistics	Prob.	F statistics	Prob.
1	5.37134	0.02702	0.22668	0.63723
2	2.76753	0.07943	0.16561	0.84817
3	2.38952	0.09171	0.11444	0.95086
4	2.08922	0.11510	0.20169	0.93485
5	1.67726	0.18608	0.14546	0.97913
6	1.52228	0.23021	0.27120	0.94287

and calculated values for the selected indicators at 5 % significance level. The comparison of critical values with calculated values reveal that BT and CGDFCF are stationary at first difference. The calculated values fall within rejection region implying that the null hypothesis is rejected, and that the time series has no unit root. Similarly the values for GDP, GDPD, and CVA indicate that they are stationary at second difference. CCI was however found to be non-stationary at second level of difference.

The regressions (1) and (2) described previously was run for the possible lag values of each variable. The number of lags in causality test is arbitrary. It depends on the relationship between the variables. The causality between variables is described in the following three sections. Each section takes one economic indicator and runs the pair-wise regression with all three indicators for construction. To test causality, the results were validated using the residual plots, auto correlation function (ACF) and Durbin-Watson (DW) statistic. This paper considers the DW statistic method only.

128.3.1 Causality Between CGFCF, CVA, and CCI and GDP^2

The direction of the causality between GDP and CVA was investigated by testing the hypothesis that GDP does not cause CVA and CVA does not cause GDP, which is reported in Table 128.2 (CGFCF,[1] CVA,[2] and CCI[3]). Using the probability value of 0.02702, DW statistic of 1.94, it can be concluded that CVA does not cause GDP. Similarly, the causality between GDP and CGDFCF; and between GDP and CCI; were tested and the results are presented in Tables 128.3 and 128.4. Results indicate that CGDFCF does not cause GDP and CCI does not cause GDP for any lag. On the

[1] *First difference*

[2] *Second difference*

[3] *Third difference*

Table 128.3 Causality between GDP^2 and $CGDFCF^1$

	GDP2 does not cause CGDFCF1		CGDFCF1 does not cause GDP2	
Lag length	F statistics	Prob.	F statistics	Prob.
1	0.00033	0.98567	0.46519	0.50011
2	4.50393	0.01980	0.82644	0.44765
3	4.86264	0.00814	0.71893	0.54970
4	3.80471	0.01623	0.50978	0.72908
5	2.15563	0.10033	1.09763	0.39241
6	1.52796	0.22847	1.59569	0.20871

Table 128.4 Causality between GDP^2 and CCI^3

	GDP2 does not cause CCI3		CCI3 does not cause GDP2	
Lag length	F statistics	Prob.	F statistics	Prob.
1	10.5863	0.00994	1.88745	0.20274
2	3.50508	0.09809	0.92860	0.44530
3	1.91193	0.30394	0.48098	0.71845
4	NA	NA	NA	NA

Table 128.5 Causality between $GDPD^2$ and CVA^2

	GDPD2 does not cause CVA2		CCI3 does not cause GDP2	
Lag length	F statistics	Prob.	F statistics	Prob.
1	1.42167	0.24190	2.16629	0.15083
2	0.91315	0.41249	0.82027	0.45027
3	1.17538	0.33821	0.75831	0.52766
4	1.12230	0.37034	1.47566	0.24208
5	1.51200	0.23067	1.05663	0.41304
6	1.34620	0.29109	0.45969	0.82836
7	3.61273	0.01951	0.43628	0.86342

contrary, GDP is found to cause CGDFCF for lags 2 and 4. DW statistics of 1.85 and 1.64 for the latter models shows that there is no serial correlation between the error terms.

128.3.2 *Causality Between $GDPD^2$ and CVA^2, $CGFCF^1$, and CCI^3*

The results of the hypothesis test for causality between GDPD and CVA are given in Table 128.5. It shows that GDPD causes CVA for lag 7 and not vice-versa with a DW statistic value of 1.92. The column 3 in Table 128.6 indicates that the probability for hypothesis GDPD does not cause CGDFCF are insignificant at 5 % level for lags up to 6. However, column 4 indicates that the probabilities for

Table 128.6 Causality between GDPD[2] and CGDFCF[1]

	GDPD2 does not cause CGDFCF1		CGDFCF1 does not cause GDPD2	
Lag length	F statistics	Prob.	F statistics	Prob.
1	0.30710	0.58332	6.60690	0.0150
2	0.71116	0.49944	6.22659	0.0056
3	0.98857	0.41354	6.11313	0.0027
4	1.24627	0.31938	5.14313	0.0041
5	0.70637	0.62544	4.54295	0.0063
6	0.78163	0.59579	2.13252	0.1026

Table 128.7 Causality between GDPD[2] and CCI[3]

	GDPD2 does not cause CCI3		CCI3 does not cause GDPD2	
Lag length	F statistics	Prob.	F statistics	Prob.
1	17.7051	0.00228	2.20771	0.17149
2	5.33804	0.04658	0.46986	0.64629
3	3.81882	0.15009	0.80662	0.56801
4	NA	NA	NA	NA

Table 128.8 Causality between BT and CCI[3]

	BT does not cause CCI3		CCI3 does not cause BT	
Lag length	F statistics	Prob.	F statistics	Prob.
1	0.45888	0.51518	0.15628	0.70181
2	29.2586	0.00080	0.45222	0.65625
3	7.23194	0.06920	0.43803	0.74230
4	NA	NA	NA	NA

null hypothesis of ‘CGDFCF does not cause GDPD’ are significant for lags up to 5. The respective DW statistics of 1.86 and 1.93 confirms the validity of the models. Therefore, it can be inferred that CGDFCF does cause GDPD and not vice-versa. Table 128.7 shows that probabilities for hypothesis ‘GDPD does not cause CCI’ are significant up to lag 2 while for the null hypothesis ‘CCI does not cause GDPD’ none of them are significant. Thus, it can be inferred that GDPD does cause CCI and not vice-versa. The DW statistic value of 1.87 indicates no auto correlation between residuals.

128.3.3 Causality Between BT[1] and CVA[2], CGFCF[1], and CCI[3]

Table 128.8 shows that probabilities for the null hypothesis ‘BT does not cause CCI’ and ‘CCI does not cause BT’ are insignificant at 5 % level for all possible lags except 2. According to Table 128.9 the probabilities for null hypothesis ‘BT does

Table 128.9 Causality between BT and CVA[2]

	BT does not cause CVA2		CVA2 does not cause BT	
Lag length	F statistics	Prob.	F statistics	Prob.
1	1.33693	0.25614	1.43061	0.24045
2	1.38886	0.26546	0.50999	0.60579
3	1.20648	0.32702	0.30651	0.82043
4	1.78810	0.16563	0.94168	0.45766
5	1.71127	0.17804	0.66962	0.65100
6	1.34025	0.29340	0.39395	0.87275
7	4.12858	0.01156	0.51084	0.81180

Table 128.10 Causality between BT and CGDFCF[1]

	BT does not cause CGDFCF1		CGDFCF1 does not cause BT	
Lag length	F statistics	Prob.	F statistics	Prob.
1	0.20437	0.65418	2.83183	0.10185
2	0.91902	0.40985	1.77411	0.18697
3	0.66661	0.57987	1.82647	0.16615
4	2.14497	0.10623	2.13341	0.10773
5	3.05490	0.03164	2.67362	0.05071
6	4.84435	0.00415	1.72193	0.17315

not cause CVA' and 'CVA does not cause BT' are insignificant for all possible lags except 7. Table 128.10 indicates that probability values for null hypothesis 'BT does not cause CGDFCF' are not significant at 5 % confidence level up to lag 4 while for null hypothesis 'CGDFCF does not cause BT' is insignificant for all possible lags.

128.4 Conclusions

As it is well documented in construction economics literature, when an economy is booming, the construction sector also booms. Conversely a slowing down in the economy slows down construction activities. Hence, a causal relationship between them could be postulated. What is unknown is which causes what? Such information is useful in policy planning to prioritize investment opportunities. The current study considered the most appropriate among the available indicators to represent both the construction sector and the national economy. A summary of the results obtained from the Granger causality test is given in Table 128.11. For all indicators except CGDFCF and GDPD the cause-effect analysis reveals that the economy leads the construction sector and not vice versa. This supports the viewpoints of [11, 12] that GDP tends to lead construction flow. The results however contradict the

Table 128.11 Causality between construction and the national economy

	GDP	GDPD	BT
CVA	GDP leads by 1 year	GDPD leads by 7 years	BT leads by 7 years
CGDFCF	GDP leads by 2–4 years	CGDFCF leads by 1–5 years	BT leads by 5–6 years
CCI	GDP leads by 1 year	GDPD leads by 1–2 years	BT leads by 2 years

views expressed by [2, 10] that construction lead the national economy and that growth in construction precedes growth in GDP.

This finding could be justified for a developing country like Sri Lanka where generally construction is subject to fluctuations. During periods of rapid economic expansion, construction output usually grows faster than those of other sectors but during periods of stagnation the industry is the first to suffer. Government being the major client of the construction industry (contributing nearly two-third of the total annual output in construction) could use the construction sector as an economic regulator whereby it could reduce construction demand by cutting back on construction projects or investment funds when an economy is overheating. This deliberately stimulates investment during periods of unemployment and slack demand. Thus, the Sri Lankan economy could prioritize investment so as to increase economic growth and optimize the use of the construction sector.

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Chapter 129
Empirical Study on Influence Mechanism of Specialty, Transaction Cost and Legitimacy to Career Development of Construction Supervision Industry

Gang Wang

Abstract Construction supervision industry has developed very rapidly recently. Now, some questions have exposed. In this paper, it has been analyzed about specialty, transaction cost and legitimacy how to influence the development of construction supervision. The model has been set up, the conclusions of those mechanisms have been put forward that specialty and legitimacy will promote construction supervision career and transaction cost will hinder construction supervision career. The model and the conclusions have been proved with structural equation modeling.

