Chapter 14
Risk-Based Decision Making Framework for Investment in the Real Estate Industry

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Abstract. Investment in the real estate industry is subject to high risk, especially when there are a large number of uncertainty factors in a project. Risk analysis has been widely used to make decisions for real estate investment. Accordingly, risk-based decision making is a vital process that should be considered when a list of projects and constraints are being assessed. This chapter proposes a risk-based decision making (RBDM) framework for risk analysis of investment in the real estate industry, based on a review of the research. The framework comprises the basic concepts, process, sources and factors, techniques/approaches, and issues and challenges of RBDM. The framework can be applied to problem solving different issues involved in the decision making process when risk is a factor. Decision makers need to understand the terms and concepts of their problems and be familiar with the processes involved in decision making. They also need to know the source of their problems and the relevant factors involved before selecting the best and most suitable technique to apply to solve their problems. Furthermore, decision makers need to recognize the issues and challenges related to their problems to mitigate future risk by monitoring and controlling risk sources and factors. This framework provides a comprehensive analysis of risk-based decision making and supports decision makers to enable them to achieve optimal decisions.

Keywords: Risk-based decision making framework, risk analysis, investment, real estate industry, risk-based decision making technique.

1 Introduction

Decision making is a process of gathering input and processing the data collected for analysis to produce a list of outcomes based on given sources and limitations. All

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decisions made will involve low, medium or high level risk based on the uncertainty factors affecting the analysis. The higher the uncertainty of factors related to the decision making, the higher the level of risk. If decision makers are familiar with the sources and factors that will affect the decision making, however, and know how to monitor and control the uncertainty factors, the risk will be lower. This chapter will propose a risk-based decision making framework for investment in the real estate industry which aims to reduce risk.

Risk-based decision making concepts and applications have been explored by many researchers who have applied different techniques and methods to support the decision making process in different fields. For example, a study into the practices of risk-based decision making for investment in the real estate industry has been conducted to investigate risk-related issues in which it was found that many decisions are made based on an investigation and analysis of factors, then weighting, calculating and selecting the best option based on a high performance index (Piyatrapoomi, Kumar & Setunge, 2004). Real estate projects are characterized by high risk, high returns and long cycles; thus real estate investors need to carefully research each project if they are to maximize the return and minimize the risk (Shiwang, Jianping & Na, 2009; Ren & Yang, 2009; Juhong & Zihan, 2009).

Risk analysis decision making is an important tool because such investments normally yield a high return but at the same time pose a high risk to success (Zhou, Li & Zhang, 2008; Zhi & Qing, 2009). There are many substantial studies related to risk analysis techniques and approaches for the real estate industry. In principle, risk-based decision making techniques involve risk analysis and support the decision making process. The literature shows that various risk-based decision making techniques have been integrated with decision support tools and intelligent agents to enhance the usefulness of the technique. Predicting and controlling risk has become the key to the success or failure of a project (Wanqing, Wenqing & Shipeng, 2009). Several techniques have been proposed and applied in e-service intelligence to evaluate, analyze, assess or predict risk, including the Analytic Hierarchy Process (AHP) and Monte Carlo Simulation, Markowitz Portfolio Optimization Theory, real options methodology (Rocha et al., 2007), and a Hidden Markov Model (Sun et al., 2008; Lander & Pinches 1998, cited in Rocha et al., 2007).

Risk analysis with uncertainty in the decision making process deals with the measurement of uncertainty and probability and the likely consequences for the choices made for the investment. The uncertainty of variables or factors that will affect the risk analysis process will impact the success of a project investment in the real estate industry. Techniques such as fuzzy set theory (Sun et al., 2008) and fuzzy-analytical hierarchy process (F-AHP) have been proposed to solve such problems.

This chapter proposes a risk-based decision making framework for investment pre-analysis in the real estate industry, as shown in Figure 1. The proposed risk-based decision making framework comprises five main elements namely: foundation concepts; process; sources and factors; techniques/approaches; and issues and challenges. These five elements will be explained in subsequent sections. This framework can be applied to different problems or issues in various industries and can support decision makers to render their decision making process more structured and manageable.

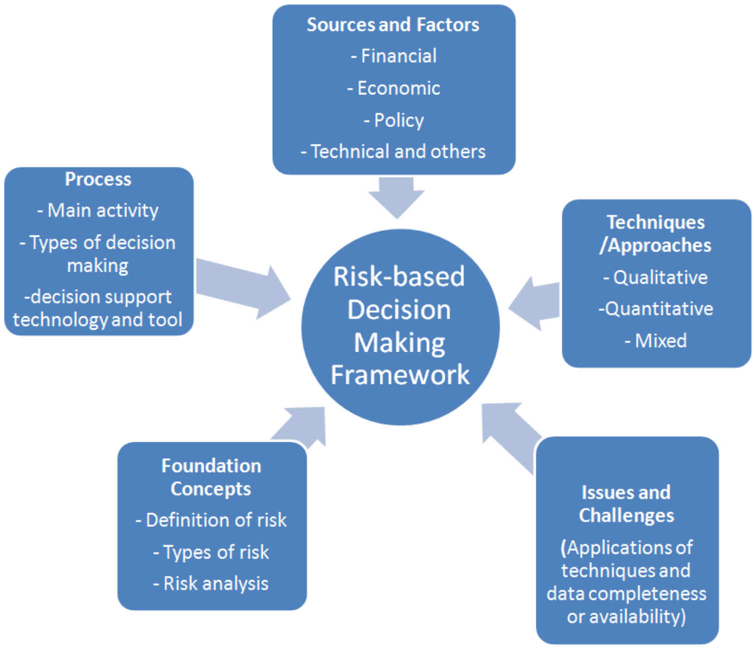

Fig. 1. The structure of the proposed risk-based decision making framework

The structure of this chapter is organized as follows. Following this introduction, risk-based decision making concepts are highlighted in Section 2. The risk-based decision making process is explained in Section 3. Section 4 elaborates on risk sources and risk factors that may affect the risk analysis for each project to be selected for investment. In Section 5, some examples of the risk-based decision making techniques currently applied in real estate project investment are described. Section 6 explains the issues and challenges of risk-based decision making, and the chapter is summarized in Section 7.

2 Risk-Based Decision Making Concepts

This section discusses the concepts of risk-based decision making including the definition of risk, types of risk, and a brief explanation of risk analysis. These concepts relate mainly to risk-based decision making for investment as applied in the real estate industry.

