Flexible Systems Management

M. K. Nandakumar
Sanjay Jharkharia
Abhilash S. Nair *Editors*

Organisational Flexibility and Competitiveness

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Flexible Systems Management

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Organisational Flexibility and Competitiveness

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To our wives
Vineetha Nandakumar,
Manisha Jharkharia and
Anjali Nair,
and children,
Dhanvant Menon, Bharat Menon,
Himadri Jharkharia, Sreyash Jharkharia
Ardra Nair and Ananya Nair

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Indian and International journals and has presented research papers at several Indian and International conferences. Two of his conference papers have received the best paper awards at the respective conferences. One at the *Sixth Annual Capital Market Conference* organized by Indian Institute of Capital Markets, Mumbai and another at the *Second International conference on Globalisation: Opportunities and Challenges* organized by Indian Business School, Ahmedabad. Moreover, on policy related issues he contributes to Business periodicals such *Economic Times* and *Business World.* His area of research interest is Financial Economics in general and Asset Pricing Models in particular. Currently, he is working on issues related to valuation of human capital and application of real options to price take out financing contracts. Recently, he has published a paper in the *International Research Journal of Finance and Economics* and another paper in *Applied Financial Economics,* a Taylor and Francis journal.

Chapter 1
Introduction

M. K. Nandakumar, Sanjay Jharkharia and Abhilash S. Nair

With growing uncertainty in the business environment, it has become imperative that organizations build flexibilities into the systems so as to cope with a dynamic environment. These uncertainties can be: (1) State uncertainties (Conrath 1967), when business environment or a particular part of it is unpredictable, (2) Effect Uncertainty (Duncan 1972), deals with the effect of these uncertainties on a particular project or firm as a whole, (3) Response uncertainty (Conrath 1967; Duncan 1972), deals with the inability to gauge the consequences of choice of response. Organizational flexibility is helpful in overcoming environmental uncertainties and enhancing competitiveness of organizations.

Organizational flexibility refers to the ability of an organization to respond to a variety of changes in the competitive environment in an effective and timely manner, and depends upon the managerial capabilities and the responsiveness of the organization (Volberda 1996). It indicates the capability of an organization to respond effectively to the opportunities and challenges presented by the competitive environment (Sanchez 1995). Such responses from flexible organizations occur with little penalty in time, effort, cost and performance (Upton 1994). When flexibility is low, the administrative relations of the organization become rigid and the organization tend to adhere to bureaucratic practices (Barrett and Weinstein 1999). Flexible organizations need agility and versatility to change and innovate and robustness and resilience to ensure stability and sustainability of advantage (Rahrami 1992). In order to respond to the internal and external conditions of an organization, it may need to develop operational, structural and strategic flexibilities (Volberda 1996). Bureaucratic structures typically emphasize formal rules and procedures leading to rigidity and inflexibility in organizations (Dastmalchian and Blyton 1998). Golden and Powell (2010) identified four dimensions of flexibility namely temporal (Eppink 1978); range (Eppink 1978) intention (Volberda 1996) and focus (Ansoff 1984). Temporal dimension is about the time taken by an organization to adapt. Range refers to the options which are available to an organi-

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zation for unforeseen change and to react to such change. Intention indicates the degree of proactiveness or reactiveness exhibited by an organization. Focus refers to the internal or external orientation of flexibility. Empirical evidence suggests that organizational flexibility is helpful in enhancing organizational performance (e.g. Barrett and Weinstein 1999).

A flexible business organization should change its offerings to the market through its ability to create new and innovative products and services in a dynamic manner. One major dimension of change is strategic change and firms need strategic flexibility to implement strategic change. The role of strategic flexibility has become even more important in wake of cyclical changes in the global economic environment. Strategic flexibility is helpful in facilitating greater level of innovation in organizations (Zhou and Wu 2010; Li et al. 2010). It also enhances organizational performance (Grewal and Tansuhaj 2001; Nadkarni and Narayanan 2007; Worren et al. 2002). Organizations need to develop the following capabilities to foster strategic flexibility: (1) ability to pay attention to negative feedback, (2) ability to collect and assess negative data in an objective manner and (3) ability to institute and accomplish change in a timely manner especially when the organization is facing uncertainty (Shimizu and Hitt 2004).

Overall strategic flexibility in organizations can be accomplished by attaining flexibilities in organizational functions like supply chain, human resources, information systems, marketing and finance. Maintaining flexibilities in supply chains is essential to mitigate dynamics of changing customer needs, reduced cycle times, lower inventory levels, storage and transportation (Duclos et al. 2003; D'Souza and Williams 2000; Martinez and Perez 2005). Accordingly, five types of supply chain flexibilities dealing with product, launch, volume, access and responsiveness (Vickery et al. 1999) need to be built in an organization. Good flexibility in supply chain is thus essential to enhance customer value and profitability. Flexibility in an organization's human resource function is helpful in overcoming uncertainties relating to attracting and retaining talented employees, downsizing, outsourcing and down scoping (Valverde et al. 2000). Furthermore one can also maintain HR flexibility within the organization by developing a wide range of skills and/or behavior in an employee through training or job rotation (Wright and Snell 1998). Maintaining such internal and external HR flexibilities is very important in services industries which are affected by technology lifecycles, economic cycles and competition. Flexibility in information systems deals with the range of possibilities that an information system provides before a major change is required (Sethi and Sethi 1990). This flexibility could be built in terms of the use of the information system or the ease of making further changes in the system (Hanseth et al. 1996). This information system would provide effective support to business processes including procurement and customer relationship management. Flexibility in marketing can be developed by building flexibility in systems and structures of marketing. If a firm wants to involve its customers in the value co-creation process, then there should be enough flexibility in the marketing system to facilitate interaction between the firm and its customers. This should lead to better customer satisfaction and marketing performance (Calin 2009). Financial flexibility deals with a firm's ability to access

new finances and/or to restructure existing finances at low cost (Gamba and Triantis 2008). Such firms could avoid distress in times of negative shocks and fund profitable investment opportunities. This would result in truncating the downside in the event of financial distress for equity holders. Furthermore such flexibility is invaluable in case of startups while attracting venture funding (Trigeorgis 1993).

This book is intended to provide a conceptual understanding of organizational Flexibility and its impact on competitiveness of organizations by exploring research studies concerning various types of flexibilities exhibited by organizations. The papers discussing about a variety of issues concerning the planning and operation of a flexible enterprise are organized into following parts:

Part I: Strategic Flexibility and Competitiveness
Part II: Organizational and Human Resource Flexibility
Part III: Information Systems Flexibility
Part IV: Financial Flexibility and Risk Management
Part V: Operations and Marketing Flexibility

The first part namely "Strategic Flexibility and Competitiveness" consists of 6 papers. Strategy execution is equally important as strategy formulation and flexibility is extremely significant during execution. The first paper on this theme elaborates on the strategy execution process. The role of a mentor in the strategy development and its execution can never be underestimated and the second paper discusses the role of a mentor in the strategy development and execution process. While strategic flexibility allows a firm to meet the uncertainties around its environment, enterprise performance measurement and management system allows it to monitor and control the performance in order to achieve the strategic objectives of an organization. Information system (IS) flexibility in terms of flexibility to use, flexibility to access and flexibility to change a system helps an organization to effectively monitor the performance. The third paper on the theme presents an empirical study on upstream oil industry in India and tries to identify the effect of strategic flexibility and IS flexibility on enterprise performance measurement and management. In a fast changing business environment many researchers are now discussing the role of virtual enterprises to take advantage of IT and globalization. The fourth paper discusses the transformation of a traditional enterprise to a virtual enterprise. The last two papers are based on the study of competitiveness in the Indian context. While one of these two papers studies the competitive situation of a key segment in solar photo voltaic industry in India using techniques such as "SAP-LAP" and "Scenario building" the other one attempts to give a new perspective on industrial competitiveness.

"Organizational and Human Resource Flexibility" theme consists of four contributions and elaborates on various issues such as knowledge management and flexibility, role of gender and positions in shaping HR flexibility, advantages of organizational flexibility on an employee's personal life, and leadership. The first paper discusses the relationship between knowledge management and flexibility. The second paper, through an empirical study, establishes that managerial flexibility is not influenced by gender, positions (junior, middle, senior), or type of organization such as private or public. The third paper examines whether organizations should

adopt a flexible approach in employing married couples. The research findings indicate that men and women whose spouses work in the same organization have significantly poorer marital quality when compared to those whose spouses work in a different organization. The findings of this study suggest that it may not be a good idea to employ couples since poor marital quality may have an impact on their performance at the workplace. The fourth paper explores the impact of Information and Communication Technology (ICT) on academic leadership exercised by the heads of academic institutions. The findings of this study indicate that those heads of institutions who effectively lead ICT integration within their colleges classically perform well in leadership and management, vision and goal setting, student learning, teaching, professional development and training, operations and infrastructure support, and assessment and evaluation.

Firms can use Information systems to derive flexibility and competitive advantage. While information technology information systems have the capability to enhance flexibility, care must be taken to ensure that they do not lead to rigidity (Golden and Powell 2000). Therefore, the ability to use Information Systems for competitive advantage depends upon effective management of IT assets such as highly coherent and dedicated human resources, reusable technology base, and a strong relationship between IT and management of an organization (Ross et al. 1996). The "Information System Flexibility" is now emerging as new winning criteria in the changing business paradigm and this is extensively discussed in part III consisting of four papers. All the four papers in this section touch upon different issues pertaining to the theme. For example, the first paper discusses various factors that influence the acceptance of ERP by its users and then proposes a model that captures all the relevant issues. The second paper demonstrates how information system flexibility addresses the environmental concerns. Another paper in this section stresses upon the need for incorporation of flexibility by IT companies to have a sustainable competitive advantage.

"Financial Flexibility and Risk Management" is discussed in part IV consisting of two papers. While the first paper in this section is based on a case study and evaluates the financial flexibility of a leading infrastructure company in India the other paper discusses the impact of a new law affecting mergers and acquisitions in India.

Operational flexibility is an important element in a firm's operations strategy, providing the capability to respond quickly to changes in the market conditions (Boyer and Leong 1996). Evidence from the literature suggests that operational flexibility is becoming a major competitive advantage and even a condition for adaptation and survival of the enterprises (Zukin and Dalcol 2000). Therefore, future research should explore how this flexibility could effectively be developed and implemented. The last part of this book is on "Operations and Marketing Flexibility" and consists of six papers. The first five papers in this section are based on supply chain and flexibility related issues. The last paper of this section discusses the popular marketing scales their limitations and potential research directions. Two papers in this section have made use of quantitative techniques such as Data Envelopment Analysis (DEA) and Genetic Algorithms (GA) to discuss flexibility in supply chain management. One of the three conceptual papers discusses about a framework for analyzing flexibility in supply chains.

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Part I
Strategic Flexibility and Competitiveness

Chapter 2
Adapt: A Critical Pillar of Strategy Execution Process

Amit Srivastava and Sushil

2.1 Introduction

The issues of strategy execution have been highlighted at every stage of evolution of strategic management (Dufty and Taylor 1962; Cohen and Cyert 1973; Hrebiniak and Joyce 1984; Alexander 1985; Wooldridge and Floyd 1992; Kaplan and Norton 1996; Beer and Eisenstat 2000; Zagotta and Robinson 2002; Bossidy and Charan 2002; Higgins 2005; Neilson et al. 2008; Franken et al. 2009). Still the strategy formulation research has been more prominent than the execution (Noble 1999a; Hrebiniak 2006). The debacle of heavy weight corporations pushed both the scholars and practitioners to rethink on the improving success of strategy execution. Responding to the challenge, the last decade witnessed significantly high attention paid to strategy execution.

With the increasing pace of change, both within and outside the organization, the challenges of execution is multiplying. The literature of strategic management, in general, pointed out the issue of 'Adapt' for competitive performance and advantage. Various aspects of adapt such as flexibility (Eppink 1978; Adler 1988; Volberda 1997; Sushil 2000, 2005) and learning (Senge 1990; Prahalad and Hamel 1990; Ortenblad 2004) have been discussed. However, these research learning have been used to formulate superior and competitive strategy and the thought on strategy execution was somewhat missed.

The literature has been using terms 'implementation', 'execution' and 'actualization of goals' as interchangeable to each other (Sashittal and Wilemon 1996). Most of the authors do not differentiate strategy implementation from strategy execution. Consequently, this study also treats strategy implementation as strategy execution.

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This study focuses on Adapt aspect of strategy execution process, considering the gaps in literature, opinion of experts and practitioners and its significance in strategy execution success. The study is divided in two stages. The first-stage of the study is exploratory and qualitative in nature, while the second-stage of the study is conducted to validate the framework of Adapt. Finally, the chapter discusses the implications of research findings and future scope of research.

2.2 Literature Review

The early stage of strategy execution research was attributed to the issues of organization management (Miles et al. 1978; Grinyer et al. 1980; Drazin and Howard 1984; Galbraith 1986). Later on researchers underlined activities and barriers in strategy execution (Alexander 1985; Heide et al. 2002; Hrebiniak 2006) and facilitators/success factors of strategy execution (Bhide 1986; Hambrick and Cannella 1989; Giles 1991; Zagotta and Robinson 2002; Higgins 2005; Neilson et al. 2008). Due to the contribution of scholars of different management streams, the research on strategy execution became eclectic in nature (Noble 1999a). The lack of strategy execution framework integrating diverse perspectives led to the situation where most of the managers are unaware about how to execute the strategy (Hrebiniak 2006). Reflecting on this challenge, the last decade shifted its research focus to the development of comprehensive and integrated framework of strategy execution (Okumus 2001, 2003; Aaltonen and Ikavalko 2002; Miller et al. 2004; Higgins 2005; Hrebiniak 2006; Pryor et al. 2007; Sull 2007; Kaplan and Norton 2008).

The challenges of strategy execution multiply with the pace of changes. Today organizations are facing rapid changes both within and outside the organization. During 1960s, scholars started to link the business with its surrounding environment (Cohen 1973; Mintzberg 1978; Grinyer et al. 1980). However, the focus was given to organization management issues (Dufty and Taylor 1962; Taylor 1973; Miles et al. 1978; Peters and Waterman 1980; Grinyer et al. 1980). Some of the authors have also indicated the importance of change management (Mintzberg 1978; Taylor 1973). Managing change is among the biggest threats and absolutely critical for successfully executing the strategy. Execution often involves change in structure, incentives, people, objectives, responsibilities etc. The inability to manage change and reduce resistance to new decisions can create disaster for execution efforts (Hrebiniak 2006). Managing change and employee resistance requires clear attention to detail, a focus on objectives, measurement of performance, and a strong commitment to the execution task. Therefore, organizations should incorporate its learning in selecting and executing a strategy (Aspesi and Vardhan 1999). Organizations experience both adaptive and generative learning, however, the processes of such learning, particularly the latter, have not been widely analyzed and incorporated into the organizational learning process (Chiva et al. 2010). Companies should have a formal and regular process of collecting, discussing, and incorporating

inputs from important stakeholders so as to match best practices, creating innovative approaches to capture new business and realize incremental improvements.

This section reviews some of the important frameworks of strategy execution in the context of adapt. Delisi (2001) highlighted that the superior execution itself can be a strategic advantage of the firm, though a solid strategy is an obvious prerequisite for strategic success. He unearthed that the strategy execution fails from people, cultural, organizational as well as from pure strategy reasons. His study helps managers avoiding common mistakes in execution, however, he did not come up with a clear roadmap to strategy execution and neglected the adapt aspect of execution. Taking more process oriented perspective, Noble (1999b) organized strategy implementation framework around four major stages of the implementation effort and five managerial levers for these implementation phases. The focuses has been given to organization and HR issues but adapt aspect is compromised. Beer and Eisenstat's (2000) "six strategy killers" also does not reflect on the adapt issues and limited to team composition, management style, communication, and leadership issues. According to Bossidy and Charan (2002), strategy execution process includes developing the mechanisms for changing assumptions as the environment changes and upgrading the company's capabilities to meet the challenges of an ambitious strategy. Though, not commenting directly on the role of Adapt in execution, Higgins's (2005) "8S" framework of strategy execution underlines the importance of monitoring and assessing the cross-functional execution of strategies. Qi (2005) also proposed 'seven factors for successful strategy execution', which highlights the importance of feedback system and organization culture. The 'Balanced Scorecard' (BSC) and 'Management System' frameworks (Kaplan and Norton 1996, 2008) highlighted the reflection and incorporation of learning to make changes in strategies, strategic plan, operational plan, capabilities and finally the targets. Sushil (2008) pointed out that there is need for a more integrative tool so as to cover the whole cycle of strategy formulation and implementation in a seamless manner. He proposed Adapt as one of the most important enablers of superior strategy execution process (Sushil 2009).

2.3 Research Questions and Objective

The review of literature and initial discussion with the experts and practitioners led to following research questions to be undertaken in this study:

1. What are key variables of Adapt in strategy execution process?
2. How the variables of Adapt are inter-linked?

The above mentioned research questions helped in setting research objective as:

To develop the framework for 'Adapt' in the context of strategy execution.

Table 2.1 Profile of the respondents of TISM

SN	Organization	Management area	Years of experience	Designation
1	Leading B school	Strategy management	30	Professor
2	Leading B school	Organization management	40	Professor
3	Management consulting firm	General management	20	Managing Director
4	Leading Government Information Organization	System software management	28	Senior Scientist
5	Central Government Ministry	Administration	23	Deputy Registrar
6	Major automobile company	Human resource management	28	DGM HR
7	Major FMCG company	Supply chain management	25	Vice President

2.4 Stage 1: Identifying the Variables of 'Adapt' and Developing Their Linkages

2.4.1 Methodology

To support the research objectives of the study, following exploratory research has been conducted to identify the variables of Adapt, followed by their linkages.

The first logical step followed in this study is literature review on strategy execution in the context of role of adapt in the execution process. The literature review has been conducted using electronic databases: EBSCO, Science Direct, Proquest and Google Scholar. Search terms that were used independently or in combination are: strategy, execution, implementation, translating strategy into action, framework, adapt, and flexibility. This exercise was continued to identify further articles using the references sections of the previously retrieved articles. As a final selection criterion, those articles were included which had at least 10 citations on Google Scholar database. Additionally, articles of last three years and some other important articles of significance were included. Following the literature review, a four-hour brainstorming session was conducted with 43 corporate practitioners in India to further explore the possible variables of adapt, which influence the strategy execution process. The average years of experience of the participants was 9.3 and they represent 12 industries. The depth of experience of participants and breath of industry covered helped in making the exploratory exercise more comprehensive.

After identifying the variables of 'Adapt', the 'Interpretive Structural Modeling' (ISM) is made to establish the linkages among the variables of Adapt. For this an ISM survey was conducted taking the detailed expert views from five corporate practitioners and two senior academicians (Table 2.1). The participants were also asked to provide the interpretation of the linkages they suggest in the TISM questionnaire (Appendix 2.1). This process enriched the ISM by depicting the how part of the linkages (Corley and Gioia 2011). The framework was further supported by the 14 live caselets (Lewis 1998; Eunni et al. 2005) and developed a 'Total Interpretive Structural Model' (TISM) of Adapt for empirical validation (Nasim 2011; Sushil 2012).

2.4.2 Results and Discussion

There has clearly been consensus in literature and among the practitioners and experts that organizations need to proactively read the changes and shifts in environment to continuously update the strategies so as to ensure high organization performance. For example, digital music technology brought a threat to cassette and CD-based Walkman. But with adaptive approach Sony took it as an opportunity to come up with MP3 player. Adapting the organization can be difficult, but successful execution depends on it. The inability to manage change and reduce resistance can result in disaster for execution efforts. Successful strategy execution necessitates changes in many areas and it can be an indicator of effective management of change. Therefore, there are multiple aspects or variables of adapt in the context of strategy execution. Considering the literature and opinion of practitioners and experts, we identified seven variables of Adapt—adapt the targets (A1), modify strategies (A2), reformulate strategic plans (A3), redefine operational plan (A4), reassess capabilities (A5), adaptive culture (A6), and incorporating reflections (A7).

There are also logical linkages among the variables of adapt. For example, changes in strategies may not be enough for long-term growth. Organizations may have to develop the adaptive culture so that they can continuously incorporate the learning and update the strategies. The EDS case can be classical example to understand it. After joining as CEO at EDS in 1999, Brown reviewed EDS' operations and found that strategy is sound but the execution is poor. To address the problem, he proposed new EDS' beliefs, changed the performance measurement and compensation system. The outcome of the exercise brought great success for Brown (Bossidy and Charan 2002). Unfortunately, Brown could not sustain the success for long. Brown failed to read the signals of industry downturn in early 2002 and repeatedly project high performance. In September 2002, the stock price of EDS fell to 20% of its high. Later, Brown tried to improve the adaptive capabilities, but it was too late. By March, 2003 Brown had to go. The case shows that the focusing on one aspect of adapt (e.g. changing the strategy) while ignoring other aspects (e.g. adaptive culture) bring no success to organizations on a sustainable basis. The following section discusses the TISM model of Adapt to explain the linkages of variables of Adapt (Fig. 2.1).

Adaptive Culture The TISM study reveals that 'adaptive culture' is the most important driver influencing all other variables of adapt. This initiates that without having adaptive culture in the organization it is difficult to execute change in the organization. Without adaptive culture, the change may be superficial or temporary in nature. The adaptive culture can be a valuable competitive asset, which is sometimes a necessity; especially in fast-changing environments. The firm with adaptive approach use environmental changes as strategic advantage by responding better and quickly to changes (Wei and Jiang 2005). There should be robust dialogue among the people of the organization and leaders to develop the adaptive culture in the organization (Bossidy and Charan 2002). For example, to make British Petroleum (BP) an adaptive organization, John Browne deliberately raised the creative tension

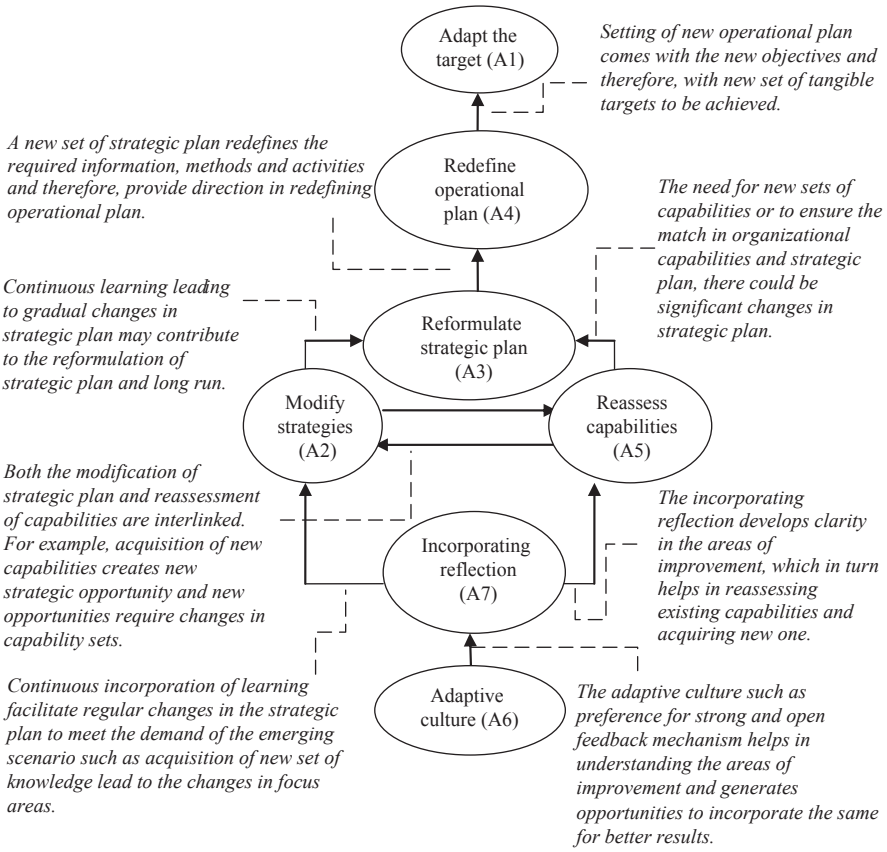

Fig. 2.1 TISM framework of adapt

in the organization so that it cannot only survive but also prosper in uncertain and turbulent times. To promote the adaptive culture, the chief executive of an international oil exploration business, started rewarding individuals acting in an innovative fashion. Besides monitory reward, he also gave the winners his most limited resource, namely, his time. He symbolically accompanied the "winners" around the golf course. This message of the criticality of change, and the extent to which it was valued by the chief executive had a significant impact upon all staff (Franken 2009).

Developing the adaptive culture is more crucial for the organizations operating in high-speed and rapidly changing environments such as technology sector. For example, the emergence of the Internet was viewed as a threat by many organizations but successful organizations saw it a great opportunity. E-Bay visualized that internet companies can respond and cope with change much faster than other companies. Therefore, it used Internet as new source of immense business opportunity. Another success story is Walt Disney, which embraced television when most movie studios resisted it at the earlier stage. 'Zenon Environmental' acquired the ability

to develop an innovative water treatment process at lower cost than its rivals. Zenon educated its employees, about the cost reduction strategies, through regular meetings and discussion. This approach impacted all the activities of the organization including employees' teamwork and dealing with suppliers. Zenon's success is manifested by the fact that GE acquired it in 2006 at a 60 % premium above its stock price (Sheehan 2006).

Incorporating Reflections The concept of learning for organizational growth is not new; though it got momentum with the work of Senge (1990) when he detailed out the concept of learning organization as a necessary condition for continuous and sustained growth. Thompson and Strickland (2001) also highlighted the need for incorporating reflections and adapting the organizational activities and direction as per the need of the time. Bossidy and Charan (2002) also talked about the need of incorporating reelections in the context of strategy execution. Many organizations continuously measure and monitor performance matrices. Organizations need to go beyond this and should meet, interact and take the input of employees at different levels. Reflections help in understanding what is changing and how the changes are going to influence the strategies and strategic plans (Sheehan 2006). For example, British Petroleum promoted a framework of knowledge management for continuously incorporating the learning. The framework had three components—a learning cycle (before, during and after any event), the lessons discussed and refined through practice, and lessons incorporated as knowledge assets on the corporate intranet. These knowledge assets further help in refining strategic and operational plans. It is also evident from the TISM framework that incorporation of reflection provides clear guideline on what to change and how to change.

Modify Strategies Kaplan and Norton (2001) found that 85 % of executive teams spent less than one hour per month discussing strategy, with 50 % reporting that they spent virtually no time on strategy discussions. The lack of adaptive culture and practice of incorporating the learning explain such situations. Bossidy and Charan (2002) pointed out that the company needs to test whether its fundamental strategic assumptions remain valid. As comes out in TISM framework of adapt, any change in the strategy requires dialogue among the actors of the organization. The linkages of adaptive culture, incorporation of reflections and changes in strategies can be understood by the case of GE. After joining as CEO of GE, Jeffrey Immelt realized that key to sustain the success is to change how GE achieved growth. Past key success drivers were deal-making and cost cutting. Immelt focused on launching new products and improved services as important drivers of growth. While Welch as CEO of GE, tried to match best talent with the most promising opportunities, Immelt focused on continuous interaction with executives to analyzes and develop innovation ideas for GE's growth targets (Sheehan 2006).

Reassess Capabilities Consistent reassessment of capabilities is necessary to effectively execute the strategy. Bossidy and Charan (2002) emphasize that organizations should develop the leadership pipelines through continuous improvement succession depth, and reducing retention risk and talent review. Gautam and Batra

(2007) proposed self-renewal process, where an organization changes the configuration of its personnel while maintaining its identity. The self-renewal process may be reactive or proactive. Any changes in capabilities should be in congruence with the strategy. As Ulrich (1998) pointed out that HR activities are usually disconnected from the real work of the organization. He emphasized that HR should become partner in strategy execution by taking the role of—defining an organizational architecture, developing detail plans and performance matrices and taking charge of continuously monitoring the progress. Galbraith's star model (1986) and Higgins's (2005) "8-S" model can be useful in this regard. The case of Enron amply shows the linkage of strategy and capability. Enron adopted the transformational strategy, which fits well with its skills in risk management, deal making, and finance. For filling any gaps in capabilities in executing the strategy, Enron was poaching talent from other companies, which helped Enron support its visionary strategies.

Reformulating Strategic and Operational Plans A large IT organization decided on strategic alliances as future growth driver. However, the performance matrices of the organization were strictly focusing on delivery of sales targets, and therefore restricting the employees from exploring innovative alliances. To tackle this, top management ensured that all the control systems of the organization became congruent, contributing towards the establishment of strategic alliances (Franken 2009). A company ABC was leader in various industry segments but was facing tough competition (Frigo 2004). The CEO of the company motivated the management teams to develop a new strategy and strategic plan. The strategic plan was developed quickly, and management started developing the performance measures and targets for execution. However, they also realized the need of a mechanism of strategy and execution reviews, which would be deeply grounded in the foundations of the strategy. This helped the company to review the planning process, the strategic plans, and execution processes. These case examples underline that to respond to the environmental changes an organization not only has to focus on the changes in culture and strategy but also on the strategic and operational plans of the organization. Following through is important to make execution process to be on track. The information on changes in the environment and new ideas/opportunities suggested by organizational actors can show the way to superior execution. The operational dashboards and monthly Balanced Scorecard metrics can be useful to review the strategic plans.