Keywords Construction supervision • Specialty • Transaction cost • Legitimacy • Career development • Structural equation modeling

129.1 Introduction

In half a century ago, the market is considered to be an automatic and accurate "clearing" machine. Government is not the market manipulators, but the market's "night watchman." The market problems can be settled by themselves under the guidance of the "invisible hand"; Market supply and demand can be precisely balanced, there is neither the supply without demand nor the demand without supply. These thoughts can be reflected in the research about the career development. How dose career development? The standard answer is that under the guidance of comparative advantage people form the result though market division of labor and mutual transactions. The people have different skills and physical strength. For the liberal thinking of many Western countries, this explanation has great power. Before the industrial revolution, this theory can explain the career

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_129,

development characterized by physical such as farmers and artisans [1]; After the Industrial Revolution, this theory can explain the career development characterized by intelligence services such as certified public accountants and teachers.

However, in China, this theory has been challenged. One of the examples is the course of China's construction supervision professional development. Considering the construction supervision is a highly specialized engineering consulting career, first this article will introduce the development of China's construction supervision, and then will describe the mechanism of China's construction supervision career development through specialization, transaction costs, the legitimacy of professional theory to model, to do empirical analysis and to conclude.

129.2 Construction Supervision Career Overview

Construction supervision is a trade name, is also a management consultant in the construction field work. With certain qualifications and workers, it is commissioned by the owners and engaged in engineering construction project management. In the late 1980s, China's construction field introduced several major reforms; one of them is construction supervision. It raised that 'Ministry of Construction will be responsible for implementing a major new reform which means implement with the construction supervision system with Chinese characteristics in china'[2].

However, some chance events also significantly changed the construction supervision's career development path. First, in 1999, Premier Zhu Rongji said:' Construction supervision should strictly perform their duties, supervises the whole process of project construction, strictly control the process; Important projects should be implemented the next-stop supervision and attendant supervision.' This speech ends the debate that whether construction supervision needs a stander in the construction site and make the supervising engineer to focus more inclined at the site. It also played a catalytic role to improve the quality of the project. But the "stand-by supervision, attendant supervision" reduces the technical difficulty of supervision and increased the responsibility of supervision, which is contrary to the supervision system design for the high intelligence and decent job image. Second, in 2004, "Construction Safety Management Regulations" clears that the supervision unit and the supervision engineers assume supervisory responsibility for production safety; when they find hidden safety supervision, they should require the construction unit for rectification until the suspension, then report to the administrative department of construction. So far safety supervision becomes a pair of invisible chains of our country construction supervision development. Because of the chanciness of production safety, it can't be accepted that in the case of low wage, asking the high intelligence, high-quality people to both bear responsibility for uncertain security and ask them to become the 'whistle people' [3]. For the consulting industry, the quality of personnel is the life of industry development. Without high-quality talent, industry development is the talk about; Third, in 2000, Nanjing TV studio center project's template support system collapse, killing six people, one seriously, 33 people minor injuries. Supervision Engineer sentenced to imprisonment for 5 years because he didn't review the construction program and agreed to the overall casting process without sub-acceptance [4]. In 2007, Shenzhen Bishui Longting projects' crane collapsed, resulting in three dead seven injured. Supervising engineer was sentenced to 1 year in prison, suspended for 2 years, but project manager who directly beard the responsibility for construction safety was exempted from criminal punishment'. This results caused huge repercussions and online discussion is very intense. Currently, many companies have emerged director (the chief supervision engineer) resign because concerning about the penalty. The director also prefer to be on behalf of director rather than be director, which caused serious turmoil in our city of the supervision team' [5]. The fresh cases further the sense of crisis to be supervisors.

What is the concept used to explain the plight of China's supervision of the industry? This is the problem of this paper.

129.3 Influence of Specialty, Transaction Cost and Legitimacy to Career Development of Construction Supervision Industry

In terms of professional construction supervision for the study, we have number of theoretical tools to choose.

Based on North's point of view, System development is path-dependent [6]. Some random events will lead to changes in the entire history, and enter the "locked" state. Some events have a great influence on the development of construction supervision, such as next-stop supervision, Safety supervision, supervision engineer's criminal responsibility, and are "locked" state in a non-virtuous cycle. But the path dependency theory can not explain these phenomena that some scholars more accurately summed up the development of the supervisory industry have issues before the occurrence of chance events. This shows that path dependence is a phenomenon, not the root cause.

Short [7] and Aoki [8] more inclined to understand the system under the framework of game theory. They think the system be ascribed to system in the human endogenous dynamic game results. Aoki believes that System is based on participants 'total faith' in the equilibrium form of 'summary representation'. Theoretical explanation within the health system, can avoid the problem generated per system. This theory successfully explains a number of Western countries, customs and organizational system, but ignores the political, social, legal effects on the economy, is the main problem. In China, more supply is mandatory system (exogenous), rather than induced the (endogenous). If you ignore the role of government and stressed that the process of spontaneous evolution can not explain that why construction supervision industry in China gone through several centuries of foreign development process of project management during two decades.

Grief thinks the changes in the system due to cultural [9]. In his view, precisely because the merchants of Genoa and the Maghreb businessmen have different cultural backgrounds, leading the former to create a modern business model, gave birth to modern Western civilization. Needless to say, Eastern and Western cultures differ materially. For the Eastern cultural environment construction supervision which is from Western cultures has some acclimatized. However, in the initial stage of our supervision industry, the government proposed "Establishing a supervision system with Chinese characteristics" [10], which indicates that the government has taken note of the potential problems of cultural differences. Moreover, taking the culture as reasons to explain will inevitably lead to the suspect of pan-cultural.

Hodgson explain the system changes in the view of evolution [11]. Evolution is the application of Darwin's evolutionary theory in economics and sociology, emphasizing the role of practice, institutional development is a "trial and error" process. Although acknowledging the theory test, trial and error, learning [12], did not fully understand the people's initiative. If only to explain the construction supervision system development in the evolutionary point of view, although this development process can be a good "fit", but there are "wise after the event" means. Be different with "evolution type" scholars, Northrop reflect on their own institutional change and path dependence theory, and raised that "ideas" or "ideology" of the system in the beginning of this century [13]. Human systems and biological systems is different, there is a sense to explore the world and continue to modify their consciousness. Although this theory from a macro perspective more aptly described the process of people understand the world, this theory does not explain anything compared with 20 years ago.

If you want to explore the problems of the construction supervision industry in depth, you can available some hand tools from the new classical economics, new institutional economics and sociology. This is specialized, transaction costs and legitimacy theory.

129.3.1 Influence of Specialty to Career Development of Construction Supervision Industry

Specialization is the driving force to promote the career development. In the eighteenth century, in Adam Smith's mind, there is a very important professional position for it. Adam Smith's pin factory example to a button shows specialization to bring the professional improvement of production efficiency. He believes that there are l three reasons to lead to productivity improvement: 'First, the skills of workers gradually increased because they do it everyday; Second, we always lost lots of time from one work to another one, but with the division of labor we can exempt this lost; Third, many mechanical inventions can simplify the work and reduce the labor, so that one can do a lot of people's work' [1]. For the construction supervision industry, studying the first and second learning effect is more importantly. First of all, supervision engineer spend the longer the time in the supervision work, the ability to find question and solve problems is stronger. Second, the long-term career in the supervision make the supervision knowledge into a coherent work, avoiding different units conversion such as the owners, design, supervision and construction work, avoiding the experience is not consistent and the loss.

Nineteenth century, Böhm-Bawerk distinguished the two different production methods, and raised specialization is not the direct production, while the use of roundabout methods because the latter creates a whole greater productivity and greater effectiveness (If the utility can be accumulated). Construction supervision is the important part after the construction industry to extend the production chain. We can see circuitous mode of production in construction industry, for example building the houses. The first stage, the owners directly composition, preparation, building housing by themselves or by the employment of labor; The second phase, there are the contractors, so the owners build the houses though the contractor. The third stage, the owners hire designers to design houses, hire contractors for construction; Fourth stage, the owners hire supervision engineers to manage the construction and the supervision engineer is responsible for organizing the design and construction. Visible, supervision engineer is product of construction procedures' extending. Every time a circuitous increase, the owner as whole interest groups will get higher benefit and efficiency, it is also support division of labor and career development foundation.

Early twentieth century Yang Ge criticized that at that time the economist on individual enterprise observation to understand its using mechanism. He proposed that "division of labor depends on the size of the market and the size of the market and depends on the division of labor" [14]. Division of labor depends on the division of labor; this is not agreed to repeatedly, but the significance of deepening. Theory of division of labor market effects was carried forward in the framework of Yang Xiaokai's new classical economics. Yang Xiaokai criticized Marshall artificially divide people into the producers and consumers, and the use of ultra-marginal analysis, described the economy from economic self-sufficiency economy to partial division of labor economy to a full division of labor economy [15]. The Young and Xiaokai tell us that there is a division of labor and the interaction of market size, "self-reinforcing mechanism." This view can explain the regional imbalance career development of China's construction supervision. For investment-intensive, large-scale regional construction market, such as Beijing, Shanghai, Guangdong, Jiangsu, supervision and development of the industry is ideal. But this only reflects the "self-reinforcing mechanism" aspect. Similarly, the supervision of the industry's development can also promote the development and the creation of the construction market because the supervision improves the efficiency of owners and makes construction project originally don't have the value now has one. Division of labor forms market, market promotes division, which is professional supervision to see positive cycle prospects.