2.1 Definition of Risk and Risk-Based Decision Making

According to Aven (2007), risk is defined as the combination of possible consequences and associated uncertainties, as shown in Figure 2. Associated uncertainties refer to the uncertainties of the sources of risk. A source is a situation or event that carries the potential of a certain consequence, and ‘vulnerability’ is defined as the combination of possible consequences and associated uncertainties from a given source. There are three categories of sources: threats, hazards, and opportunities. Exposure of a system to certain threats or hazards can lead to various outcomes such as economic loss, the number of fatalities, the number of attacks and the proportion of attacks that are successful. Based on the identified vulnerabilities, risk can be described, using standard risk matrices showing the likelihood of threats and possible consequences (Aven, 2007). The vulnerability analysis literature has a focus on methods for identifying vulnerabilities and measures that can be implemented to mitigate these vulnerabilities. A common definition of vulnerability is a fault or weakness that reduces or limits a system's ability to withstand a threat or to resume a new stable condition. Vulnerabilities are related to various types of objects such as physical, cyber, human/social and infrastructure (Anton, et al., 2003 as cited in Aven, 2007).

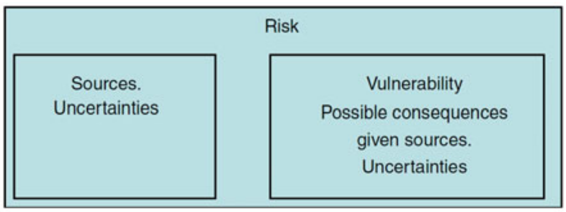

Fig. 2. Risk viewed as a combination of sources and vulnerability (Aven, 2007)

Risk-based decision making is a process based on the analysis of risk related issues. The result of the analysis of the choices on the list will vary depending on the level of uncertainty factors that will affect the decision making process. Risk arises because of possible consequences and associated uncertainties, and there are various risk sources that will affect the level of risk for given alternatives. The risk-based decision making for each investment project aims to minimize or eliminate unwanted outcomes to optimize the benefits of the investment.

2.2 Types of Risk

Two main types of risk affect the decision making process for investment in the real estate industry: *systematic risk* (beta) and *unsystematic risk*. According to Chauveau and Gatfaoui (2002), systematic risk is a measure of how the asset co-varies with the economy, and unsystematic risk also known as *idiosyncratic risk* which is independent of the economy. According to the Capital Asset Pricing Model (CAPM) (Lintner, 1965; Sharpe, 1963, 1964, cited in Lee & Jang, 2007), the total risks are calculated as follows:

$$\text{Total risk} = \text{Systematic risk} + \text{Unsystematic risk}. \tag{1}$$

2.2.1 Systematic Risk

Systematic risk refers to a type of risk that influences a large number of assets. It cannot be avoided despite stock portfolio diversification (Brealey & Myer, 2000, cited in Lee & Jang, 2007). According to Lee and Jang (2007), systematic risk can differ from period to period. Managerial decisions about operations, investments, and financing will influence the performance for the company, consequently affecting how its returns vary with market returns. The CAPM suggests that the expected rate of return on a risk asset can be obtained by adding the risk-premium to the risk-free rate; the expected risk premium varies in direct proportion to beta in a competitive market (Chen, 2003; Gencay, Selcuk & Whitcher, 2003; Lintner, 1965; Sharpe, 1963, 1964; Sheel, 1995, cited in Lee & Jang, 2007). Mathematically, the expected rate of return is described as

$$R_i = R_f + (R_m - R_f)\beta_i, \tag{2}$$

where R_i is the expected return on the ith security R_f the risk-free rate; R_m the return on the market portfolio; β_i the estimated beta of the ith security; $(R_m - R_f)\beta_i$ the risk premium. Based on CAPM, systematic risk refers to a type of unavoidable risk on the stock market. Systematic risk is presented by beta which is calculated by linear analysis between the daily prices of stocks and the security index of the stock market (Jian, Zhao & Xiu, 2006).

2.2.2 Unsystematic or Idiosyncratic Risk

Unsystematic risk, or idiosyncratic risk, is sometimes referred to as a specific risk which is sensitive to diversification, contrasting with systematic risk, which is undiversifiable. Idiosyncratic risk is significant for asset pricing because it inhibits the intergenerational sharing of aggregate risk (Storesletten, Telmer & Yaron, 2007).

CAPM and Arbitrage Pricing Theory (APT) assert that idiosyncratic risk should not be priced in the expected asset returns, and the recent surge of interest in the idiosyncratic risk of common stocks has generated substantial evidence on the role of idiosyncratic risk in equity pricing (Liow & Addae-Dapaah, 2010). The main reason for this interest is that most investors are under-diversified due to wealth constraints, transaction costs or specific investment objectives; as such, idiosyncratic risk may be important to less well-diversified real estate investors who wish to be compensated with additional risk premium. Such investors need to consider idiosyncratic risk (together with market risk) when estimating the required return and the cost of capital on assets or portfolios. Both systematic (market) and idiosyncratic volatility are relevant in stock asset pricing (Campbell et al., 2001, cited in Liow & Addae-Dapaah, 2010).

Various intelligent techniques including the Real Option method, Multi-State approach, variable precision rough set (VPRS), Condition Value-at-Risk (CVaR), AHP, Support Vector Machine (SVM), Radial Basis Function Neural Network, Fuzzy Comprehensive Valuation Method and Projection Pursuit Model based on Particle Swarm Optimization (PSO) have been applied to deal with and support unsystematic or idiosyncratic risk-based decision making.

2.3 Risk Analysis

Risk analysis is the process of identifying the security risks to a system and determining their probability of occurrence, their impact, and the safeguards that would mitigate that impact (Syalim, Hori & Sakurai, 2009). The risk analysis concept is present in business transactions, especially in the real estate industry which involves high cost and high capital (Wu, Guo & Wang, 2008). Regardless of the types of risk, the application of risk analysis has a positive effect in identifying events that could cause negative consequences for a project or organization and taking actions to avoid them (Olsson, 2007). Risk analysis is a vital process for project investment in the real estate industry which has low liquidity and high cost. It mainly consists of three stages: risk identification, risk estimation and risk assessment (Yu & Xuan, 2010).

Several risk analysis techniques, tools, and methodologies have been developed to analyze risk in different industries. Some of these techniques, such as the even swaps method, have been integrated with decision support tools called Smart-Swaps to support multi-criteria decision analysis and assist decision makers, in particular the project manager, to engage in optimal decision making (Mustajoki & Hamalainen, 2007).

2.3.1 Risk Identification

There are currently several risk identification techniques at present including the Delphi technique, brainstorming, Fault Tree Analysis, SWOT analysis and expert survey. Of these, Delphi is the most widely used.