The practitioners should also analyze the risks involved in operational plan and should instill flexibility in case new opportunities arise or the plan fails. Some issues, which should get attention are sound assumptions about the situation, a balanced trade-offs as per the need of the time, clearly defined outcomes, continuously following through and developing contingency plans. For example, company XYZ, which was using a three-year strategic planning cycle, developed a strategic plan in 2003 based on return strategy. CEO of the company found results better than what was the target. Still, realizing the future opportunities and challenges, CEO felt that the company needs a process for continually refining the strategic plan and its execution. He viewed that a strategy and execution review process should be developed so as to reenergize the planning process (Frigo 2004).

Table 2.2 Profile of respondent for confirmatory questionnaire survey

Criteria	Respondents' profile
Sectors	ICT (27.1%), power (12.5%), consulting (10.4%), banking (8.3%), construction (8.3%) and others
Functional areas	Operation (33.3%), IT (14.6%), planning (10.4%), marketing (10.4%), HR (4.2%), consulting (4.2%) and others
Hierarchical level	Lower management (35.4%), middle management (35.4%), top management (29.2%)
Total work experience (years)	Minimum (3), maximum (28), mean (13.5), SD (8)
Experience in the current organization (years)	Minimum (1), maximum (27), mean (8.5), SD (7)
Planning/coordination/execution	Planning (29.2%), coordination (20.8%), execution (50%)
Leadership role	Leadership role (70.8%), non-leadership role (29.2%)

Adapt the Targets The managers also need to assess continuously the important milestones for execution plan. Organizations usually fall short of targets because it does not match with the changes in strategic and operational plans. The targets could be under or over estimated in the changing situation (Bossidy and Charan 2002). Therefore, the change in strategic and operational plans should lead to changes in the targets.

2.5 Stage 2: Confirmatory Study for Adapt Framework

2.5.1 Methodology

Second stage of the study tries to quantitatively verify the framework of Adapt by conducting a survey taking response from the practitioners. After finalizing the linkages among variables, a small questionnaire survey was administered with 48 respondents for conducting t-test (Table 2.2). The questionnaire was developed on five-point Likert scale, where 1 was strongly-disagree and 5 was strongly-agree (Appendix 2.2). The judgmental sampling technique was adopted by using criteria—variety of the sectors, coverage of all functional management areas, people from all the hierarchical levels, range of experience both total and in current company, respondents' involvement in planning/execution/coordination, and leadership role. Though, the respondents are based in India, their varied background helped in improving the generalization of the research findings and therefore, improving the acceptability of the developed framework. All the questionnaires were personally administered to improve the validity of the response. The respondents' familiarity with the authors and subject also ensures high validity of the data.

2.5.2 Results and Discussion

The descriptive statistics (Table 2.3) like a higher mean (from and above four), median (four and above), and mode (four and above) of the distribution endorsing

Table 2.3 One sample t-test (95 % confidence interval) of adapt framework

SN	Linkages	Mean	Median	Mode	SD	Test value = 3	
						t	Sig. (2-tailed)
1	Adaptive culture influencing incorporation of learning	4.0	4.0	4.0	0.8	9.3	0.0
2	Adaptive culture influencing modification in strategies	4.1	4.0	4.0	0.8	9.8	0.0
3	Adaptive culture influencing reassessing organizational capabilities	4.1	4.0	4.0	0.8	9.8	0.0
4	Adaptive culture influencing changes in strategic plans	4.2	5.0	5.0	0.8	10.9	0.0
5	Adaptive culture influencing changes in operational plans	4.2	5.0	5.0	0.8	10.6	0.0
6	Adaptive culture influencing changes in targets	4.0	4.0	4.0	0.8	8.4	0.0
7	Incorporation of learning influencing changes in strategies	4.0	4.0	4.0	0.8	8.7	0.0
8	Incorporation of learning influencing reassessment of capabilities	4.2	4.0	4.0	0.8	14.4	0.0
9	Incorporation of learning influencing changes in strategic plan	4.0	4.0	4.0	0.6	12.2	0.0
10	Incorporation of learning influencing changes in operation plan	4.0	4.0	4.0	0.5	10.6	0.0
11	Incorporation of learning influencing changes in targets	4.0	4.0	4.0	0.7	10.1	0.0
12	Changes in strategies influencing reassessment of capabilities	4.0	4.0	4.0	0.7	9.7	0.0
13	Changes in strategies influencing changes in strategic plans	4.1	5.0	5.0	0.7	9.6	0.0
14	Changes in strategies influencing changes in operational plans	4.1	4.0	4.0	0.8	10.3	0.0
15	Changes in strategies influencing changes in targets	4.1	4.0	4.0	0.8	10.6	0.0
16	Reassessment of capabilities influencing changes in strategies	4.2	4.0	4.0	0.7	11.7	0.0
17	Reassessment of capabilities influencing changes in strategic plans	4.3	5.0	5.0	0.7	12.0	0.0
18	Reassessment of capabilities influencing changes in operational plans	4.2	4.0	4.0	0.7	11.2	0.0
19	Reassessment of capabilities influencing changes in targets	4.0	4.0	4.0	0.7	9.4	0.0
20	Reformulation of strategic plan influencing changes in operational plans	4.2	4.0	4.0	0.8	13.6	0.0
21	Reformulation of strategic plan influencing changes in targets	4.2	4.0	4.0	0.6	13.6	0.0
22	Changes in operational plan influencing changes in targets	4.2	4.0	4.0	0.6	11.6	0.0

the significance of the linkages and provide a fair basis of accepting the framework as verified. However, to authenticate the survey results, one sample t-test of significance has been used to compare the mean value of each of the linkages in adapt framework with a specified constant called test value, which is taken to be mean value greater than three (mean test value = 3). Since the survey participants response range from strongly disagree (1) to strongly agree (5), a mean value of more than 3 seems to be a reasonable test value for testing. Thus, a linkage would be accepted as valid if the significance value of the t-statistic is less than 0.05 (95% confidence interval) indicating a higher level of acceptance of the framework (Table 2.3).

The result of the survey of management practitioners clearly strengthens the TISM framework of Adapt. All the variables and linkages identified and development on the basis of literature review, brainstorming and TISM exercise were found to be statistically valid, at least, in Indian context. An analysis of the practitioners' responses reveals a strong verification of the developed TISM framework of Adapt for which the t-value has been found significant enough.

All the linkages were accepted valid as the significance value was less than 0.05. Among all the linkages of adapt, reassessment of capabilities to make changes in strategic plan has been found most significant with the maximum mean score alongwith median and mode scores of 5. The influence of adaptive culture on changes in strategic and operational plans has also emerged very significant with mean value as 4.2 and median and mode value 5. There is highest consensus on the argument that the incorporation of learning is an important enabler of changes in strategic plan, operational plan, and targets. Again there is strong consensus on influence of changes in strategic and operational plans on changes in targets.

2.6 Synthesis and Conclusion

The analysis reported have comes out with the proposition that the adaptive culture is the prime enabler of the organization to develop processes and mechanisms to cope up with changes. The conceptualization of learning (Mintzberg 1978) and learning organization (Senge 1990; Prahalad and Hamel 1990) can only be possible when organization develops a culture of learning and change. When an organization becomes learning organization, it starts becoming vital by adopting flexibility wherever and whenever it is required. This vitalization process helps organization sustain its growth better than others (Volberda 1997; Sushil 2005). In the context of strategy execution, the 'BSC' and 'Management System' frameworks (Kaplan and Norton 1996, 2008) also talked about learning and adapt. However, BSC has not always been found successful (Pickard 2006). A plausible reason for this can be found in the adaptive culture and incorporation of learning. The adaptive culture and learning organization attributes give impetus for learning and growth suggested in BSC and adapt suggested in Management System. The Adapt framework, developed in this study, proposes the sequential linkages among some of the important concepts in strategic management (Fig. 2.2). Organizations if follow these

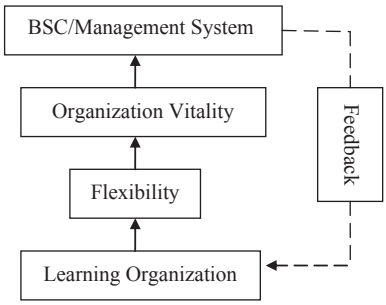

Fig. 2.2 Emerging linkages among some concepts

linkages, where first concept is the prerequisite for the second one and so on, can have more effective and efficient strategy execution process. The proposed linkages of these concepts needs further exploration and empirical validation.

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Appendix 2.1: TISM questionnaire

SN	Elements	Paired comparison of variables of adapt	Yes/No	In what way a variable will influence/enhance other variable? Give reason in brief
1	A1–A2	Adapt the targets—Modify the strategies		
2	A1–A3	Adapt the targets—Reformulate Strategic Plan		
3	A1–A4	Adapt the targets—Redefine Operational Plan		
4	A1–A5	Adapt the targets—Reassess Capabilities		
5	A1–A6	Adapt the targets—Adaptive Culture		
6	A1–A7	Adapt the targets—Incorporating Reflections		
7	A2–A1	Modify the strategies—Adapt the targets		
8	A2–A3	Modify the strategies—Reformulate Strategic Plan		
9	A2–A4	Modify the strategies—Redefine Operational Plan		
10	A2–A5	Modify the strategies—Reassess Capabilities		
11	A2–A6	Modify the strategies—Adaptive Culture		
12	A2–A7	Modify the strategies—Incorporating Reflections		

Considering the large size of the questionnaire, only a part of it is given here

Appendix 2.2: Survey questionnaire for confirmatory study

Part One: Personal profile of the respondent

Name (optional) : _____
Company (Optional) : _____
Department/division : _____
Are you in a leadership role : Yes / No
Age : _____Years
Gender : Male / Female
Qualification : _____
Total work experience (number of years) : _____
Experience in current company (number of years) : _____
What is your role in the organizational policy? Planning / Coordination / Execution
What is your designation in the organization? : _____

Part Two: Rating the statements on a scale of 5

S.N.	Statements	Response
1	Adaptive culture of the organization facilitates incorporation of learning	Strongly disagree (1) to strongly agree (5)
2	Adaptive culture helps in modifying the strategies	
3	Adaptive culture helps in reassessing the organizational capabilities	
4	Adaptive culture facilitates the reformulation of strategic plans	
5	Adaptive culture facilitate redefining of operational plans	
6	Adaptive culture facilitates in adapting the targets	
7	Incorporating reflections affect changes in strategies	
8	Incorporating reflections affect reassessment of capabilities	
9	Incorporating reflections affect changes in strategic plan	
10	Incorporating reflections affect changes in operation plan	
11	Incorporating reflections affect changes in targets	
12	Changes in strategies push the reassessment of capabilities	
13	Changes in strategies facilitate the reformulation of strategic plan	
14	Changes in strategies facilitate redefine operation plans	
15	Changes in strategies facilitates changes in targets	
16	Reassessment of capabilities give inputs to change strategies	
17	Reassessment of capabilities facilitate the reformulation of strategic plan	
18	Reassessment of capabilities facilitate redefine operation plans	
19	Reassessment of capabilities facilitates changes in targets	
20	Reformulation of strategic plan lead to redefine operational plan	
21	Reformulation of strategic plan helps in changing the targets	
22	Redefine of operational plan leads to changes in targets	

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Chapter 3
Flexibility and Sustainability of Mentorship Model for Entrepreneurship Development: An Exploratory Study

Deepali Mishra and Sudhir K. Jain

3.1 Introduction

SMEs are the key component of an economy. It caters the need of large firms and provides employment to local skilled/unskilled labour. Small firms grow systematically therefore they are responsible for the systematic growth of an economy. Audretsch et al. (2002). while researching for OECD countries found that the growth rates are enhanced when there is a greater presence of entrepreneurial firm (small enterprise). SMEs are mostly started by first time entrepreneurs who are young and enthusiastic to do something on their own, in early stage of their career. Ragins and Cotton (1991) found that it is not necessarily that the credentials help in making the first move for everyone. Studies by Kram and Isabella (1985) shows that 20s is the age for professional concern and self belief. Veciana et al. (2005) compared the perception of university students (age group 20–35) of two countries. Catalonia (Spain) has SMEs based model where as Puerto Rico use fiscal incentives to attract foreign capital. University students from both the countries showed positive desire to start a new venture that is 74 and 92 % respectively. They found that the desirability towards startups has increased in past decades. Catalonians perceived that starting a new firm is not easy**.** This may happen due to lack of experience and expertise and probably lead to the sickness of an enterprise**.**For instance**,**sickness in MSMEs increased from 13.98 % (2001–2002) to 14.47 % (2006–2007) for India (Fourth All India Census 2009). This study proposes the need of a formally assigned mentor before starting an enterprise. The relationship would be analyzed between potential entrepreneur and potential mentor to keep the enterprise sustainable in long run. Since mentor would be the key driver, he/she would be examined in terms of

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motivation, de-motivation and rewards whereas potential mentees (entrepreneurs) would be asked to give their preferences for suitable mentor.

3.2 Literature Review

The entire literature of mentorship is divided into formal and informal mentoring. Informal mentoring uses direct tactics. Mentee do not feel threatened and pressurized to keep the relationship stable whereas formal mentoring is an assigned responsibility. Under such relationship both mentor and mentee may feel uncomfortable (Tepper 1995). Kram (1980, 1983, 1985) argued that informal mentorship undertaken by peers is important in all stages of life. Mentees value their mentors as very important, helpful and influential at the time of shaping their career (Fagenson 1989). Literature confirms a significant need of formal mentorship for women and minority protégés as argued by few researchers like Hubbard and Robinson (1998) that women must pro actively search for a mentor because women and minorities are less likely to be accepted by others in the organization than those who are conventional mentees. Ragins and Cotton (1991) found that women supposed to face more barriers in accessing a mentor than men thereby have to have a mentor to overcome such barriers. On the other hand Talya (1999) contradict the previous findings when he did not find the gender specific barriers. Burke (1984) affirmed that men experienced more significant influences on both personal and career growth whenever undergone mentorship support

In context of SMEs, it is very important to see whether the entrepreneurs can be developed through mentorship or not. It's always a topic of debate that "Entrepreneurs are born or made". Drucker (1958) said entrepreneurs can be developed through teaching in orderly, purposeful and planned manner with proper marketing intervention. Individuals report significant career and job outcomes through mentorship support (Fagenson 1989). It is evident that both mentor and mentee should feel synchronized when undertake mentorship. A mismatch of mentor and mentee could lead to an unwanted failure.

3.2.1 Who Can Be a Mentor?

Raggins (1997) done the pairing and measured the effect of gender on diversified mentoring relationship which is a combination of mentors and protégés from different groups having different power perspective in an organization. A majority mentor can be white collar men and a minority mentee can be a women/any other person from minority group or a white collar men can be a mentee and women can be a mentor (Table 3.1).

Table 3.1 Pairing of mentor and mentee in diversified relationship

Relationship	Majority mentor	Minority mentor
Majority mentee	Homogeneous	Heterogeneous
Minority mentee	Heterogeneous	Homogeneous

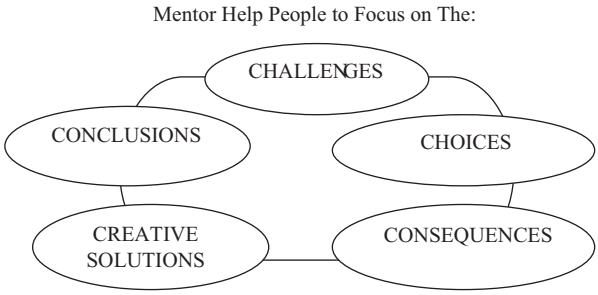

Fig. 3.1 The "Five C" model of mentoring. (Source: Pegg Mike, The Art of mentoring, 1999)

Intention of becoming a mentor is equally desired by women as desired by men (Janice and Wanda 2000). Although extremely high performing mentor may not necessarily cater emotional and personal expectations because mentor may do not have time and ability (Burke 1984). Burke argued that a person who wants to become a mentor should be a combination of hard work, sensitivity and care. Therefore, not every person can become a mentor. Pegg (1999) said there are different types of mentors who palys different roles in mentee's life to shape his/her career, for instance (Fig. 3.1):

- **Classic mentors:** They have credibility, and willing to pass their wisdom
- **Leaders:** They inspires mentee to do his/her best
- **Models:** Those mentors whom mentee likes and think of replicating
- **Coaches:** Mentors who develop the interpersonal skills of a mentee
- **Teachers:** Mentor focus on encouragement, accomplishment and incorporation
- **Advisers:** Mentor tries to make mentee specialized in his area
- **Counselors:**Mentor provides personal and professional support
- **Buddies:** Seniors and mates, mentor the buddies around and serve their needs.

Risk of Mentorship

Mentor may feel that he has created the competition for himself and started feeling jealousy. As a consequence it develops the conflict between work demands and functions (Hansford et al. 2002). Professional expertise/personality/ideology mismatch hinders the proper functioning of mentorship. Some mentor and mentee are biased in terms of gender and race (Ehrich et al. 1999). Untrained mentor exploited the mentee, blocking the mentee's career (Douglas 1997).

Rewards to Mentor

A mentee can easily climb the ladder of success if he/she gets mentored by a one who is excellent in his work. He is the one who identifies the mentee and his problem. He provides the timely solutions and motivates mentee to move forward at every walk of life. Mentor-Mentee relationship can be seen as Student-teacher and physician-intern etc. one of the popular examples in India is Chankya and Chandragupt. Wright and Wright (1987) recognized professional/career development, networking and personal identity enhancement, are some of the benefits to both mentor and mentee.

3.2.2 Other Benefits

- Mentor's background helps Mentee to visualize the odds, thereby helping mentee to enhance his/her interpersonal skills
- Mentee shares his mentoring experience with others
- Mentoring rejuvenate the career of Mentee/Mentor
- Psychosocial functions provided by mentoring
- Mentors gain more experience in other areas also
- Increases self confidence of both mentor and mentee
- Mentoring helps in increasing the networking area for both Mentor and Mentee

(Burke 1984; Fagenson 1989; Fagenson et al. 1997; Kram 1983, 1985; Noe 1988; Ragins and McFarlin 1990; Scandura 1992, 1998; Hubbard and Robinson 1998)

Motivating Factors for Mentorship

A potential entrepreneur when thinks from the perspective of organization then productivity, increased contribution or profit by employees, attraction or retention of talented employees, loyalty, empathy or team spirit, improvements in workplace communications and relations can be some of the motivating factors for him to undertake mentorship (Ehrich et al. 1999; Hansford et al. 2002) whereas reward or growth, challenging or pleasing, physiological benefits and role modeling are the factors which affect the motivational level of mentor (Douglas 1997; Kram 1983)

De-motivating Factors for Mentorship

Both mentor and mentee may feel de-motivated under mentorship. Additional pressure, unrealistic demands, lack of gratitude, recognition/reward, lack of trust, characteristics or attitudes from mentee's side affect the enthusiasm of mentor where as mentee feel de-motivated when there is a fatal error from mentor's side in understanding the program goals or expectations (Douglas 1997; Kram 1983; Ehrich et al. 1999; Hansford et al. 2002).

Table 3.2 Phases of mentorship

Initiation	6 to 12 months: within this period relationship is started
Cultivation phase	2 to 5 years: the range of functions provided expands to maximum
Sepeartion phase	5 years: adjustment and modification being done because carrer and psychosocial functions can continue no longer in their previous form
Redefinition phase	Friendship and peer status: relationship evolves as a new form which is significantly different from the past, or the relationship ends completely

From the literature it can be hypothesized:

Hypotheses 1: Mentee desires a mentor who is known to him and prefer to under go informal mentor-mentee relationship.

Hypotheses 2: Mentoring is done to provide more and more benefits to mentee whereas mentor does it for the purpose of self satisfaction and philanthropy.

Time Period of Mentor–Mentee Relationship

Kram (1983) divided the mentoring relationship in four phases and averaged the relationship for 5 years (Table 3.2)

Learning from the Literature Review—Model of Mentorship

Tennent et al. (2001) divided mentorship in three phases (1) Initiation phase encounters the hurdles of mentoring and overcome one by one (2) Process phase is the blending stages where irrespective of any mismatch of mentor or mentee relationship established and nurtured (3) Outcomes phase is the result of mentoring (Fig. 3.2).

3.3 Methodology

Entrepreneurs of Delhi/NCR region and first generation potential entrepreneurs (IITD Students of engineering) are chosen as the sample set who are willing to take entrepreneurship as their career.

Size and Data Collection: 50 Questionnaires were distributed out of which 41 were filled by respondents, making the response rate of 82% which is highly acceptable response rate.

Statistical Tools: Mean Scale value Index and ANOVA (to know Statistical significance) are used to measure the construct. Since no published measure operationally define the construct suitability of mentor and motivation/de-motivation of the mentor, specially as per the requirement of this study in context of entrepreneurs, we develop a five-point likert–type scale with responses ranging from 1 = strongly disagree to 5 = strongly agree. See Appendix A, B and C. Few operational definitions are also given below for the purpose of this study.

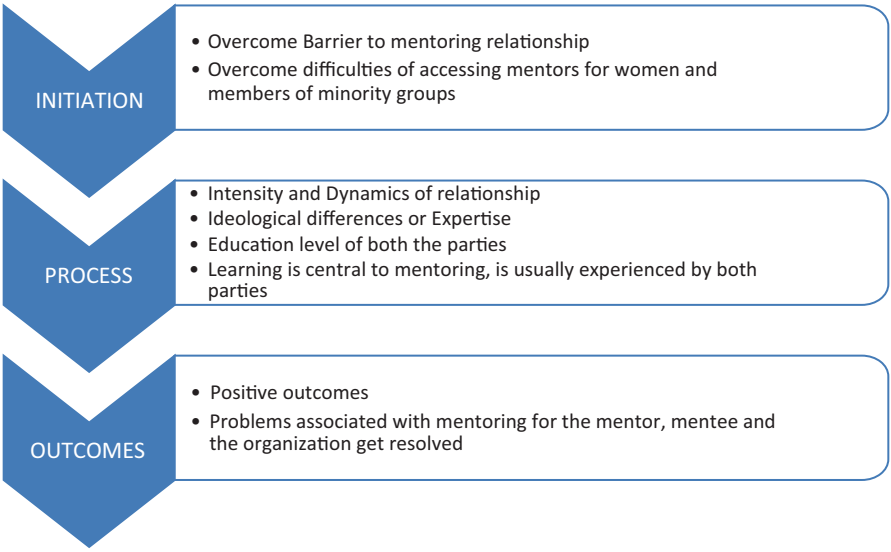

Fig. 3.2 Flow of mentorship

Definition of First Generation Entrepreneurs/Potential Entrepreneur/Mentee: "The potential entrepreneur is one who is about to complete his/her studies or completed and willing to start his/her own enterprise**".**

Definition of Potential Mentor: "The potential mentor is one who endorses formal mentorship and believes in mutual benefits to both mentee (potential entrepreneur) and mentor in terms of financial outcomes".

Definition of Formal Mentorship: "Formal mentorship is a legal mentor-mentee relationship for a period of time, decided mutually"

As per (Noe 1988) barriers to mentor-mentee relationship are inconsistent with work timetable, time difficulty and lack of physical immediacy, also Habbler and Lowe (1985) found that the mentoring relationship in an organization sometimes present a threat to mentor from mentee's side, mentor may see his mentee as a competitor in long run

Motivation/De-motivation of Mentor: These variables are measured in context of entrepreneurs and their mentor. Thereby requiring different items which is been given in Appendix B and C.

3.4 Results and Discussion

The respondents were asked: To what extent the following can be suitable a Mentor for a budding entrepreneurship that is the respondents who are interested in becoming an entrepreneur but do not have any business background to guide them,

need a suitable mentor. Above question is analyzed from the perspective of a Mentee to know his preferences for his future mentor. Two things are crucial to know first the level of interest of a mentee to become an entrepreneur secondly according to the level of interest, how strongly a Mentee needs a mentor. The first Table 3.1 shows the mean value of level of interest becoming an entrepreneur vs. suitable mentor. Interest has been categorized between low, medium and high level where as the suitable mentors are taken from the various sectors.

Results—On the basis of MSVI Table, it has been noted that those who have the low, medium, high inclination or interest towards becoming an entrepreneur they perceived successful entrepreneur as a suitable mentor followed by professional consultant and Sr. manager marketing at second and third place respectively. It is interesting to notice that irrespective of level of interest, a successful entrepreneur is the first choice as a would be mentor where as professional consultant, Sr. marketing manager and a management professor are also having a good prospects to become a mentor.

Results: Respondents who perceive that there is low level need of mentorship support, showed more faith in professional consultant as a suitable mentor. Those who strongly feel the need of mentorship support showed the faith in successful entrepreneur. Prospects for professional consultant and management professor can also be seen from the mean value index table to become a mentor. Overall in all categories the most preferable mentor for those who think that there is a need of mentorship support, is a successful entrepreneur followed by professional consultant and management professor. It can be attributed to the fact that success of an entrepreneur becomes a motivation for mentee to start his venture. Mentee might have taken the success of a mentor as a granted outcome of mentorship support

Results of Tables 3.3 and 3.4 are further checked with ANOVA to see the statistical difference and the variables are ranked according to the values of F (Tables 3.2, 3.3 and 3.4).

Discussion: Surprisingly, a management professor has been given rank 1 to show its preference over successful entrepreneur, who is the most preferred mentor as per the mean scale value index in Tables 3.2 and 3.4. Since the respondents are about to complete their studies and interested in starting their enterprise found a management professor as the suitable mentor. It is a clear indication of influence of surroundings and environment on mentee. As it is to be noted that these respondents are being taught entrepreneurship by a management professor. He is also motivating them to take up entrepreneurship as their career this is why these respondents thought that he can be of help in real business also. It seems first generation entrepreneurs prefer mentor not necessarily from their own life unlike to those who has family business background but they (mentee) are open to seek professional help from industry expert like successful entrepreneurs, professional consultant, management professor and sr. marketing manager etc. these evidences do not support **Hypotheses 1**, which means potential entrepreneurs are open for formal relationship. It depends upon the kind of business they start with and the type of difficulty they encountered. For instance the one who starts in dealing with engineering product may like to prefer a mentor from the same background.

Table 3.3 Interest-based suitability of a mentor

Mean scale value index table										
Interest in becoming entrepreneur		Successful entrepreneur	Sr. Executive (technical)	Sr. Manager (marketing)	Banker	Charted Accountant	Engineering Professor	Management Professor	Lawyer	Professional consultant
Low	Mean	3.800	2.600	3.000	2.600	2.800	2.800	2.400	2.600	3.800
	Std. deviation	0.837	1.140	1.414	1.140	1.304	1.095	1.673	1.140	0.837
Medium	Mean	4.412	3.294	3.765	3.000	3.000	2.412	3.176	3.000	3.647
	Std. deviation	0.712	0.920	0.831	1.118	0.707	0.870	0.728	0.935	0.931
High	Mean	3.842	2.895	3.474	3.158	3.000	2.474	3.421	2.526	3.368
	Std. deviation	1.344	1.197	1.020	1.214	1.247	0.964	1.216	1.073	1.535

Table 3.4 Need based suitability of a mentor

Mean scale value index table										
Need of mentorship support		Successful entrepreneur	Sr. executive (technical)	Sr. manager (marketing)	Banker	Charted accountant	Engineering professor	Management professor	Lawyer	Professional consultant
Low	Mean	3.33	3.50	3.50	2.67	3.00	2.67	2.83	3.17	3.67
	Std. deviation	1.37	1.05	0.84	1.21	1.26	1.03	1.47	0.75	0.82
Medium	Mean	4.07	2.71	3.64	2.93	2.93	2.21	2.71	2.50	3.79
	Std. deviation	1.21	1.20	1.15	1.38	1.00	0.70	1.07	1.22	1.25
High	Mean	4.29	3.10	3.48	3.19	3.00	2.62	3.62	2.76	3.33
	Std. deviation	0.85	1.00	0.98	0.98	1.05	1.02	0.92	0.94	1.32

3.4.1 Motivating and De-motivating Factors of Mentorship

Respondents were asked: To what extent the following motivating factors are likely to enhance Mentorship. The purpose of this question is to know mentee's perspective that why a mentor is interested in supporting him and what are the reasons behind the motivation to support mentor-mentee relationship (Table 3.6).

Results: Respondents with low need of mentorship give more importance to utilization of capability. It shows that a mentee perceive that mentor will support him

Table 3.5 ANOVA

Suitable mentor	Table 3.1			Table 3.2		
	F	Significance	Rank	*F*	Significance	Rank
Successful entrepreneur	1.459	0.245	2	1.890	0.165	2
Sr. executive (technical)	1.048	0.360	4	1.208	0.310	3
Sr. manager (marketing)	1.206	0.311	3	0.115	0.891	8
Banker	0.459	0.635	6	0.544	0.585	7
Charted accountant	0.078	0.925	9	0.021	0.979	9
Engineering professor	0.333	0.719	8	0.932	0.403	4
Management professor	1.698	0.197	1	3.474	0.041	1
Lawyer	1.005	0.376	5	0.902	0.414	5
Professional consultant	0.351	0.706	7	0.598	0.555	6

Table 3.6 Motivating factors for mentorship support

Need of mentorship support		Feeling of giving to society/ country	Utilization of such capability	Experimenting new business ideas	Post-retirement from own business	Monetary benefits/ wealth maximization	Quest for fame
Low	Mean	3.5	3.83	3.33	3.33	3.67	3.17
	Std. deviation	1.378	0.983	1.033	0.816	1.506	1.329
Medium	Mean	3	3.71	4	3.14	3.79	3.57
	Std. deviation	1.109	0.994	0.877	1.027	1.424	1.505
High	Mean	3.62	3.76	4.14	3.52	3.9	3.67
	Std. deviation	1.117	0.831	0.793	1.123	0.831	1.065

because he wants to use his/her skills, experience and capacity to support formal mentorship. In medium and high category where mentee thinks that there is high need of mentorship support, perceives that experimenting new business ideas seems to be a motive of mentor to support mentorship. Mentor may have new business ideas which he has captured during his journey but may not be able to fertilize. This is why he wants to implement his ideas during the span of mentorship. But the respondents are not ignoring the qualitative aspect of mentorship as their second preference is utilization of such capability. It compels to visualize mentorship support as a gate way to innovation and research and development.