129.3.2 Transaction Cost of Specialty to Career Development of Construction Supervision Industry

Coase two articles "the nature of the firm" and "the problem of social cost" will transaction costs into the economics field of vision. In neo-classical economics, the theory is perfectly competitive market reference point. This is an ideal friction-free world. The trade between people is under the complete information instantaneous and don't need cost. Coase suggested that transaction costs can not be ignored; "blackboard economics" does not help to explain the real world. Williamson inherited and developed the Coase's theory, and made a framework for transaction cost. In his view, the real world people are "the three concepts together: First, bounded rationality, and second, speculative thinking, third, asset-specific conditions"[16]. In our country, the transaction cost of construction supervision mainly involves trust and risk two aspects. Trust includes based on personal characteristics of trust, based on system of trust and based on reputation of trust. For the construction supervision, the relationship between employees and owners is based on personal characteristics rather than the system and credibility. The lack of trust mechanism increased transaction costs between owner and supervision engineer. As follows the owner give supervision engineer examination authority and right to make recommendations but not willing to let supervision engineer have decision-making power, supervision engineer work efficiency is not high. Owners need to be equipped their own engineering and technical management staff to oversee the behavior of supervisors, Repeated labor. Between the owner and supervision engineer there is certain communication cost. Man without believe and will not make anything. When the owner of the organization more believe the supervision and ability, but don't trust supervision market, is seriously affected the development of professional supervision.

129.3.3 Legitimacy of Specialty to Career Development of Construction Supervision Industry

In sociology system school opinion, organization faced two different environments: technology environment and system environment [17]. Organization does not only improve labor productivity, meets the technical requirements and produce, also is the product of institutional environment. Moreover, the two environments of the organization's requirements may be contradictory. Institutional environment requires enterprises to adopt the social identity of organizational patterns and behavior, and these activities may be irrelevant with efficiency. The phenomenon caused by the institutional environment of organizations using the efficiency or effectiveness of possible organizational model or behavior known as the legitimacy of the mechanism. Also, industry or professional is also strongly influenced by Legitimacy mechanism. Dimaggio and Powell put forward three kinds of mechanism of legitimacy role: imitate mechanism, compulsive mechanism and social regulating mechanism [12].

Theory thought [18], imitation mechanism came from the uncertainty of the environment. The successful organization in biological evolution or organization evolution will become an imitation of other biological objects or organization. The emergence and development of professional supervision can be said to be the product of imitation mechanism the government will supervision system as a kind of international practice. In the early 90s, our country construction department officials and scholars has to go to Singapore, Japan, Britain, Australia, the United States to examine and learn establishing and implementing supervision system experience. At the same time, China introduced foreign experienced project management in the large scale construction projects, such as Australian Snow Mountain Engineering Consulting Company in the Lubuge project, Kim Suk Company in the Tianjin-Tanggu Expressway Project. It can be said that the imitate mechanism is very good to describe in our career start construction supervision process.

Compulsive mechanism is depended on the government to carry out. When the government realizes construction supervision is a kind of advanced engineering management mode, is hoping it get rapid development. Also, the Government is used to the economic management, neglects to cultivate the market and use more of market forces. Thus, the central government and local government construction departments through various policies and regulations impose construction supervision system. Mandatory performance in two aspects: First, the regulatory requirements. China's Ministry of Construction provides the scope and standards for mandatory supervision. The local government construction department and state-owned enterprises take the mandatory supervision as a sign of legality. If they don't delegate supervision within the specified range they will be subject to administrative penalties. Second, the procedural requirements. Some local building department did not propose mandatory supervision, but requires owners to provide relevant documents as the relevant procedures, such as construction permits. In fact, it is also a disguised mandatory.

Social regulating mechanism is concepts and ways shared by certain areas of the population. Social norms Social norms will put pressure on individual and organizational and have impacts on them. The person or organization conforms social norms will be easier access to social recognition, while if the behavior is different, it will be more vulnerable to social exclusion. For example, hiring a supervision engineer is the sign to identify the quality of the project. The owner will make their building products better when they hired supervision engineer. In the two decades for supervision industry's development, it improves the quality of construction projects, shorts the construction period, saves construction investment, guarantees construction production safety and all of them have apparent effect and get the government and the society generally accepted. But, supervision hasn't brand effect, not like the architect that becomes owner commercial publicity logo. It also shows that the social standard mechanism is favorable to the career development of supervision, and is a mechanism needs o be further development and be marketization.

129.4 Model and Test

129.4.1 The Research Model and the Research Hypotheses

According to the above theory, establish the following models to analyze the professional development mechanism of our country construction supervision.

In the above model, there are four latent variables: specialization, transaction cost, legitimacy and the development of the industry/professional development. The arrows represent there is a direct effect from one variable to another variable. The independent variable is legitimacy, transaction costs and specialization, the dependent variable is the development of the industry/professional development.

129.4.2 The Research Hypotheses

Proposition to be proved the following two aspects:

Proposition 1. Transaction costs and significant impact on the construction supervision of specialized industry/career development.

Hypothesis 1a: professional industry with the construction supervision/career development is related;

Hypothesis 1b: transaction costs, with construction supervision industry/career development negatively.

Proposition 2. Supervision of the legality of the construction market can reduce transaction costs, facilitate the construction supervision of the industry/career development;

Suppose 2a: legitimacy negatively correlated with transaction costs;

Assuming 2b: the legitimacy of the industry with the construction supervision/career development are related.

129.4.3 Establish Structural Equation Modeling

Use survey methods to validate the model. In order to ensure validity and reliability of the questionnaire, before do the investigation, first pull 120 questionnaires (recovery 74) trial investigation, then revise the questionnaires according to pre-test to provide advice and pre-investigation of the reliability and validity.

The formal investigation questionnaire including 80 questions, investigated the four variables: transaction cost, specialization, legitimacy, industry/professional development. Questionnaires, there are four ways: the way in supervision engineer the follow-up education class and collect questionnaire, supervision company to send questionnaire, through friends or relatives to send questionnaire and through the network to send questionnaire. Total of 517 questionnaires were returned of 394 copies, recovery was 76.21 %. In the recovery of the 394 questionnaires, there are some multiple choice questionnaire, the wrong choice, missed selection phenomenon. After the sample adjustment, there are 343 valid questionnaires and the returned questionnaires efficiency is 87.06 %.

Based on the 343 survey questionnaire, there are the following three steps to establish career development structure equation model of our country construction supervision. First, we take the half of the sample as the basis for the exploratory factor analysis. Considering the questionnaire has 80 questions and we need to measure four latent variables, so model may be difficult to build because each variable involved too much factors. Therefore, Measurement of each latent variable uses the content of the questionnaires, factor analysis results and reliability index as the main selection standards, after screen the problem and calculation three times, then finally determine the measurement method. The measurement variables cronbach α coefficients are: 0.756 specialization indicators; transaction cost index 0.659; legitimacy index 0.860; professional/industry index 0.800. Shows the variables have an acceptable reliability.

Secondly, we take the other half of the sample as the basis for a confirmatory factor analysis. Validation index is also used cronbach α coefficient. Among them, the specialization index 0.801; transaction cost index 0.713; legitimacy indicators 0.772/0.845 (two dimensions); professional/industry index 0.789. And it shows that the result of confirmatory factor analysis is an ideal. Verify the correlation analysis based on the confirmatory factor analysis and measured the correlation significantly is not 0 between variables and the latent variables. Third, it established analysis of the impact of construction supervision mechanism for professional development of structural equation modeling based on 343 questionnaires. By using Amos software application structure equation model method to test Fig. 129.1 model, and the results are as follows (Table 129.1):

From the above indexes, the basic model that passes the test, indicating that the model is to some extent, there is some explanatory power about professional development of China's construction supervision and development of the reality of the mechanism.

129.4.4 Results

Figure 129.1 models the correlation coefficient between the variables shown in Table 129.2:

Transaction costs and professional career with the construction supervision/ development of the industry is significantly related. Among them, the professional supervision of construction of variables with vocational/industry correlation, regression coefficient 0.244; transaction costs variable with professional construction supervision/development of the industry a negative correlation, regression coefficient −0.842. This shows that Proposition 1 is verified. We can see that in

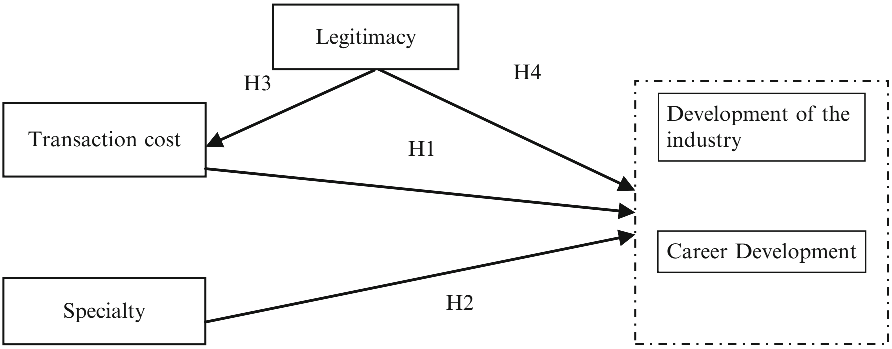

Fig. 129.1 Construction supervision vocational/theoretical model of development of the industry

Table 129.1 Construction supervision occupation/industry indicators summary of structural equation model testing

Index name	Acceptance criteria	Results	Acceptability
Chi-square statistics	>0.05 or >0.01	0.000	Doubt
RMSEA	<0.1	0.06	Acceptance
ECVI	Less than the comparison model ECVI	1.618<9.48	Acceptance
NFI	≥0.9	0.859	Doubt
IFI	≥0.9	0.917	Acceptance
CFI	≥0.9	0.916	Acceptance

Table 129.2 The correlation coefficient between the latent variable model, the return value and test conditions

The relationship between variables			Return value	Standard deviation	T-test	Significance
Occupation/industry	<–	Specialty	0.244	0.108	2.266	**
Occupation/industry	<–	Transaction cost	−0.842	0.157	−5.346	***
Occupation/industry	<–	Legitimacy	0.612	0.132	4.647	***
Transaction cost	<–	Legitimacy	−0.095	0.062	−1.551	0.121

** means that the relation between the dependent variable and the argument is statistically significant in 97%;
*** means that the relation between the dependent variable and the argument is statistically significant in 99%

our industry, the transaction cost has greater impact on supervision/career development. On the one hand, the owner don't trust supervision engineer, make supervision market development difficulties; On the other hand, supervision's risk is big, Personnel practitioners will decline. Specialization has a significant impact for the professional supervision/development of the industry. Supervision engineers transfer knowledge and create the management benefit for the owner by increasing the standard of professional service and knowledge and thus can promote the career/industry.