2.3.2 Risk Estimation

Risk estimation quantifies the risks that exist in the process of investment in real estate projects. It uses risk identification, determines the possible degree of influence of such risks and objectively measures them to make evaluation decisions and subsequently choose the correct method to address the risks. The theoretical basis of risk estimation includes the Law of Large Numbers (LLN), the Analogy Principle, the Principle of Probabilistic Reasoning and the Principle of Inertia (Xiu & Guo, 2009).

2.3.3 Risk Assessment

The risk assessment or risk evaluation of investment in real estate projects refers to the overall consideration of the risk attributes, the target of risk analysis and the risk bearing capability of risk subjects on the basis of investment risk identification and estimation, thus determining the degree of influence of investment risks on the system (Xiu & Guo, 2009).

Risk occurs at different stages of the investment process. There are many techniques or approaches available for risk-based decision making, each of which has its own features or criteria and is used for quantitative or qualitative analysis, or both. Some researchers have combined or embedded these techniques to conduct both quantitative and qualitative analysis. For example, the real options method is strictly concerned with quantitative analysis. However, Information and Communication Technology (ICT) investments experience tangible and intangible factors, and the latter can be mainly treated by qualitative analysis. They have proposed a decision analysis technique which combines real options, game theory, and an analytic hierarchy process for analyzing ICT business alternatives under threat of competition (Angelou & Economides, 2009).

Risk analysis involves decision making in situations involving high risks and large uncertainties, and such decision making is difficult as it is hard to predict what the consequences of the decisions will be (Changrong & Yongkai, 2008; Ju, Meng & Zhang, 2009; Hui, Zhi & Ye, 2009; Chengda, Lingkui & Heping, 2001). There are two dimensions of risk analysis, namely, possible consequences and associated uncertainties (Aven, Vinnem & Wiencke, 2007).

An example of the risk analysis framework proposed by Li et al. (2007) including the risk factor system, data standards for risk factors, weights of risk factors, and integrated assessment methods was used to quantitatively analyze the outbreak and spread of the highly pathogenic avian influenza virus (HPAI) in mainland China. They used a Delphi method to determine the risk factors according to predetermined principles, and an AHP integrated with multi-criteria analysis was used to assess the HPAI risk.

Risk analysis is an important process that needs to be conducted to achieve optimal decision making. Real estate franchisors can achieve their goals and objectives if they fully understand and can identify the uncertain factors and variability that will affect the level of risk for each given alternative. The uncertain factors or variables will lead to probability and consequences and can be retained as a list of threats that will affect the risk level. It is therefore important to propose a framework of risk analysis as a guideline for investors in the real estate industry.

3 Risk-Based Decision Making Process

This section discusses the risk-based decision making process which includes the main risk-based decision making activities, the types of decision making process and the decision support technology for risk-based decision making. The decision support technology discussed briefly as this chapter focusing on the five main elements of risk-based decision making framework for investment in real estate industry.

3.1 Main Risk-Based Decision Making Activity

According to Busemeyer and Pleskac (2009), decision making processes become more complex, experience greater uncertainty, suffer increasing time pressure and more rapidly changing conditions, and have higher stakes. Thus, it is important to have a guidelines or step-by-step activity that will ensure all the requirements and elements for the risk-based decision making are clearly identified, defined and prioritized.

The main activity for the risk-based decision making need to be listed and perform accordingly as required to ensure the decision made is beneficial. Moreover, risk analysis needs to be performed carefully to ensure there are no undetected or potential problems on the horizon as the risk factors and its sources have the tendency to be uncertain. The uncertainty of risk factors will lead to probability and consequences to the outcome of the decision making process with risk. Risk can be distinguished from other events due to the unwanted effects associated with it, and its ability to change the outcome of the interaction in a negative way or towards an unwanted direction. The consequences are the outcome of an event expressed qualitatively or quantitatively, being a loss, injury, disadvantage or gain. There may be a range of possible outcomes associated with an event (Hussain et al., 2007). Figure 3 shows the main activities of risk-based decision making for investment in the real estate industry.

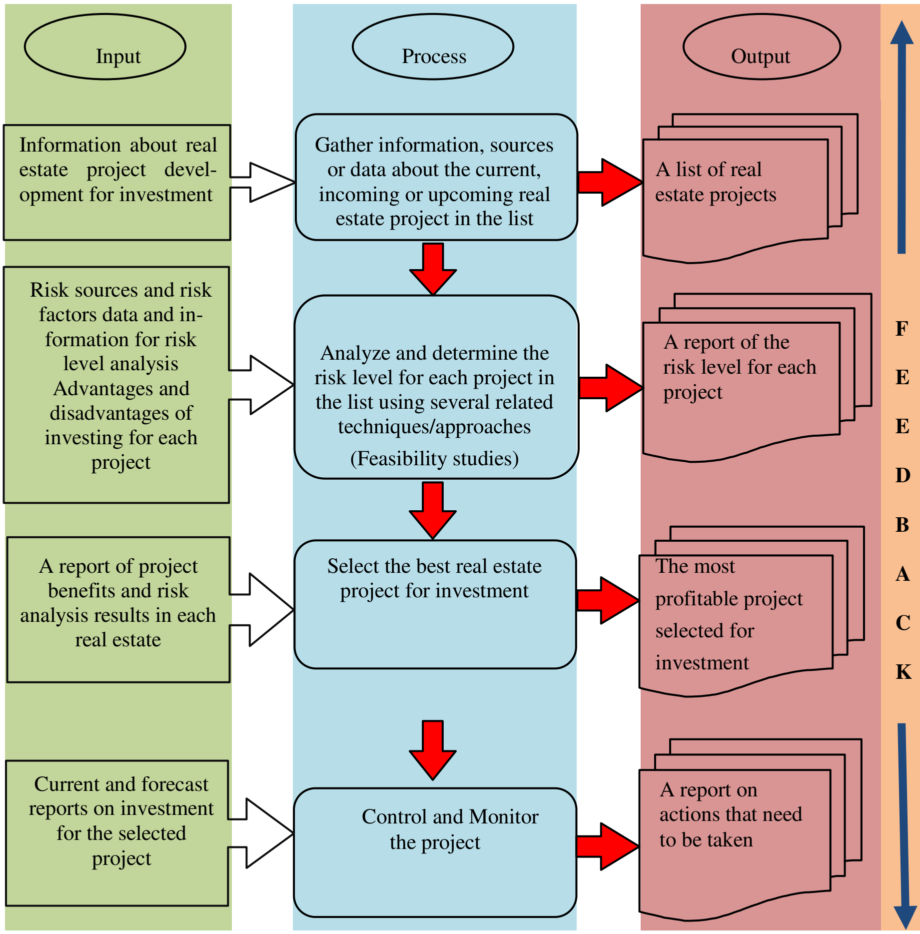

Fig. 3. Risk-based decision making main activity for investment in the real estate industry

The process starts from defining and gathering information sources or data about a current, incoming or upcoming real estate project in the list. For example, the details about the properties or property portfolio need to be collected from valid sources such as real estate agency. Information regarding the project available in the real estate industry should be gathered as much as possible for the risk-based decision making. A check list is used to determine all the elements of potential risk factors are identified and to ensure they are all covered. All the potential risk factors will be identified by asking questions such as what can happen, why it happens and how it happens. The risk identification processes include internal and external sources through brainstorming, inspections, professional consultations, case studies, audits and questionnaires.