It can be inferred that according to mentee, the major motivation of a mentor is utilization of capability, experimenting new ideas and monetary benefits whereas **as per Hypotheses 2,** mentor's motivation is to use his experience and expertise in philanthropic manner. Therefore hypotheses 2 cannot be accepted in case of potential entrepreneurs as mentee. Both utilization of capability and experimenting new ideas will ultimately lead to some monetary outcomes to mentor. It gives a sense of accountability and responsibility from mentor's side to mentee which in turn creates mentee's faith in mentor. Moreover, It creates the need of formal mentorship which helps in sustaining the entrepreneur and hence SMEs.

Table 3.7 De-motivating factors for mentorship support

Need of mentorship support		Creation of competitor for self	Fear/jealously of mentee overtaking the mentor	Not expecting financial rewards from mentorship	Mentee may not listen to genuine advice	Mentee may fudge accounts and show lower profits	Possible behavioral problems of the mentee	Mentee may be instigated against mentor
Low	Mean	2.167	2.667	2.167	3.167	3.000	3.500	2.667
	Std. deviation	1.329	1.211	0.753	0.753	0.894	0.837	0.516
Medium	Mean	2.643	2.643	2.643	2.857	2.571	2.571	2.429
	Std. deviation	1.336	1.277	1.082	1.406	1.222	1.399	1.089
High	Mean	2.952	2.857	3.143	2.810	2.857	2.952	2.952
	Std. deviation	1.564	1.459	1.014	0.928	1.062	1.203	1.244

Table 3.8 ANOVA de-motivating factors to hinder mentorship

	F	Sig.	Rank
Creation of competitor for self	0.715	0.496	4
Fear/jealously of mentee overtaking the mentor	0.118	0.889	7
Not expecting financial rewards from mentorship	2.551	0.091	1
Mentee may not listen to genuine advice	0.251	0.779	6
Mentee may fudge accounts and show lower profits	0.423	0.658	2
Possible behavioral problems of the mentee	1.224	0.305	3
Mentee may be instigated against mentor	0.930	0.404	5

Respondents were asked: To what extent the following de-motivating factors are likely to hinder mentorship that is what are the activities of mentee which affects the motivation level of a mentor?

Results: Possible behavioral problems of the mentee found to be the most de-motivating factor for more than 17% respondents from low category. Assuming the most common qualitative aspect affecting negatively to mentorship support. In medium category respondents perceived "mentee may not listen genuine advice" as the de-motivating factor but have not ignored the other factors like "creation of competition for self", "fear of mentee overtaking the mentor " and "not expecting rewards from mentorship", but also weighted them equally. The higher side is more into the expectation of financial rewards and keeping other qualitative parameters as secondary to get de-motivated. Results of Table 3.7 are further checked with ANOVA to see the statistical difference and the variables are ranked according to the values of *F* (Table 3.8).

Discussion: The relative mean difference obtained from ANOVA shows the expectation of monetary benefits is the key driver for mentor to undertake mentorship. Lack of such reward may hinder mentorship. Hypotheses 2 is again not acceptable

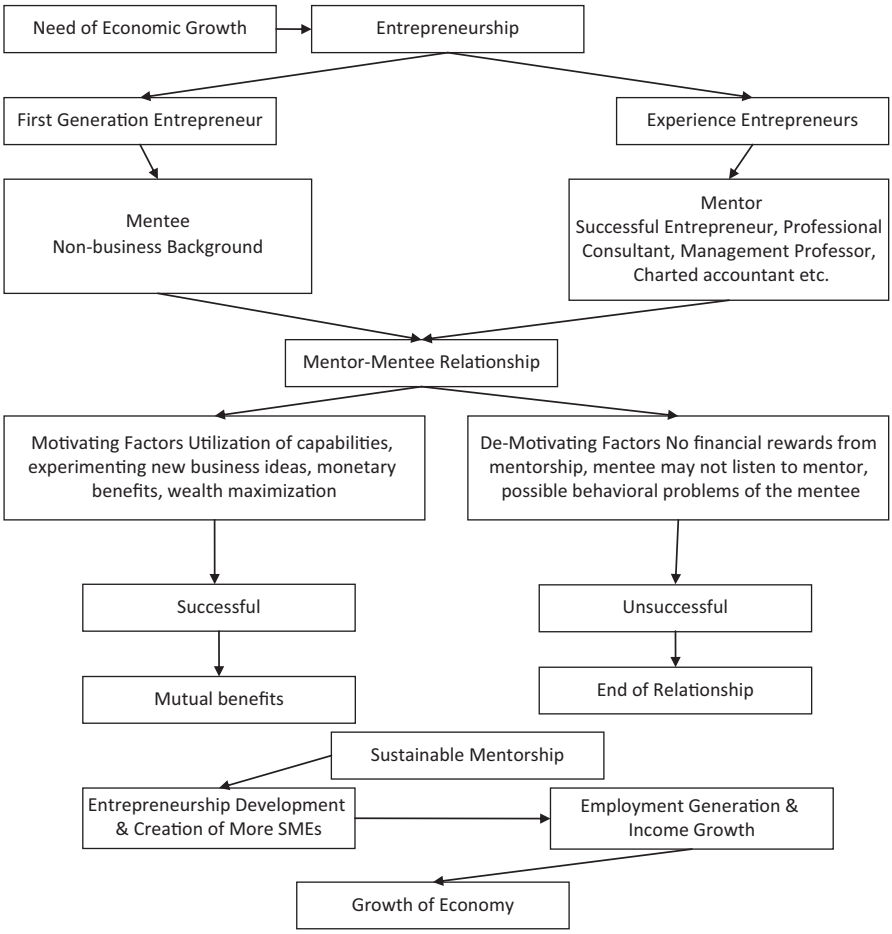

Fig. 3.3 Conceptual framework for mentorship

as it suggested that mentor does mentorship for self satisfaction and philanthropy. Whereas seventh rank is been given to such a parameter which shows the confidence level of a mentor as the mentor is not much afraid of taken over by mentee but giving preference to other factors. A mentee should analyze himself on the above parameters and control as per the need of relationship. A mentor should not feel de-motivated because it can directly hamper the mentor-mentee relationship in both short and long run.

Conclusion: The study begins with the problem of sickness of SMEs which can be controlled by mentoring the first generation of entrepreneurs. Mentorship support is needed to run an enterprise successfully which in turn draw the benefits to mentee as well as mentor and the survival of the enterprise ultimately affects the growth of an economy (Fig. 3.3).

Scales Developed for This Study

Appendix A

To what extent the following can be suitable Mentor for a budding entrepreneurship?

	1	2	3	4	5
Successful entrepreneur					
Sr. Executive (technical)					
Sr. Manager (marketing)					
Banker					
Charted Accountant					
Engineering Professor					
Management Professor					
Lawyer					
Professional consultant					

1 = lowest to 5 = highest

Appendix B

To what extent the following motivating factors are likely to enhance Mentorship for entrepreneurship?

	1	2	3	4	5
Feeling of giving to society/country					
Utilization of such capability					
Experimenting new business ideas					
Post-retirement from own business					
Monetary benefits/wealth maximization					
Quest for fame					
Any other					

1 = lowest to 5 = highest

Appendix C

To what extent the following de-motivating factors are likely to hinder mentorship?

	1	2	3	4	5
Creation of competitor for self					
Fear/jealously of mentee overtaking the mentor					
Not expecting financial rewards from mentorship					
Mentee may not listen to genuine advice					
Mentee may fudge accounts & show lower profits					
Possible behavioral problems of the mentee					
Mentee may be instigated against mentor					
Any other					

1 = lowest to 5 = highest

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Chapter 4
Strategic Flexibility, Information System Flexibility and Enterprise Performance Management

Mohammad Akhtar and Raj Kumar Mittal

4.1 Introduction

Enterprise Performance Management (EPM) is a set of processes that help enterprise to improve performance by efficient use of resources, systems and infrastructure. It is, sometimes, also referred to as performance management system (PMS). It describes all the processes, methodologies, metrics and systems needed to measure and manage performance of the organization. It is used as a strategic tool of learning, enabling to better understand what drives value creation in the enterprise. It helps organization to achieve their strategic goals. The objective of performance measurement has changed over the past few decades. Traditional performance measures based on financial performance or productivity are no longer appropriate in today's competitive global market. Alternative performance measurement systems have been developed incorporating variety of performance measures/key performance indicators (KPI) based on efficiency, effectiveness, productivity, quality, customer satisfaction, innovation, and employee satisfaction in addition to financial measures, to produce world-class enterprise performance. Alternative EPM models such as economic value added (EVA), return on capital investment (ROI), activity based costing (ABC), total quality management (TQM), six sigma, etc., were proposed but they were having a particular perspective in focus and lacking in strategic perspective and comprehensiveness. Modern comprehensive EPM models such as Balanced Scorecard (Kaplan and Norton 1992), EFQM Excellence Model (1991), and Performance Prism (Neely and Adams 2001) have overcome the above shortcomings. The effectiveness of EPM have been studies in detail and is found to be affected by various factors including flexibility.

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4.2 Literature Review

Enterprise performance management help the firm to make efficient use of systems and resources to improve business results. According to Drucker (1964), two concepts that underlie organizational performance are efficiency (doing things right) and effectiveness (doing the right things). Initially, the focus of measurement was on financial aspects. Traditional systems concentrated more on financial or productivity aspects. Latest generation of performance management systems which came up in last 10–15 years, are multi- dimensional in nature and mainly focusing on strategic perspective. An enterprise performance management system (EPM) is a system having set of performance measures or key performance indicators (KPIs) to quantify efficiency, productivity, quality, and effectiveness of actions undertaken by the enterprise so as to monitor, control, manage and perform the activities. The information generated by the system must be accurate, relevant, timely and easily accessible for the persons who need them (Neely et al. 1995; Bourne et al. 2002, 2003).

Balanced scorecard (BSC) proposed by Kaplan and Norton (1992, 1996) to incorporate balanced set of leading and lagging, financial and non-financial performance measures/ indicators from four perspectives of financial, customer, internal business process, and learning and growth to drive performance improvement. Performance measures are to be derived from vision and strategy of the organization. Neely and Adams (2001) conceptualized a Performance Prism framework, which depicts the measurement as the process of gathering management intelligence. It is a three-dimensional model having five facets for delivering stakeholders value namely stakeholders satisfaction, strategies, processes, capabilities, and stakeholders contribution. Business Excellence Model, developed by The European Foundation for Quality Management (EFQM) (1991), is a self- assessment framework for measuring the strengths and areas for improvement of an organization which consist of nine criteria. Five enablers are leadership, people, policy and strategy, partnership and resources, and processes. While four results criteria are people, customer, society, and key performance indicators.

According to Volberda (1996), “Flexibility is the degree to which an organization has a variety of managerial capabilities and the speed at which they can be activated, to increase the control capacity of management and improve the controllability of the organization”. Flexibility necessary to compensate for strategic changes that originate in indirect environment and reach via component of direct environment (Eppink 1978). It is the ability to precipitate intentional changes and adapt to environmental changes through continuous re-thinking of current strategies, asset deployment and investment strategies (Evans 1991; Rahrami 1992; Sanchez 1995). Organisations that are under high continuity forces as well as high change forces are ‘synthesizers’ and are supposed to exhibit strategic flexibility to integrate the opposing forces acting simultaneously (Sushil 2005). Information system (IS) flexibility has several dimensions such as compatibility, functionality, data transparency, connectivity, technical and functional skill and technology management. It is

positively correlated with mass customization, market position and innovativeness of the organization (Byrd and Turner 2000).

An empirical study of 175 Canadian SME manufacturing companies related to supply chain showed a direct effect of strategy on flexibility and flexibility on performance (Kamel et al. 2009). Healthcare PMS should have multi-perspectives such as efficiency, effectiveness and flexibility (Purbey et al. 2007). Chenhall (1996) studied the performance of 37 manufacturing firms and found a positive association of high degree of manufacturing flexibility, performance measurement and organizational performance. Deloitte and Touche (2001) suggested three pronged strategy to be adopted viz. adoption of strategic flexibility to deal best with uncertainty; creation of strategically flexible organizations to deal with wide range of potential threats and opportunities using techniques such as scenarios, real options, financial options; and addressing uncertainty rather denying or resisting it. Sharma et al. (2010) has studied the effect of various flexibilities on competitiveness, which enhances performance in mobile telecom companies in India. Strategic, financial, marketing, and operational flexibilities are best predictors of competitiveness and affect various perspectives of performance.

The EPM models have been implemented in hundreds of organizations across the world in different forms in various industries but have failed in many organizations to achieve the intended objective of driving performance improvements. Some researchers have studied the effect of EPM implementation, and causes of success and failures. Martinez and Kennerley (2005) studied EPM in energy companies in Europe and found a mix of positive and negative effects of EPM. Eight positive effects of EPM observed include; focus on important aspects, business improvement, improvement in customer satisfaction, increase in productivity, alignment of operations with strategy, improvement in employee satisfaction, continuous improvement culture, and improvement in company reputation. On the other hand seven negative effects include: time consuming, considerable investment, bureaucratic, over- complicated measures, misleading prioritization, mechanistic, and monotonous. Ittner and Larcker (2003) have studied more than 60 service and manufacturing companies and discovered that only a few companies are able to achieve benefits of non-financial measures. The main reason for not able to achieve benefits are: measure not linked to strategy, cause and effect relationship not validated, right performance target not set, and incorrect measurement i.e. statistical validity and reliability of performance indicators. According to Eccles (1991), data generation in respect of non-financial measures such as market share, quality, innovation, customer satisfaction and employee satisfaction is less often quarterly or annual and rarely become part of regular reporting to managers. Flow of information at various levels in the organization is another important issue, which affects performance measurement and decision making.

From an empirical study of 349 CEO(s) of large and medium companies in Spain, Gimbert et al. (2010) have established a positive association between top management use of strategic performance measurement system (SPMS) and comprehensive strategic decisions/agenda in terms of number and variety, in each strategic review/reformulation, which eventually affect corporate strategic change.

Edson et al. (2009) developed a process to integrate operations strategy and operations performance measurement system, which leads to consistent strategy implementation. Lack of acceptance of BSC by the employees, which is due to inadequate communication by the management, leads to weak BSC implementation (Chen and Jones 2009). Due to uncertainty and competition, Chinese put greater emphasis on growth. Fleming et al. (2009) from an empirical study of 104 Chinese manufacturing firms, have established a linkage that those firms making greater use of BSC are performing at high levels. According to Thomas and William (2005), to effectively adopt and realize the benefit of performance management system, long-term planning, short-term planning and management reporting should be synchronized. Senior executives and business line managers should collaborate and communicate. Organizations adopting effective PMS, have flexibility devoting more time in proactive informed decision making and less time reacting.

Tangen (2004) highlighted that modern frameworks have not addressed the practicalities of measurement and there is a need for these frameworks to fulfil the unique measurement needs of a specific company, particularly at the operational level. Tapinos et al. (2005) provided empirical evidence on the impact of performance measurement and management on the strategic planning processes. Impact is greater in large organizations and organization operating in rapidly changing environment. Bruno et al. (2005) in a case study in Brazilian company demonstrated how resources and competencies convert into performance. They found that environmental factors related to demand have strong impact on performance and employee satisfaction have shown association with all BSC perspectives but employee competency is found to have no correlation with enterprise performance in the case study. Performance management is a process to ensure that resources including human resources are to be used to attain desired goals (Halachmi 2005).

The impact of flexibility on effectiveness of enterprise performance management system is lacking in the literature, which is being studied. In this empirical study, the effect of strategic and information system flexibility on effectiveness of EPM has been studied in oil industry in India.

4.3 Research Objectives

The objective of the study was to identify factors of strategic flexibility (SF), information system flexibility (IF) and their impact on the effectiveness of enterprise performance management system (EPM).

4.4 Research Methodology

A conceptual model has been developed based on literature review (Fig. 4.1). Twelve research variables have been identified from strategic flexibility, seven from IS flexibility and 6 from dimensions of EPM effectiveness. Based on conceptual model, macro and micro hypotheses has been formulated as under.

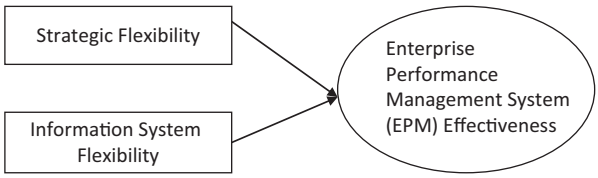

Fig. 4.1 Conceptual model for enterprise performance management effectiveness

Table 4.1 The macro hypotheses for research

Macro independent variables	Hypotheses	Hypotheses code
Strategic flexibility (SF)	Strategic flexibility positively influences the EPM effectiveness	HSF
Information system flexibility (IF)	Information system flexibility positively influences the EPM effectiveness	HIF

4.4.1 Macro Hypotheses

The macro hypotheses are mentioned below (Table 4.1).

H0: Independent variables are **not** predictor of EPM effectiveness.

H1: Independent variables are predictor of EPM effectiveness.

4.4.2 Micro Hypotheses

H0FiEj ($i=1,\ldots,19, j=1,\ldots,6$): *i*th type of flexibility factor does **not** influence *j*th type of EPM effectiveness

HFiEj ($i=1,\ldots,19, j=1,\ldots,6$): *i*th type of flexibility factor influences *j*th type of EPM effectiveness.

The micro hypothesis **HSF1SA** means that the government policy and control positively influences the EPM strategic alignment. Similarly other micro hypotheses have been formulated.

Empirical study based on survey method has been carried out to establish the relationship between EPM effectiveness and flexibility variables, both at macro and micro levels. Questionnaire using 6-point likert scale (1 for strongly disagree to 6 for strongly agree) was used to test the impact of strategic flexibility and IS flexibility on EPM effectiveness along six dimensions viz. strategic alignment, strategic monitoring, and four perspectives i.e. financial, customer, internal business process, and learning and growth.

The questionnaire was pilot tested and validated for consistency and reliability. Primary data was collected through questionnaire based survey. After repeated follow-ups, 139 responses from ten companies (six government owned and four private owned corporations) were received out of 500 questionnaire mailed and emailed to executives in 15 upstream oil and gas companies in India. Univariate and multivariate analysis was carried out using SPSS package. Descriptive statistics of independent/dependent macro and micro variables are exhibited in Tables 4.2, 4.3, and 4.4.

Table 4.2 Descriptive statistics of independent and dependent macro variables ($N = 139$ (6-Point Likert's scale))

S.no.	Independent/ dependent macro variables	Description	Mean	Median	Std. dev.
1	SF	Strategic flexibility	4.47	4.58	0.79
2	IF	Information system flexibility	4.27	4.29	0.92
3	EFF	EPM effectiveness	4.06	4.24	0.90

Table 4.3 Descriptive statistics for independent micro variables ($N = 139$ (6-Point Likert's scale))

S. no	Independent micro variables	Description	Mean	Median	Std. dev.
1	SF01	Government policies and control	4.39	4.50	0.98
2	SF02	Organizational infrastructure	4.45	5.00	1.25
3	SF03	Technological capability	4.40	5.00	1.06
4	SF04	Skilled manpower	4.69	5.00	1.03
5	SF05	Global opportunity	4.77	5.00	1.03
6	SF06	Global competition	4.60	5.00	1.05
7	SF07	Core competence	4.67	5.00	0.94
8	SF08	Diversification opportunity	4.63	5.00	1.00
9	SF09	Competitive strategy	4.55	5.00	1.07
10	SF10	E-Business	4.57	5.00	1.02
11	SF11	Merger and acquisition	4.18	4.00	1.20
12	SF12	Market forces	4.25	5.00	1.28
13	IF01	EPM computerization	4.63	5.00	1.09
14	IF02	EPM functionality	4.08	4.00	1.23
15	IF03	Flexibility to access EPM system	4.40	5.00	1.09
16	IF04	Processing capability	4.25	4.00	1.06
17	IF05	Flexibility to change software system	4.10	4.00	1.08
18	IF06	Minimal investment for change	4.27	4.00	1.01
19	IF07	Flexibility of IT personnel	4.37	5.00	1.12

It is evident from the Table 4.2 that mean and median are close to normal distribution and the mean values are greater than 4.0. Hence it can be said that organizations are giving greater emphasis on strategic flexibility, IS flexibility and EPM effectiveness.

The mean values are close to median and hence it is close to normal distribution (Table 4.3). All the 12 strategic flexibility and seven information system flexibility micro variables are having mean score greater than 4.0 and standard deviation around 1.0, which gives enough confidence in mean values.

All the six dependent micro variables of EPM effectiveness have mean score of >4.0 and standard deviation around 1.0, which gives enough confidence in mean value as indicative data (Table 4.4).

Table 4.4 Descriptive statistics of dependent micro variables of EPM effectiveness ($N=139$ (6-Point Likert's scale))

S. no	EPM Effectiveness dependent micro variable	Description	Mean	Std. dev.
1	SA	Strategic alignment	3.98	1.08
2	SM	Strategic monitoring	4.03	1.08
3	FP	Financial perspective	4.33	1.03
4	CP	Customer perspective	4.40	0.99
5	BP	Internal business process perspective	4.00	0.95
6	LP	Learning and growth perspective	4.09	0.88

Table 4.5 Correlation analysis between independent and dependent macro variables

	SF	IF	EFF
SF	1		
IF	0.674	1	
EFF	0.719	0.782	1

All correlations are significant at the 0.01 level (two-tailed)

4.5 Results and Discussion

Bivariate and multivariate analysis has been carried out to test the hypotheses and validate proposed EPM model (Fig. 4.1). Pearson's *correlation analysis* has been carried out to measure the relationship between independent macro/micro and dependent macro/micro variables. The results of correlation analysis for macro and micro variables are exhibited in Tables 4.5 and 4.5(a) respectively. Macro as well as micro variables are exhibiting strong correlation between independent and dependent variables of the model.

Regression analysis has been carried out for macro variables (Table 4.6). The values of coefficient of determination (R^2) is more than 0.65 i.e. 65 % variation in EPM effectiveness (EFF) is explained by independent variables. Strategic flexibility and IS flexibility are major predictor of EPM effectiveness at macro level.

To analyse deeper, stepwise regression analysis at micro level has been carried out for each dependent micro variable (Table 4.7). The coefficient of determination (R^2) is above 0.60 i.e. more than 60 % of variation in micro variables of EPM effectiveness is explained by the independent micro variables of strategic flexibility and IS flexibility except customer perspective for which value of R^2 is 0.42. All the six models are overall good at confidence limit >99 % as significance of $F<0.01$. All the independent variables are significant in the models at confidence level of 99 % as significance of t-test <0.01.

Table 4.5a Correlation analysis of independent and dependent micro variables of EPM effectiveness

	SA	SM	FP	CP	BP	LP
SF01	0.361	0.390	0.432	0.417	0.452	0.392
SF02	0.562	0.533	0.349	0.277	0.527	0.432
SF03	0.338	0.345	0.399	0.220	0.434	0.448
SF04	0.441	0.513	0.409	0.374	0.528	0.497
SF05	0.470	0.540	0.411	0.243	0.475	0.442
SF06	0.426	0.452	0.489	0.223	0.466	0.344
SF07	0.471	0.481	0.371	0.251	0.503	0.385
SF08	0.509	0.546	0.399	0.283	0.564	0.501
SF09	0.566	0.546	0.440	0.319	0.536	0.493
SF10	0.443	0.431	0.288	0.281	0.376	0.430
SF11	0.500	0.488	0.488	0.449	0.428	0.493
SF12	0.655	0.611	0.529	0.493	0.688	0.570
IF01	0.620	0.672	0.606	0.469	0.611	0.670
IF02	0.733	0.824	0.615	0.456	0.721	0.653
IF03	0.537	0.614	0.507	0.445	0.574	0.544
IF04	0.592	0.628	0.556	0.532	0.606	0.617
IF05	0.672	0.707	0.658	0.450	0.662	0.676
IF06	0.392	0.413	0.306	0.249	0.457	0.439
IF07	0.376	0.400	0.397	0.385	0.468	0.439

All correlations are significant at the 0.01 level (two-tailed)

Table 4.6 Regression summary at macro level

EPM dependent macro variables	R^2	Std. error	*F*	Sig. of *F*	EPM const/ ind. variables (predictors)	*B*	*t*	Sig. of *t*
EFF	0.679	0.516	144.06	0.000	Const.	−0.037	−0.143	0.886
					IF	0.539	8.300	0.000
					SF	0.403	5.334	0.000

4.6 Interpretation and Conclusion

The effect of strategic flexibility and information system flexibility on the effectiveness of enterprise performance management system has been examined in the study. The major factors related to strategic flexibility and information system flexibility affecting EPM effectiveness in driving performance improvement and competitiveness have been identifies in the study of the Indian upstream oil organizations. The hypothesis has been proved i.e. the strategic flexibility and information system flexibility factors positively influence the effectiveness of enterprise performance management and they are in-line with findings of earlier researchers.

The identified micro factors, in order of importance are: market forces, EPM functionality, EPM computerization, global opportunities, flexibility to access, flexibility to change system, minimal investment for change system, government policies and

Table 4.7 Regression summary at micro level

EPM dependent micro variables	R^2	Std. error	*F*	Sig. of *F*	EPM cons/ ind. variables (predictors)	*B*	*t*	Sig. of *t*
SA	0.652	0.651	76.05	0.000	Cons	0.219	0.808	0.421
					IF2	0.409	6.917	0.000
					SF12	0.247	4.091	0.000
					SF9	0.215	3.167	0.002
SM	0.743	0.549	69.43	0.000	Cons	0.165	0.536	0.593
					IF2	0.491	7.894	0.000
					SF12	0.174	3.537	0.001
					IF3	0.196	3.105	0.002
					SF5	0.172	3.169	0.002
					IF6	−0.134	−2.296	0.023
FP	0.613	0.698	31.38	0.000	Cons	0.555	1.316	0.191
					IF5	0.619	6.741	0.000
					SF6	0.477	5.329	0.000
					IF6	−0.358	−4.326	0.000
					IF1	0.274	3.642	0.000
					SF5	−0.304	−3.239	0.002
					SF1	0.159	2.178	0.031
CP	0.422	0.824	44.92	0.000	Cons	1.071	2.965	0.004
					SF12	0.337	5.432	0.000
					IF1	0.391	5.116	0.000
BP	0.674	0.539	84.06	0.000	Cons	0.686	2.855	0.005
					IF2	0.258	4.335	0.000
					SF12	0.326	7.124	0.000
					IF3	0.191	3.125	0.002
LP	0.609	0.553	63.30	0.000	Cons	0.808	3.293	0.001
					IF5	0.264	3.894	0.000
					IF1	0.314	5.335	0.000
					SF12	0.164	3.349	0.001

control, global competition, and competitive strategy. Based on the results of hypotheses testing, following interpretations and conclusions are made:

1. Enterprise performance management is strongly correlated with strategic flexibility and IS flexibility, both at macro and micro level. Micro variables of strategic flexibility and IS flexibility are also strongly correlated among themselves.
2. Strategic flexibility and IS flexibility influences positively the effectiveness of enterprise performance management.
3. Predictors of EPM strategic alignment are EPM functionality, market forces, and competitive strategy.
4. EPM functionality, market forces, flexibility to access system, and global opportunity will increase strategic monitoring. Investment required to change system affects strategic monitoring negatively i.e. if investment is not made for change of system software, it will not be able to monitor strategically.

5. Financial perspective is influenced by flexibility to change system, global competition, EPM computerization, and government policy and control. To change system and global opportunity will require additional investment and hence influencing financial perspective negatively.
6. Marker forces and EPM functionality affects customer perspective.
7. Internal business process perspective is affected by EPM functionality, market forces, and flexibility to access system.
8. Flexibility to change system, EPM computerization, and market forces are major predictor of learning and growth perspective.

4.7 Implications and Limitations of the Study

The study is limited to middle and senior management of Indian upstream oil companies and operational managers have not been covered. Further research on effect of other flexibilities such as organizational, operational, technological, functional, and HR on effectiveness of EPM may also be carried out. To enhance the utility, the study may also be extended to cover operational level managers, other sectors and industries.