There was a significant correlation between Legality and construction supervision professional/industry, the coefficient is 0.612. This shows that in China the legitimacy mechanism main enforcement mechanism has played a significant role in promoting construction supervision of professional/industry, proposition 2 is verified.

Legality and transaction costs are negatively related. The influence of the transaction cost to legitimacy is not obvious. This shows that the forced function of government's laws and regulations, social expectations and imitation of foreign management system can't effectively reduce the market transaction cost of our country construction supervision. That also means it can't increase trust between the owner and supervision engineer and reduce the risk of employees.

129.5 Conclusions and Outlook

After the study, the following conclusions can be drawn:

1. Specialization is positively correlated with career development.
   Specialization is both the result and cause of career development. Promoting specialization is equivalent with the promotion of professional development. Therefore, improving the level of service and quality of supervision, to create more value for the owners, is the primary factors to promote the health development of supervision occupation.
2. Transaction costs are negatively correlated with the career development.
   Transaction costs are mainly reflected in trust and risk. At present, the risk of the supervision engineer is high, which is the duty limits and standards of supervision engineer in the work are not clear. The owner does not quite trust to supervision engineer, which is the owners worry about giving the whole project management business to supervision engineer and build a management team, so increase management costs. Lower transaction costs, including clear supervision engineer field, establish the Supervision engineers professional liability insurance. Strengthen the propaganda, promoting mutual trust of the owner and the supervision engineer will be beneficial to the development of professional supervision.
3. The influence of Legitimacy to career development is uncertain.
   In the short term, legitimacy can reduce the impediment to the development of career development, so as to promote professional development. However, legality can not affect the professional development of the degree of specialization in the short-term does not have a significant impact. In the long run, legality mechanism, especially mandatory mechanism may inhibit competition, barring the deepening of specialization and thus detrimental to career development. Therefore, our government construction departments appropriate relax the mandatory protection to the supervision and strengthen the market competition and elimination mechanism beneficial for career development.

In the process of the research of the supervision professional, there are always many imperfections, which is also the next step direction of the research. Expansion of the study is consisted by two directions: First, the scope of the study. Currently, the study is based on a sample of Shenzhen supervision of the industry, there may be sampling bias. If can collect major cities in China and the comparative analysis of the data, should be able to get the more convincing data. Second, the content of the study. At present, the research theory is based on professional, legitimacy and transaction costs, no further discusses the system and cultural dimensions of the research which is expected to be very necessary.

Supervision is a kind of special career which belongs to the consultation. It still need to discuss whether the professional theory can be applied to consulting industry or un-consulting industry, namely the universality of the specialization, transaction costs and legality mechanism model. The path can be studied by engineering consulting industry – consulting – service industry – all career development. In addition, this study is based on China's economic and institutional environment and whether the research is adapt to the developed countries, such as the United States, Britain, Japan, which means the cross-cultural study, is worth to wait.

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Chapter 130
Analysis of Causes and Countermeasures for Rising Labor Costs in International Construction Projects

Yong Wu, Zhouya Wang, Jun Guan, and Zhihui Zhang

Abstract The labor costs in international construction projects conducted by Chinese building enterprises have presented rapid rising trend in recent years, which has adverse impacts on the project success and financial performance of building enterprises. This paper analyzes the causes for rising labor costs in terms of market supply/demand conditions and expected wage growth driven by inflation force. In order to reduce the labor costs and improve the working efficiency, we propose the countermeasures as (1) to determine the bid price and labor wage reasonably, (2) to adjust the ratio between Chinese and local workers, (3) to emphasize the importance of the training for local workers, (4) to strengthen the construction organization.

Keywords International construction projects • Labor market supply/demand conditions • The ratio between Chinese and local workers

130.1 Introduction

Construction industry is one of the representative labor-intensive manufacturing industries. It has absorbed approximate 240 million peasant-workers in China. Labor costs usually occupy a major percentage in construction project costs, so work efficiency and labor costs control of construction industry have been research focuses for many years [1, 2]. In the recent years, the labor costs of construction

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_130,

industry have represented rapid rising trend, which has adverse impacts on the project success and financial performance of building enterprises. In this paper, we analyze the causes for rising labor costs in terms of market supply/demand conditions and expected wage growth driven by inflation force. In order to reduce the labor costs and improve work efficiency, we propose the countermeasures described in the following text.

130.2 Analysis of Labor Costs Rising Trend in International Construction Projects

130.2.1 Analysis of Rising Labor Costs of Construction Industry in China

In the recent years, labor costs of construction industry have represented rapid rising trend under the influence of macro-economy development, inflationary force and population structure transformation. The data presented in Fig. 130.1 distinctly shows the rapid rising trend of average labor costs in construction industry between 2009Q3 and 2011Q4 in China. In this article, we find that the average labor costs of 2010Q4 increased 21.45 % over the same period of the previous quarter and the quarter to quarter rising rate of 2011Q4 achieved 22.9 %. Obviously, the rising rate of average labor costs of construction industry exceeded the rising rate of GDP (about 9 %) greatly in the recent years in China. The rising rates in metropolis were remarkable such as the average rising rate of Beijing had achieved around 15–25 % in the recent 5 years.

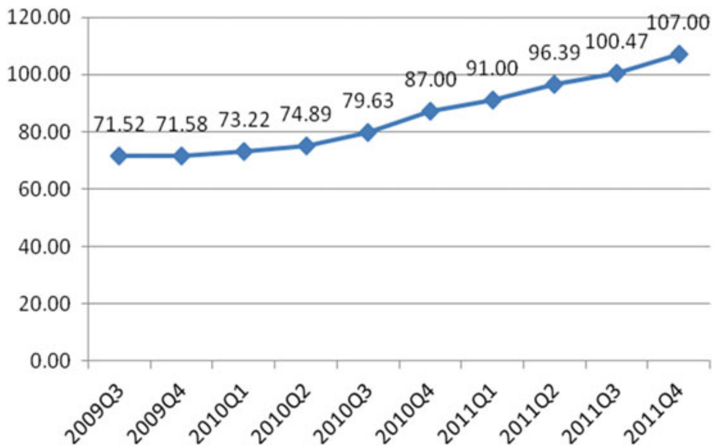

Fig. 130.1 The average labor cost of construction industry in China (yuan/working day) (Data from: 2012/5/5,http://www.chrd.com.cn/index.html)

130.2.2 Analysis of Rising Labor Costs of international Construction Projects

Because the skilled workers taking up international projects would require higher expected wage than the ones working inland and employ restrictive policies were applied in some host countries, the labor costs of international construction project exceeded inland projects greatly. In the recent years, the average wage of skilled workers increased about 5–10 % annually in international projects conducted by Chinese building enterprises. Taking the Congo (Brazzaville) National Road One Second Project as an example, the average wage of skilled workers achieved about 1,400$ per month exceeding the inland ones' (about 400$ per month) greatly. Rising labor cost rapidly could cause contractors to have deficits in terms of labor costs, which have brought about some adverse impacts to international construction projects conducted by Chinese building enterprises. Firstly, the profit performance of contractors will decline under the influence of rising labor costs. It will exert adverse impacts on contractors' long-term development. Secondly, some contractors might pursue profit at the cost of project quality. Finally, labor subcontractors could reject the labor price made in the subcontract, and some radical subcontractors even might stimulate workers to strike or delay the projects in order to make the labor prices enhanced.

130.3 Analysis of Causes for Rising Labor Costs of International Construction Projects

The factors causing labor costs of international construction projects to rise are various, we conclude these as following.

Firstly, economy sustained growth caused the demand of construction labor to increase rapidly. The fundamental driving force of rising labor costs comes from economy development. China's economy has been keeping rapid increasing since 1978, which is the essential dynamic to make labor wage increased and the labor market conditions of supply/demand changed obviously. In terms of the demand of labor, the amount of labor in construction industry is increasing annually under the impacts of boosting domestic demand, stimulating economy development and enlarging fixed assets investment in China [3].

Secondly, the amount of being willing to take up construction production is descending gradually under the impacts of various factors as following. (1) The construction industry is a representative high risk industry as well as the hard and poor working environment. Therefore, most of peasant-workers have to take up construction industry only when they can't find a desirable job in other industries [3]. (2) The application of policies of supporting agriculture and benefiting farmers advances the rural living standard in China, which weakens the driving force of working outward gradually. (3) The value of peasant-workers has evolved greatly, and the new generation owns more working chances and higher pursuing for material and spiritual civilization than their priors. Therefore, the construction enterprises have to enhance the labor price in order to attract and retain them. All in all, the amount of peasant-workers inflowing into construction industry have been declining in the recent years. According to the statistics of All-China Federation of Trade Unions (ACTU), the amount of peasant-workers inflowing into construction industry has declined about 6 % in the recent 5 years. The contradiction between supply and demand of labor is aggravating constantly, which drives the labor price to rise further more.

Thirdly, the price of commodities are keeping rapid rising in China, and we are encountering greater inflation force. The economic environment causes most of industries to enhance labor price in order to make workers' wage matched with the amplification of consuming. The average wage of construction industry is below the average of all industries, which makes labor price of construction industry increase more rapidly. Rising of commodities price and inflation force have become the key short-term driving factors for rising the labor costs of construction industry.

Finally, the environment of international construction projects is more complex than inland projects, and the expected wage of working abroad increases more than working inland. Peasant-workers working abroad need pay more cost than working inland, moreover, many overseas projects might encounter adverse impacts as political environment instability, social instability and the higher risk in the process of working, etc. Therefore, the peasant-workers working abroad have to require more than working inland.