The identified risk will be analyzed and the risk level for each project in the list will be determined using several related techniques. The analysis involves ranking and prioritizing the risks for each project based on the project's profile and the risk-consequences analysis. The risk analysis might use qualitative or quantitative techniques, or a combination of the two, to identify the risk level and the consequences of each project. Feasibility studies for all elements in the list will be checked and aim to uncover the strengths and weaknesses of the identified risk factors and determine whether or not the project will be successful. Once the analysis is done, the best project for investment will be selected and monitored. Feedbacks from the decision makers will be asked for each of the output of all of the risk analysis activities involved to ensure all elements or criteria have been met.

The output or decision point of the decision making process can be categorized into three choices or alternatives: hold, proceed (go) or discard (stop) (Strong et al., 2009). The hold state stipulates waiting for a better time to continue the process; the proceed (go) decision point is to proceed with the potential or actual line of business; and discard (stop) decision point terminates the process. Feasibility studies on all the sources and factors or variables that will affect the project investment need to be carried out to eliminate, hedge or mitigate the risk.

3.2 Types of Risk-Based Decision Making Process

Decision making process can be divided into two main types: *static decision making process* and *dynamic decision making process*. These two main types of decision making process are related to different investment strategies in the real estate industry: simultaneous strategy or sequential strategy. Simultaneous and sequential investments are common in the real estate market (Rocha et al., 2007). All decision making analysis will involve risk, and what matters is the level of risk involved in each solution chosen by decision makers. The risks that arise are an inherent implication of decision making processes which need to be analyzed carefully, and there is a need for a system that can cater for this problem, thus helping decision makers to lower the risk or to make wise decisions for every problem they face.

3.2.1 Static Risk-Based Decision Making Process

The static decision making process normally corresponds to the simultaneous investment strategy. It is a now-or-never decision where the two options are represented using the circle nodes and the triangle nodes represented the end of process in Figure 4. All irreversible resources are compromised at once, and are a process that is related to investment in the real estate industry. The simultaneous strategy is usually implemented during periods of increased demand and implies lower construction costs but, in turn, carries less certain returns. The industry has suffered bitter experiences with residential housing developments and mega-entertainment resorts that started simultaneously but have generated profits only after five or more years of construction. Figure 4 shows the static decision making process.

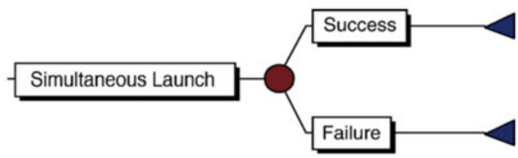

Fig. 4. Static (simultaneous) decision making process (Rocha et al., 2007)

3.2.2 Dynamic Risk-Based Decision Making Process

The dynamic decision making process is related to sequential investment strategy, in which risks are faced in sequence with relatively smaller increments at every phase of the project, but at the expense of relatively higher construction costs. In sequential investment strategy, the initial outflow is lower than in simultaneous investment strategy and expected inflows of a previous phase may finance subsequent ones. Dynamic decisions arise in many applications including military, medical, management, sports, and emergency situations. Dynamic risk prediction is an important process in achieving optimal decision making when dealing with investments with a limited budget plus time and other constraints. The dynamic decision making process for the prediction of risk level is generally related to three managerial flexibilities characteristics (information gathering, waiting option and abandon option) as shown by three different nodes (circle, square and triangle) of real option methods, as depicted in Figure 5. The circle nodes represent the options available for the next steps and the triangle nodes represent the end of the process for the particular decision made. The most important characteristic related to the dynamic decision making process is the waiting option represented in square nodes.

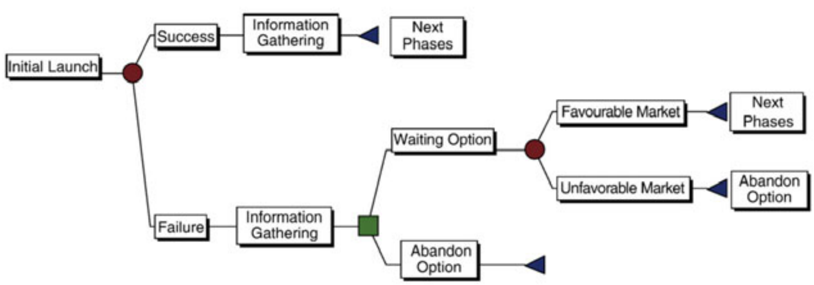

Fig. 5. Dynamic (sequential) decision making process (Rocha et al., 2007)

The challenge decision maker's face with is that the characteristics of each option are often unknown, especially when dealing with a higher uncertainty of risk factors or risk sources. Higher uncertainties of risk sources or risk factors will lead to higher probability of unsuccessful investment or consequences of the decision made for given options. Owing to the increased complexity of the decision, the uncertainty of evaluation also increases. In this situation, decision makers are unable to use precise numbers to express their evaluations, although they can still give approximate ranges of evaluations through their knowledge and cognition (Lin, Lee & Ting, 2008). To achieve optimal decision making, however, it is important for them to master good knowledge of risk analysis, and they need to analyze the risk sources and risk factors for the given options.

3.3 Decision Support Technology for Risk-Based Decision Making Process

The literature review indicates that there is much work to be done to develop an intelligent decision support system (IDSS) for handling risk-based decision making in business operations. Decision support tools help businesses to manage their business tasks efficiently and effectively, especially when managers deal with decision making processes in their daily routine (Lu, et al., 2007; Niu, Lu & Zhang, 2009). This is perhaps the most important concern for the future of risk analysis systems for managers, since it will promote vital and useful technology that helps decision makers to identify the risks involved in making decisions to meet their organization's goals and objectives.