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Chapter 5
A Value Optimising Structure in Virtual Enterprises for Manufacturing Systems

Y. Zhang and Ashok K. Kochhar

5.1 Introduction

The escalation of inter-organisational collaboration during the last two decades (Cravens et al. 2000; Robinson 2003; Mathews 2006) has lead to the concept of Virtual Enterprise (VE). Virtual Enterprise is defined as an organisation which can optimally utilise operational externalisation to improve its performance. Different from traditional companies, VEs can achieve tasks beyond their internal capacity (Pollalis and Dimitriou 2008; Hoffmann 2005), and focus more resources on core competencies thus becoming agile (Arnold 2000).

This paper recognises the fact that as a special kind of social organisations, VEs should have a special functional structure different from that of traditional companies. This functional structure should be enable an organisation to optimise its external (i.e. alliance) and internal operations, and thus help it become a virtual enterprise.

5.2 Alliance Management Function

Research indicates that organisations with a dedicated alliance management function created more value from alliances than those without such a function (Heimeriks 2010; Dyer et al. 2001; Kale et al. 2001). The following responsibilities of the alliance management function are identified in the literature:

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1. Coordinating alliances to improve their compatibility (Duysters et al. 1999; Kale et al. 2001)
2. Internal resource allocation for alliances (Kale et al. 2001)
3. Gaining stakeholders' support for alliances (Kale et al. 2001)
4. Evaluating alliance performance (Draulans et al. 2003; Kale et al. 2001)
5. Alliance knowledge management (Kale et al. 2001; Draulans et al. 2003; Bonner et al. 2004)

In Kale et al.'s field research (2001), they found that global leaders such as Hewlett-Packard, Parke-Davis, Eli Lilly, and Oracle have created a totally separate "alliance management team" to perform such responsibilities, and the team is usually headed by a middle or senior level executive with the title of "Vice President" or "Director Strategic Alliances". Companies that create such a team adopt a variety of approaches to organise or locate the team within their organisations (Kale et al. 2001).

- A large computer company, as described by Kale et al. (2001), has 4–5 key strategic partners with each of whom it has several alliances. It has set up separate alliance teams (each comprising an alliance manager supported by a technology and marketing manager) to coordinate its multiple alliances with each strategic partner. These alliance teams in turn report to a corporate-level alliance function.
- On the other hand, a large global financial services company, as described by Kale et al. (2001), has organised its alliance teams by geography. A separate alliance team coordinates and supports all alliance activities in its four geographical regions of North America, Europe, Latin America and Asia including Japan. A senior Vice President coordinates the effort of all these individual teams.
- Kale et al. (2001) also found that some multi-business sample companies organise their alliance teams on a divisional or sector basis. Each relevant division/sector has its own alliance team, if necessary, and teams from different divisions are occasionally coordinated further at the corporate level.

Thus, Kale et al.'s field research (2001) indicates that alliance management teams can be organised as central functions for either focal partners, geographies or divisions as the case may be.

Because tasks along a firm's value streams can be either externalised or internalised, the alliance management teams can be viewed as the central functions of the externalised part of the value streams, and this part can be called externalisation structure (or alliance structure). The alliance management teams and their surrounding functions form a firm's externalisation structure. For example, the externalisation structures of the above mentioned organisations (organising alliance management teams around focal partners, geographies or businesses) can be depicted in Figs. 5.1, 5.2, and 5.3, respectively.

Although the alliance management teams act as the central functions of a firm's externalisation structure, they have difficulties in becoming the central functions of a firm's entire structure due to their relatively little role in managing the other part of the value streams—the internal part (also called as the internalisation structure).

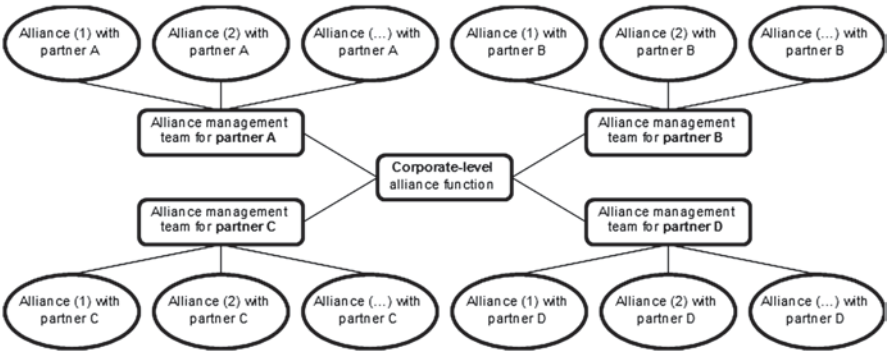

Fig. 5.1 Externalisation structure around focal partners

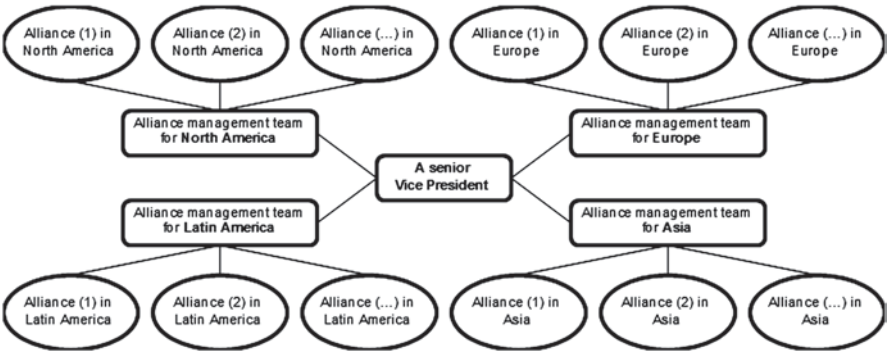

Fig. 5.2 Externalisation structure around geographies

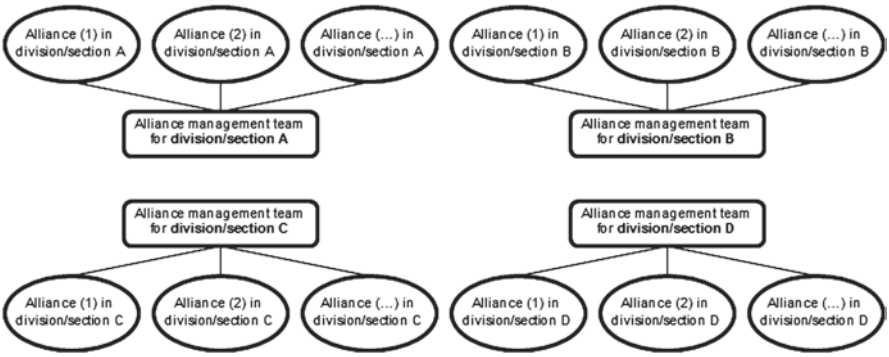

Fig. 5.3 Externalisation structure on a divisional or sector basis

Table 5.1 Upgrading alliance management function to cover both externalisation and internalisation

Covering externalisation		Covering both externalisation and internalisation (EI)
Coordinating alliances to improve their compatibility	→	Improving EI compatibility
Internal resource allocation for alliances	→	Internal resource allocation for EI
Gaining stakeholders' support for alliances	→	Gaining stakeholders' support for EI
Evaluating alliance performance	→	Evaluating EI performance
Alliance knowledge management	→	EI knowledge management

However, if the alliance management teams' responsibilities can be extended to overcome such insufficiencies, they have the potential to become one of the central functions of a VME's entire structure, thus giving clear guidance as to how to construct a VME's functional structure.

This extension of the alliance management function is referred to as externalisation-internalisation (EI) management function in this paper.

5.3 Responsibilities of EI Management Function

5.3.1 Responsibilities Enhancement

The responsibilities of the alliance management function form the basis on which the responsibilities of the EI management function are designed. Firstly the responsibilities identified in the literature are all upgraded to cover both externalisation and internalisation (see Table 5.1).

The reasons for the upgrading are specified as follows.

1. **Improving EI compatibility**
   An organisation can have alliances that are often in direct conflict (Duysters et al. 1999; Kale et al. 2001). Incompatibility may also exist when internal operations are taken into consideration. In the JVCO joint venture between Hexagon and NAMCO (Ariño and Doz 2000), the alliance operations resulted in the cannibalisation of NAMCO's products, since the alliance products used the same channels and distribution space as those for NAMCO's products.
   Alliance operations might also be not compatible with a company's strategies, thereby requiring adjustment. This situation was found in the field case studies by the authors.
   When started, Shanghai Fu Qin Machine Company (SFQMC) delegated almost all of its manufacturing activities to suppliers, and itself focused on product development. After several years' successful operation, based on cost reduction and performance improvement, the company is now gradually investing in land and manufacturing equipment for building new factories. This reflects the shift in

strategy from externalisation to internalisation. The company carefully checked the compatibility between its alliances, and operations to be internalised, and began to eliminate, step by step, its collaborations with some suppliers. Such elimination cannot be too quick, since the company still needs time to learn the relevant operations; in fact, new collaborations with suppliers were set up for the company to learn from its suppliers. The ultimate objective of the company's internalisation, e.g. heat treatment, is that "We are able to do the procedure by ourselves completely; external suppliers are only called upon when orders exceed our capacity". This also means that collaborations with relevant suppliers won't be removed completely.

Sometimes, even when no conspicuous incompatibility exists, a firm's EI situation may still need to be adjusted to improve overall business performance, as demonstrated by EADS acquisition of BAE SYSTEMS 25% stake in EADS Astrium in 2003.

The acquisition is a key element in EADS' effort to restructure and integrate all its Space interests in the UK, France, Germany and Spain. EADS will gain the strategic and restructuring flexibility required by the current space market conditions. (Source: http://www.paradigmsecure.com/, http://www.defense-aerospace.com/).

The Toyota case study (Ahmadjian and Lincoln 2001) exhibited a similar situation. Toyota's building of an in-house capability in electronic components, thus scaling down its dependence on Denso, was due to the escalating importance of automotive-electronics technology and Toyota's increasing difficulties in evaluating Denso's pricing and delivery of electronic components caused by the information asymmetries between the two companies.

The research by Hoffmann (2005) also demonstrated the importance of aligning a company's alliance portfolio with the company's strategic goals. Thus, it can be concluded that not only the compatibility among a firm's alliance operations needs to be improved, but also their compatibility with the firm's internal operations and overall strategies.

2. **Internal resource allocation for EI**
   Similar to external operations, internal operations may also trigger significant internal resource allocation. What's more, carrying out internal operations often requires much more internal resource allocation than if the work was done externally; this is one of the main reasons why alliances are often sought as alternatives. The Concorde project involving collaboration between Sud-Aviation and British Aircraft Corporation (Dussauge and Garrette 1999) was triggered since both firms realised that they did not possess the financial and human resources needed to launch alone an aircraft of this kind. Other similar case studies were also found in the literature, e.g. the Stork-Wärtsilä joint venture (Douma et al. 2000), and the IBM, Siemens and Toshiba's R&D venture (Brouthers et al. 1995).
3. **Gaining stakeholders' support for EI**
   A company can have a variety of stakeholders, such as shareholders, employees, local government, etc. Gillespie and Teegen (1995) indicated that "Stakeholders may be able to exercise influence over an alliance at its inception as well as

during its life span. Formal and informal programs must be in place to ensure the support of all relevant stakeholders, such as customers, suppliers, other alliance partners, financiers and unions".

Similarly, stakeholders may also be able to exert (great) influence on internalisation decisions. For example, in the Renault-Volvo alliance (Bruner and Spekman 1998), the Volvo's Executive Chairman underestimated the resistance from a number of key stakeholders, which directly resulted in the failure of his proposal to merge Renault and Volvo. As another example (Zhang and Li 2001), the proposal by the Japanese partner of buying 60% of the international joint venture (IJV) equity shares held by the Chinese partners was strongly opposed by the local Chinese IJV general manager, since he believed that the proposal would damage the interests of the IJV and the employees. The proposal could not be passed without the general manager's approval in the board, and the manager also had called for all employees not to cooperate with the consultant team sent by the Japanese headquarters for restructuring.

It can be concluded that both external and internal operations need stakeholders' support. The situations could become even more complicated when external parties have been involved in alliances, in which relevant tasks need now to be internalised.

4. **Evaluating EI performance**

Since the early 20th century, financial performance measures such as return on investment began to be used by companies such as Dupont and General Motors to control and improve their financial performance. These performance measures became important management information for decision-making, and were not questioned by academics and practitioners until the 1980s (Johnson and Kaplan 1987). One reason for the questioning is that such measures are difficult to use to measure the day-to-day operation of a company (Dixon et al. 1990; Kald and Nilsson 2000).

During the 1990s, performance measurement models combining both financial performance measures and non-financial performance measures were presented. Kaplan and Norton (1992) presented the Balanced Scorecard model that can be used to evaluate business performance from four perspectives: (1) customer perspective, (2) internal perspective, (3) innovation and learning perspective, and (4) financial perspective. Maisel (1992) further demonstrated the causal links among these four perspectives, and Kaplan and Norton (1996) included these causal links into their Balanced Scorecard model. The balanced scorecard model has been adopted in companies like Sears (McLemore 1999), Boeing (McLemore 1999), General Electric, Michigan Consolidated Gas (McLemore 1999), Petrobras, Australian Healthcare System, and Madison Paper Company (http://www.bscol.com/).

Neely (1998) suggested a "what-how" performance measurement model based on Kaplan and Norton's Balanced Scorecard, indicating that top-level performance measures should be mapped on the four perspectives of the Balanced Scorecard model, and low-level performance measures should have explainable causal links with these top-level performance measures. Neely (1998) called

these causal links as assumptions and indicated that companies should challenge these assumptions to establish a perfect performance measurement system, and the challenge process is the learning process of the company.

Another important model is the Performance Pyramid System (PPS) originally developed by Judson (1990) and improved by Lynch and Cross (1991, 1995). PPS divides a company's performance measures into two sides (i.e. a company's internal and external sides) and four levels (i.e. a company's overall level performance measures; individual business unit level performance measures grouped under the market and financial headings; key measurement level of customer satisfaction, flexibility and productivity; the bottom level measures such as product quality and delivery reliability). The contribution of PPS lies in its mapping of performance measures to a company's organisational structure, and mapping these measures on the day-to-day operations of business units.

The recent trend of increasing vertical disintegration and outsourcing in many industries has shifted the focus from a pure intra-organisational towards a more holistic inter-organisational view of the overall value system. The result has been an increasing awareness of the importance of inter-organisational management control (Source: http://www.ifm.eng.cam.ac.uk/csp/projects/johannes.html).

The above review of performance measurement evolution illustrates the importance of performance measurement for internal operations. These approaches' influence is so great that they became the outset of many of the subsequently designed alliance evaluation approaches. Thus, it is appropriate to say that performance measurement for internal operations has at least the same level of importance as that of performance measurement for external operations. This is why the responsibility of "evaluating alliance performance" is upgraded into "evaluating EI performance".

5. **EI knowledge management**

Knowledge management practices are used by many organisations to capture, share, and create useful knowledge for improving their alliance operations (Pollalis and Dimitriou 2008; Heimeriks 2010; Kale et al. 2001; Draulans et al. 2003; Bonner et al. 2004; Tsang 1999). Hoang and Rothaermel (2005) suggested that firms should assess whether they are providing sufficient resources and organisational support to leverage alliance experience, e.g. increasing efforts to codify knowledge and creating systems to coordinate and disseminate information between alliance managers across projects and across time. Firms must be able to account for the results of their alliances and deliberately engage in organisational routines to methodologically capture, process, and disseminate knowledge (Emden et al. 2005).

In addition, knowledge management practices are also deliberately used for learning and capturing alliance partners' knowledge (Jiang and Li 2009; Chen et al. 2009; Goerzen 2005; Revilla et al. 2005; Kandemir and Hult 2005; Chen 2004; Hermens 2001; Inkpen 1998, 2000; Parise and Henderson 2001; Simonin 1999; Tsang 1999), and at the same time, protecting own knowledge competencies (Norman 2001, 2002; Das and Teng 1999; Baughn et al. 1997; Jordan 2004).

However, knowledge management has very diverse roots (Drew 1999), none of which supports that knowledge management is only for external operations:

- Academically, the field of organisational learning popularised by Senge (1990) dates back to the late 1970s.
- Innovation is another contributing thread. Firms' core competencies are essentially knowledge-based sources of competitive advantage.
- Other academic roots of knowledge management can be located in the business process re-engineering (BPR), IT management, and strategic control literature.
- Practically, the BPR trend of the early 1990s has led to widespread adoption of new systems, notably ERP systems. The growth of the Internet and Corporate Intranets serves as platforms for information and knowledge dissemination.
- Governments are concerned with promoting economic growth, for which knowledge is an important driver, especially in the high-tech and service sectors. Encouragement of innovation in knowledge-intensive firms, dissemination of best practices and investments in education have become hot political issues.
- Knowledge management can also generate new competencies for firms, which attracts relevant stakeholders (e.g. shareholders).

Companies like Siemens (Davenport and Probst 2002), IBM (Mertins et al. 2001), ABB (Hoegl and Schulze 2005), Ricardo (Ward 2005), Unilever (Drew 1999), and Volkswagen (http://www.vw-personal.de/www/en/wissen/wissensmanagement.html) have successfully established their knowledge management systems, which mainly focus on improving the efficiency of their internal operations.

Knowledge management also plays an important role during mergers/acquisitions.

For example, in the acquisition of MediaOne by AT&T (Armistead and Meakins 2002), merger-specific knowledge was collected and stored in a repository, the objective being to help teams track their progress against each other and share lessons learned in real-time. In the merger of BP and Amoco (Armistead and Meakins 2002), knowledge management also played an important role to make sure that lessons learned before were taken into consideration, a broad range of views from employees as to how the merger had gone could be collected, and merger-specific knowledge could be shared and captured throughout the merger process.

Thus, knowledge management is not restricted to an organisations external operations, but has a much wider scope of application. It is a crucial factor in the improvement of both external and internal operations. This is why it is upgraded to further cover an organisation's internal operations.

5.3.2 Additional Responsibilities

The above discussed responsibilities are **updates** of those of the alliance management function. This section discusses some new responsibilities included in the EI management function to further strengthen its central functioning role within a VME. These new responsibilities are listed in Table 5.2 as (6) and (7).

Table 5.2 New responsibilities included in the EI management function

Covering externalisation		Covering both externalisation and internalisation (EI)
Coordinating alliances to improve their compatibility	→	Improving EI compatibility
Internal resource allocation for alliances	→	Internal resource allocation for EI
Gaining stakeholders' support for alliances	→	Gaining stakeholders' support for EI
Evaluating alliance performance	→	Evaluating EI performance
Alliance knowledge management	→	EI knowledge management
	New	Ensuring value stream optimisation
	New	Designing competency protection

6. **Ensuring value stream optimisation**
   Value stream optimisation is the objective of configuring external and internal operations. If separated, EI configuration loses its significance in helping improve overall performance of the new enterprise. Thus, continuous value stream optimisation signals wise usage of alliances, and also provides guidance to EI configuration.
   Adding the responsibility of "ensuring value stream optimisation" into the EI management function essentially guides proper EI configuration along value streams. Since "value stream" can be defined as "the set of all the specific actions required to bring a specific product" through the following three critical management tasks (Womack and Jones 2003), this responsibility strengthens the EI management function's central position in a VE.

   - The problem-solving task running from concept through detailed design and engineering to production launch;
   - The information management task running from order-taking through detailed scheduling to delivery;
   - The physical transformation task proceeding from raw materials to a finished product in the hands of the customer.

7. **Designing competency protection**
   Competency risks due to alliances have been well documented in the literature (Das and Teng 1999; Duysters 1996; de Man and Duysters 2004; McCutcheon and Stuart 2000; Brouthers et al. 1995; Norman 2001, 2002; Quintas et al. 1997; Dickson et al. 2005). The reasons why alliances might particularly trigger competency risks can also be justified. Since VMEs have a much higher possibility to become heavily dependent on alliances than traditional manufacturing companies, it is important to set up a defence system against competency leakage. This is why the responsibility of "designing competency protection" is included in the EI management function.
   A variety of competency protection approaches can be followed to help the EI management function design a proper defence system. These approaches are summarised as follows:

1. Identifying competencies (Norman 2001; Baughn et al. 1997)
   Assessing risk of competency leakage prior to initiating alliances:
   (i) estimating the consequences of competency leakage (Baughn et al. 1997);
   (ii) anticipating partners' intents of competency acquisition (Norman 2002; Baughn et al. 1997); (iii) assessing partners' absorption capability (Norman 2002; Baughn et al. 1997). "Firms should make it clear prior to alliance formation that they are aware of the possibility of unauthorized learning" (Das and Teng 1999). Jordan (2004) indicated the importance of "recognising potential dangers".
2. Creating a moving target by continuously improving competencies (Nair and Stafford 1998; Shultz and Saporito 1995)
   Controlled information disclosure: To prevent opportunistic learning, "a firm may withhold information from a partner. Management of knowledge flows and communication has been identified as a critical method for protecting knowledge (Baughn et al. 1997)… Because the structure of information flows influences how much a partner can learn (Levinson and Asahi 1995), limitations on the amount of information sharing and the frequency of communication can protect against the loss of competitively important knowledge (Kumar and Seth 1998)" (Norman 2002). Das and Teng (1999) also suggested limiting the exposure of tacit knowledge and know-how to their partner firms. Norman (2001) indicated that to protect knowledge, information flows could be limited to one person (gatekeeper), limited to a few people (communication stars), or completely excluded from alliances. "Participating firms should be aware of what the appropriate access points are, and what information is channelled through them. When consistency and coordination regarding information access is not established within a firm, multiple requests for information may be undertaken by a partner firm at different levels, departments or divisions. The firm may unwittingly provide information through one access point that would have been restricted by another" (Baughn et al. 1997).
3. Using patents (Norman 2001)
   Using high-tech labelling for direct protection to limit access, such as special inks and dyes, holograms, and electronic passwords and signatures (Nair and Stafford 1998)
4. Establishing reward practices for competency protection (Norman 2001; Baughn et al. 1997)
   Staff training and education (Norman 2001; Baughn et al. 1997; Das and Teng 1999; Jordan 2004): Norman (2001) indicated that both top management and alliance management should stress protection of core competencies; human resource management should take the responsibility of educating and training personnel about competencies protection; an information manager can be designated to an alliance, and act as a consultant in cases where employees feel that the circumstances surrounding knowledge protection are vague or unclear. Jordan (2004) indicated "the important role that the individual played in the control of knowledge flows. Attempts to protect the knowledge leaks

were often directed at individuals, who were sometimes instructed to withhold certain types of information in formal meetings".

5. Choosing proper alliance structure among equity and non equity forms (Norman 2002; Baughn et al. 1997; Das and Teng 1999; Das and Teng 1996; Mitchell et al. 2002)
   Task design: (i) to limit partners' access to competencies (Norman 2001; Baughn et al. 1997); (ii) to perform certain tasks to maintain relevant expertise (Dussauge and Garrette 1999). Greater emphasis should be placed on task partitioning and modular working (Jordan 2004). Langlois (2002) explains that by "breaking up a complex system into discrete pieces which can then communicate with one another only through standardised interfaces within a standardised architecture—one can eliminate what would otherwise be an unmanageable spaghetti tangle of systemic interconnections". "While the modular design approach still required extensive exchanges of information, these exchanges between partners could occur despite physical separation of personnel, in particular engineers, which allowed core technology to be 'walled off' and thereby protected" (Jordan 2004).
   Restriction on alliance location: Baughn et al. (1997) comment: "Conducting joint activities within one's own firm allows the partner access to one's facilities, providing a window to ongoing processes and access to knowledgeable personnel. This greatly increases the permeability of the interface, with a strong potential for outflow of knowledge to the partner … By placing the joint activities in a third location, the parents can more effectively decide what technology to include in the venture and what to exclude." Thus, to protect competencies, partners' access to facilities and non-alliance personnel can be limited (Norman 2001; Das and Teng 1999).
   Alliance staffing design: e.g. Norman (2001) suggested the use of information managers in alliances to monitor and act as consultants for competency protection. Baughn et al. (1997) indicated that "The personnel comprising the alliance interface serve both as gatekeepers of information and as potential receptors of partner skills. The knowledge, skills, and abilities of the individuals selected for partnership roles represent a critical determinant of information access. Interface personnel should be well briefed in what skills can and cannot be shared, and should be aware of the strategic costs and benefits of collaboration (Hamel 1990; Pucik 1988)". To have one's own staff in key posts in an alliance is also a significant mechanism for effective managerial control (Das and Teng 1999). Jordan (2004) indicated that "rapid turnover of staff in a number of the alliance projects did … produce a rather unexpected benefit, namely it reduced the risk that tacit knowledge would leak to partners."
   Alliance timing design: "Many firms limited their involvement with alliance partners, initially transferring older technologies, and gradually introducing newer technologies over time. Temporal limitations may also be stipulated in the alliance contract, limiting the planned duration of the alliance, and thereby the window of learning opportunity for each partner" (Baughn et al. 1997).

Counterbalance activities (Norman 2001; Lui and Ngo 2004; Dussauge and Garrette 1999): activities that could produce a force counterbalancing the effects of possible resource leakage: e.g. an agreement forbidding a partner to compete with the company within 10 years after the alliance dissolves.
Monitoring: Norman (2001) suggested the use of an information manager to: (i) scrutinise critical knowledge used in alliances, and ensure that it has been classified accurately and that alliance employees are properly informed and educated; (ii) continuously ensure that employees are actually following the guidelines and procedures established by the knowledge protection system. Norman (2001) also suggested the monitoring of contacts with partner employees. Baughn et al. (1997) indicated that "Monitoring information flow is likely to prove more difficult. However, information regarding information requests by the partner can be tracked, as well as compliance with expectations to control information flow (hiring practices, personnel rotation, technical contribution), and geographic or product expansion by the partner firms". Das and Teng (1999) suggested tight monitoring of alliance operations as a useful way of controlling relational risks.

5.4 EI Structure

As depicted in Figs. 5.1, 5.2 and 5.3, organisations' externalisation structure can be organised around focal partners, geographies or divisions, with alliance management functions as central links. However, after the alliance management function is upgraded to EI management function, especially for the responsibility of "Ensuring value stream optimisation", it becomes difficult to create an organisation's EI structure around focal partners, geographies or divisions, since the EI management functions now supervise a firm's value streams, which are organised around the organisation's customers/products/services!

Constructing EI structure around an organisation's value streams (see Fig. 5.4) is perceived as more beneficial than the original externalisation structure around partners/geographies/divisions, because it complies with both the academic and practical trends which are in favour of customer-oriented operations. For example, one innovative costing method designed to deal with the deficiencies of traditional costing systems is Activity-Based Costing (ABC) (Roztocki et al. 2004). ABC, pioneered by Robin Cooper, Robert Kaplan, and H. Thomas Johnson (Cooper 1988a, b, 1990; Cooper and Kaplan 1988; Johnson 1990), is a costing methodology used to trace overhead costs directly to cost objects (i.e. products, processes, services, or customers). ABC can radically change how managers determine the mix of their product line, price their products, identify the location for sourcing components, and assess new technology (Turney 1989). Another example is the lean approach. Originated in the auto industry in Japan, the lean approach has been adopted by many of those companies which could be characterised as "world-class" (Rafuse 1996). Lamming (1994) argued persuasively that all significant product value systems will ultimately

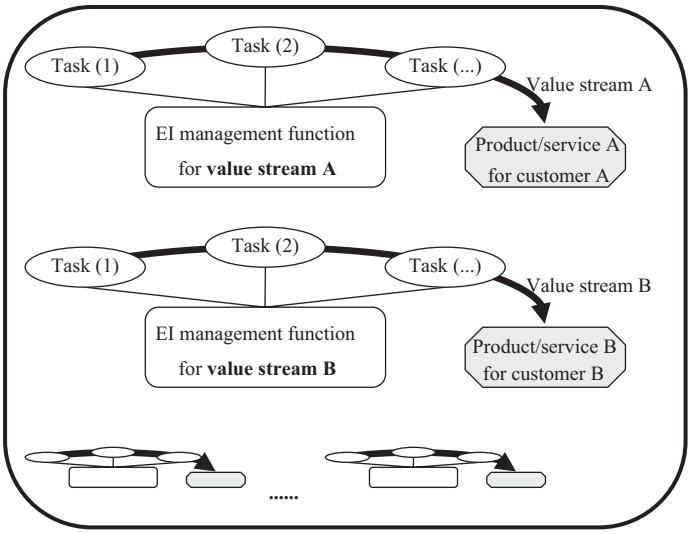

Fig. 5.4 EI structure around a VME's value streams

adopt the lean approach. The basic idea of lean operations is to identify entire value stream for each product, to eliminate any waste along value streams, to precisely synchronise the production rate with the sales rate through continuous flow in small-lot production, and to offer customers exactly what they want (Womack and Jones 2003).

Based on the responsibilities discussed above, the boundaries between the EI management function and other functions along the value streams can be clearly perceived (see Table 5.3).

5.5 Further Validation

To validate the model proposed in this paper, seven manufacturing organisations (five in China and two in the UK) were investigated. These companies were selected to form a theoretical niche in terms of industry, size, location and market scope, as shown in Table 5.4. Other selection criteria included:

1. The case study companies must be manufacturing companies.
2. The case study companies must have alliance experience, thus possessing the data/knowledge sought by this research.

The evidence found in these organisations, together with the evidence collected from the literature, including both researcher views and literature case studies, provide support for triangulation evidence.