130.4 Countermeasures of Rising Labor Cost

In order to reduce the labor costs and improve the working efficiency, we propose the countermeasures of rising labor costs as follows.

Firstly, a contractor should determine bidding price and labor price reasonably. In fact, rising labor costs of construction industry is an inevitable trend, so a contractor should keep labor price moderate. If a contractor provided a lower price for workers, he would be hard to obtain sufficient and high-quality workers, and it would be difficult to guarantee project performance. Apparently, it would bring about many disadvantages to the contractor's long-term development. Therefore, the contractor should make a tradeoff between descending labor cost and project's comprehensive benefits rather than only pursuing to minimize the labor costs. A Contractor should ask for more information about labor costs, and forecast the level of labor costs with the help of experience and analysis of history. Based on the comprehensive preliminary work, a contractor should determine artificial man-days per unit reasonably in bidding documents rather than lowering labor costs to pursuing to win the bidding blindly [4].

Secondly, a contractor should adjust the ratio between Chinese and local workers in order to lower labor costs as much as possible on the premise of ensuring work efficiency and quality. If the wage of Chinese workers were higher than local workers', a contractor could hair more local workers to lower labor costs, and vice versa. There are some law and policies constraining working hours in some countries, so a contractor must think about their impacts on working efficiency. There are some other factors that should be considered, such as the technical level of workers, the exchange rate variation risk, etc. Based on taking all the relative factors into consideration, a contractor can make a decision of employing more Chinese workers or local workers [5]. Local artificial man-days per unit consists of artificial man-days per unit of ordinary workers and that of skilled workers. There are minimum wage standards for ordinary workers and skilled workers in many countries, and even annual minimum wage standards in some countries. Therefore, a contractor must get the in-depth knowledge about these policies and the constitution of local workers wage, because there are no medical insurance or unemployment insurance standards in some countries or regions. A contractor should adjust the level and constitution of wage of local workers when he encounter the condition that there are great difference between the physical truth and labor laws [6]. In addition, many contractors usually pay more attention to the level of wage than the quantity of employed workers when they employed local workers, which has adverse impact on work efficiency. So the contractors should contract work and adopt piece rate as far as possible in order to enhance work efficiency [7]. Taking the Congo (Brazzaville) National Road One Second Project as an example, the average wage of Chinese workers was about 12,000 yuan/month, and the average wage of local workers was about 2,000 yuan/month. The contractor measured to get that the work efficiency ratio was about 1:4. The amount of working days provided by quota was 30 days per month. The ratio between Chinese and local workers determined by the contractor was 1:3. We could use the formula[1] to get that the comprehensive labor wage per working day was 301 yuan/working day.

Thirdly, a contractor should emphasize the importance of training the local workers and strengthen construction organization to enhance work efficiency. There are some points that should be noted as following. (1) The Chinese construction industry work efficiency still possesses more advancement than some advanced countries at present. The construction contractors of China should increase technology content sequentially in order to enhance work efficiency [8]. (2) The contractors of international construction projects should emphasize the importance of training the local workers, cultivating local labor monitors and distribution

[1] the comprehensive labor wage per working day = the Chinese workers' wage per working day $\times$ the percentage of the Chinese workers to all workers + the host country workers' wage per working day $\times$ the percentage of the host country workers to all workers/work efficiency ratio

of works. (3) The contractors should meticulously formulate construction organization design, construction method statement and detailed construction schedule against losses caused by poor construction organization, not timely material supply and insufficient working face. (4) The contractors should reasonably divide construction section and organize running water construction to ensure production process continuous in space and time. These measures contribute to reduce losses caused by construction interrupts and reworks.

130.5 Conclusion

Rising labor cost rapidly has adverse impacts on the project success and financial performance of building enterprises. Rising labor cost rapidly is caused by contradiction between supply and demand of labor, expected wage growth and so on. In order to enhance work efficiency and reduce labor costs, we propose the countermeasures as (1) to determine bid price and labor price reasonably, (2) to adjust the ratio between Chinese and local workers, (3) to emphasize the importance of training the local workers, (4) to strengthen construction organization, etc.

Acknowledgments The writers gratefully acknowledge support from overseas business department of China State Construction Engineering Corporation.

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Chapter 131
Innovative Australian Public Sector Construction Management: Effectively Engaging the Private Sector

John Douglas Thomson

Abstract This research addresses problems where 'poor quality tender documents continue to be a source of inaccurate estimates, claims and disputes' (Laryea Constr Manag Econ 29:275–286, 2011) and 'few industries suffer more from conflict than construction' (Black et al. IJPM 18:423–434, 2000). Much of this conflict derives from differing aims – Australian public sector owners aim to achieve 'value for money', while contractors aim to optimize profit and improve reputation. Counter-intuitively, the research found that construction industry experts engaged early assisted in translating owner's needs expression, established and maintained good interface relationships, and moderated contract variations. With period and price fixed, process transparency was improved, tenderers concentrated on submitting 'value for money' offers, tender assessment time and cost were reduced, and the contract completed without dispute. Increased design and construction risk was transferred to and accepted by the Contractor, and provided innovative opportunities pre and post contract award for owner and contractor.

Keywords Project planning • Construction industry • Public sector • Innovation • Capability

131.1 Introduction

The Australian government is the construction industry's largest single domestic client [1, p. 63] and can be 'influential in stimulating innovation' and 'sustainable technologies' ([2] in [1, p. 63]). There is a 'growing preference for "performance" vis a vis "prescriptive" based regulations because they encourage innovation' ([3]

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_131,

in [1, p. 63]). The UK National Audit Office [4] has also identified the need for ongoing public innovation given that ‘there are pressing social, demographic and environmental challenges that will demand the development of innovative products, business processes and ways of delivering services’. Mathews, Lewis and Cook [5, p. 2] suggest that the ‘contemporary public sector management agenda that has been emerging since the early years of the new century seeks to challenge the ethos that the public sector is neither equipped to be nor should seek to become, innovative.’ Organization for Economic Cooperation and Development [6] governments are seeking to put into place comprehensive innovation friendly policy stances. In the USA, Stephen Goldsmith, Director of Innovations in American Government Programs at the Harvard Kennedy School states that the innovation process ‘cannot remain a top down bureaucratic process, far removed from the concerns of citizens’ [7, p. 3] – ‘there is no going back to the all knowing, all encompassing role of the government in the context of welfare states’ [8].

131.2 Research Question

Indicative of the current state of the industry is that ‘poor quality tender documents continue to be a source of inaccurate estimates, claims and disputes’ [9, pp. 275–286] and ‘few industries suffer more from conflict than construction’ [10]. While Australian public sector owners aim to achieve ‘value for money’, contractors aim to optimize profit and improve reputation. These differing aims cause much conflict. This research frames how these differing aims could be better achieved and this may in due course influence construction industry theory and practice.

131.3 Planning Commences with Project ‘Owner’

‘Poor scope definition is recognized by industry practitioners as one of the leading causes of project failure, adversely affecting projects in the areas of cost, schedule, and operational characteristics. Unfortunately, many (owners) do a poor job of adequately defining a project’s scope leading to a poor design basis’ [11, p. 115]. Adequate and timely preconstruction planning is essential for the successful delivery of projects [12, p. 567]. Such planning commences with the project ‘owner’, not with the construction industry. A project ‘owner’ is defined as the organization responsible for commissioning and financing a project [13]. The effectiveness of (an owner’s) front-end planning will profoundly affect project cost and schedule performance as well as the overall success of a project [14]. While project planning provides a common reference point that serves as a basis for project monitoring, control, and corrective action [15], it is necessary for construction industry professionals to understand the (owner’s) needs prior to any project commencement [12, p. 567]. But the resources an owner allocates to the conceptual planning stage are often well intentioned but inadequate or inappropriate. Well prior to the start of a construction industry project it is necessary for an owner to develop a vision of its future and the capabilities it needs to implement that vision. These are usually expressed in the form of a capability brief/business case. This is a challenging process for owners. It is an owner's capability planning investment that will reap subsequent benefits and which precedes the construction industry's design, development, tendering, contract and completion processes.

131.4 Innovation: Capability Brief/Business Case Construction Industry Expert Engagement

A government's capability brief/business case sets the scene for ultimate project success or failure. If the project is incorrectly or inadequately defined, or if the strategy and risk assessments are wrong, a poor result is inevitable. But the Australian public sector's development of its capability brief/business case is usually neither made accessible to industry nor involves industry. This exclusion makes it very difficult for industry to be informed of the public sector owner's business requirements, owner stakeholders, or to be of assistance in the translation of the public sector owner's capability brief/business case requirements into construction industry language, or to make available to the owner industry knowledge relevant to the development of the capability brief/business case. While government will usually expect translation of its needs from capability brief to design brief to be undertaken by an internal organization, even interested conscientious public servants find it difficult to keep up with the pace of change in the construction industry and associated technology. Other difficulties include public sector employees being posted for short term career development and therefore being inexperienced, and being protective of internal information (doctrina vim promovet). Lopez and Love [16, p. 585] found that 'design errors can adversely influence project performance' but 'were found to not significantly vary with procurement method or project type used'. This suggests that design brief errors take place before the 'procurement method or project type' is selected, that is, during the development of the capability brief/business case.

Design adjustments taken at a later time are 'directly responsible for considerable costs driven by changes that could have been avoided emerging at later stages of a project. Late changes are far more costly and time consuming than when they are made early on in a project' [12]. The 'ability to influence the final characteristics of a project's product is highest at the start of the project and decreases as the project progresses towards completion ... the cost of changes and correcting errors typically increases substantially as the project approaches completion' [17, p. 17]. Levitt and Mahalingam [18] suggest that an owner's project planning ability to influence project outcomes falls rapidly once the project begins (the inverse of the cost S-curve) – when outcomes become known, all project funds have already been expended and no influence remains. The best public sector planners can hope for is to learn from a given project and to adapt this for future projects – even this is difficult, because project participants scatter at the end of a project, and their learnings get diffused.