A combination of tools in an IDSS will make the system more useful to organizations, especially when dealing with risk analysis. All decision making involves risk, and it is the level of risk involved in each chosen solution that matters to decision makers. The risks that arise need to be analyzed carefully using a system that helps decision makers to lower the risk and make wise decisions. There appears to be general agreement that the use of an intelligent agent as one of the artificial intelligence mechanisms integrated with decision support system tools will provide an IDSS that helps managers to make decisions effectively and efficiently. IDSS is an example of decision support technology which is flexible in use. IDSS for real estate investment can help real estate investors to make effective cost, fund and market analysis, and can assist investors to make scientific decisions. Furthermore, IDSS is reliable and can result in a profitable outcome because the factors in the decision support system are numerous and a large number of modules and methods are provided to help a policy maker analyze problems (Rui et. al., 1996).

Uncertainty and complexity are common conditions that have led to greater recognition of systemic and holistic approaches to problem solving (Cassaigne & Lorimier, 2007). Cassaigne and Lorimier have reported on the findings of exploratory research into the technical and organizational challenges facing IDSS for nonoperational decision making and have indicated directions for future research. They believe that due to the complexity of nonoperational decisions, it might be necessary for the decision maker to involve one or more domain experts to identify the possible characteristics of the problem, the decision technique, the possible solutions and their impacts. IDSS "would combine the knowledge-based reasoning method with formal methods of decision analysis" (Holtzman, 1999, cited in Cassaigne & Lorimier, 2007). Thus, the integration of different methods with decision support tools to solve uncertainties of risk factors should be applied to achieve the optimal decision. This is possible when dealing with semi-structured problems.

The literature also notes current developments in the field of decision support technology use for risk analysis. Most research efforts reported in popular journals or databases have tried to fulfill the need to develop IDSS for structured types of decisions to solve the daily routine activities of an organization. The systems related to

IDSS proposed by other researchers have focused more on how daily problems are solved in industry. For instance, Delen and Pratt (2006) developed an integrated IDSS for manufacturing systems that is capable of providing and independent model representation concept. They believe that managers need to integrate intelligent information systems that are capable of supporting them throughout the decision making life-cycle, which starts with structuring a problem from a given set of symptoms and ends with providing the information needed to make the decision. They also report on a collaborative research effort, the aim of which has been to fill this need by developing novel concepts and demonstrating the viability of these concepts within an advanced modeling environment.

According to Mora et al. (2007), research on how to design, build and implement IDSS from a more structured and software engineering/systems engineering perspective in absent in the entire research period from 1980–2004. They used an existing conceptual framework to assess the capabilities and limitations of the IDSS concept, and through a conceptual meta-analysis research of the Decision Support System (DSS) and artificial intelligence (AI) literature from 1980 to 2004, they developed a strategic assessment of the initial proposal called Capability Assessment Framework for decision making support system (DMSS). This framework identifies three dimensions as core structural components: the user-interface capability dimension (UICD); the data, information and knowledge-representation capability dimension (DIKCD); and the processing-capability dimension (PCD). They discovered that the DMSS community focused on the decision making process rather than on the development of a specific AI mechanism. Most of the decision support technologies developed have been integrated with intelligent agent to make the software system more useful and beneficial to users.

4 Risk Sources and Risk Factors in the Real Estate Industry

This section explains the five main categories of risk sources and risk factors for investment in the real estate industry, namely financial risk, economic risk, scheduled risk, policy risk, and technical risk and others. Each of these risk sources has its own risk factors as a sub element. The next part of this section discusses the risk factors based on the stages of real estate investment.

4.1 Financial Risk

Financial risk refers to the uncertainty of profits which originate from the process of financing, money allocation and transfer, and interest payments as financial aspects of a project. The financial risk consists of three sub-categories of risk factors: policy, engineering and market. The value of financial risk will normally be decreased because of the high rates of return in a short period of time that allow investors who have sufficient budget and capital to engage in investment in the real estate industry. Some investors acquire their capital for investment through mortgages, either from a bank or an organization; however, since this involves high cost and high capital, and properties are not easily sold, the risk level for the real estate investment will be very high. Over the past decade, real estate has become a hot investment area, but real estate projects are characterized by high risk, high return and long cycles, which require that real estate investors carefully research each project to maximize the return and minimize the risk. Risk analysis using scientific methods and tools to understand the risk situation thoroughly is therefore essential when making decisions on investment (Yu & Xuan, 2010).

According to Zhi and Qing (2009), financial risk includes own fund risk, bank loan risk, shares risk and financial structure risk. Financial risk analysis is the core of real estate investment risk analysis and will directly determine the decision making concerning the investment.

Real estate industry business processes include managing, buying and selling properties, rental services for properties, and advertising properties for sale or rent. Buying and selling properties involves high project costs or investment and careful consideration needs to be given to any transaction. Even though investment in the real estate industry incurs high cost and slow liquidity, it offers more value and a higher rate return on investment in a short period of time (Zhou, Wang & Li, 2010). The value of financial risk can be minimized with rises in the price and value of the property over time, especially when the property is located in an area which is still in a development phase. For example, if public transport or other amenities such as a children's playground or park, community centres, or schools are still in the development phase, the value of the property will increase once these facilities are completed. Property prices are also affected by many other factors, such as interest rate, land supply and inflation rate (Hui, Yu & Ip, 2010).

Real estate investment is subject to high risk because it is heavily dependent on bank loans, and the risks involved can be traced back to the asset security of bank loans (Xiaozhuang, 2008). Financial risk can also be mitigated by analysing the real estate portfolio, based on the financial requirements of the real estate investment (Wu et al., 2009).

According to Saleem and Vaihekoski (2008), currency risk can have very important implications for portfolio management, the cost of capital of a firm, and asset pricing, as well as currency hedging strategies, as any source of risk which is not compensated for in terms of expected returns should be hedged. Real estate investment is speculative and its return and risk are influenced by many factors, such as the natural environment, the socio-economic environment, the market, and enterprise purchasing capability (Liu, 2007).

4.2 Economic Risk

Economic risk includes regional development risk, market supply and demand risk, and inflation risk (Zhi and Qing, 2009). Li and Suo (2009) define economic risk factors as consisting of the sales cycle, industry competitiveness, economic operation, exchange rate and interest rate. Sun et al. (2008) propose a model based on general relationships among significant elements of dynamic risk prediction for real estate franchisors in the real estate industry using the real option method. One of the risk sources proposed in the model is economic risk, which includes finance, financing, market requirement and land price.