It is important to view this research in terms of its limitations. Although the model has been validated through triangulation evidence, it would have been useful

Table 5.3 Boundaries between the EI management function and the value streams (other functions)

EI management function		
(1) Ensuring value stream optimisation Improving EI compatibility	Guiding →	Other functions along value streams
(2) Internal resource allocation for EI	Fuelling →	
(3) Gaining stakeholders' support for EI	Smoothing →	
(4) Designing competency protection	Defending →	
(5) Evaluating EI performance	Evaluating →	
(6) EI knowledge management	Refining practices →	

to study the companies through direct observation of the implementation of the proposed Value Optimising Structure. By directly observing how the companies customise and implement the structure according to their specific situations, it would have been possible to incorporate into the model the knowledge based on practical experience.

Further research could be carried out in more UK companies to confirm/challenge the case study results of this research. Companies in countries other than the UK and China could also be included to enlarge the boundary limits of the theoretical niche.

In its current form, the model is independent of the characteristics of manufacturing organisations. Additional research could be carried out to prioritise the elements within the model according to organisations' characteristics, such as industries, locations, size, etc., so that the model could help organisations focus their precious resources on those issues with higher priorities.

Specific to this area of research, small companies generally attracted much less research attention than large international companies, and therefore little guidance could be found in the literature regarding the issues specific to small companies, such as how to ensure continuous value stream optimisation, and how to establish knowledge management system. Due to the distinguishing features of small companies, e.g. less influence upon their value stream parties, non existence of large professional community for adopting standard knowledge management practices, specific guidance is needed for small organisations to resolve the relevant issues.

5.6 Conclusion

Building a dedicated VE functional structure is a critical step of transforming a traditional company into a virtual enterprise. The proposed structure provides guidance about how to formulate their functions in order to achieve an optimal

Table 5.4 Theoretical niche of selected case study companies

		A	B	C	D	E	F	G
Industry (Code)	Iron and steel forgings (3462)	✓						
	Steel foundries (3325)		✓					
	Motor vehicles and motor vehicle equipment (3710)			✓				
	Motor vehicle parts and accessories (3714)			✓				✓
	Construction machinery and equipment (3531)				✓			
	Metal heat treating (3398)					✓		
	General industrial machinery and equipment (3569)						✓	
Size	Small ≤100	✓ 50				✓ 65		
	100< Medium ≤250				✓ 148		✓ 200	
	250< Large		✓ 290	✓ 21,000				✓ 18,000
Location	China (developing country)	✓	✓	✓	✓	✓		
	UK (developed country)						✓	✓
Market Scope	National		✓ China	✓ China		✓ China		
	Regional	✓ China; Japan			✓ South East Asia			
	Global						✓	✓

combination of internal and alliance operations. Based on the functional structure, an organisation can also for example adjust its departmental structure to reinforce a proper implementation of the relevant functions.

The alliance management function researched in the literature provided a similar structure for managing a company's alliance operations. However, because a virtual enterprise closely combines its internal and alliance operations, this structure is not capable of managing the entire VE. Recognising this deficiency, the paper extended the alliance management function through upgrading its existing responsibilities and adding new ones, to enable it to manage both internal and alliance operations.

Instead of being organised around a company's divisions, the structure proposed in this paper is organised around a company's value streams. Doing so offers some advantages: first, it facilitates a company to be functionally value adding through focusing functions on value streams; secondly, because value streams are

combinations of internal and alliance activities, doing so helps improve their holistic performance, rather than the performance of individual activities.

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Chapter 6
Competitiveness Situation of a Key Segment in Solar Photovoltaic Industry in India: An Exploratory Study

Ashish Sharda, Sudhir K. Jain and Kirankumar S. Momaya

6.1 Introduction

India, presently the world's sixth largest energy consumer, fourth largest emitter of planet-warming greenhouse gas is expected to meet 75 % of its oil and gas needs by imports by 2020 due to expected rise in commercial energy need of by 2.5 times (Muneer et. al. 2005; Reuters 2009). Industrialization needs to be regulated, in terms of adapting energy saving and environmentally benign technologies for sustainable development (Narayanan and Palanivel 2003).

Stepping forward to meet the upcoming challenges, Government of India (GOI), launched Jawaharlal Nehru National Solar Mission (JNNSM) recommending the implementation in three stages leading up to an installed capacity of 20,000 MW by the end of the 13th Five Year Plan in 2022 (Ministry of New and Renewable Energy (MNRE) 2010). During this time, we expect many new ideas and technologies to emerge for both on grid and off-grid SPV technologies so that the price of solar power will attain parity with grid power (Solar Conclave, MNRE 2010).

In a photovoltaic BOS, ground fault detectors, charge controllers, batteries and inverters are the components that could benefit most from technology and understanding developments (Sandia Photovoltaic 2011). The paper deciphers the situation of the inverter segment in India through identifying the major players on BoS's inveter segment and exploring their business interest in the budding solar energy sector of the country. Both quantitative and qualitative analysis elaborated through rigorous SAP-LAP analysis and scenario building techniques.

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6.2 An Overview of Solar Inverters

Solar inverter performs the conversion of the variable DC output of the Photovoltaic (PV) module(s) into a clean sinusoidal 50 or 60 Hz AC current that is then applied directly to the commercial electrical grid or to a local, off-grid electrical network (Texas Instruments USA 2011).

Strategic focus is required for standalone inverters section development first for Indian context.

6.3 Overview of International Solar Inverter Market

The following table summarizes the details of few prominent players in world market:

Other player's viz., Sungrow, Bonfiglioli, Danfoss, General Electric and AEG Power Solutions offers the world's most comprehensive portfolio of premium power supply and control products, systems, solutions and services. Definitely Germany and United States form the frontier of the leaders in this section and their expertise in this domain is exemplifying. Other European nations are also among the other process and product leader category. Definitely companies from Asian region are striving hard to climb up the ladder of excellence in solar domain viz., Mitsubishi Electric, Sanyo from Japan; GCL-Poly Energy Holdings Limited, Yingli Solar from China are among the notable few. However, still in the inverter segment none of the Asian company outshines to a global level, evident from research reports of global rankings.

6.4 Overview of Indian Solar Inverter Market

Though the domestic market of India is in its nascent stage as far as inverter segment is considered. There is abundance of players, but their reach is highly restricted to local markets. Further, the market has to grow to manifolds so as to reach a mature state.

There is a high lack of highly authentic source for depicting the status of solar inverter companies in India, so a list of companies was compiled from various databases and each was being accessed through their websites, select reports and articles were referred to come out with the following table:

6.5 Methodology for Case Development

Understanding sources of competitiveness is utmost important for capability building. It is companies that ultimately compete by strategic decisions for capacity building and flexibility (Banwet et al. 2002). Sources of competitiveness for the

Table 6.1 Understanding type of solar Inverters and their criticality. (Source: Functionality based on description by Texas Instruments, USA)

Type of inverter	Description and criticality in Indian context
Stand alone inverters	Useable in independent solar energy systems at remote locations viz., cabin, cottage, water pump or monitoring station and also for mobile energy stations such as boats and RVs
	Their criticality is high in Indian context
The grid-tie inverters	Match the phase alongside a utility charged sine wave. Programmed to automatically turn it-self off during power losses to ensure safety
	Recommended for an urban home powered by a utility grid
The battery backup inverters	Able to supply alternating current (AC) power to selected areas which require energy during a power outage
	Incorporating batteries into the system requires more components, is more expensive, and lowers the system's overall efficiency
	For urban homeowners with regular outages

firm identified have been classified and structured hierarchically. Companies for detailed case study have been carefully selected based on analysis of secondary data about competitiveness performance of the company over a period. Secondary data is collected from the company's annual report, internet/web sites, magazines etc., and is being analyzed. The company's financial performance, international performance (exports, imports, etc.), its achievements, in comparison to its competitors/industry averages etc., are being calculated and scrutinized. The leaders are being identified for best in the class benchmarking. Finally, the reasons for the company's competitiveness have been extracted. Apart from all secondary sources, few informal interactions with senior executives of the national companies were held.

Relevant select factors from the following facets of competitiveness (Momaya 2001) have been explored to develop the case studies:

1. Competitive Assets: Parameters like factor costs, human resources, industry infrastructure, technological factors, demand conditions, government, intangible assets and leadership.
2. Competitive Processes: Processes like strategic management, implementation, human resources development, technological management, synergies, competence building, supply chain management and operations management.
3. Competitive Performance: Dimensions like productivity, human resources, quality, cost, financial, international, technological and intangibles.

Each area has been grilled upon to develop cases that reveal the indicators of competitiveness, the reasons and areas of concern for competitiveness of the industry (Momaya 1998).

Table 6.2 Leading international players in solar inverter market. (Source: IMS Research Report, Inverter Market Rankings 2011)

Company	Country of origin	Description
Advanced Energy	United States	AEIS which is a US semiconductor company is also a big manufacturer of solar inverters
Fronius International	Austria	Fronius was a top 3 player in 2009 but has seen upstarts like Power-One take more market share
Kaco New Energy	Germany	Their product portfolio is being used around the globe for rail vehicle and photovoltaic applications
Power-One	United States	Recently established as the world's 2nd largest
REFUsol	Germany	A world-leading manufacturer of photovoltaic inverters and is renowned for its technical superiority
Satcon	United States	Strong in the US utility market and is growing but has not grown as fast nor does it have the high margins
Santerno	Italy	A multinational specialized in power transmission systems, with production premises and engineering centers in more than 16 countries worldwide
Siemens	Germany	Sophisticated and technically superior products
SMA Solar	Germany	40% market share of the global market So far sold solar inverters of about 200 MW in India
Sputnik Engineering	Switzerland	Using the European solar growth to become a reasonably big player in the solar inverter market

6.6 Case Studies

Detailed case studies are being developed for two selected companies, one from overseas and one from India.

6.6.1 Case I: SMA Solar Technologies (International)

SMA Solar technology is the world leader in inverter segment of BOS with almost 40% international market share. It possesses the cutting-edge competitiveness in the sector. Further, their intention to get established in India is an important filed of concern exemplified by the fact that they have already sold 200 MW inverters in the domestic market and are now eyeing to capture large share of market soon.

Indicator's of SMA Solar Technologies' Competitiveness

SMA Solar Technology AG is the worldwide market leader for solar inverters, a leading supplier of transformers and chokes, and a provider of innovative energy supply solutions for mass transit and main-line rail transportation. SMA Solar inverters are characterized by a particularly high efficiency of up to 99%, which allows for increased electricity production. The multi award winning product range covers solar inverters for roof systems, major solar projects and off-grid systems,

Table 6.3 Summary of players in solar inverter market in India. (Source: List compilation from information through select databases about domestic industry)

Company	Description
Tilak International	Tilak International is a specialized manufacturer of solar charge controllers, solar inverters, solar lantern, solar power packs etc.
Su-Kam	Su-Kam is a manufacturer of solar sine wave inverters
Sterling Systems	It is an ISO 9001:2008 certified company, having high tech infrastructure for manufacturing professional grade systems such as UPS power systems and UPS power inverters
Ammini Solar Pvt. Ltd.	Ammini Solar is a manufacturer of solar lanterns, solar inverters, solar home systems, solar street lighting systems etc.
SR Electronics	Leading manufacturers, exporters and suppliers of electronic equipment like online UPS, solar inverter, digital inverter etc.
Bharat Electronics Limited	BEL is one of the eight PSUs under Ministry of Defense, Government of India
Corporation Limited (Webel SL Solar)	Websol Energy Systems Ltd. (formerly Webel SL Energy Systems Ltd.) is a leading manufacturer of photovoltaic monocrystalline solar cells and modules in India
Usha India Ltd	A multi product consumer durable manufacturing, marketing and distribution company. With a diverse portfolio, they are now focusing on developing low cost solar technology
Udhaya Semiconductors Ltd.	SL was established in the year 1984. The company manufactures Solar PV cells, Modules and Module based systems with a capacity to produce 5 MW cells and 10 MW modules
TATA/BP Solar	Provides complete solutions for deploying a solar power system in the harsh conditions of an offshore rig and several remote terrains
Moser Baer Photovoltaic	Known for CD/VCD's it ventured into Solar field and has developed high standard technology enabled plants for solar PV manufacturing
Maharishi Solar Technology Pvt. Ltd	An ISO 9001:2000 Company exporting its products to countries viz. USA, Italy, Spain, France, Germany, Netherlands etc
Indosolar Ltd	Leading manufacturer of solar photovoltaic cells with 160 MWp capacity and an average efficiency rating of 16+%, peaking at 17.2%
Central Electronics Limited (CEL)	Largest manufacturer of SPV in India. CEL today is also a major international player in industry

enabling SMA to provide a technically optimized inverter solution for all size categories and system types. The highly flexible manufacturing plants for solar inverters in Germany and North America have a capacity of approximately 11.5 GW a year. SMA Solar Technology AG is headquartered in Niestetal, near Kassel, and is represented in 19 countries on four continents with a staff of over 5,300 worldwide. In 2011 SMA reached first place in the federal "Great Place to Work" competition. Since 2008, the company has been listed in the Prime Standard of the Frankfurt Stock Exchange (S92), and also company's shares have been listed in the Tec DAX. It has been given Best Innovator Award category Renewables, by A. T. Kearney and WirtschaftsWoche (SMA Annual Report 2010). Comparison with competitors can be good indicator of competitiveness. Table 6.4 summarizes the financial comparison:

Table 6.4 Comparison of financial statements: leading solar inverter companies (mUSD). (Source: Annual Business Report(s) and Bloomberg Business Week; data as on 2/1/2011)

	SMA Solar	Advanced Energy	Power-One
Total revenues	2596.9	459.4	1047.1
Gross profit	937.5	198.9	406.6
Total operating expenses	238.2	133.2	112.6
Operating income	699.3	65.7	294.1
Net interest expense	2.3	0.5	−6.3
EBT excluding unusual items	702.3	67.8	286.6
EBT including unusual items	700.7	67.4	251.5
Net income	493.7	71.2	147.9

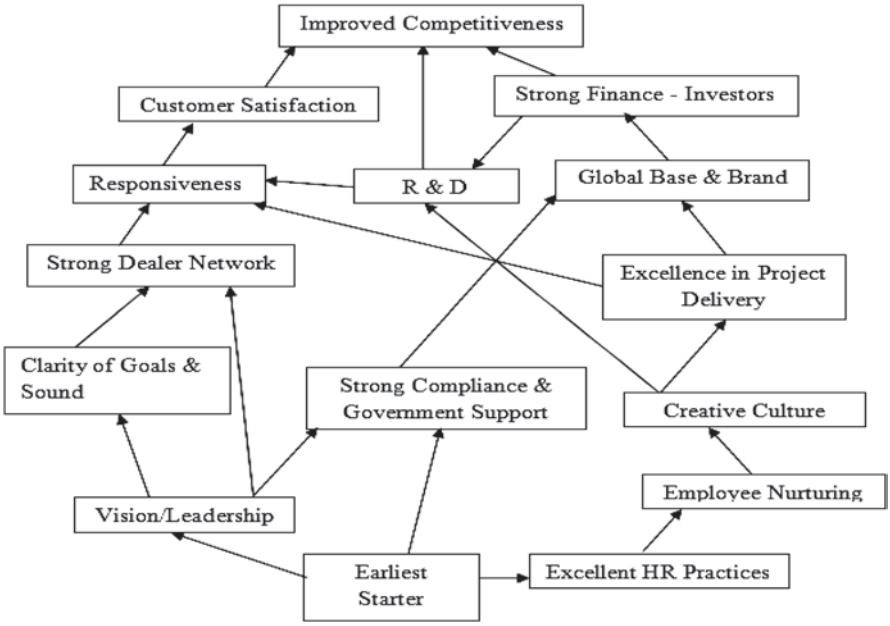

Fig. 6.1 Sources of competitiveness for SMA Solar Technologies Global

It is distinctly visible that nearest of its competitors are not even its half in size. It is the sole leader of the market, but it has to put in more efforts to be expanding and continue the legacy since other players though yet not comparable in financial terms are rapidly growing.

Reasons for Competitiveness of SMA Solar Technologies

Their ability to innovate is a major driver of the competitiveness; reflected by their pursuit of top quality in both product and service. Figure 6.1 depicts sources and reasons of their competitiveness:

Table 6.5 Comparison of financial ratios: globally leading solar inverter companies. (Source: Annual Report(s) and Bloomberg Business Week; ratios as on 30/9/2011)

	SMA Solar	Advanced Energy	Power-One
Return on assets	13.47	9.52	23.91
Return on capital	23.80	13.10	44.39
Return on equity	27.61	15.52	49.22
Gross margin	28.66	41.72	34.88
EBITDA margin	19.04	16.92	24.50
Lev. free cash flow margin	−5.83	−0.22	0.68
SG&A margin	7.67	14.68	7.77
Total assets turnover	1.3	1.1	1.7
Accounts receivable turnover	10.2	4.5	5.1
Fixed assets turnover	7.4	16.9	16.2
Inventory turnover	4	4	5.1
Current ratio	2.4	4.2	2.6
Quick ratio	1.6	3	1.8
Total liabilities/total assets	43.3	23.2	45.3

Open employee communication on all levels, more involvement in the definition of the company goals, joint design of changes, the freedom to structure jobs self dependently, fairness, equal treatment and respect, profit-sharing, and opportunities for further training for individuals are some of the major stakeholders in HR competitiveness paradigm SMA possesses high degree of flexibility and ability to change. Financial success is further adding to its competitiveness as it is far ahead of any other competitor. Strong compliance with laws and other legal regulations of countries where they operate adds to their long term success. Being the earliest starter in the field it has certain accrued advantages. Factors like visionary leadership, quality orientation and spirit of entrepreneurship have been the reasons for constant growth. It is always a first mover in global expansion strategy and tries to explore new markets.

Modern ethos like corporate social responsibility helps it to get closer to society & the customer. The culture followed by it's over 5,300 employees is highly innovative and full of flexibility. Being a giant it has good linkages with administration and government bodies. Strong dealer network provides the best promotion. High responsiveness, strong financial base, flexibility, employee attention and technological innovation add feathers to its cap of competitiveness.

Areas of Concern for Competitiveness of SMA Solar Technologies

Turning to the other side of the coin, SMA needs to focus on its weaknesses to continue its regime. The upcoming companies are expanding at a faster rate. It is due to enhanced product modulation, advertising strategies and rapid innovation adopted by them. SMA needs to come out of the traditionalism to meet the ever changing needs of new customized generation. It is clearly visible that Power One is posing a stiff competition to SMA as far as competitiveness dimensions are concerned.

Table 6.6 Comparison of growth over last year: leading solar inverter companies (in %). (Source: Annual Business Report(s) and Bloomberg Business Week; data as on 2/1/2011)

	SMA Solar	Advanced Energy	Power-One
Total revenue	−8.11	49.92	35.54
Tangible book value	13.53	38.72	57.51
EBITDA	−42.25	74.30	28.93
Gross profit	−31.34	46.28	29.15
Receivables	−8.55	17.42	12.83
Inventory	13.67	39.18	24.57
Diluted EPS before extra	−47.73	63.65	41.25
Capital expenditures	6.44	173.06	97.49
Cash from Ops.	−64.84	−966.45	−69.40
Levered free cash flow	−149.04	−96.90	−94.86

Owing to its huge size, SMA definitely is more than double of Power-One, but, the way it has been growing in past 5 years; definitely it's an alarming situation for SMA. Very clearly visible that power-one is far ahead in capital utilization factor. They have almost clinched 70% more from same money the value than SMA did by generating higher margins on the same sales. Other turnover rations describe the same story more or less.

There is considerable scope for improvement in innovation and product flexibility in SMA. Though it has been in market for almost 30 years but there may be weaknesses in technology management in terms of technology transfer to develop new customer attractive designs. Managing large number of permanent and contractual employee is yet another challenge in the process of fostering innovation throughout the company. However, with its long experience it must focus on its core strengths to improve the scenario.

Looking down to the latest 1 year financial statistics of growth (Table 6.6); the situation looks not so favorable for SMA's growth. The total revenue generated has deflated against very high growth by Power-One and Advanced Energy furthered by sinking gross profits. Product designs, brand awareness, innovative finishing and strengthening distribution channels are key areas to be re-focused. It could also look for forming strategic alliances and mergers in new markets rather than looking to set up its own base each time. In developing and under-developed economies wherein such products have not reached yet, it can almost create new demands, tie-up with their governments; so as to continue the supremacy in the global market through blue ocean strategy.

Summary of Competitiveness of SMA Solar Technologies

Definitely, SMA Solar Technologies is the biggest player in the market. The group has shown very phenomenal success in the past and is still the market leader. The group may be slightly weak on paying attention to factors focused upon by their upcoming competitors, but overall, SMA solar technologies continues to be the world leader in the field. However, it must be vigilant and flexible enough to counter the growth challenge by emerging competitors.

6.6.2 Case II: Sukam Inverters—Prominent Indian Company in Solar Inverters

Su-Kam Power Systems Limited is India's one of the most admired power solutions provider, with a growing presence across India and over 70 countries worldwide. Su-Kam develops intelligent power back-up solutions, engineered to be energy efficient and thus reduce the user's carbon footprint. Very small as compared to global giants but is one of the prominent names in domestic sector.

Indicator's of Su-Kam's Competitiveness

The company sells its products through a strong network of branch offices, channel partners, and distributors. Su-Kam awarded the prestigious Enertia Award' 2011 for Technology and Innovation—Renewable Energy category in recognition of its initiatives in the field of Solar Energy. The CEO, Mr. Kunwer Sachdev was among the Top 10 SME (Small & Medium Enterprises) Entrepreneurs awarded by SME Channels. Top national and multinational companies, service providers, enterprises, governments, research and educational institutions India-wide rely on Su-Kam to deliver products, services and innovative.

It is a pioneer to develop India's first MOSFET based inverter, India's first microcontroller based inverter, India's first plastic body inverter, India's first Home UPS which eradicated the need to buy a separate UPS for computer. It also developed India's first sine wave based inverter. It developed 5 KVA Inverter for AC & Refrigerator (500 KVA). It also developed India's first SMF batteries to be used with inverters. Thus it has number of factors to count on its domestic competitiveness.

Reasons for Su-Kam's Competitiveness

It exports its products to various international markets. The company is based in Gurgaon, India and has strong presence with branch offices in various cities across India. Su-Kam has been selected for the award for its continued focus on R&D and the indigenous development of several products in the solar energy sector. The company has spent over 2% of its turnover on R&D in 2010–2011, making it among the top spenders on R&D in the Indian private sector. The in-house development of products like solar inverters, solar charge controllers, solar PCUs, India's first solar home UPS and more, provides further testimony to both Su-Kam's technological superiority and its commitment to green energy sources. Su-Kam has filed over 70 Patents, 80 Copyrights and 38 Trademarks. It has 53 Designs to its credit. One of the major investors associated with Su-Kam is the Anil Dhirubhai Ambani Group (ADAG) with a market capitalization of $ 81 billion and net assets of $ 29 billion. This name has amply proved its mettle when it comes to business acumen and vi-

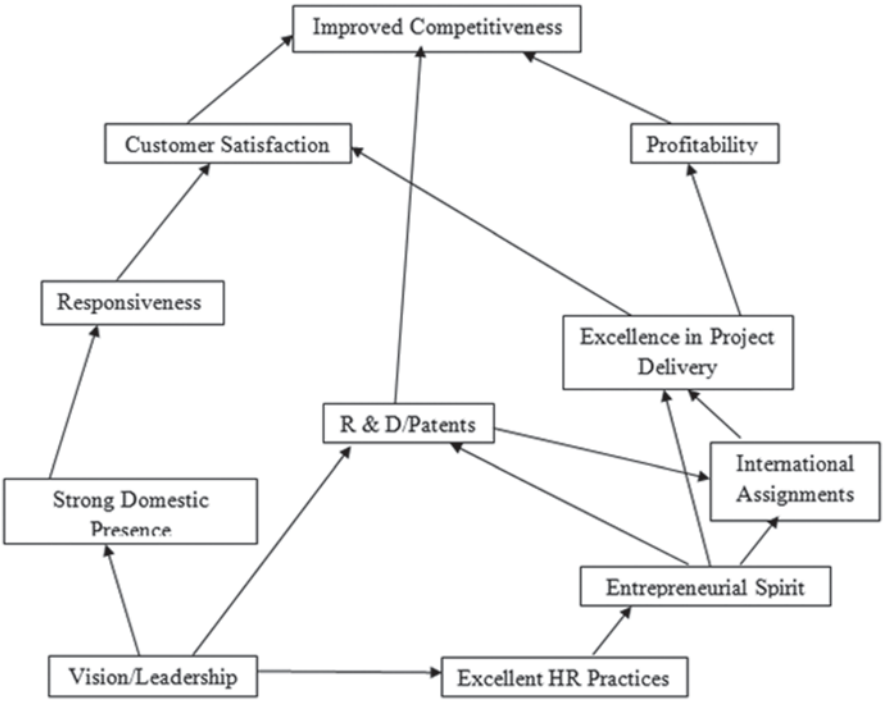

Fig. 6.2 Sources of competitiveness for Su-Kam Batteries

sion. Temasek Holdings is another prominent investor which investment arm of the Government of Singapore managing a portfolio of $ 142 billion. It is one of the few global firms to have been awarded the highest corporate credit.

Areas of Concern for Su-Kam's Competitiveness

Though, Sukam has high number of credits to count on its domestic excellence but to mark a presence on international fore front it will have to strengthen its financial and technological base manifolds. In comparison to global giants like SMA solar technologies or emerging one's like power-one its financials reservoirs stand below 20%. So, the company may not be able to withstand the competition posed by international competitors even in domestic market in upcoming years. Also, it may problems with depreciation of Indian currency as it has significant trade deficit (difference between imports and exports). There needs to be a strong focus on talent acquisition and nurturing the work-force with global technology. It needs to form strategic alliances with global leaders of the field for technology acquisition. Also, it may count upon the domestic technology institutes and organizations to work for technology transfer.

6.7 Development of SAP-LAP Framework for Indian Solar Inverter Industry

SAP-LAP is a holistic framework that aids the process of analysis to generate models for managerial enquiry and problem solving (Sushil 2001). The Situation, Actor, and Process comprise of the SAP framework where the freedom of choice lies with the Actor. A synthesis of SAP leads to LAP which deals with Learning, Action, and Performance. Thus, it is highly important for the stated actors to focus on the learning to do the action so that the sector may give the desired performance. It is very important to understand that through a strategic vision and appropriate R&D the Indian companies may find their sustainability in the sector. Available data and interactions with industry professionals hint at huge opportunity for scale-up in capabilities for Indian players, before the international giants set-up bases to dominate.

Ongoing research on competitiveness of industries in India (e.g. Auto Components, Engineering Construction and Telecommunications; Momaya 2011) hints that the regaining competitiveness and market shares from established international giants is very difficult. For instance, despite massive growth in domestic market, firms in India entered vicious cycles (incl. technological competitiveness (e.g. Mittal et al. 2009) that they are finding so difficult to break. Solar PV can provide opportunities for employment and low carbon development, if key stakeholders learn from past and implement flexible strategies to build capabilities and leverage them for international markets.

6.8 Scenario Building for the Inverter Segment of Indian Solar PV Sector

6.8.1 Introduction to the Scenario Building Technique

'Scenario Building' is an important management technique used in strategy planning and policy formulation (Nasim and Momaya 2008). Although the concept of scenario was first introduced by Berger (1964) the word 'scenario' was reportedly first used by Kahn (1967). A scenario is basically the description of a future situation based on sequence of events leading from the present situation to the future situation (Nasim and Momaya 2008). Scenarios are not projections, predictions or preferences, but alternative futures. It is a story that describes a possible future, identifying some significant events, the main actors, helping people explore what the future might look like and the likely challenges of living in it. (Watt and Davis 2003).There exist various methods of scenario building ranging from quantitative simulations to highly creative methods. To name a few are System Dynamics simulations (Forrester 1961), Harva method, Storytelling etc. (Maira and Scott-Morgan 1997).

6.8.2 Scenario Building—the Methodology

A mix of Harva method and the Shell's method for scenario building is used. The steps undertaken to arrive at the potential scenarios may be broadly enumerated as follows:

1. Decision on the key question to be answered by the analysis
Given the context of the paper, the key question is "What are the actions to be taken to develop the competitiveness of Domestic players in Solar PV Segment in India?" this key question however was finalized after extensive data search and brainstorming reviews.

2. Setting the time and scope of analysis
A usual timeframe of 9–11 years has been considered.

3. Identification of major stakeholders
Although there may be a number of stakeholders, but the major ones considered are Solar PV firms, Government Bodies, institutes and technology research organizations.

4. Mapping basic trends and driving forces
Forces driving changes in these sectors are identified and trends are mapped to for an in depth understanding of the context. SAPLAP analysis of the sector has given important dimensions.

5. Finding key uncertainties
Key uncertainties refer to those driving forces which are important and uncertain (less predictable). In our context, the basic uncertainty lies whether domestic industry progresses due to Sustained Efforts and will be able to capture considerable share of Global Market.

6. Identify and description of the potential scenarios by mapping the uncertainty
Mapping the uncertainty identified above on *xy* axis helps identify the future potential scenario. For our context, four potential scenarios identified (Preferred, Positive, Pessimistic, and Worst scenario) are further explained in detail and represented in the Fig. 6.3.