Including industry experts early in the development process is likely to achieve improved needs definition so improving ‘value for money’ outcomes. This will give both public sector owner and industry a better understanding and definition of the price, period and quality implications of design decisions. This could be achieved by competitively selecting construction industry experts who are competent in both the public sector owner’s business and in their project’s area of the construction industry. There are many companies who could offer such expertise. This is likely to have better productivity outcomes than solely public servants fulfilling this role, which is currently the case. However, the employer of such expert(s) would not be permitted to bid for the contract or any subcontracts for reasons of conflict of interest and confidentiality. The contracted entity would need to sign a confidentiality agreement with the public sector owner.

131.5 Innovation: Fixed Cost (Price); Fixed Time (Period); Award Based on ‘Value for Money’

The Chan and Chan [19] review of journals on project success revealed that cost (price), time (period) and quality (‘value for money’) (Atkinson’s [20] ‘iron triangle’) are the three most important performance indicators in projects, and so provide a ‘focus on key success factors’ [21] ‘to meet customers needs’ [22]. The purpose of the Barnes [23] triangle of objectives was to illustrate that the three primary objectives of cost, time and quality are interrelated – greater emphasis on achieving one or two of these objectives may be made at the expense of the other criteria. Some argue that quality can be achieved without extra cost by engaging in the concept of ‘zero defects’ [24, p. 4]. But a definition of quality is that a service or good is ‘fit for the purpose for which it was intended’ [25]. So quality may not be negotiable, but cost and time may be. Alternatively, this may be expressed as what quality (‘value for money’) can be achieved by a contractor within a fixed cost and time, that is, conditions which provide for a Pareto-efficient development of public infrastructure, where Pareto optimality in this case refers to achieving better quality at the same cost. For example, suppose the cost and start and finish times were fixed for a new construction, and all tenderers were requested to competitively provide solutions within the specific fixed period and fixed price in response to a public sector owner’s performance brief/business case. This would mean all tenderer’s bids would be based on the same period and price, but quality (‘value for money’) would vary. Period and price would then be unnecessary as bid assessment criteria since all bids would be using the same fixed price and fixed period parameters. Focus for both tenderers and tender assessors would be solely concentrated on bid quality alone, that is, ‘value for money’. This approach eliminates the need for contractors to submit a lean and mean price driven down by cost competition.

131.6 Innovation: Contract Risk Adjustment

After the parties have entered into a contract, the construction phase of performance commences and is associated with contract management. Research in Sweden [26] indicates that during the construction phase there are often many specification/scope changes. As every construction project is unique, the drawings and specifications in the owner's approved contract documents seemingly will always contain errors and omissions that have to be corrected. Changes in public sector owner needs, market demand or government regulations will modify public sector owner preferences and lead to changes in requirements. This is in a contracting construct where currently an owner 'approves' specification of requirements (usually very detailed), drawings, contract changes and so on. But need this be the case? Perhaps the selected tenderer/contractor could accept increased risk and opportunity for innovation in exchange for the guaranteed payment arrangements Australian government contracts carry. Kadefors et al. [26] found that in Sweden, many owners shared the view that closer co-operation with contractors would be advantageous, but that there was a need to look for a better integration of design and construction, less conflict and more flexibility – that many owners were suspicious of contractors and were reluctant to abandon general contracts and their control of the design, and view co-operation as something that primarily benefits the contractors. Kadefors et al. [26] indicated that contractors for their part, have tried to persuade owners to use 'design and construct' contracts more frequently and to make such contracts less specific so that contractors may participate in the initial phases of a project.

Since the financial risk to contractors of not being paid for satisfactorily completed Australian government work is zero, it would seem an equitable and appropriate risk adjustment to move greater design and construction risk to contractors who are, in any case, better placed to carry such risks. In this context, the Australian Attorney General was requested to consider contract terms and conditions which would transfer greater risk to the Contractor and more equitably enable project scope variations. The Australian Attorney General suggested terms and conditions as follows:

'Acknowledgement': 'any inaccuracy or mistake however arising shall neither affect the contractor's obligation to complete the work under the contract nor entitle the contractor to payment of any extra moneys whatsoever';

'Acceptance' of drawings and specifications: 'after acceptance of the contractor's tender, the contractor shall expeditiously prepare and complete all other documentation';

Liability remains with the contractor until completion of the contract: 'No approval, direction or assistance given to the contractor in respect of specification or designs or other data produced shall relieve the contractor of responsibility under the contract for the correctness of all such designs, drawings, specifications and other data created or supplied for the purposes of the contract';

Warranty of sufficiency and fitness for purpose: 'the contractor warrants the sufficiency and fitness for its purpose of all designs, drawings, and specifications prepared pursuant to the contract for use in the execution of the work'; and

Variations cause or delay: 'the contractor shall not be entitled to claim from the Principal any damages, loss, loss or expense or extra costs incurred by the contractor in respect of cause or delay'.

These risk transfer and contract variation clauses suggest opportunity for innovative competitive tenders to be submitted, this in exchange for guaranteed payment for work satisfactorily completed. The effectiveness of this alignment provides for the owner to 'acknowledge' rather than 'approve' the tendered offer. Since no two tenders will be identical, each tenderer will need to be innovative in its offer in delivering value for money.

131.7 Methodology

The methodology for this research should not only be helpful and improve practice but also contribute to a theoretically and scientifically useful body of knowledge. For such frames to be achieved, 'it does not necessarily follow that theory leads practice' [27, p. 5]. 'The most useful research is that which takes a more fine-grained approach, the challenge being to extract from it some general conclusions, insights and frames that contribute to theory ... with the problem of gathering (empirical) data in such a way that it is replicable' [27, p. 11]. Phelps and Horman [28, p. 58] identified a critical need for theory building methods and methodological challenges. 'What has changed is the interpretation of the ideas and problems that confront the construction sector globally and the methodological pluralism approaches available to resolving them' [29, p. iii]. This research will take a pluralist methodology through the development of an artefact in the form of a construct, model or method and test a case [32] using a fine grained approach over a lengthy period. From this some general conclusions, insights and frames may evolve which contribute to theory, and in doing so gather empirical data that is replicable.

131.8 Method: An Artefact Incorporating Innovation

This artefact will incorporate the early engagement of a construction industry expert to assist the owner with the development of the capability brief/ business case and further assist through all phases to contract completion; the fixing of the period and price and using these and the capability brief/business case to call

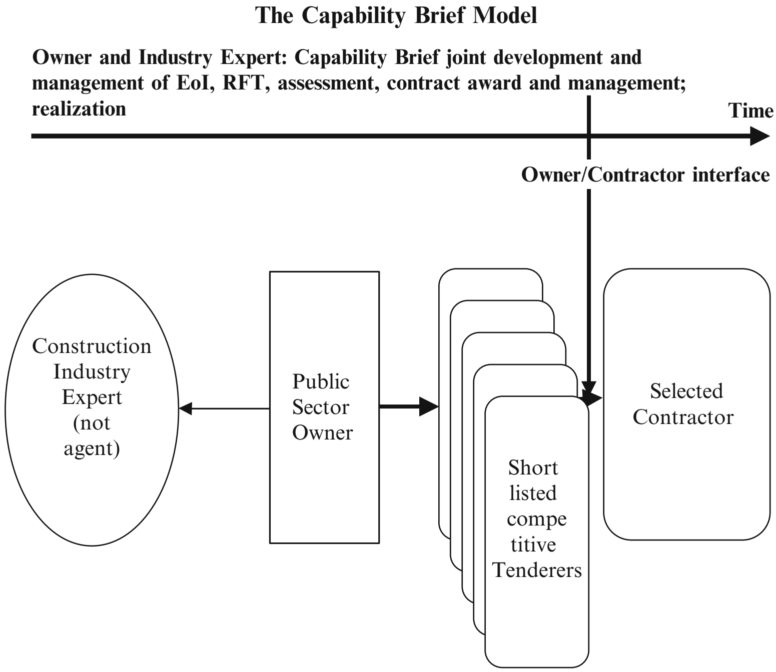

Fig. 131.1 Public sector construction – effectively engaging the private sector

tenders and award a contract; and the transfer of greater design and construction risk to a contractor. This model was agreed by defence to be tested through a RAN project. An expert would be competitively engaged to assist the RAN in the development of the capability brief/business case and thence through all processes to contract completion. Following the registration of interest process, the RAN with expert assistance would shortlist interested parties to the three to five best and request tender submission. Tenderer's bids would be required to contain all details such as drawings, specifications, program of work, progress payments, bills of quantity, timings and so on. Contract award would be based on 'best 'value for money' since price and period would be fixed for all tenders, that is, the best offer for the fixed price and fixed period. The contractor would implement its offer assisted as appropriate by the expert, who would liaise and moderate project development issues at the owner/contractor interface. The contractor would be paid by the RAN according to the contractor's programme for work satisfactorily completed. Negotiation of contract variations would be undertaken within the fixed price and fixed period limitations, assisted and moderated as necessary by the expert. The RAN with expert advice will manage, monitor and moderate the contractor through to contract completion, close off the contract and the defects liability period (Fig. 131.1).

131.9 Innovation Implementation: Case Study

Defence provided an accommodation facility for 24 Senior Non Commissioned and Warrant Officers at HMAS Cerberus, a RAN shore station in Victoria, Australia for the case study. Project period and price criteria were based on precedent defence 'design and construct' projects and Defence Scales and Standards of Accommodation. Based on these criteria, the project period and price were calculated by the expert (John Holland Group) to be a pre-contract award period of 4 months, a construct period of 8 months, and an estimated price of AU$0.891 m. The 4 month pre-contract award period comprised the time taken from receipt of the capability brief/business case by the Defence Support Group from the Defence Capability Development Group, the development of the 'design brief' through all the regulated processes to contract award. The 8 month post contract award period was the estimated time taken for construction of the project. Government Scales and Standards set specifications for floor areas, common use clothes washing and drying facilities, twin share bathroom and toilet, rudimentary paths and car-parking facilities, within a design to cost target of $27,500 per person. The $27,500 per person included the cost of the specified building areas, desk, bed and wardrobe. In addition, an allowance of 10 % i.e. $2,700 per person was permitted for specified non fixed furniture, fittings and equipment, and an additional allowance of 25 % i.e. $6,875 per person for the balance of all other works. These data provide the basis for value for money comparisons to be made with design and construct.