4.3 Scheduled Risk

Scheduled risk affects the degree of risk for the given alternatives (Sun et al., 2008). Real estate investment is normally related to capital risk and liquidity risk. Investors must have the knowledge to understand and manage these factors in the real estate industry. The list of projects for an investment need to be analyzed and priority is given to the most beneficial project according to the available budget and time. Liquidity risk is related to scheduled risk because both of these risk sources are dependent on time series.

Yu and Xuan (2010) define scheduled risk as the delay of part of the whole project process, or even the entire project, which is often accompanied by an increase in cost. The Critical Path method based on Work Breakdown Structure (WBS) is the most commonly-used methodology for scheduled risk.

4.4 Policy Risk

Policy risk refers to uncontrollable elements which can cause great harm as a source of risk in real estate development, even though there is only a small likelihood of their occurrence (Yu & Xuan, 2010). Jin (2010) highlights policy environment risk as the lifecycle risk impact factors of a real estate project. Organization policy and industrial policy are also examples of the variables or factors that might affect the result of risk analysis (Sun et al., 2008). Zhi and Qing (2009) define policy risk as including monetary policy risk, industrial policy risk, land policy risk, housing policy risk, tax policy risk, and town planning risk. Li and Suo (2009) point out that policy factors consist of environmental policy, tax policy, financial policy, and industrial policy.

4.5 Technical Risk and Others

Technical risk refers to the harm and danger caused by technical deficiencies or defects (Yu and Xuan, 2010), and tendering management, design change and project construction are the source of risk factors for technical risk (Sun et al., 2008). Leifer et al. (2000, cited in Strong et al., 2009), define three major dimensions of uncertainty that are relevant for all innovation development projects targeting new lines of business: technological, market organizational, and resource uncertainties.

Other risk factors include political risk, construction risk, location factors, and settlement risk. Sun et al. (2008) propose political risk as a major source of risk. Risk factors for political risk include industrial policy, housing and regulation reform, and social risk: city planning, zone development and public interference.

Zhi and Qing (2009) describe construction risk as the first-level index, other than financial, policy and economic risk that should be selected for risk evaluation after investigating residential real estate markets. Construction risk includes nature condition risk, the risk of project delays, project quality risk, development cost risk and construction claim risk.

Li and Suo (2009) highlight two other main risk factors for real estate investment: the location factor, and settlement risks: sales return sum, settlement ability, settlement period. Moreover, Yu and Xuan (2010) suggest that another source of risk is management risk; that is, risks that originate from errors or changes in management, or that are linked to how a project is organized, managed and implemented. Xiaobing and Haitao (2009) state that the risk indicators for the early stage of real estate projects includes purchasing land risks, removing and resettlement risks, survey risks, design risks, financing risks, bidding risks, contract risks and approval risks. Based on the review of literature, Table 1 depicts the risk factors that will affect risk analysis for investment in the real estate industry.

Table 1. A summary of risk factors that will affect the risk analysis for investment in the real estate industry

Risk Analysis Factors	
Sociological risk	Technical risk
Organizational policy risk	Economic risk
Contractual risk	Behavioral risk
Types of user (decision makers)	Organizational risk
Goals and objectives of decision maker	Scheduled risk
Political risk	Currency risk
Social risk	Technological risk
Financial risk	Policy risk
Market organizational risk	Resource uncertainties risk
Construction risk	Psychological risk
Regulatory risk	Natural environment risk
Socio economic environment risk	Market risk
Enterprise purchasing capability risk	Nature condition risk
Location factor risk	Settlement risk
Management risk	Purchasing land risk
Removing and resettlement risk	Survey risk
Design risk	Bidding risk
Contract risk	Approval risk

4.6 Risk Factors Based on Stages of Real Estate Investment

Li et al. (2009) divided risk factors into four stages of real estate project investment. 1) Risk factors during the investment decision process: development opportunity risk, risk of regional economic environment, risk of regional social environment and risk of project positioning. 2) Risk factors during the process of obtaining land: risk of market supply and demand, risk of development cost, risk of financing and risk of levy land and remove. 3) Risk factors during the construction process: risk of project quality, risk of project duration, risk of development cost, risk of contracting, risk of project technology, risk of construction claim, risk of natural conditions and risk of contract mode. 4) Risk factors during the rent and sale management process: risk of marketing opportunity, risk of sales planning, risk of operating contract and risk of natural disasters or other contingencies.

Jin (2010) illustrates the lifecycle risk impact factors according to the different stages of a real estate project as follows. 1) The risk in the investment decision stage, including: policy environment risk, investment opportunity choice risk and investment property type choice risk. 2) The risk in the land acquisition stage, including: land price change risk, land idle risk, levy land and dismantle risk and raise funds risk. 3) The risk in the construction stage, including: inviting public bidding mode risk, contract way risk, contract bargain risk, quality risk, schedule delay risk, development cost risk, construction safe risk and construction claim risk. 4) The risk in the lease and sale stage, including: lease and sale opportunity risk, lease and sale contract risk. 5) The risk in the property operation stage, including: natural disaster risk and contingency risk.

5 Risk-Based Decision Making Techniques for Real Estate Project Investment

Investment in the real estate industry in emerging economies demonstrates tight working capital, low liquidity, slow payback, high sunk cost, capital intensive outflows that are not immediately recovered, enduring uncertainties about demand, price/m^2, land costs, and short to medium construction times. It is very important for investors to have an approach or technique to analyze the real estate project investment to minimize the uncertainty or risks that will affect their profits and margins (Rocha et al., 2007; Sun et al., 2008). This section will explain some of the risk-based decision making techniques for investment in the real estate industry, which are divided into three categories, namely, quantitative, qualitative and hybrid technique.

5.1 Quantitative RBDM Technique

Quantitative technique refers to the analysis of variables or elements that can be measured using either discrete or continuous numerical data involving statistical data analysis. Some examples of quantitative RBDM techniques for investment in the real estate industry include Beta, Projection Pursuit model based on Particle Swarm Optimization (PSO), condition value-at-risk (CVaR), Maximal Overlap Discreet Wavelet Transform (MODWT), Markowitz's Portfolio Analysis, Regression Analysis, Statistical Stepwise Regression Analysis and Neural Network Sensitivity Analysis.

5.1.1 Beta

Beta is a risk measurement for systematic risk (Li & Huang, 2008). Beta measures the degree of co-movement between the asset's return and the return on the market portfolio. In other words, beta quantifies the systematic risk of an asset (Xiong et al., 2005).The systematic risk, as denoted by β_i, is a measure of the slope of a regression line between the expected return on the ith security (R_i) and the return on the market portfolio (R_m) such as Standard and Poor's 500 (S&P 500 cited in Lee & Jang, 2007) and Stock Index and New York Stock Exchange (NYSE) Index. Mathematically, the beta (β_i) is expressed as

$$R_i = \beta_0 + \beta_i R_m + e_i. \tag{3}$$

Based on the formula given above, an asset with a higher beta should have a higher risk than an asset with a lower beta (Tang & Shum, 2003).