7. Recommend actions for the stakeholders to achieve the preferred scenario
Having identified the preferred scenario for the future, the next logical step is to identify what needs to be done. For this actions are recommended for the stakeholders, to help preferred scenario come true in the future.

Potential Scenarios for Solar PV Industries in India

Figure 6.4 shows the potential scenarios for the sector and it depends on two uncertainties:

a. Progress of Domestic Industry due to Sustained Efforts
b. Large Share of Global Market Captured by Indian Industries

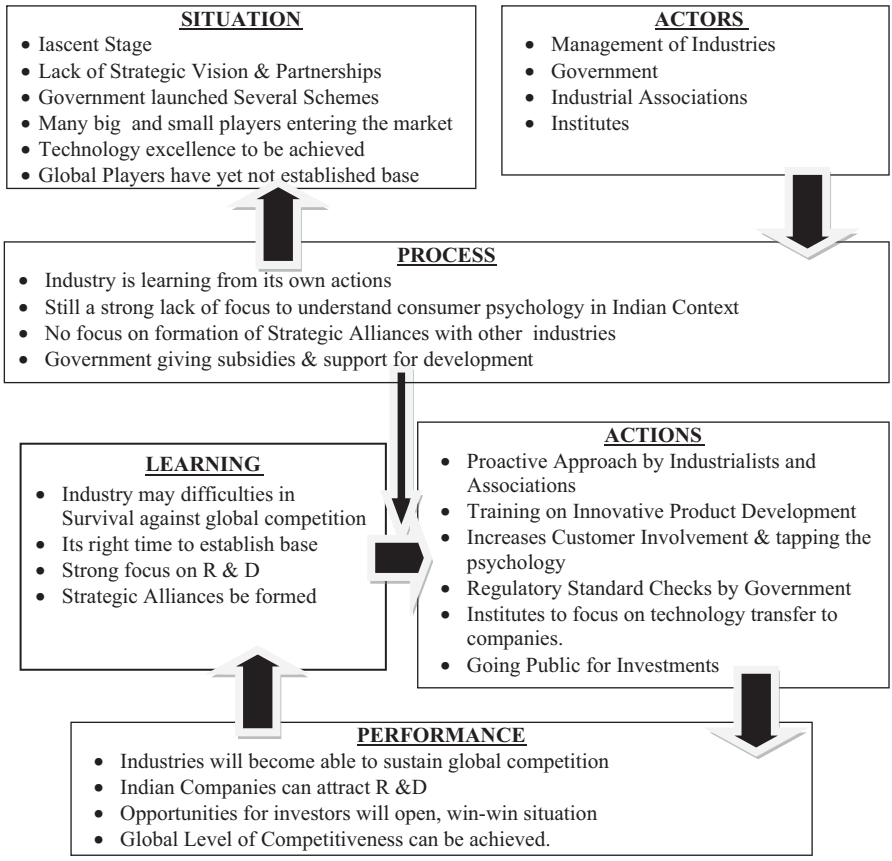

Fig. 6.3 SAP-LAP framework for olar inverter industries in India

Description of the Potential Scenarios…2020

As evident from the Fig. 6.4, four scenarios are described as follows:

Preferred Scenario-2020: India-Global Hub of Quality Solar Inverters There has been a sustained progress of domestic Industry due to high efforts put in by all the actors viz government, industries, technology institutes and now the large share of global market has been captured by Indian Industries, backed by strong R & D and very competent ethos.

Positive Scenario-2020: Flourished Domestic Inverter Segment in the Country There has been a appropriate progress of domestic Industry due to high efforts put in by all the actors viz government, industries, technology institutes and however still the major share of global market has not been captured by Indian Industries. Still the sector is competent enough to survive in the front of global competition and exploring new benchmarks.

Pessimistic Scenario-2020: India-Domestic Players Facing Stiff Competition There could not be appropriate progress of domestic Industry due to entry of strong global competitors who have used the advantage of capital to eat up the market, still due to various efforts put over time industry is surviving but the scenario is too though for their expansion as it needs lot of monetary investment which is being attracted by opponents.

Worst Scenario-2020: India-Domestic Players Lost the Battle to Foreign Companies

The Indian inverter industry almost collapsed due to its archaic methodology. The plans and efforts were only on paper. The global players have established strong base in the country. The monopoly developed by them almost kills any local player entering the market. Even government subsidies could not attract the quality work force and methodology in the sector.

Actions Recommended for the Preferred Scenario

1. Management of inverter firms, related industries and industrial associations:
   - Define your arenas of operation and differentiators carefully.
   - Try to figure out their core strengths.
   - Attempt catch-up in terms of manufacturing, technology management (incl. R&D, Design and Engineering), marketing, internationalization and other capabilities.
   - Try to achieve leading market positions in India and in parallel gain entry and seek growth in key international markets.
   - Encourage research teams to work on product differentiation (e.g. more sturdy products to meet rigorous conditions such as high temperature, salinity, dust, etc.), grid management, compliance and standards.
   - Involve customer to have the development of user-friendly products.
   - Try to form Strategic alliances with certain bigger and smaller partners or consolidate if scale is critical success factor.
2. Government
   - Stress on more Industrial R&D by firms.
   - Try to get international collaborations for the sector.
   - Provide subsidies to the bigger domestic houses entering the field.
   - Have capabilities to at least ensure level playing field indigenous firms.
   - Put a check on foreign industries trying to eat up the domestic sector.
   - Put strict qualitative checks on the industries.
   - Try to give them position in Special Economic Zones (SEZs).

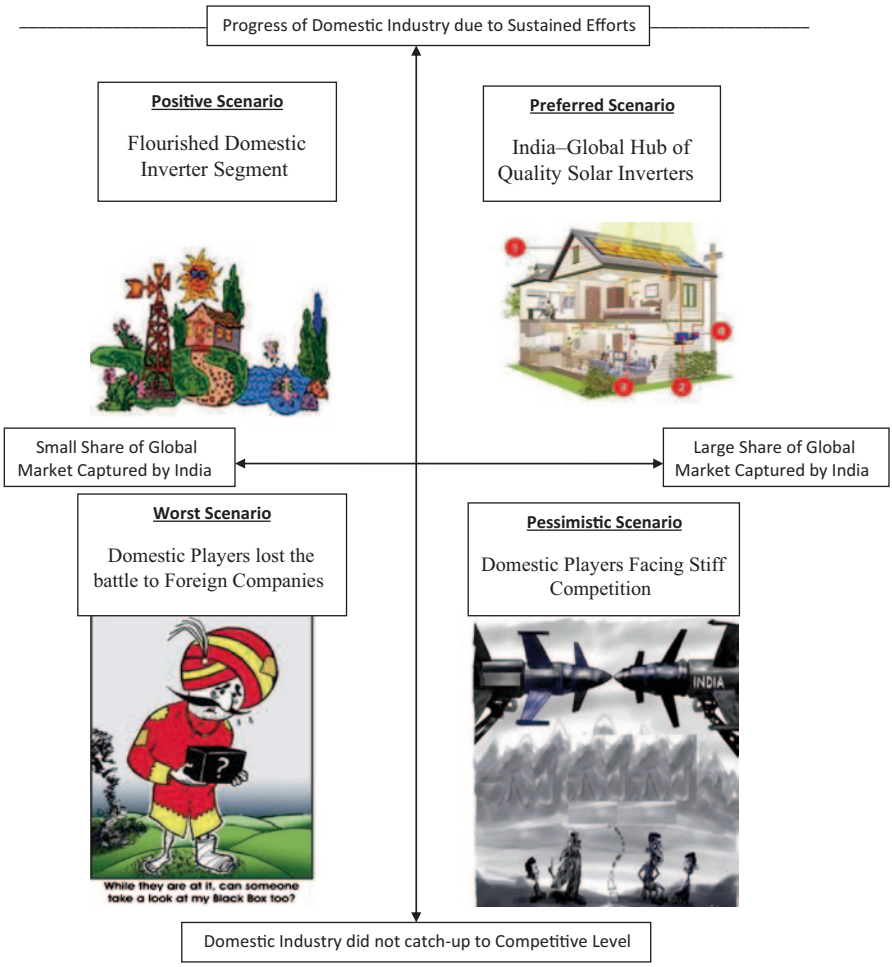

Fig. 6.4 Potential scenario of inverter segment of Indian solar PV industry in 2020

3. Academic and Research Institutes

- Nurture human resources that are much tougher (mentally and physically) to take challenges of competing in emerging industries
- Conduct Training on Best Practices of the Sector.
- Focus on Technology Transfer to Industries.
- Help the sector in goal setting and benchmarking for the industry.
- Foster best project management techniques to industries.

6.9 Concluding Remarks

The solar PV inverter segment in India is still at an infancy stage and needs systematic nurturing. Global giants have rich experiences and are keen to leverage markets in India for growth. The domestic industry still has an opportunity to flourish, if it can act fast before the domestic markets are dominated by global giants. The role of government and research institutions is indispensible for the same. The sector needs to understand the global practices and methodology to develop new definitions of flexibility for growth. Developing competitiveness to a higher stage may be possible, if indigenous firms catch up through sustained efforts in right direction, for which the critical time has arrived.

6.10 Road Ahead for the Work

Lot more research is needed to advance knowledge in this emerging area of competitiveness. Among the long list of firms given above (in Tables 6.2 and 6.3), we plan to carefully select few polar cases that are open to interactions and sharing data, and further benchmark the industries to develop industry specific competitiveness facets and factors. Reluctance of the firms to share data and poor availability or access to quality data poses major barriers to research. Our ongoing research on competitiveness in emerging industries (e.g. Momaya 2001, 2011) hints at critical role of cooperation and policy across levels. Cooperative strategy between two indigenous focal firms, preferably on different parts of the industry value system (e.g. BoS, and EPC player or cell and module manufacturer) can create enormous value for many stakeholders. Examples of progressive states such as Gujarat (already dedicated 600 MW, 2/3 of the 900 MW solar power generated in the country as of 2011) indicate that state and local governments can also play a crucial role, if government at centre can play supportive role. Ballooning trade deficit due to massive imports (e.g. from China) will soon necessitate indigenous value added products (from components to equipments) and that demands rapid scale-up in technological capabilities. These can be fertile areas for building on the research front.

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List of Websites Being Referred (except above)

To get the financial and other information about companies to benchmark their competitiveness:

Company	Website
Tilak international	www.tilaksolar.com
Sterling systems	http://www.sterlingsystems.com
Ammini Solar Pvt. Ltd.	www.ammini.com
Novergy	www.novergy.co.in
Soyo Systems	www.soyosystems.co.in
SR Electronics	www.srelectronics.in
Bharat Electronics Limited	www.bel-india.com
Corporation Limited (Webel SL Solar)	http://www.webelsolar.com/
Udhaya Semiconductors Ltd.	http://www.uslsolar.com/
TATA/BP Solar	http://www.tatabpsolar.com/
Moser Baer Photovoltaic	http://www.moserbaersolar.com/index.asp
Maharishi Solar Technology Pvt. Ltd	http://www.maharishisolar.com/
Indosolar Ltd	http://www.indosolar.co.in/
Central Electronics Limited (CEL)	http://www.celindia.co.in/
Bharat Heavy Electricals Limited (BHEL)	http://www.bhel.com/home.php
Kaco New Energy	www.kaco-newenergy.com/
Fronius International	www.fronius.com/
Satcon	www.satcon.com/
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Chapter 7
A New Perspective for Industrial Competitiveness: Exploring the Role of IITs

Kirankumar S. Momaya

7.1 Brief Background

Discontinuities in world markets and financial meltdown should be considered opportunities to evolve better alternatives for competitiveness and development. The last century and a half, since the industrial revolution, has witnessed unparalleled material development and consumption. The economic model paid less attention to equity and replenishment of natural capital, threatening the future progress of humanity by challenges posed by increasing income inequalities, widespread poverty, terrorism and alarming degradation of the environment. Symptoms have become visible in phenomenon such as global warming and climate change, which impacts the poorer sections even more; Indian sub-continent will continued to be the home to largest mass of such sections.

Practices and theories are shaped by contexts and competitiveness also needs relook as the context is changing rapidly. Competitiveness concept and theories have come a long way since the Adam Smith era. Recent theories and concepts articulated in books such as "Competitive Advantage of Nations" (Porter 1990), "Competing for Future" (Hamel and Prahalad 1994) evolved in contextual factors in North America and may need significant extensions, if not replacements as the context is significantly different for populous emerging countries such as India. Since per-capita endowments for several populous countries are very low compared to most developed countries, new perspectives on competitiveness are needed to meet aspirations of masses. For instance, for 17% of the world's population (on average more younger, aspiring and growing) India has only 4% of fresh water resources and 1% of global forest resources.

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India needs industrial development, but of quite different type that complement her strength in sustainability over millennia. Large population and their growing needs, including of latest products of industrial development, may be a root cause of persistent trade imbalances. If India can catch-up on industrial competitiveness, not only employment, but other issues such as balances, equity and environment can also be addressed. With more than half century journey, several old Indian Institutes of Technology (IITs), are better positioned to enhance their contribution to industrial competitiveness through technological and other innovations.

This perspective paper is organized as following. We begin by quick review of trends in competitiveness journey of India. The need for scale-up in competitiveness is assessed. Preliminary findings from ongoing research about institutional competitiveness are highlighted to identify areas for further research. A unique contribution of the paper may perhaps be more balanced perspectives, building on more than decade and a half diverse experiences in the Indian, North American as well as Japanese contexts.

7.2 Competitiveness Journey of India

Youth is among the most exciting stages in competitiveness journey of a country. Most countries aspire to be developed; very few achieve it at the pace that also matches with aspirations of masses. With several countries in Asia and Europe progressing quite effectively, the aspirations have been rising in India. Success in climbing to double digit growth rates, sustaining them and climbing up the ladder demands industrial competitiveness and rapid scale-up. A country's youth can drive the exciting stage in its competitiveness journey.

Scale-up in competitiveness is quite an exciting and demanding concept. Competitiveness is an interdisciplinary area having relevance across levels: country, industry, cluster and firm. In context of firm, drivers and enablers can be from any function, e.g. Operations, HR, marketing, finance or technology. We will attempt to simplify it for benefit of readers who are actively striving for such a scale-up irrespective of their context: corporate, government or institutions. We considered many perspectives on competitiveness and popular definitions to experiment and evolve generic definitions and frameworks to evaluate competitiveness (Momaya 1998, 2001; Banwet et al. 2002; Ajitabh and Momaya 2004). In this article, the focus is on the macro: a key dimension of scale-up for country competitiveness. In simple terms, a country's competitiveness can be defined as its capability to produce goods and services that meet the test of local and international markets while simultaneously enhancing the real wealth of its citizens (CC 1984). In practice, it is evaluated as a relative competitive position and is measured on more than 200 criteria including the best of Prof. Porter's Diamond Framework and its extensions including more relevant human factors. Data for benchmarking in our research is taken from a comprehensive country competitiveness report after careful analysis (for details, please see Momaya 2011a): National Competitiveness Research.

Table 7.1 Trends in competitiveness ranks of India and select countries. (Sources: Developed based on data from National Competitiveness Research (various years))

Country	Per capita GDP US$			National competitiveness research year of survey				
	2009	2008	2007	2009	2008	2005	2004	2003
USA	46,381	46,716	46,849	2	1	1	1	1
Canada	39,669	42,030	39,901	3	4	2	3	8
Australia	45,587	47,498	43,752	7	10	15	16	14
Japan	39,731	38,443	40,207	20	16	19	19	30
Korea	17,074	19,115	16,740	23	22	22	25	27
China	3,678	3,263	3,593	17	20	24	32	31
India	*1,031*	*1,068*	*904*	*28*	*33*	*47*	*42*	*42*
Out of no. countries	67	67	67	67	67	66	68	56

Ranks for India in NCR in 2006 and 2007 were 38 and 32 respectively

The significant leap in competitiveness that India has achieved in the last 4 years is indicative of the challenging opportunities on the road ahead. Rarely in the past has India jumped that high on competitiveness ranks as in the last half decade—from 47 to 28 (see Table 7.1). China's massive scaling up over several decades with double digit growth enables it to jump to rank 4 in the large strong country group and it is aiming for rank 2 within few years. Vast gaps in per capita GDP of India as compared to developed countries hint at huge potential opportunity. While some leaders in G7 can say that Indians should be content with development they can have with annual per capita income below Rs. 1 lakh (say about US$ 2,500 by 2015), that may not be acceptable to many in India, particularly the youth teams that have energy and capability to play in challenging arena internationally.

7.2.1 Evolving Working Definition of Industrial Competitiveness

At this stage evolving a generic working definition of industrial competitiveness of a country can be useful. OECD and select serious countries have been evolving definitions of competitiveness at different levels. Building on our ongoing research about competitiveness and context highlighted above a working definition can be proposed as:

The ability of companies and industries of the country to produce goods and services that meet needs locally and internationally, and generate relatively higher factor employment and income levels on a sustained basis.

The above generic definition will require adaptation for specific contexts. For instance, international trade balances has been long accepted as a good proxy for industrial competitiveness in several countries that could actually increase employment and incomes. Glimpse of years of lag for India (if not decades) is given in the facts in the next section.

Table 7.2 Glimpse of positions of select countries on key human factors. (Source: Developed based on data from National Competitiveness Research (IPS 2010))

Country	NCR aggregate ranks on human factor				
	Workers	Politicians	Bureaucrats	Entrepreneurs	Professionals
USA	27	19	17	8	14
Canada	11	9	5	2	11
Australia	20	8	6	9	13
Germany	33	17	22	26	25
Japan	21	27	20	38	24
Korea	47	50	43	18	16
China	2	15	25	31	36
India	*1*	*33*	*31*	*36*	*31*

7.3 Why Scale-Up in Industrial Competitiveness for India Now?

India has been working hard to accelerate its development journey for quite some time and rapid scale-up in industrial competitiveness is necessary to achieve the same. The journey post independence has been remarkable in several respects, but inadequate to meet growing needs of huge population India could not stabilize. Compared to its historical share of output, trade and other contributions to the world, recovery post-independence can be considered marginal. For instance, in the important dimension of industrial development—manufacturing—, India's share in the world was 24.5% in 1750 and 2.4% in 1938. India's share of world trade which was about 2.5% at time of independence shrunk to less than 1% and despite all trade policies, incentives and efforts, remains below 2% with record deficit on trade front every year. For instance, as per RBI data, trade deficit was INR 293,758 crore (more than 50% of exports of INR 574,917 crore) in 2006–2007; too high despite many advantages. If India does not attempt a rapid scale-up in its competitiveness with the best of its youth force available, it will face a massive turmoil sooner or later. The opportunity to catch-up on production (e.g. a simple proxy say per capita GDP, see Table 7.1) is quite huge. Forget about levels of developed countries with low population density, many in India will aspire at least Rs. 2 lakh (about US$ 5000) per capita GDP at constant prices to have some basic needs met, when inflation can be high.

Efforts to lay foundations began quite early but progress on the competitiveness journey has been too slow, particularly on human factors. For instance, organizations such as Indian Space Research Organization (ISRO), Indian Airforce/Army/Navy, Gujarat Cooperative Milk Marketing Federation (GCMMF) and institutions such as IITs that started making impact are now in their 40s or 50s and may be ready for scale-up. Competitiveness research indicates that **human factors** play more important role in scale-up for the stage India currently is. India recently surpassed China to reach rank 1 in terms of unskilled workers (see Table 7.2), transforming them into quality skilled workers is a real challenge. Comparisons with select

relevant countries, hint at big opportunities of scaling lie with stakeholders like entrepreneurs, aspiring intraprenures and professionals playing the most important role. Survey results hint that their education level and international experiences are relatively lower to tackle the massive challenges India is currently facing.

Glimpse of context given above can give us some clues to elements of the new perspectives needed for industrial competitiveness. Urge to think differently about competitiveness and strategy (e.g. Hamel and Prahalad 1994) and to evolve great focal firms has been there. They defined long term as a point of view about one's industry and how to shape it, not far distance returns. Some of India's international powerhouses have been trying to play with international majors and learn. Our ongoing research about competitiveness hints that some industrial houses in India seem to be adapting rapidly to emerging context. While established industrial houses such as Birla and Tata have some interesting elements in their DNA, many other firms also provide some clues. Here are examples of elements in new perspectives:

- Human-centric: human resource development, more balanced on dimensions such as ethics, equity and trust
- Sustainable operations: processes, products, minimize resource wastages and carbon load
- Flexibility: strategic, organizational, operational
- Cooperative: from team to higher levels such as industry-academia and intra/inter firm and industry

Thus "the ability of a business or other organizations to adapt to low carbon operations as well as sustainable business practices will become a critical determinant of competitiveness." We are trying to evolve explicit criteria for the sustainable practices e.g. under the facet competitiveness processes of the "Competitiveness Assets-Processes-Performance (APP)" framework (Momaya 2001), so that organizations keen on differentiating on sustainability can think about actions. Countries that have nurtured strong implementation capabilities for competitiveness through innovation, engineering and technology and achieved sustained industrial competitiveness, such as Japan have been developing alternate innovations and scenarios of carbon reduction; e.g. 25 % from base level of 1990 by 2020 (Komiyama 2010).

7.4 Exploring Role of IITs

Educational institutions should play a key role, they being the places nurturing human factors. Considering constraints, we will focus on case of IIT Bombay, an institution with significant achievements in half a century journey and much higher potential for next phases. Other reason is that, building on learning from experiments done at IIT Delhi, we have initiated an exploratory research on institutional excellence. Concerns about enhancing institutional competitiveness have been felt at policy level and will magnify as the international players in education intensify competition and try to change ground rules. Public institutions need to be more

concerned as they have lesser strategic flexibility compared to private players. With factual record of Indian firms losing market share to international MNC's across many industries and several public sector firms reaching nadir despite booming markets (e.g. Air India, BSNL), public institutions should be more careful. Committee of some of the veterans on "Institutional Competitiveness," constituted by AICTE (2004), have addressed several issues such as benchmarking, curricula, faculty excellence and governance. Unfortunately, very little research has been happening on such critical aspect of institutional excellence, at least in India and many leaders rely excessively on magazine ranking (including international ones) that are less relevant.

IIT Bombay has several achievements and strategic intent to grow and contribute much more in the second half century of its journey. From focus on teaching undergraduates, post-graduate teaching and research are getting more attention. The institute is attracting best of talent the entrance tests permit: students (e.g. more than 60 of top 100 JEE rankers in 2011) and faculty in engineering. Research infrastructure and output is also improving. In next phase of journey, expectations about contribution to industrial competitiveness can rise significantly.

Yet, there are significant opportunities of improvement on several fronts. For instance, R&D, design and engineering (RDDE) can be important enablers of IITBs contribution to industrial competitiveness, but due to less factual accounts there are concerns, e.g. about the structure of engineering R&D (e.g. Sohoni 2011). The agenda and methodology of 'world-class research' was achieved by defining it to be measured by 'papers in international journals.' Jayaram (2011) has highlighted other important aspects such as challenges to quality and meritocracy. The contribution of IITs to dimensions such as **industrial competitiveness** of India is more difficult to define and measure, and hence seem to have received less attention. Our research hopes to draw attention to this key dimension, I feel, of the purpose for which IITs were created.

7.5 Discussion and Select Implications

Nuclear capability, self-sufficiency in food production, an array of indigenous satellites and missiles, an unmanned Moon mission—India's achievements in the scientific domain in recent years have been spectacular (Kalam and Rajan 2010). But we have just begun. In a century that many experts predict can belong to India and China, the realization of the vision of better future for many will require a keen understanding of our needs and this can **only** be achieved by tailoring technology, research and development, design and engineering (RDDE) and **innovations** to the **goal of national development.** While institutions such as IITs and IISc have been contributing their share in such achievements, efforts of Indian industry are yet to help the country achieve balances on trade front; product and technology fronts are much more challenging.

Our ongoing research has identified huge opportunities of scale-up in competitiveness for indigenous firms across industries from automotive (e.g. Sahoo 2010; Momaya 2001) and construction (Bhattacharya and Momaya 2009), to telecom (Mittal et al. 2013), segments of nanotechnology (e.g. Momaya 2011a) and software (Banwet et al. 2002; Ajitabh and Momaya 2004). The scale-up will demand flexibility on many fronts, the most important may perhaps be strategic flexibility on part of key stakeholders. Major shifts in strategic intent (e.g. mission, vision, values) and choices in strategy diamond (e.g. arenas, vehicles, differentiators) may become necessary, but balances of continuity & change (Sushil 2005), should be strived for. We, volunteers at the labs such as Strategy and Competitiveness Lab, are happy to have contributed our fair share for research on topics related to competitiveness.

Giving pointers to young researchers committed to take next level challenges is an objective of this paper. Here are focused implications for the researchers keen to purse challenging careers in academia, industry or governments.

- Think deeply about directions the country and our institutions are heading under influence of multiple stakeholders and market forces. Some attribute the slow competitiveness journey to socio-political compulsions of a so called true democracy; the key question is why the country is too slow to adapt the system that is less conducive to the vision (e.g. 2020), if it can't evolve indigenous one. One may recall that limitations of parliamentary democracy were quite well known to many leaders of India in early 1990s (e.g. Gandhi 1909). Assess if there is need for any major correction in light of the perspectives on competitiveness highlighted above and the need of team leadership (e.g. Momaya, 2011b).
- Among factors of competitiveness given in APP framework (e.g. human resources, strategy, innovation, technology, knowledge,..), identify ones you are passionate about. Think about linkages for scale-up in overall competitiveness of the unit or organization you are focusing and evolve research agenda.
- Journey of playing over next stage (from factor-driven, cooperation-driven to investment- or innovation-driven; Momaya 2011a) can be quite exciting. Explore the options to overcome limitations of factor-driven stage (e.g. gaps in institutions, infrastructure, health, primary education and macroeconomic environment) by jump-start focus on efficiency in key factors such as human resource development (e.g. through higher education), so that similar better position of India in workers (e.g. Rank 1 of India in workers (refer Table 7.2)), can be achieved in other human factors. IITBs contribution to such human factors is less quantified and is an area of exciting opportunity.
- Work with relevant firms or organizations for experimentation.
- Having several similarities with India (e.g. on population density, resource scarcity), Japan seems to have very rich knowledge and achievements on industrial competitiveness. It also seems quite open to cooperation with India, if teams in India are committed and willing to take challenges. Build foundations early on to explore cooperation with Japan and similar competitive countries in East Asia and world.

Based on our ongoing research in strategy, competitiveness, flexibility and related areas, highlighted above, here are some topics for exploration in form of key questions.

- Which industries can be growth engines for the scale-up of India?
- While strength of India in Jugaad is well know, the large country cannot climb up without systematic innovation (e.g. Krishnan 2010) and intraprenureship (e.g. Bhardwaj et al. 2007). Which industries provide better opportunities for systematic innovation from India?
- Which among them have higher sustainability for Indian context (e.g. significantly lower carbon intensities)?
- Some states in India have historically invested in industry or human capital (e.g. Kerala in basic education). Others seem to have been focusing on investment-driven phase for competitiveness. Some have been trying with elements of innovation-driven phase. Role of focal institutes to accelerate competitiveness journey of nearby states (e.g. IITB for Western states), particularly for innovation-driven phase, can provide rich research arena. Which states have higher potential to support internationally competitive clusters in what industries?

7.6 Concluding Remarks

The concept of competitiveness is context specific and has relevance across levels: firm and industry to country. Remarkable strides in macro-competitiveness for India hint at the potential to climb next difficult stages leveraging youth power. Progressive states of India need to scale-up competitiveness massively to meet rising aspirations of masses and climb the next relevant stages such as cooperation-driven and innovation-driven (Momaya 2011a). Such stages demand higher levels of cooperation and industrial competitiveness, where institutions such as IITs were expected to play a lead role. Evolving case of IITB hints at significant contributions, yet bigger challenges as capabilities and expectations rise. Exploratory nature of this paper does not require conclusions, but few remarks based on ongoing research and context of this paper may be useful. New perspectives, only a glimpse of which could be achieved in this paper in terms of elements of one, and the emerging paradigm should be considered opportunities for correction in directions institutions in India are evolving. Human-centric dimension of the new perspective can drive other dimensions to initiate virtuous cycles that can help firms or other organisations to break-out to higher stages of competitiveness. Major changes in elements of strategic intent, culture and environment, processes, systems and structure may need to be implemented effectively with sustained cooperation from key stakeholders. Strategic flexibility balancing continuity and change (e.g. Sushil 2005, 2007) will be needed, if the great institutions that employees and leaders have nurtured over decades are to realize their true potential and play a bigger role. That will also demand team leadership from enduring professionals. Younger, committed and energetic researchers can take bigger challenges and benefit.

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Part II
Organizational and Human Resource Flexibility

Chapter 8
Knowledge Management Process in Organizations and Its Linkages with Flexibility: A Caselets Based Inductive Study

Sumant Kumar Bishwas and Sushil

8.1 Introduction

Concept of knowledge management has been sifted in the current knowledge era. It is becoming more segmented such as knowledge management for marketers, for HR functions and integrating many other activities such as best practices, organizational learning, etc. In early stages, knowledge management was largely considered as IT solutions for business activities but off late it has also incorporated social factors such as communities, personal development, working environment, etc. This second generation of knowledge management considers other concepts like innovation and organizational learning is integral parts of knowledge management (Gloet and Terziovski 2004).