131.10 Testing the Artefact

For the artefact, the price (AU$891,000) and period were fixed (4 months for preparation and 8 months for construction), and the capability brief/business case set the criteria to be met by industry. This comprised a capability brief of seven pages which expressed the owner's performance requirements. This brief became an annex to the General Conditions of Contract which included AAG's contract clauses. Tenderers were required to competitively provide a set of design drawings and documentation sufficient to accurately define and quantify the project, including a statement substantiating the design, a location/site plan, floor plans and matching elevations and sections, finishes schedule and materials specifications, a project delivery bar chart and resource schedule, cash flow chart, landscaping, life cycle costing and a fixed lump sum price with no rise or fall. The RAN then called for Expressions of Interest (EoI) using the fixed price (AU$0.891 m), fixed period (8 months), and seven page capability brief. Fifty-seven Expressions of Interest were received from the marketplace. These were shortlisted by the RAN and the expert to five companies on the basis of financial capacity; resource capacity; previous experience; designer's experience; sub-contractors; and insurance/indemnity strengths. Two of the five were global/national corporations, two were national/regional, and one was regional/local. The RAN then requested tenders from these five using the same capability brief, fixed period and fixed price. The five tenderers made post tender closure presentations to the RAN and the expert. Based on these competitive tenders and presentations, the selection of the 'best 'value for money' tender became quickly obvious, was not complicated by variations in period or price, or delayed by 'trade-offs' or contract negotiations. Assessment and award of the contract by the RAN with expert assistance took 1 day, including the tenderer's presentations. There were no appeals. This pre- contract award work was completed within 2 months. Once awarded the 8 month AU$891,000 contract, the selected contractor set to work without delay and completed within 7 months to price.

Initially there was expressed disbelief from the tenderers that the RAN would stay with the fixed price and fixed period arrangement, as there had been no previous experience of such. None of the tenderers had concerns about the transfer of greater design and construction risk through the use of the Australian Attorney General contract clauses, or with any of the processes including the use of the industry expert once it was known that the expert would not be permitted to bid for the contract. The contractor completed the project 1 month ahead of time, to price, and to a much higher quality than that which would have been achieved had defence used its usual 'design and construct' contract method. Scope/quality benefits above that which would have been achieved using the standard 'design and construct' model included a motel style individual unit for each occupant with its own bathroom, toilet, washing machine, tumble dryer, bar fridge and tea making facilities, carpet, steam iron and ironing board, car wash and parking, all provided within the $891,000 design to price target. The Contractor sought and was granted a contract variation to finish 1 month ahead of schedule. This suggests the conditions which provide for a Pareto-efficient development [30] of public infrastructure were achieved, where Pareto optimality in this case refers to achieving better quality at the same cost. Further, competitive tenderer innovation was achieved through early engagement of a construction industry expert leading to improved expression of defence capability requirements; shortlisting through use of registration of interest; rapid tender evaluation and outcome advice; use of contract clauses which not only created greater owner transparency but also transferred increased design and construction risk to the construction industry thus encouraging greater innovation and responsibility from tenderers.

131.11 Conclusions

Heilman [31] argues that public policy experimentation often means innovating through implementation first and drafting universal laws and regulations later. This is in direct contrast with standard assumptions about public policy making given that the 'conventional model of the policy process that is widely taken for granted ... holds that public policy analysis, formulation and embodiment in legislation precede implementation'. But 'an increased practice-led focus on public sector innovation within government suggests that practice has driven theory' [5, p. 2]. This public policy project experimentation meant innovating through implementation first, with the possibility of the drafting of universal laws and regulations later.

In this context, the research addressed some of the enduring problems where 'poor quality tender documents continue to be a source of inaccurate estimates, claims and disputes' [9, pp. 275–286] and 'few industries suffer more from conflict than construction' [10]. In this case, the Australian public sector owner achieved better 'value for money' than it had previously when using its traditional 'design and construct' model with no disputes, extensions of time or increased costs. The early engagement of an industry expert provided assistance not only in establishing and maintaining good relationships, but also in the management of the contract and moderation of scope changes and other issues through to contract completion. Tenderers were able to reduce their costs of tendering and were motivated to submit competitive innovative proposals largely because they were given firm fixed period and price information and a seven page owner's performance requirements, and not the usual detailed specifications of most owners. This process enabled a quick turn around of tender development, assessment and outcome since there were far fewer variables to be considered by the owner, the period and price being fixed. Post contract award, the Contractor, completely familiar with its own submission and not having to interpret someone else's or be other than clinical in relationship maintenance, completed 1 month early thereby gaining additional profitability and improved reputation. Future research will involve undertaking further case studies to test the efficacy of the capability brief/business case model's applications in the global construction industry. The capability brief/business case model is generic in nature and in time may be applied to other industries.

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Chapter 132
The Diversification Discount Research of Supervision Enterprise

Gang Wang and Shucheng Liu

Abstract The construction industry as a pillar industry, play an important role in promoting economic growth. And construction supervision as an important part of the construction grows fast. The construction supervision companies will face with the problem of strategic choice. Most companies want to translate into the project consultancy company. But, does it fit for the constitution supervision industry? Our paper will discuss this problem based on the theory of specialization and diversity by researching the values of the constitution supervision companies.

Keywords Construction supervision • Diversity • Discount • Tobin Q

132.1 Introduction

How to define diversification is the focus of dispute theory. In 1925, Ansoff defined it as a growth or expansion behavior when the company developed to a certain stage [1]. Penrose thought that we could not measure the degree of diversification by the number of final products and intermediate products [2]. Gort put the point of definition on the product diversity [3]. Rumlet [4] believed that we could not define it, it is just as a strategy when the company owned the diversification character combine the limited diversification ability with skill and goal. But it is necessary for this paper to have a definition. Nowadays there are two research methods: the static way consider diversification as an inherent characteristic for the company, the trend way consider diversification into the field of production. This paper defines the diversification in the difference of the business enterprise.

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_132,

With the further research, scholars have new understanding on diversification. Cassano accorded to the two dimensions of the classification as diversification product diversification and market diversification [5]. Hitt and Hoskisson [6], Duru and Reeb [7] thought diversity contain business diversification and area (international) diversification two components. Mao Yun Shi thought diversification contain business, space (regional) and the function of the three content [8]. This research will relate to the category of business diversification.

132.2 Diversification Premium/Discount

Chandler first researched the relationship between the diversification and performance [9]. He thought that enterprises to choose the diversification development strategy improved enterprise performance. But academia did not have a confirm conclusion about the relationship between the diversification and performance. In 1960s, influenced by the diversification strategy of GE, most of the literature showed that diversity benefit to the enterprise performance increase. But in 1990s, most of the diversification companies stripped many loss departments and developed the cow departments as a refocusing strategy. The research results also turned to indicate that diversification would reduce the companies' performance. In 1994, Lang and Stulz used the datum from COMPUSTAT with the method of excess value and Tobin Q and discovered that the Tobin Q was more high in the specialized companies than the diversification companies. So they thought diversification would reduce the performance [10]. Berger and Ofek through to use the relative value index to calculate the degree of diversification and indicated the diversification companies existed 13–15 % discount [11]. Denis [12] analysed about 5,332 global companies between 1984 and 1993 and also indicated that the diversification companies existed diversification discount [11]. Rajan's [13] research showed that diversification companies spent capital on the inefficiency departments. On the other hand, many research indicated that most datum used before came from financial statement which had some problem itself. Mansi and Reeb indicated if scholars used book value to calculate the degree of diversification would reduce the company value. They discovered the discount would disappear if considered the joint influence by the creditor and the shareholder from diversification [14]. Glaser and Muller also got the same similar result [15].

Scholars in China also have many researches on the relationship of diversification and performance. Zhu Jiang [16], Jing Xiaobin's researches showed that the relationship between diversification and performance in Chinese companies was neutral [17]. Xin Zhao's research showed that the diversification companies had less tobin Q so the companies had the diversification discount [18]. Wang Zhen, Ma Bing chose the datum from public company and used tobin Q with the panel date by regression analysis to confirm the relationship between diversification and performance. Their research showed that with the increase of departments, the corporate value would reduce [19].

Most of the research about the relationship between diversification and performance are based on the all industries but not considering the difference in different industry. With the deeper research, we may put our attention in the specific industry.

Supervision companies have grown fast in recent years. So many companies may turn to be diversification. In one hand, the diversification strategy may distinguish by different qualification like: housing project supervision, highway engineering supervision, power project supervision and so on. The other hand, the diversification strategy may distinguish by different project consulting work like: design supervision, project pricing management, bidding agency, construction supervision and so on. The influence of the diversification strategy in supervision is not researched by the academia.

132.3 Diversification Premium/Discount in Supervision Companies

132.3.1 Excess Value and Tobin Q

For judge the influence between diversification and performance, we base on the method presented by Lang and Berger [11]. This method use excess value to judge the influence between diversification and performance. Excess value is the appreciation by the value of the diversification companies with the value just accumulated by different business. Meng Min and Cao Peihong [20] indicated that excess value came from the share among strategy resource, human resource, market skill and management method in different department so that the company could reduce its marginal cost and had more superiority in the business. Of course, there were adjustments in the different departments, and the resource also need adjust. But only make the cost which used to adjust less than the benefit in business, the excess value would increase.