5.1.2 Projection Pursuit Model Based on Particle Swarm Optimization (PSO)

The Projection Pursuit model based on Particle Swarm Optimization (PSO) is used to process and analyze high dimensional data, especially non-linear and non-state high-dimensional data. PSO can be used to solve a large number of non-linear, non-differentiable and complex multi-peak optimization problems and has been widely used in science and engineering. The Projection Pursuit model can make exploratory analysis and is also referred to as the deterministic analysis method (Shujing & Shan, 2010). Modeling steps for the Projection Pursuit Model are as follows: Investment risk assessment program of the normalized values; Projection index structure function; Optimized projection target function; Scheme selection.

5.1.3 Condition Value-at-Risk (CVaR)

A dynamic condition value-at-risk (CVaR) technique is one of the new tools of risk measurement for studying investment in real estate. This technique was proposed by Rockafellar and Uryasev as cited in Meng et al. (2007) and has many good properties, such as being computable, convex and more efficient than the Markowitz value-at-risk technique for portfolio investment.

5.1.4 Maximal Overlap Discreet Wavelet Transform (MODWT)

Maximal Overlap Discreet Wavelet Transform (MODWT) provides a natural platform for investigating the beta or systematic risk behavior at different time horizons without losing any information (Xiong et al., 2005). They proposed this method to decompose a time series of any length into different timescales and listed the advantages of MODWT over the Discreet Wavelet Transform (DWT) as follows: 1) The MODWT can handle any sample size, while the Jth order DWT restricts the sample size to a multiple of 2^J; 2) The detail and smooth coefficients of a MODWT multi-resolution analysis are associated with zero-phase filters; 3) The MODWT is invariant to circularly shifting the original time series; 4) The MODWT wavelet variance estimator is asymptotically more efficient than the same estimator based on the DWT.

5.1.5 Markowitz's Portfolio Analysis and Regression Analysis

Lin and Chen (2008) carried out a study on the identification of default risk as a systematic risk based on Chinese stock markets using two analyses, namely portfolio analysis and regression analysis to check whether default risk is systematic and to discover the relationship between the expected return and the default risk. Regression analysis was used to examine whether default risk is systematic in the Chinese stock market. They determined that default risk is not a systematic risk factor of the Chinese stock market; however, these two analyses can be used to analyze and identify the systematic risk for investment in an industry.

5.1.6 Statistical Stepwise Regression Analysis and Neural Network Sensitivity Analysis

Based on the research study by Wang, Hsiao and Fu (2000) exploring the relationship between a firm's systematic risk and its long-term investment activities, the results of these techniques show that systematic risk is reduced for investment activities in the fibre industry. For the electronic industry, however, the systematic risk is higher, as firms increase their long-term investment ratio. Companies with a higher portion of long term investment in assets will show a more significant difference. They use step-wise regression analysis to explore the impact of independent variables on systematic risk and neural network sensitivity analysis to analyze the non-linear relationship between a firm's systematic risk and its long-term investment activities. Their findings indicate that if an industry is somewhat mature and does not have many investment opportunities, the long-term investments in the industry are more diversified.

5.2 Qualitative RBDM Technique

Qualitative technique is a method for analyzing variables or elements that cannot be measured using numerical data; these variables or elements will instead be given a category such as low, medium or high. Some examples of qualitative RBDM techniques for investment in the real estate industry include the fuzzy comprehensive valuation method and variable precision rough set (VPRS) technique.

5.2.1 Fuzzy Comprehensive Valuation Method

The fuzzy comprehensive valuation method is used to evaluate the risk degree of a real estate project. Jin (2010) applied this method for comprehensive risk evaluation which would be beneficial and practical for the real estate projects lifecycle. Fuzzy comprehensive valuation is also used to estimate the lifecycle of the project's identified risk factors to confirm the risk level (highest risk, higher risk, general risk, lower risk, low risk), the first class index evaluation and index weight of all classes. The results of the paper shows that the total risk of each stage of a real estate project reduces gradually with the development of real estate projects, and the risk of same stage reduces gradually with the development of real estate projects. This would provide a foundation data to dynamic deal scheme decision for risk for real estate projects. This technique has also been used to obtain the value of the risk of real estate investment and has significance in theory and practice for investment risk analysis (Li & Suo, 2009).

5.2.2 Variable Precision Rough Set (VPRS)

Xie et al. (2010) designed an adaptive algorithm for dynamic risk analysis in a petroleum project investment based on a variable precision rough set (VPRS) technique. Their intention was to develop a risk ranking technique to measure the degree of risk for individual projects in a portfolio for which experts are invited to identify risk indices and support decision makers in evaluating the risk exposure (RE) of individual projects. Their investigation includes the definition of multiple risks involved in any petroleum project investment using multi-objective programming to obtain the optimal selection of projects with minimum risk exposure. The significance of risk indices is then assigned to each of the corresponding multi-objective functions as a weight.

5.3 Hybrid RBDM Technique

In order to provide a comprehensive evaluation of risk analysis, the combinations of qualitative and quantitative techniques have been useful for generating better decisions and takes into account all possible uncertainty factors.

5.3.1 Radial Basis Function Neural Network

Radial Basis Function (RBF) Neural Network is an example of an evaluation model for development risk in the real estate industry. RBFs are embedded in a two-layer feed-forward neural network; the input into an RBF neural network is nonlinear while the output is linear. The RBF neural network consists of one hidden layer of basic functions, or neurons and the chosen RBF is usually a Gaussian. At the input of each neuron, the distance between the neuron's centre and the input vector is calculated. The output of the neuron is then formed by applying the basis function to this distance. The RBF network output is formed by a weighted sum of the neuron outputs and the unity bias shown. It empirical analysis shows that the evaluation model is characterized as good data approximation, with high stability and normalization. RBF neural network has the advantage of automatically defining the initial weights and reducing the influence of overlay depending on the experience and knowledge of experts (Zhi & Qing, 2009).

5.3.2 Support Vector Machine

The SVM modelling approach has been proposed by Li et. al. (2009) to predict risk for real estate investment. Firstly, the merits of the structural risk minimization principle and the small study sample and non-linear case are used to analyze the risk factors during the investment stage in real estate projects. A model based on SVM in real estate investment risk is then built up. SVM learning training samples are usually based on a project proposal, project feasibility study report, project evaluation reports and other information.