Knowledge is considered as one of the strategic resource of the organization, which can be used for managing the crises. Organizations need different kinds of knowledge strategy for different crisis situations. Wang and Belardo (2009) have defined the interrelationship between the crisis management strategy, knowledge management strategy and performance of the organization.

This study is an attempt to understand the relevance of knowledge management (KM) process for organizational success, identify the key dimensions in the implementation process of KM in various organizations, and to find the interlinkages between these dimensions and other issues like culture, flexibility etc., which is largely based on content analysis of select caselets. Total eight caselets have been considered for this study that are largely focused on the knowledge management issues. The final interpretive structural model (ISM) (Singh and Kant 2008) explains the relationships among the dimensions identified after the content analysis of caselets.

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8.2 Literature Review

For achieving performance excellence worldwide and sustaining that position, it is not enough to focus only on the quality aspects. In current scenario, knowledge management aspects are the ones that organizations cannot avoid if they want to sustain their competitive position (Ribière and Khorramshahgol 2004). To become successful and sustaining growth in this competitive era, organizations need to understand its capabilities and about its competitors and external environment (Gloet and Terziovski 2004).

Knowledge management (KM) is a modern phenomenon; its importance is acknowledged by over 90 % of the companies surveyed for knowing importance of KM in their respective organizations (Call 2005). Organizational knowledge has been defined primarily of two types: tacit knowledge and explicit knowledge (Nonaka and Takeuchi 1995). Tacit knowledge is personal knowledge and is difficult to communicate fully to others, whereas explicit knowledge is the knowledge that can be articulated, coded, and recorded. One can externalize tacit knowledge into explicit knowledge by creating documents, e-mails, reports, memos, etc.

Interaction among individuals is one of the prerequisite for knowledge creation and transfer in organizations. Four modes of knowledge conversion (Nonaka and Takeuchi 1995) take place during interaction among individuals. These four modes are defined as socialization, externalization, combination, and internalization (SECI).

There are also indications that many projects are at times started without clear objectives or managerial support, and being managed by people without experience or appropriate measures (KM Review 2003). Cultural issues are one of the critical issues for success of knowledge management process and act as the first barrier for KM implementation (Akhavan et al. 2006; Spender 2006). Mathi (2004) has also defined culture as one of the key success factors for implementing KM in organizations.

To better manage the knowledge in any organization one needs to build a knowledge infrastructure in the organization. The three core elements of knowledge infrastructure are knowledge culture, technology, and knowledge processes (Sivan 2000). While technology is the most efficient way of managing information, for example documents, records and email, leveraging tacit knowledge requires a much stronger focus on the cultural and behavioral aspects of an organization (Vuuren and Jansen 2008). The interaction for the creation or transfer of knowledge is performed by the individual employee rather than by the whole organization (Nonaka and Takeuchi 1995).

The flexibility in an organization is the outcome of an interaction between the controllability or responsiveness (Volberda 1997) of the organization and the dynamic control capacity of management. This interaction should be made in a way that there remains a balance between the two.

Small firms are more flexible in their initial stage to attract new customers in the market and when they go up to intermediate stage the flexibility level decreases (Grau and Aranda 2006). This is because of the difficulty to make a

balance between attracting new customers and providing services required by them. This problem can be handled by way of making a balance between change and continuity.

Eppink (1978) has defined the relationship between environmental changes and flexibility and classified it into operational, competitive, and strategic flexibility. Organizational 'flexibility mix' defined by Volberda also includes operational and strategic flexibility with structural flexibility (Volberda 1997). Customer interaction and customization are the dimensions that imply the degree of flexibility in the service sector. Customers are more interested in integrated solutions from the same organization rather than a single solution. In the service industry, operational strategy and flexibility are interrelated with each other.

Flexibility has also been defined as the capacity to change and develop new products and strategic issues such as entering into new markets or industries (Volberda 1998). A common problem faced by the managers when dealing with flexibility in organizations is to make a balance between change and continuity process in the organization. Sushil (2006, 2013) has suggested a strategy known as "Flowing Stream Strategy" for managing change and continuity forces (which is one of the key issues in flexibility) in the organization. Nasim and Sushil (2010), in one of the study on e-government projects, found that change can be managed in a better way if continuity is also taken care of.

Managerial capabilities are the critical factors for improving flexibility, which leads to innovation. Management is responsible to develop dynamic capabilities that enhance flexibility. Workplace-related flexibility and innovation performance are interrelated with each other (Sanchez et al. 2009). High innovative firms are normally more flexible compared to low innovative firms. Flexible working time in organizations promote more knowledge building (Brence and Sloka 2010) in organizations and leads to more innovation.

Successful innovation is more than research and development, which is to be transformed into products and services that will add value to the stakeholders. Although the innovation pattern or process are not same for all the industries, Innovative organizations exhibit some common characteristics, competitive innovators understand the fact that it is not the organization which is innovative but innovation is the result of some of the individual efforts in the organization, posses a culture which is proactive in nature, made decisions in the past to become innovative, and are able to leverage resources (Dobni 2008). Innovation, knowledge management process and performance are interdependent phenomena (Hung et al. 2010; Nicolas and Cerdan 2011). An efficient KM process in organization leads to more innovation and high performance.

Managers' perception about innovation depends on the level of customer satisfaction. Innovation should be customer driven for gaining profits and that is possible if the organization has better knowledge of markets and its customers (Ruggles and Little 1997). Nagura and Honda (2001) have given importance to the organization culture for innovation in organization.

8.3 Methodology

This study has been done in two phases. First phase is based on the brief review of literature on knowledge management (KM) issues in general and to identify the dimensions for successful implementation of KM process. The second phase of this study is based on the inductive caselets study, which includes cases of various companies that have successfully implemented KM process. For this study, secondary data sources like journal papers and websites have been used. The case data has been updated whereever possible. The references for caselets have been mentioned after each case. The key issues during implementation of KM process have been identified and discussed taking support from real life practical case examples. Finally, the key dimensions and then interpretation have been discussed.

The content analysis of each caselet has led to the identification of keywords that have been used to identify dimensions of KM process and linked issues such as innovation and flexibility. These are, finally, summarized in a tabular format and the linkages of these dimensions as observed in case situations are also mentioned. Finally, an interpretive model has been developed using ISM method for defining the linkages between these dimensions.

8.4 Caselets Study

The cases selected for this study are mostly concerned about knowledge management issues with some other perspectives like innovation and flexibility. The cases are selected with a broad overview of literature and not limited to a particular sector or geographic region. Most of the cases are summarized as given below.

Caselet 1: Advanced Semiconductor Engineering Group (ASE)

ASE was established in 1984. It is one of the world's leading providers of semiconductor manufacturing services, including IC packaging, IC testing, and IC materials. ASE has classified its business strategy into three parts. First focuses on the continuous innovation, diversification, and flexibility perspective to exceed customer expectations and satisfy their needs. Second was on emphasizing execution, having effective quality assurance, controlling cost and discipline in order to achieve high quality growth, and to build up the contents of the knowledge management system. The third and last part was related to the personal and cultural perspectives. The focus is on strengthening the training and evaluation system, elevating personnel quality and loyalty, raising the contribution of every personnel, and establishing a culture of enthusiasm and a keen sense of responsibility.

ASE gives emphasis to the "cultivation of environments" for the knowledge management strategy. ASE has started knowledge management in 1998 and has formally established a knowledge management center (as a part of knowledge infra-

structure development) in January 2001 with a focus on planning and implementation of knowledge management for the ASE Group's engineering, R&D, and quality assurance departments. The center first educates and promotes the implementation model of knowledge management to every department and then based on its own culture, each department adjusts the implementation and evaluation process. This kind of system helps to gain support from the senior managers and to reach a common understanding of knowledge management. The key problem in initial phase was to communicate continuously to the top management about the relevance of knowledge management in the organization.

As a part of its culture, ASE requires every employee to produce one to two teaching materials within six months of employment according to the reference sample. These materials are being used in KM platform after the approval from experts. This process not only increases the feeling of accomplishment as the employees share their knowledge but also facilitates mutual knowledge management enablers. This kind of sharing culture increased the amount of knowledge transfer and strengthened the quality of the knowledge structure, which ultimately reaches to effective sharing, and flowing of information. For encouraging innovation among the employees, ASE used the method of expert evaluation. The proposal by the employee is first placed in the knowledge management platform, and then it is being evaluated by the experts and after approval; it is further promoted for execution among the employees. The employee giving the proposal has been cited and rewarded. ASE setup the knowledge management center as a dedicated unit to promote knowledge management in order to show the support from top management concerning the company's policy and determination in executing knowledge management in the company (Yeh et al. 2006; http://www.aseglobal.com/content/1–9.htm.).

Caselet 2: VIA

VIA was established in September 1992 with an investment capital of US$ 0.405 billion. It operates in the area of core logic chipsets, low power × 86 processors, advanced connectivity, multimedia, networking, storage silicon, and complete platform solutions that are driving system innovation in the PC and embedded markets. The aim behind implementing the KM process was to provide "anytime, document in hand" in order to meet the demands of the customers and to satisfy their needs.

It initiated various ways of knowledge management (patent management, proper documentation etc.) to meet the different knowledge needs in different departments without announcing it in a formal way. The belief was that the first step of knowledge management implementation is to have all the top managers to agree and recognize the importance of knowledge management and support it. After getting the top management support, various methods can be used to help the department heads to reach an agreement on the strategy of knowledge management.

A flexible corporate culture inspired the employees to work on new projects with freedom and provide support to each department manager to act as a supporter to help the employees. It fully utilizes its corporate culture in facilitating knowledge management. First, it lets the department managers identify the importance

of knowledge management, and then allows each manager to implement it within his/her own department. Every department has different indicators to evaluate the extent of knowledge management. VIA believes that the implementation of knowledge management varies depending on the type of industry and corporate culture. The implementation of knowledge management in VIA is mainly because of the acceptance of the top management (Yeh et al. 2006).

Caselet 3: Ernst & Young (E&Y)

This organization was formed by Arthur Young and Ernst and Whinney in 1989. Some of the services offered by this organization are in the area of Audit, Tax, and management consulting. According to its strategic plan, announced in 1993, operational vision has been defined into five key processes: (1) sales; (2) service; (3) delivery; (4) people; and (5) knowledge. Goals had been defined for knowledge processes some of which are like capturing and leveraging knowledge from consulting engagements, every consultant contribution to the firm's stock of knowledge, to known by clients as a valued source of knowledge and thought leadership. E&Y believes that there is a requirement to make a balance between stability and rapid change. Being a flexible organization, this balance can be made easily (http://www.ey.com/GL/en/About-us.). This organization recognized as a leader in knowledge management strategy, culture, processes, and infrastructure.

E&Y had created three centers to create new knowledge (the Center for Business Innovation), structuring the knowledge into methods and tools (the Center for Business Technology), and gather and store the knowledge acquired by the firm as well as external knowledge and information (the Center for Business Knowledge). The accessibility to knowledge resources and technology helps to develop a culture of teamwork. A continuous improvement in infrastructure, incorporating new technology, leads to better idea exchange. This kind of knowledge infrastructure helps members to levereage all kinds of knowledge from anywhere in the world.

Some new designations and committees were made for development purpose of these processes like John Peetz had been appointed as first Chief Knowledge Officer and was responsible for looking over the knowledge related processes and technologies of the firm. A Knowledge Process Committee, consists of senior consulting partners, had been formed for advising the directors of the three centers. Commitment of people, who address the importance of managing knowledge, who leverage knowledge to support productive, practical service for customers, participation in knowledge sharing networks, rewards for knowledge sharing, training in knowledge-sharing as a part of new hire orientation program and at each level, are some of the dimensions of its knowledge culture.

The Center for Business Knowledge (CBK) expanded its functions and became more focused towards knowledge strategy and tactics. Another key task of the CBK was to develop a knowledge architecture and classification to focus on knowledge acquisition and retrieval. It was important to focus KM in specific domains with the maturity of the initiatives taken. The knowledge architecture would help to

specify the categories, terms in which the organization needed to gather and store knowledge, and it could be used also in searching databases and document files and helped the consultants and knowledge facilitators (Akhavan et al. 2006; http://www.ey.com/GL/en/About-us.).

Caselet 4: Siemens

Siemens' Information and Communication Networks (ICN) Division provides telecommunication solutions globally and is active in more than 100 countries. Since mid-1990s, Siemens ICN was facing problem with its old business model because of the massive change in market scenario. The members who were on the front lines of the organization are more familiar with the latest development and changes and the company was forced to rely on these people to deal with the change forces. Sales people had to act more and more like consultants. The skills like business analysis, business development, network planning, and outsourcing were on high demand suddenly. Solution selling had been considered as an important value-adding activity for the organizations. Doing these things rightly means identifying best practices quickly, sharing them on a global scale and making sure that they were reused for profit in similar settings.

A "global knowledge sharing network" named as ShareNet was developed within the organization for sharing the knowledge globally. This covers both explicit and tacit knowledge, related to sales value creation process including project know-how, technical and functional solution components, and the business environment. This has both structured and less structured spaces like chat rooms, community news, and discussion groups on special issues, for promoting knowledge sharing.

The focus is more on experience-based knowledge, i.e. it's not in the format of official "brochureware" rather knowledge will be available in form of personal statements, comments, and field experience gained during sales projects or about the real-life solution.

The knowledge elements that are related to each other can be linked with each other and stored in a better-managed form. This knowledge can be from within ShareNet and any other web-based system inside the organization or with other network outside the organization. The whole community can comment on the contribution made by any person in the same manner like the book reviews in online bookstores. This method of virtual collaboration via a website complements the traditional ways of co-operation using telephone conferences and personal meetings. This kind of network provides even richer exchange of knowledge and helps to build trust and a sense of teamwork among the community members.

To support and foster the development of knowledge management efforts in the organization some new designation have been set up. A 'ShareNet Manager' was there in every local company who was responsible for supporting the members in his/her organization and to ensure that ShareNet remains an integral part of their work. Providing training to the new users, fostering intra-organizational re-use, promoting the "philosophy" of this with all stakeholders in his country, and promoting success stories to attract more "power users" are some of the steps that can be done

to get the maximum benefit from this. A Global Editor is the main contact partner for the ShareNet Managers who is responsible to coach them for success, trigger the content quality review process and serve as a community manager with regular news and updates.

Combinations of individual and organizational measures drive knowledge contributions in Siemens. Members are benefitted from ShareNet for their daily business in terms of saving time and receiving quick answers for a problem and have an inclination to give something back to the community. Often, it may happen that the real subject matter experts may not be identifiable on a simple organizational chart rather than they work hidden somewhere in the world without much publicity. With the contributions by these experts, ShareNet makes these "hidden champions" visible to the global organization and to the board, who have the responsibility for regular checking and promoting of these experts. A web-based incentive system has been developed for promoting the contribution. For any valuable contribution, members have been given ShareNet "Shares" or bonus points that can be redeemed for prizes and can be used for acquiring more knowledge by way of participating in conferences, courses and seminars depending on their own interests. Both contributors and re-users of knowledge are rewarded for sharing their experiences (Akhavan et al. 2006).

Caselet 5: Company A

The Company A is an international consulting firm. The focus is on the key areas of infrastructure and transportation. The company has given the responsibility to specific individuals for coordinating the knowledge management activities. Company A has the strong continued support of top management in establishing formal policy on knowledge sharing, encouraging employee participation through rewards, and committing substantial resources to the learning effort.

This company, because of its diverse geographic locations, faced problem of cultural differences. The information system was developed to focus on individual business sectors rather than overall organization requirements. Due to different cultural backgrounds, Company A was facing difficulty in implementing the knowledge sharing process in the whole organization. In this kind of environment, information systems may not provide the final answer for establishing learning strategies in the organization. They can erect the barriers that prevent the implementation process of strategies. As a key strategy, to enhance the knowledge sharing in the organization it has given extensive importance on working with individuals. In each case, communication of goals, objectives, and long-term plans are considered the core of successfully obtaining its objectives (Chinowsky and Carrillo 2007).

Caselet 6: 3M

3M has given more importance on the "tacit to tacit" knowledge conversion process. The 3Ms are said to stand for 'meetings and more meetings' itself explains the extent of focus of this organization towards KM process. The organization believes

that one can't order its members to share their knowledge and become creative. Motivation is the key factor which pushes people to come forward for KM, and innovation process. Effective knowledge management and innovation are parallel to each other. It has developed a kind of culture that is flexible enough for the employees to use their time in some innovative process other than their regular work. Further, a successful innovation works as a catalyst for others to work in a flexible manner for contributing more. An atmosphere of generosity, freedom and safety flourishes the innovation process.

3M believes that for successful innovation, organization needs vision (what it wants to be), foresight (a knowledge of where the world is going), understanding core competencies (which will assist in setting knowledge management priorities), stretching of goals (which in the case of 3M requires every single business, no matter what its history, to have at least 30% of its sale from products not in the line four years ago), giving more freedom to its employees, and setting an enabling atmosphere. Top management in the organization encourages the knowledge linkages as their major duties. Trust is one of the important factors for innovation and KM processes.

3M has a learning and experiment supportive culture. It brings people together (activities like technical audits of the various labs regularly) from diverse background which results in the generation of new ideas. Its well-known 15% rule has supported the growth of innovation process a lot. Money and time are the two basic requirements for innovation. The 15% rule deals with the time issue and two grants (Genesis and Alpha) were being given for meeting the money issue. A number of award programs were there in the organization to promote the innovation process (Brand 1998).

Caselet 7: Deloitte Touche Tohmatsu

Deloitte LLP has a single focus towards customer satisfaction, i.e. "serving clients and helping them solve their toughest problems". In USA, the organization has about 45,000 professional organizational members. It works mainly into four key areas: (1) audit; (2) financial advisory; (3) tax; and (4) consulting. It believes that its strength comes from combining the group talent to address client's needs.

The organization had brought knowledge management, HR and leadership, and learning functions together under "People and Knowledge" group. It created opportunities (like organizing informal lunch) for supporting the informal communication among the members like developed learning programs, organized knowledge-sharing lunches etc. As a knowledge audit process the organization focused on the client and partners both. What kind of services partners are providing and how, what are their key strength areas, what are the requirements of the client's side etc were some of the issues taken in the audit process.

It also improved its reward structures; it was alighned with knowledge sharing, and collaboration activities for promoting the conversation, feedbacks, concern and trust among members. This kind of cultural shift helped in knowledge sharing. The awareness at senior level was increased which was also a positive point for KM.

TANGO, a knowledge simulation game was developed as a part of learning process and to determine the knowledge-based strategy for the company (http://members.optusnet.com.au/~cristownley/pdf/KMreviewfinal.pdf; http://www.deloitte.com/view/en_US/us/About/index.htm).

Caselet 8: Mahindra Satyam

It's a leading company in area of information, communications and technology (ICT). It's a part of Mahindra Group, an $11.1 billion group and one of the top 10 business houses based in India. The company provides services in the domain of business consulting, information technology and communication services. The interests extend to automotive products, aviation, components, farm equipment, financial services, hospitality, information technology, logistics, real estate and retail. The company has its presence in more than 35 countries with development centers in about 10 countries. The company has more than 28,000 employees and serves a large number of clients, including several Fortune 500 companies.

The company's values focus on customer first, good corporate citizenship, individual dignity, professionalism, and quality aspects that lead to customer satisfaction. It has a dedicated KM team for continuously recording the organization's knowledge, upgrading and disseminating it across the enterprise. It helps the professionals to develop and maintain the capabilities and to know the way to succeed in a rapidly changing business environment. The other key consideration in KM process is company's ability to transform its knowledge into stakeholder value.

The company's KM initiatives have built hard and soft infrastructure for reflection, idea exchange, knowledge documentation, and formation of horizontal networks of practice communities. Some of the KM initiatives taken by Satyam are: (1) K-Window- includes a knowledge repository that contains documents related to best practices, case studies, offering services, projects, customers, competitors and alliance partners; (2) *Pathshalas* (Learning Sessions)—Highly interactive, informal knowledge-sharing sessions for capturing and sharing tacit knowledge; (3) Blog- A powerful communication medium that enables associates to share best practices/ideas and express opinions.

Based on the eight criteria listed below, Satyam was enlisted in top 16 out of 69 organizations among the winners of Asia's Most Admired Knowledge Enterprise Awards (MAKE) for its lead in KM process and for creating value using its knowledge through innovation, product or service excellence and operational effectiveness.

The eight criteria are: (1) Transform enterprise knowledge into shareholder value; (2) Deliver knowledge-based products/solutions; (3) Create a knowledge-driven culture; (4) Develop knowledge workers through senior management leadership; (5) Maximize enterprise intellectual capital; (6) Create an environment for collaborative knowledge sharing; (7) Create a learning organization; and (8) Deliver value based on customer knowledge (http://www.mahindrasatyam.com/media/pr4oct06.asp.; http://www.mahindrasatyam.com/bpo/documents/eSCM-Transformation-of-Satyam-BPO.pdf.; http://www.mahindrasatyam.com/corporate/about_us.asp.).

Table 8.1 Dimensions identified from caselets

Dimensions	Organizations								
	ASE	*VIA*	*E&Y*	*Siemens*	*Company A*	*3M*	*Deloitte*	*Mahindra Satyam*	*Total no. of caselets supporting this dimension*
KM strategy	Y	Y	Y		Y		Y		*5*
Knowledge sharing	Y		Y	Y	Y	Y	Y	Y	7
Top management support	Y	Y		Y	Y	Y			*5*
Knowledge application			Y						1
Trust				Y		Y	Y		3
Knowledge audit							Y		1
Knowledge arch/infra			Y	Y			Y	Y	*4*
Knowledge creation			Y						1
Culture	Y	Y	Y		Y	Y	Y		*6*
Innovation	Y		Y			Y			*3*
Flexibility	Y	Y				Y			*3*
Resource allocation			Y		Y				2
Change force				Y					1
Reward			Y	Y	Y	Y	Y		*5*
Motivation						Y			1
Collaboration				Y			Y		2
Learning							Y		1
Knowledge transformation								Y	1
Customer satisfaction	Y	Y					Y	Y	*4*
Total no. of dimensions in each caselet	7	5	9	7	6	8	10	4	

Y—represents that these dimensions are reflected in the respective caselet

8.5 Synthesis and Discussion

The dimensions for successful implementation of KM process in organizations have been represented in Table 8.1.

Table 8.2 Dimensions chosen for ISM development

Dimension Code	Dimension
K1	Knowledge management strategy
K2	Knowledge sharing
K3	Top management support
K4	Trust
K5	Knowledge infrastructure
K6	Culture
K7	Innovation
K8	Flexibility
K9	Reward
K10	Customer satisfaction

8.5.1 Nature of Relationships

Out of eight organizations chosen for this study, KM strategy, knowledge sharing, top management support, trust, and knowledge infrastructure are some of the issues that are considered more important dimensions for success of KM process. Other than these dimensions, the organizations have further identified the importance of culture, innovation, reward system, collaboration, allocation of resources, and flexibility. Table 8.2 shows the dimensions selected (dimensions having presence in three or more than three cases) for ISM model development and Table 8.3 represents the interrelationships between the dimensions identified from the cases.

The interrelationships presented in Table 8.3 explains that knowledge infrastructure is strongly affecting the knowledge sharing process in the organizations. Similarly, organization culture affecting the knowledge sharing process in a strong way and reward system is having a high impact on the knowledge sharing and innovation process in the organization. The interrelationships are shown in Table 8.3.

Figure 8.1 exhibits the Final ISM model *representing* the relationship among the dimensions. The details of the step by step outcome are given in the Appendix. The steps for this model development are:

1. First, we make a reachability matrix from Table 8.3. If there is any relationship than that block has been filled with 1 else the value given is 0 (Appendix 8.1).
2. This matrix has been checked for transitivity and a transitive reachability matrix has been created (Appendix 8.2).
3. From this transitive reachability matrix, reachability and antecedent sets have been defined and partitioning has been done. The factors which have common reachability and intersection sets marked as level 1 and repeat the steps 3 after removing that dimensions from the table. The first and the final partitioned tables are shown in the Appendix (Appendix 8.3).
4. The final partitioned table and Digraph are given in Appendix 8.3**b** and Appendix 8.4 respectively.

Table 8.3 Interrelationship between KM dimensions

Dimension Code	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10
K1		Company A			E&Y, Deloitte	ASE				
K2							3M			
K3	VIA	Company A			Siemens			VIA	Company A	
K4		Siemens					3M			
K5	Deloitte	E&Y, Siemens, Mahindra Satyam		Siemens		A, ASE	ASE			Siemens
K6	ASE, Deloitte	ASE, Company A, Deloitte, 3M, E&Y			E&Y		3M, ASE	VIA		
K7		3M						3M		ASE
K8							3M			ASE
K9		ASE, E&Y, Siemens		Deloitte			ASE, 3M, E&Y, Siemens, A, Deloitte			
K10										

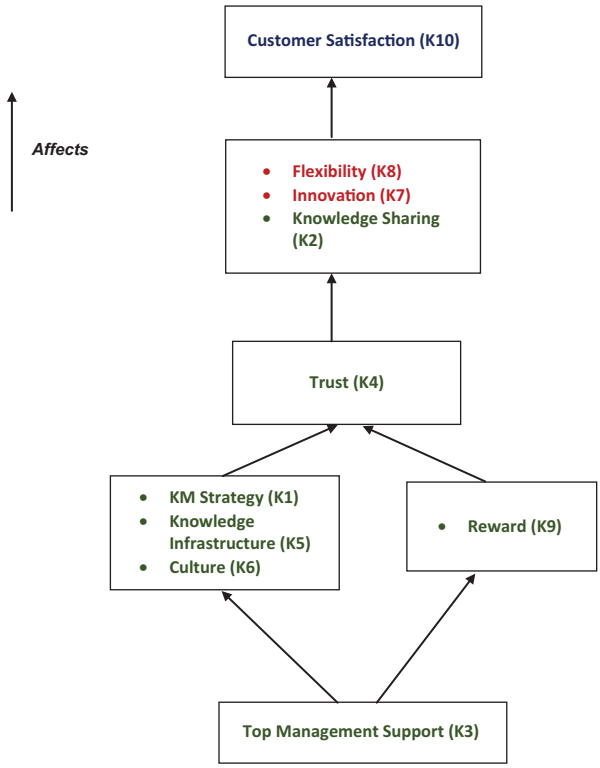


Fig. 8.1 Interpretive structural model: key knowledge management issues

The model shows that top management support is the top most driving factor while customer satisfaction is the major dependent factor. Knowledge management strategy, knowledge infrastructure, culture, and reward system come in the second level of driving forces. These four factors enhance more trust among the organizational members, which leads to knowledge sharing.

Knowledge sharing, Innovation and flexibility come at the same level, i.e. they are interrelated with each other. In one-way innovation, affects the flexibility in the organization and an organization having more flexibility tends to be more innovative in nature (Sanchez et al. 2009). The findings suggest that integration of knowledge management process with other processes lead to more efficient innovation (Xu et al. 2011).

The more sharing of knowledge will increase the possibility of more innovation in the organization and high innovation level will motivate people to come forward and participate in knowledge sharing process. Flexible work environment provides enough time to participate in activities other than the daily routine work that leads to more knowledge sharing and innovation. These all, Finally, Lead to the customer satisfaction, which is one of the key determinants of organizational performance. These findings support the statement of Ruggles and Little (1997) that innovation and flexibility should be focused on customer satisfaction. Sharma et al. (2010) also found the similar finding that concerning flexibility in strategic process of organization leads to better performance and competitiveness.

There is a clear indication that a supportive culture is one of the important dimensions for knowledge sharing in organizations. A good infrastructure like accessible database, proper maintenance of documents etc leads to better sharing of knowledge in the organizations. Rewards and innovation process are closely related. Rewards give a recognition to the person and a feeling or proudness, who contributes in innovation process. This kind of culture pushes the innovation in the organizations.

Knowledge infrastructure also contributes in strategy development process for knowledge management implementation in the organizations. KM strategy should be developed keeping in mind the available and required infrastructure.

8.6 Conclusion

This study has been done to identify the key issues in knowledge management implementation process and its relationship with other dimensions like innovation, flexibility, culture, etc. Knowledge management strategy, top management support, knowledge sharing, knowledge infrastructure, trust, and reward system are the key issues identified for knowledge management implementation process. The other issues, which effect the KM process and having strong relationship, are organization culture, innovation, flexibility, and customer satisfaction. Out of these dimensions, top management support has come as the key driving factor while customer satisfaction is the highest depending factor. All the knowledge management components, finally, lead to innovation and flexibility in the organization, which helps to satisfy the customer needs/expectations and achieve the highest customer satisfaction level.

This study is based on literature review and caselets study only. The study is based on secondary data. Eight cases are taken for this study; more number of cases can be taken in future for further generalization. This result can be further tested empirically using primary data. A detailed case study can be done to validate the current model and generalize it.