We can calculate excess value by this formula:

$$\mathrm{EV} = \mathrm{Ln}(\mathrm{V}/\mathrm{V}_{im})$$

$$\mathrm{V}_{\mathrm{im}} = \sum \mathrm{Sale}_{\mathrm{i}} \times (\mathrm{V}/\mathrm{Sale}_{\mathrm{median}})$$

In the formula:

EV-excess value of the enterprise
V-company value, calculate by the company's total assets
V_{im}-the estimate value of the enterprise
$\mathrm{Sale}_{\mathrm{i}}$-corresponding main business income in business units i
$(\mathrm{V}/\mathrm{Sale}_{\mathrm{median}})$-the median of the ratio of the business units i's company value and the corresponding main business income

Table 132.1 Excess value and Tobin Q in all sample

	Excess value in all sample analysis	Tobin Q in all sample analysis	Excess value in professional analysis	Tobin Q in professional analysis	Excess value in diversification analysis	Tobin Q in diversification analysis
N vaild	5,115	5,115	2,053	2,053	3,062	3,062
Mean	−1.0449	1.8521	0.0777	1.7950	−1.7975	1.89
Median	−0.8789	1.3648	0.0000	1.2993	−1.5856	1.41

If EV > 0, means diversification is benefit for the industry.
If EV < 0, means diversification is disadvantageous for the industry.
Tobin Q is the ratio of enterprise market and the enterprise's replacement cost.
If Q > 1, means benefit for the purchase of new production capital products. It will increase the demand of investment.
If Q < 1, means cheaper for buying ready-made capital products than new generation of capital products. It will reduce the demand of investment.

132.3.2 Sample Analysis

This paper use data from the supervision enterprise in 2009. Sample is divided into two parts: one part is the companies which only manage one business called professional company and another part is the companies which manage more than one business called diversification company. We use three terms to analysis the sample: the whole samples analysis, professional analysis and diversification analysis.

In Table 132.1, average of excess value in all sample analysis is $-1.0449 < 0$, median is $-0.8789 < 0$. It means that supervision enterprise exist diversification discount. Average of excess value in professional analysis is 0.0777, median is 0.0000. It means that professionalization is not notable for the performance. Average of excess value in diversification analysis is $-1.7975 < 0$, median is $-0.15856 < 0$. It also means that supervision enterprise exist diversification discount.

We think the data in the large-scale companies is more important than others. So we choose the top 1,000 enterprises income and use the same method to analysis the new sample.

In Table 132.2, average of excess value in all sample analysis is $-2.0839 < 0$, median is $-2.0503 < 0$. It means that supervision enterprise exist diversification discount. Average of excess value in professional analysis is 0.36, median is 0.68. It means that professionalization is not notable for the performance. Average of excess value in diversification analysis is $-2.3012 < 0$, median is $-02.2265 < 0$. It also means that supervision enterprise exist diversification discount.

In Table 132.1, all the Tobin Q are less than 1. It means cheaper for buying ready-made capital products than new generation of capital products. So the supervision enterprise may grow through expanding the scale but not increase the departments.

Table 132.2 Excess value and Tobin Q in top1,000 sample

	Excess value in all sample analysis	Tobin Q in all sample analysis	Excess value in professional analysis	Tobin Q in professional analysis	Excess value in diversification analysis	Tobin Q in diversification analysis
N valid	1,000	1,000	95	95	905	905
Mean	−1.0449	−2.0503	2.2668	0.36	2.53	−2.3012
Median	−0.8789	−2.0839	1.7057	0.69	1.57	−2.2265

If as the law of excess value, it will be the rand-size relationship like: Tobin Q in professional analysis > Tobin Q in all sample analysis > Tobin Q in diversifi cation analysis. But from Tables 132.1 and 132.2, we find that Tobin Q in diversification analysis (1.89) > Tobin Q in all sample analysis (1.8521) > Tobin Q in professional analysis (1.7950). How can we explain this phenomenon?

We may introduce two concepts about diversification, one called positive professional and another called Passive professional. Every industry has the existing threshold. Enterprise enter an industry may be only in one business because of the less of capital resource or human resource. We call this strategy Passive professional. And when the company grows up, it may have ability to adjust its strategy. If the enterprise chooses professionalization, we call it positive professional.

Positive professional and passive professional have different influence. Supervision companies which are positive professional may control more resource and it may have some benefit for the performance. But the companies which are passive professional may be the last resort, so they may have not good professional. In our sample, there are many small-scale supervision companies. They may have low professional. So it makes the Tobin Q in professional analysis less than the Tobin Q in diversification analysis.

So, after we choose the top 1,000 sample, we can observe this result in Table 132.2. The result about Tobin Q is: Tobin Q in professional analysis (2.53) > Tobin Q in all sample analysis (2.2668) > Tobin Q in diversification analysis (2.2375). The result accords our anticipation.

132.4 The Relationship Between Diversification and Performance

132.4.1 Research Hypothesis

This research may use the method of linear regression.

Dependent variable: we choose V as the dependent variable.

Independent variable: we choose the degree of diversification (DT) as the independent variable. We use entropy to express it: $\sum_{i=1}^{n} p_i \cdot Ln(1/p_i)$, n means the number of business, p_i means the ratio of the business i income and the enterprise the proportion of total income.

Table 132.3 Model summary

Model	R	R square	Adjusted R square	Std. error of the estimate	Change statistics R square change	F change	df1	df2	Sig. F change	Durbin-Watson
1	0.775[a]	0.601	0.601	1.21313	0.601	4521.665	1	2,998	0.000	
2	0.793[b]	0.629	0.629	1.17043	0.028	223.716	1	2,997	0.000	
3	0.800[c]	0.641	0.640	1.15202	0.012	97.577	1	2,996	0.000	
4	0.801[d]	0.642	0.642	1.14958	0.002	13.709	1	2,995	0.000	
5	0.802[e]	0.644	0.643	1.14774	0.001	10.613	1	2,994	0.001	1.906

Dependent Variable: V
[a]Predictors: (Constant), HZ
[b]Predictors: (Constant), HZ, DT
[c]Predictors: (Constant), HZ, DT, NO
[d]Predictors: (Constant), HZ, DT, NO, K
[e]Predictors: (Constant), HZ, DT, NO, K, DTA

Other independent variable: we choose the Staff scale (NO), knowledge level (K), Financial leverage (DTA), Business turnover (HZ) as the other independent variable. And we can calculate NO by the number of staff, K by the ratio of number of senior professional titles and practitioners, DTA by the ratio of total liabilities and total assets.

So the equation model is:

$$\mathrm{InV} = b_0 + b_1\mathrm{InDT} + b_2\mathrm{InNO} + b_3\mathrm{InK} + b_4\mathrm{InDTA} + b_5\mathrm{InHZ}$$

132.4.2 Data Analysis

We use SPSS to analysis all the datum (Tables 132.3 and 132.4).

So the equation model is:

$$\begin{aligned}\mathrm{InV} = {} & 0.333 - 0.491\mathrm{InDT} + 0.378\mathrm{InNO} + 0.117\mathrm{InK} + 0.2891\mathrm{InDTA} \\ & + 0.885\mathrm{InHZ}\end{aligned}$$

132.4.3 Some Explains

In our country, supervision enterprise exist diversification discount. Performance discount comes from the disability of business integration. Now the diversification of supervision enterprise is in the category of Correlation diversity. It means that the diversification businesses are correlation, they may be strategic alignment.

Table 132.4 Coefficients

Model		Unstandardized coefficients B	Std. Error	Standardized coefficients Beta	t	Sig.
1:	(Constant)	0.908	0.108		8.408	0.000
	HZ	1.064	0.016	0.775	67.243	0.000
2:	(Constant)	0.487	0.108		4.511	0.000
	HZ	1.086	0.015	0.792	70.815	0.000
	DT	−0.456	0.031	−0.167	−14.957	0.000
3:	(Constant)	0.044	0.115		0.385	0.701
	HZ	0.908	0.024	0.662	38.588	0.000
	DT	−0.491	0.030	−0.180	−16.236	0.000
	NO	0.375	0.038	0.170	9.878	0.000
4:	(Constant)	0.317	0.137		2.318	0.021
	HZ	0.901	0.024	0.656	38.228	0.000
	DT	−0.495	0.030	−0.181	−16.383	0.000
	NO	0.378	0.038	0.172	9.986	0.000
	K	0.116	0.031	0.041	3.703	0.000
5:	(Constant)	0.333	0.136		2.444	0.015
	HZ	0.885	0.024	0.645	36.840	0.000
	DT	−0.491	0.030	−0.180	−16.294	0.000
	NO	0.378	0.038	0.172	9.992	0.000
	K	0.117	0.031	0.041	3.750	0.000
	DTA	0.289	0.089	0.037	3.258	0.001

Dependent Variable: V

Supervision companies may also have businesses on project pricing management and bidding agency or they may have businesses on housing project supervision and highway engineering supervision. But integrating businesses may have agent problem and financial matter. There are also invalid between departments crossing subsidies. The benefits came from diversification can not remedy the costs came from the problem.

This paper just describes a phenomenon of the relationship between diversification and performance in supervision enterprise. Companies can just regard it as a strategy view. We do not give the standard on the strategy.

We can know Staff scale, knowledge level, Financial leverage, Business turnover are benefit for the performance.

132.5 Conclusions

This paper uses the method of excess value and Tobin Q to evidence the relationship between diversification and performance in supervision enterprise. The result is that the supervision enterprise exits diversification discount. Than we use the method of linear regression to evident the result.

This paper also presents positive professional and passive professional influence the industry.

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ERRATUM

Chapter 123
Identification and Structural Evolution of Real Estate Enterprises' Growth Ability

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J. Wang et al. (eds.), *Proceedings of the 17th International Symposium on Advancement of Construction Management and Real Estate*,
DOI 10.1007/978-3-642-35548-6_123, © Springer-Verlag Berlin Heidelberg 2014

DOI 10.1007/978-3-642-35548-6_133

The author name is unfortunately incorrectly displayed in the original version. It should read "Xiaoyan Lin".

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