According to Tao and Yajuan (2010), the main idea of SVM is to transform the input space into a higher dimension space with the nonlinear transformation of inner product function definition, then seeking out the nonlinear relation of the input variables and output variables in the higher dimension. They agreed that SVM can solve such problems as small samples, nonlinear case and higher dimensions, and that it provides a global optimal solution since SVM is a convex quadratic programming problem.

5.3.3 Analytic Hierarchy Process

AHP is a multi-criteria decision analysis technique that is commonly used for risk analysis. It aims to choose from a number of alternatives based on how well these alternatives rate against a chosen set of qualitative as well as quantitative criteria (Saaty & Vargas, 1994; Schniederjans, Hamaker & Schniederjans, 2005, cited in Angelou & Economides 2009). AHP has also been employed to determine the weight of every index to deal with the uncertainty of the risk analysis of real estate investment (Li & Suo, 2009).

5.3.4 Real Option Method

The application of a real option method seeks to examine the changes in uncertainty that will affect the optimal timing for investment. There are three managerial flexibility criteria of the real option method that influence optimal timing: information gathering, waiting option and abandon option (Rocha et al., 2007).

Wong (2007) examines the effect of uncertainty on investment timing in a canonical real options model. His study shows that the critical value of a project that triggers the exercise of the investment options exhibits a U-shaped pattern against the volatility of the project. It is found that there is a positive relationship between the risk factor and return factor when the volatility of the project increases.

According to Xie et al. (2010), a related factor that makes the timing of a project crucial is the irreversibility of the investments because, for example, the sunk cost cannot be recovered even if market conditions change adversely. One way to avoid regret for irreversible investments under uncertainty is to 'wait and see what happens'.

There are other RBDM techniques, not discussed here, which can be applied in the real estate industry, but this chapter focuses on the RBDM framework. Each technique has its own limitations and benefits because decision makers must have the knowledge of how to apply the particular technique when making decisions. Decision makers need to choose the best technique to suit their problem solving situation.

6 Issues and Challenges of Risk-Based Decision Making

The issues and challenges of RBDM need more consideration and would be a relevant focus for future research. The risk analysis of investment in real estate projects refers to the overall consideration of the risk attributes, the target of risk analysis and the risk bearing capability of risk subjects on the basis of investment risk identification and estimation, which determine the degree of influence of investment risks on the system (Xiu & Guo, 2009). There are several methodologies or techniques proposed by other researchers to evaluate, analyze, assess or predict the risk. Some of these are the Monte Carlo method, fuzzy set theory (Sun et al., 2008), Markowitz, fuzzy-analytical hierarchy process (F-AHP), a real option method (Rocha et al., 2007), and a hidden Markov model. There are a number of issues related to these methods or models. The first is that they have different characteristics, advantages and limitations when applied in different fields (Sun et al., 2008; Lander & Pinches 1998, cited in Rocha et al., 2007). For example, real option methodology has problems in the practical implementation of risk analysis, such as lack of mathematical skills, restrictive modelling assumptions, increasing complexity and limited power to predict investment in competitive markets (Lander & Pinches, 1998 cited in Rocha et al., 2007).

Availability of high quality data is the second issue for RBDM. Zeng, An and Smith (2007) believe that high quality data are a prerequisite for the effective application of sophisticated quantitative techniques. They therefore suggest that it is essential to develop new risk analysis methods to identify major factors, and to assess the associated risks in an acceptable way in various environments in which such mature tools cannot be effectively and efficiently applied.

The third issue is that real estate investment risk evaluation is a complex decision making problem with multiple factors and multiple targets (Zhou, Zhang and Li, 2008). The majority of existing real estate investment risk evaluations give priority to single-goal decision making, use single indices such as the maximum expectation, the largest variance, the minimum standard deviation rate to evaluate the real estate investment. These evaluating methods are easy to understand, but they cannot comprehensively evaluate the quality of an overall program. There are also those who use Multi-element Analysis Model (MAM) for real estate investment risk evaluation. The traditional MAM is based on the assumption that the whole of the distribution is subject to the normal distribution, yet the whole distribution of a real estate investment program is uncertain; thus, it is imprecise to use MAM for real estate investment risk analysis. Furthermore, many evaluation programs or models involve many evaluation indices, such that the dimensions are different and the weights are difficult to determine, and there are therefore difficulties in the practical application.

The fourth issue is related to incomplete risk data availability. In decision making, the correct methodology is important to ensure that the right decision is made, and that it will be beneficial to investors, users or agents. More formal methodology is thus necessary in decision making processes (Hussain et al., 2007; Zeng, An & Smith, 2007). Formal methodologies are needed to make sure that any decision can be assessed effectively and efficiently. Many risk analysis techniques currently used in the UK construction industry are comparatively mature, such as Fault Tree Analysis, Event Tree Analysis, Monte Carlo Analysis, Scenario Planning, Sensitivity Analysis, Failure Mode and Effects Analysis, Programme Evaluation and Review Technique (Zeng, An & Smith, 2007). In many circumstances, however, the application of these tools may not give satisfactory results due to the incompleteness of risk data.

The fifth issue is the need for an effective and efficient technique. New risk analysis methods to identify major factors and to assess the associated risks in an acceptable way in various environments are needed, as older tools cannot be effectively and efficiently applied.

The sixth issue is the non scientific method proposed. The methods of risk analysis which have been used by domestic real estate developers so far, such as risk survey, break-even analysis and sensitivity analysis, are based on the discounted cash flow and net present value (NPV). These methods are far from scientific and easily lead to faults, and furthermore, to the severe consequences of failure (Yu & Xuan, 2010).

7 Summary

This chapter suggests a risk-based decision making framework that is applicable for investment in the real estate industry. Risk-based decision making is an important area of focus in real estate investment, which involves high risk and high cost. Risk with high uncertainties will lead to the occurrence of a higher percentage of probabilities and consequences. The uncertainties of a number of risk factors and risk sources contribute to the level of dynamic risk prediction, which is dependent on what takes place from the initial investment to the later stages of the real estate development.

The decision support technology review for the framework indicates that there is much work to be done to develop an intelligent decision support system that can be used for handling risk-based decision making in business operations, or as a tool for businesses managing their business tasks, particularly when they deal with decision making processes in their daily routine as a manager. This is perhaps the most important concern for the future of an information system related to risk analysis or risk aggregation for managers who deal with decision making processes, because it will promote vital and useful technology to help decision makers identify the risk involved in making certain decisions to meet an organization's goals and objectives. Thus, it is vital to explore a new technique for risk analysis using decision support technology such as Intelligent Decision Support System for investment in the real estate industry.

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