Appendix

Steps of Interpretive Structural Modeling

8.1 Reachability Matrix

Dimension Code	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10
K1	1	1	0	0	1	1	0	0	0	0
K2	0	1	0	0	0	0	1	0	0	0
K3	1	1	1	0	1	0	0	1	1	0
K4	0	1	0	1	0	0	1	0	0	0
K5	1	1	0	1	1	1	1	0	0	1
K6	1	1	0	0	1	1	1	1	0	0
K7	0	1	0	0	0	0	1	1	0	1
K8	0	0	0	0	0	0	1	1	0	1
K9	0	1	0	1	0	0	1	0	1	0
K10	0	0	0	0	0	0	0	0	0	1

8.2 Transitive Reachability Matrix

Dimension Code	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10
K1	1	1	0	1[1]	1	1	1[a]	1[a]	0	1[a]
K2	0	1	0	0	0	0	1	1[a]	0	1[a]
K3	1	1	1	1[a]	1	1[a]	1[a]	1	1	1[a]
K4	0	1	0	1	0	0	1	1[a]	0	1[a]
K5	1	1	0	1	1	1	1	1[a]	0	1
K6	1	1	0	1[1]	1	1	1	1	0	1[a]
K7	0	1	0	0	0	0	1	1	0	1
K8	0	1[a]	0	0	0	0	1	1	0	1
K9	0	1	0	1	0	0	1	1[1]	1	1[a]
K10	0	0	0	0	0	0	0	0	0	1

[a] Transitive link

8.3 Partitioning

a)

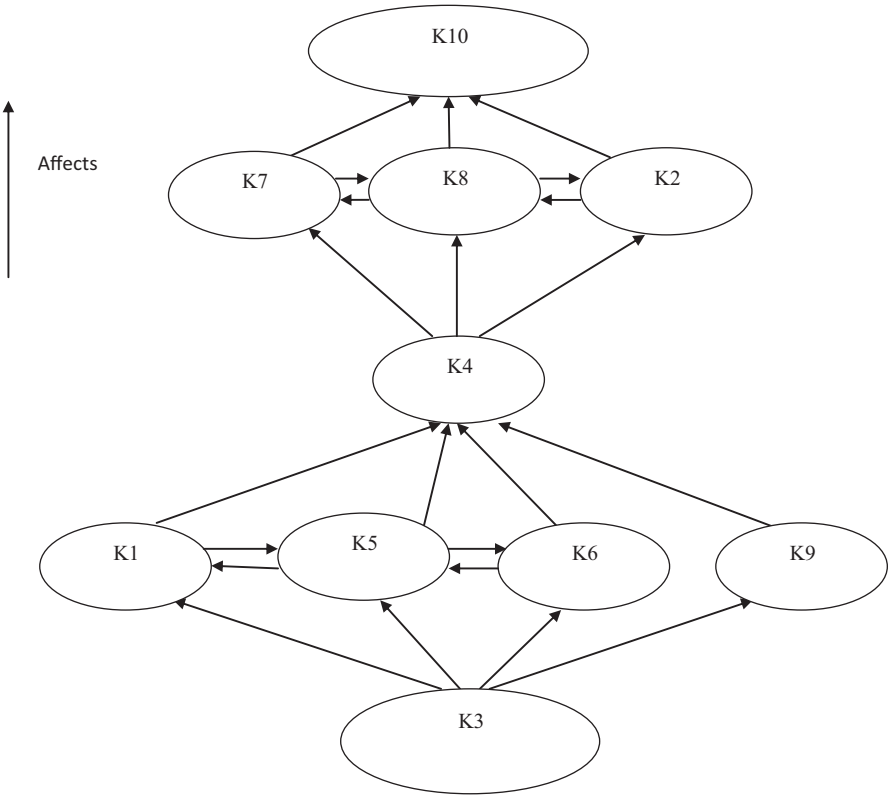
Dimension Code	Reachability Set	Antecedent Set	Intersection Set	Level
K1	1,2,4,5,6,7,8,10	1,3,5,6	1,5,6	
K2	2,7,8,10	1,2,3,4,5,6,7,8,9	2,7,8	
K3	1,2,3,4,5,6,7,8,9,10	3	3	
K4	2,4,7,8,10	1,3,4,5,6,9	4	
K5	1,2,4,5,6,7,8,10	1,3,5,6	1,5,6	
K6	1,2,4,5,6,7,8,10	1,3,5,6	1,5,6	
K7	2,7,8,10	1,2,3,4,5,6,7,8,9	2,7,8	
K8	2,7,8,10	1,2,3,4,5,6,7,8,9	2,7,8	

Dimension Code	Reachability Set	Antecedent Set	Intersection Set	Level
K9	2,4,7,8,9,10	3,9	9	
K10	10	1,2,3,4,5,6,7,8,9,10	10	***I***

b)

Dimension Code	Reachability Set	Antecedent Set	Intersection Set	Level
K1	1,5,6	1,3,5,6	1,5,6	*IV*
K2	2,7,8	1,2,3,4,5,6,8,9	2,7,8	*II*
K3	1,3,5,6,9	3	3	*V*
K4	4	1,3,4,5,6,9	4	*III*
K5	1,5,6	1,3,5,6	1,5,6	*IV*
K6	1,5,6	1,3,5,6	1,5,6	*IV*
K7	2,7,8	1,2,3,4,5,6,7,8,9	2,7,8	*II*
K8	2,7,8	1,2,3,4,5,6,7,8,9	2,7,8	*II*
K9	9	3,9	9	*IV*
K10	10	1,2,3,4,5,6,7,8,9,10	10	*I*

8.4 Digraph Indicating Relationships of KM Dimensions



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Chapter 9
Do Gender, Position, and Organization Shape Human Resource Flexibility?

Umesh Kumar Bamel, Santosh Rangnekar and Renu Rastogi

9.1 Problem Background

Business has to interact with both in-house and surrounding forces. Frequent economic fluctuations, unpredictable business events, and rapid inventive moves in technology have characterized the existing business environment. These external moves have considerably challenged the organizational competitiveness and sustainability. Beside, these move some other business decisions like expansion, mergers and acquisitions, and reengineering support the necessities of transformation . All these factors create pressure on businesses to adapt the shift and restructure their business process. As Verdú-Jover et al. (2008) recommended organizations to develop new managerial practices and strategies to maintain competitive advantage. Organizational capability to neutralize the environmental changes determines its durable growth. In other words, to be effective organizations need to accept and adjust these changes rapidly. Organization's counter responsiveness to the changes has been termed as flexibility (Mott 1971; Sanchez 1995; Volberda 1996). Sommer (2003, p. 177) has described flexibility as determinant of organizational competitiveness. Complementing with the view, Moorman and Miner (1998) advice firms

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to take a flexible approach to adapt and improvise to achieve objectives. Therefore, organizations those craving for effectiveness and competitiveness need to be flexible (Mott 1971; Verdú-Jover et al. 2008). Flexibility is a broad concept and has been concluded "as a managerial task, managerial capabilities that endow the firm with flexibility and; an organizational design task or the changeability of the organization" (Volberda 1996, p. 361). Therefore, organizations to carry out the challenges of contemporary business settings fundamentally depends on their human resource flexibility or managerial flexibility (Zolin et al. 2011). Further, similar to system approach, managerial flexibility was considered as subsystem of organizational flexibility (Verdú-Jover and Gómez-Gras 2009).

Flexibility of human resources significantly succeeds the strategic policy implementation during transition period. Moreover flexible people accept and respond in a constructive manner to contingency upshots of environmental and other uncertainties. These all assertions entail the organizations equipped with flexible human resources. Empirically studies significantly proved the positive association between firm performance and flexibility. Though, the predictors of managerial flexibility are still unidentified. Specifically, casual associations that how gender, role occupied, levels and ownership interact with individual flexibility remains unexplored sofar. Present study was conducted in this view and seeks to answer these queries.

9.2 Human Resource Flexibility

Researchers (Atkinson 1985; Atkinson and Gregory 1986) in the middle of last century termed flexibility as an attempt to neutralize the consequences of environmental contingencies and organizational requirements. Thereafter, flexibility has emerged as an approach to exploit the pragmatic and opportunistic changes through flexible work arrangements. With passage of time flexibility appeared to dissolve the traditional and concrete work philosophy and faint the demarcation between management functions (Dyer 1998). In literature numerous terms i.e., adaptation capacity, sensibility, elasticity and agility were used interchangeably with flexibility (Verdú-Jover and Gómez-Gras 2009). Seemingly, Sanchez (1995) termed flexibility as a process that reduces the switching cost and time form one resource to next and enable the integration and co-ordination of resources (Eisenhardt and Martin 2000). Later on the term human resource flexibility originated from human resource management literature and subsequent scholars (Milliman et al. 1991, p. 325) defines it "as capacity of HRM to facilitate the organization's ability to adapt effectively and in a timely manner to changing or diverse demands from either its environment or from within the firm itself". Subsequently, due attention was paid to deeply understand the flexibility and Atkinson (1985) was the first who proposed a flexibility typology as numerical flexibility (matching the number of employees with market demand); functional flexibility (swiftly mobilizing and integrating the available talent within organization i.e., quality control circles, participative management, problem solving teams) and the last one financially flexibility (matching pay with

performance i.e., pay for performance, variable pay structure, equitable pay structure etc.). Next, studies (Benach et al. 2002; Hanratty 2000; Knights and McCabe 2002) were conducted by adapting Atkinson's (1985) flexibility typology in varied context and geographies. This typology represents the flexible work arrangements which foster performance and growth (Atkinson and Gregory 1986). On the other hand, some empirical evidences raise the issues that flexible work arrangement some time negates job satisfaction, employee commitment and loyalty, workplace relations (Davis-Blake et al. 2003; Sheridan and Conway 2001). These suppositions might be the byproduct of poorly installed transition process as majority of the research purports flexibility as determinants of overall performance.

9.2.1 Employee Characteristics and Flexibility

There is a large body of research which confirms that flexibility practices advance competitiveness (Brewester et al. 1994; Lansbury 1995; Locke et al. 1995; Mott 1971; Sommer 2003; Verdú-Jover et al. 2008). Since, only limited efforts were done to investigate the interaction of employee characteristics with their flexibility, so scholars have been continually involving in identifying that how gender (Adekola 2006; Akintayo 2010; Hogan et al. 1994; Ivy and Backlund 2000; Neher 1997; Reardon 1995), level of position occupied (Hamlin 2002), and type of organization (Bao 2009; Lan and Rainey 1992; McKenna 2004; Metts 2007), mediates work place behavior. Similarly, Blau and Shvydko (2011) explored two level interactions of older employer and young female employer with workplace rigidity, and found considerable variation among their behavior and perception. Considering these view, present study aims to explore the interaction between employee characteristics and flexibility.

9.3 Research Design

9.3.1 Sample Characteristics

Present study is based on the 189 responses collected from the managers of Indian organizations situated mainly in north region of the country. Due to inherent interest in studying the flexibility according gender, position (junior, middle and senior) and type of organizations; responses from a comprehensive sample comprising of each category mentioned above were collected. The sample consists 60 % undergraduate and 40 % postgraduate managers. Next, sample comprised of 41 % junior managers whereas middle and senior managers contributed 29.5 % each. Private sector participation was 60 % and public sector shared 40 % of sample. Table 9.1 provides a comprehensive picture of sample demography.

Table 9.1 Demographic statics. (Source primary data, UG undergraduate and PG postgraduate)

	UG	PG	Junior	Middle	Senior	Private	Public
Male %	64%	36%	85%	80%	93%	84%	83%
Female %	45%	55%	15%	20%	7%	16%	17%
Sample %	60%	40%	41%	29.5%	29.5%	60%	40%

9.3.2 Instrument

Numbers of instrument were available to map flexibility from different point of view as number flexibility, functional flexibility, financial flexibility (Atkinson 1985). Some other types of flexibility which were considered are operational flexibility, structural flexibility, internal and external flexibility, and manufacturing flexibility. However as the terms indicate these all type of flexibility are specific and may not be appropriate to map the human resource flexibility. Thus for the purpose of study a five item based instrument was drawn from the work of Mott (1971). Originally these five items have been recommended as measures of flexibility and adaptability. But to the reason that adaptability was also considered as part of flexibility (Verdú-Jover and Gómez-Gras 2009); therefore in present study these five items were signified as determinant of human resource flexibility. The croanbach alpha for the instrument was 0.87, and signifies its reliability.

9.4 Results

To pacify the research query whether employee characteristics (gender, position and type of organization) causes their flexibility, GLM univariate ANOVA was performed by SPSS© 16.0. Factorial ANOVA was used to examine main effect and interaction simple. Gender (male and female), positions (junior manager, middle manager and senior manager) and organization (private and public) was taken as independent variable of the study whereas managerial flexibility was taken as criterion or outcome variable of the study. Therefore a $2 \times 3 \times 2$ ANOVA was referred for the present study.

Results in Table 9.2 reported that main effect for gender was not significant as $F(1, 177) = 0.872$, $p = 0.35$. Similarly, main effect of level $\{F(2, 177) = 0.946, p = 0.39\}$ and type of organization was not found significant $\{F(1, 177) = 0.682, p = 0.41\}$. Next, the interaction effects of gender*levels $\{F(2, 177) = 0.84, p = 0.43\}$, gender*type of organization $\{F(1, 177) = 2, p = 0.15\}$, and levels*type of organization $\{F(2, 177) = 0.40, p = 0.67\}$ were also not found significant on managerial flexibility.

Table 9.3 further shows the correlation score for selected variables and only organization and levels was found significantly correlated (0.42, p 0.01).

Further, plots were drawn to see the interaction pattern of independent variables with dependent variable. As Fig. 9.1 depicts that junior and middle level private man-

Table 9.2 Factorial ANOVA score. (Source primary data)

Source	Sum of squares	*df*	*F*	Sig.
Corrected model	38.986[a]	11	1.047	0.407
Intercept	18,649.244	1	5,509.315	0.000
Gender	2.952	1	0.872	0.352
Level	6.407	2	0.946	0.390
Org	2.308	1	0.682	0.410
Gender*level	5.718	2	0.845	0.431
Gender*org	6.788	1	2.005	0.159
Level*org	2.709	2	0.400	0.671
Gender*level*org	3.827	2	0.565	0.569
Error	599.152	177		
Total	51,616.000	189		
Corrected total	638.138	188		

(a computed using alpha = .05, R^2 = .06)

Table 9.3 Correlation score

	Gender	Level	Org
Gender			
Level	0.125		
Organization	0.027	0.42*	
Flexibility	−0.081	−0.058	−0.028

*Correlation is significant at the 0.01 level (2-tailed), N 189

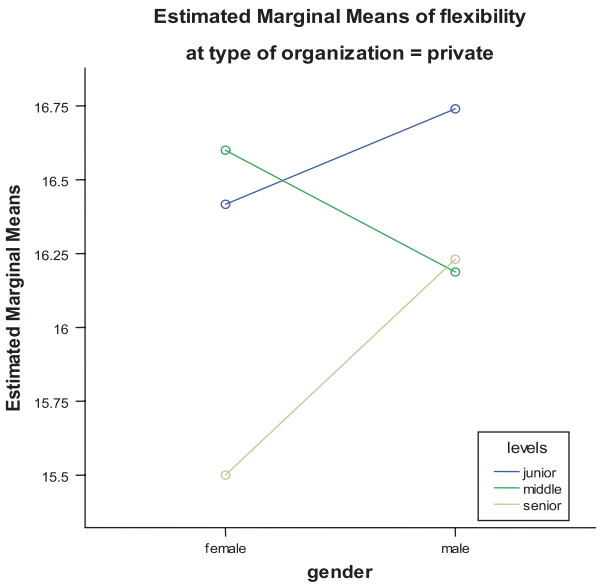

Fig. 9.1 Interaction effect gender and private organization

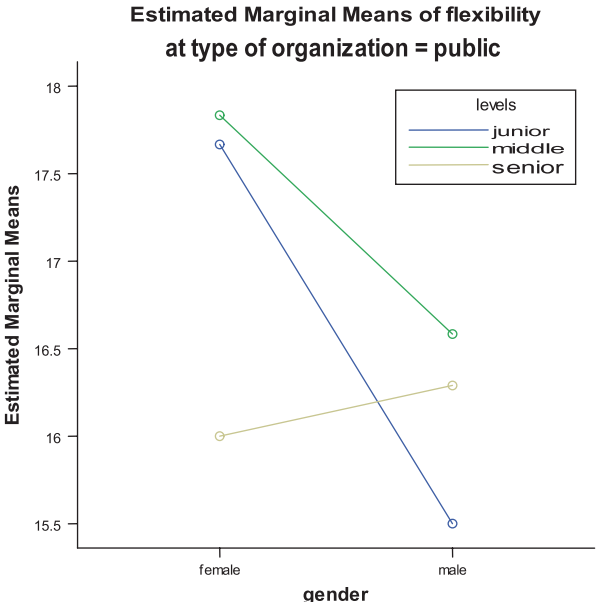

Fig. 9.2 Interaction between gender and public organization

ger flexibility increases from female to male whereas the process is reverse for middle level private managers as female were found more flexible than male. Subsequently, junior private male manager toppled the flexibility but in case of private female middle level managers scored well comparative to their counterparts. Next to this, Fig. 9.2 explains the pattern between gender and public sector managers. No interaction effect was found between junior and middle public mangers. However female managers of middle and junior were found more flexible than male. Conversely, flexibility for senior level public managers was increased from female to male.

In addition, Figs. 9.3 and 9.4 explains the interaction pattern between type of organization levels and female managers. As it shows, that all three levels of female managers exhibit positive movement from private to public sector mangers. Figure 9.3 supplemented that middle female managers are more flexible than remaining two levels. Additionally Fig. 9.4 explains the same pattern by taking public organization in account and found a cross over interaction. In case of junior level private male, managers' flexibility were higher than junior level male managers from public organizations. However junior level private managers toppled the score and junior level public managers were score on lowered side. Correspondingly, middle male and senior male level private manager scored same and the variation was also not so wide in case of public managers. By plotting the interaction association this study explored the mechanism of employee characteristics with their flexibility.

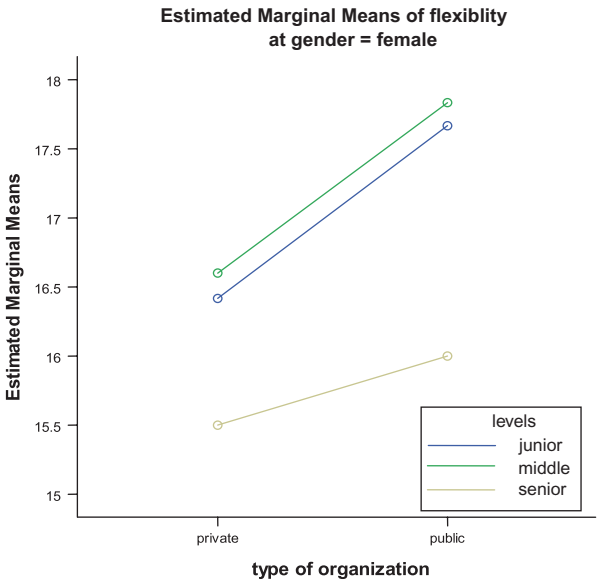

Fig. 9.3 Interaction between type of organization and female

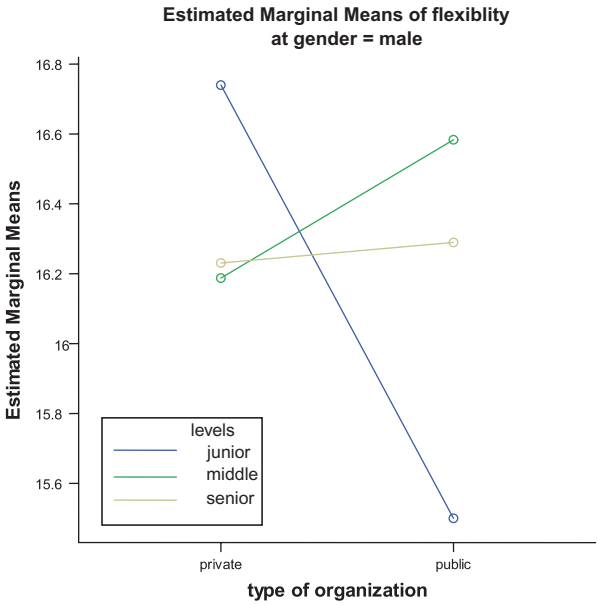

Fig. 9.4 Interaction between type of organization and female

Table 9.4 Descriptive statistics. (Source primary data)

Gender	Levels	Type of organization	Mean	Std. deviation	N
Female	Junior	Private	16.42	1.929	12
		Public	17.67	2.309	3
		Total	16.67	1.988	15
	Middle	Private	16.60	1.517	5
		Public	17.83	1.602	6
		Total	17.27	1.618	11
	Senior	Private	15.50	2.121	2
		Public	16.00	1.414	2
		Total	15.75	1.500	4
	Total	Private	16.37	1.770	19
		Public	17.45	1.753	11
		Total	16.77	1.813	30
Male	Junior	Private	16.74	1.771	50
		Public	15.50	2.029	14
		Total	16.47	1.885	64
	Middle	Private	16.19	1.615	32
		Public	16.58	2.193	12
		Total	16.30	1.773	44
	Senior	Private	16.23	1.964	13
		Public	16.29	1.887	38
		Total	16.27	1.888	51
	Total	Private	16.48	1.750	95
		Public	16.17	1.980	64
		Total	16.36	1.846	159
Total	Junior	Private	16.68	1.790	62
		Public	15.88	2.176	17
		Total	16.51	1.894	79
	Middle	Private	16.24	1.588	37
		Public	17.00	2.058	18
		Total	16.49	1.773	55
	Senior	Private	16.13	1.922	15
		Public	16.27	1.853	40
		Total	16.24	1.856	55
	Total	Private	16.46	1.746	114
		Public	16.36	1.991	75
		Total	16.42	1.842	189

9.5 Discussion

To move with flux of time organizations need continuity in change process, equally organizations also require some sort of stability. Considering the view of change management, scholars (Atkinson 1985; Knights and McCabe 2002; Verdú-Jover and Gómez-Gras 2008, 2009) identified flexibility as a technique to counter uncertainties. Then, author(s) (Atkinson 1985; Benach et al. 2002; Hanratty 2000) differentiated flexibility, focused on antecedents and consequences of flexibility, and

correlates flexibility with performance (Verdú-Jover and Gómez-Gras 2008, 2009) both at individual and organizational levels.

Besides, presents study tried to focus on how managerial characteristics (gender, organization type and levels) shape their flexibility. As some studies have predicted that gender cause variations in workplace behavior (Stringer et al. 2011). Likely, Hatfield (2005) concludes that people are different and they all have different profiles i.e., personality, knowledge, skills, abilities, interests, qualifications and competencies. And these variations might cause variations in their workplace outcomes. Hill et al. (2008) supported this view and reported how workplace flexibility options differ by gender and life stage, and found a curvilinear difference relationship between men and women with workplace flexibility. Managerial post was held appropriate in terms of masculinity as Adekola (2006) and Williams and Warrens (2003) accounted that gender cause variations in managerial performance. However, the empirical findings form present study suggests that gender may not exert influence over managerial flexibility. Maintaining this MacLean (2006) uphold that gender balance at the workplace is showing a marked improvement over time. This notion proposes to bring gender discriminations to an end at work place. Despite all these development the issue that gender exercise over performance and business outcome remains a hotcake for debate among scholars.

Next, present study holds that organization type does not influence flexibility of their members. Also managerial levels was not found significantly interacting with flexibility of managers. This might mean that managers irrespective of their level would be comfortable with the degree of flexibility required to cope the process of organizational restructuring, downsizing, expansion and other contingent forces. Generally, workforce diversity enduring as segregation of employees on the basis of gender, vertical positions and nature of organizations exists. This complex mix of workers may interact unconstructively and can become antecedents of low output and organizational unrest. Also, the good employee mix produces a competent workforce which enables an organization to progress. This diversity also develops a skill inventory for conveniences as variety goes up with diversity. And the flexibility of diverse workforce increase competencies of organizations. Moreover, these flexible managers enable an organization more adaptable and flexible (Iles et al. 1996).

9.6 Conclusion and Policy Implications

Scope of flexibility is very broad and it can be studied with different objectives and in different circumstances. As the main objective of this study was not to see antecedents and consequences of flexibility but to see whether managerial flexibility could be predicted by gender, position, and organization of managers. And from the empirical findings of the study it can be concluded that:

- Managerial flexibility is not predicted by their gender.
- Positions (junior, middle and senior) occupied by managers do not interact with their flexibility.

- Types of organization (private, public) do not predict managerial flexibility.
- The interaction of gender, position and organization do not predict managerial flexibility.

Besides, on the basis of present study some recommendation can be made for policy implication. First, the empirical findings signify the importance of flexibility in every area of business irrespective of its functionality. Therefore, management in Indian organizations should consider the issue utmost. Secondly, however statistically no significant difference was found among selected categories of managers, yet the interaction pattern shows that senior female managers in private organizations and junior male managers in public sector organizations need to tackle the issue of flexibility greatly. However besides these critics the managerial flexibility was found satisfactory.

Further, present study also has some implied constraints, as the sample size could be large and other geographical regions could have focused upon for a comprehensive view of concept. Next, the design could be more rigors by selecting antecedents and consequences of managerial flexibility in Indian organizations. And with present design also industry wise view could be explored.

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Chapter 10
The Flip Side of Flexibility in Organizations

Shalini Verma and Sneh Anand

10.1 Introduction

Flexibility is a relatively new concept in management practices only to evolve in the last few decades. It is a management technique for organizing the workplace in order to optimize the use of human resources; and in order to do so, organizations adopt various policies like, flexible working hours, flexibility in employment, flexibility at work and the like. Flexibility to some extent is good for the organization as it optimally utilizes the resource and hence increases productivity. But, flexibility beyond a certain point is a threat to both organizations as well as individuals involved. There are both pros and cons of adopting a flexible approach towards work and employment in the globalized era of today.

One could easily witness the changing trend in our society as a result of globalization and modernization. Number of people employed today is much more than it used to be two decades back. In addition to it, women these days are at the forefront contributing to the large working force. To cope with the demands of time, both men and women work simultaneously thereby making family lives even more complicated. Moreover, married couples into the same profession only add on to this 'complication'. Looking at the families wherein both husband and wife are employed, one can discover the tremendous change in the recent years. Families are to a great extent affected when the couples are employed as their work and family environments interact. Therefore the study of this interaction becomes necessary to understand the real situations faced by people in order to help them elevate their overall wellbeing.

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10.1.1 Job Satisfaction

One's work environment is a broad umbrella term that includes physical situation as well as psychological experiences at one's workplace. The physical situations at work refer to one's job conditions, peer group, leader and leadership, promotions, pay schedule etc. whereas, psychological aspect refers to the impact that the physical situation of work has on the individual i.e. one's perception of one's ideal and real work conditions leading either to satisfaction or dissatisfaction. Locke (1976) defines job satisfaction as a pleasurable or positive emotional state resulting from the appraisal of one's job experience. Job satisfaction is the result of employee's perception of how well their job provides those things that are perceived as important by them. In simple terms, job satisfaction is described as a positive evaluation of a particular job situation.

10.1.2 Marital Quality

Marriage and marriage ties are not as simple as they appear to be. Becoming a couple is one of the most complex and difficult transitions of the family life cycle. The romanticized view of this transition further adds to its difficulty since everyone including the family, friends and couples themselves want to see only the happiness of this transition. The problems entailed may thus be pushed underground, only to intensify and surface later on (Carter and McGoldrick 1989).

Marital quality (Vannoy and Philliber 1992) has been defined as a close and compatible relationship making a distinction from marital satisfaction, adjustment and happiness. Booth and Johnson (1994) used the term marital happiness to address a partner's global feeling about the marriage and its specific aspects, whereas marital quality includes the components of marital happiness, marital interaction, marital disagreement and other marital problems.

10.1.3 Work/Life Interaction

With the significant change in trend with regard to work and family in the globalization era, one cannot doubt the interaction between one's work and life realms. The Work/Family Conflict models propose that conflict arises when the demands of one domain are incompatible with demands of the other domain. Today's diverse workplace is increasingly populated with dual-career couples. Interest in family-related issues in management researchers is relatively new, manifesting itself primarily in the past 15 years. Legitimate linkages between the two spheres of work and family are a much spoken about topics these days.

Zedeck (1992) described the following three topics as targets of research in work/family conflict:

The effect of work on family: This area examines what impact work factors have on family matters. A common finding states that aspect of work such as work stress has negative effects on families.

The effect of family on work: This perspective generally focuses on how structural or developmental aspects of family have their impact on work behavior. Some researchers view family life as positive which blocks disappointment at wok; while others claim that family responsibility is a major determinant of work absenteeism.

The family-work interaction: This is the third model of work/family conflict that views work and family as interacting and interdependent. There is no simple and causal link between work and family matters.

10.1.4 Significance in the Globalized India

Today, India has witnessed tremendous change in the attitude one holds about working couples. A slight majority of the Indian population believes that both parents should contribute to the family income. The importance of balancing the demands of work and family comes into picture once one considers the case of a dual-career couple. Silberstein (1992) concluded that most dual-career couples have a work-oriented lifestyle prior to the birth of children. However, once there are children, the dual-career system undergoes a profound shift. The pragmatic demands of home life increase dramatically and cannot be postponed, rescheduled, or ignored. Silberstein (1992) also reported that the difference in the degree that wives and husbands accommodate their careers for children has become a central marital tension.

According to Bruce and Tim (1999), the 'traditional' division of family roles had the husband as the primary breadwinner; whereas, the wife was responsible for the household chores including the task of bringing up 'her' children. But as an outcome of globalization and modernization, more and more married women have entered the labour force resulting in the emergence of a more egalitarian division of family roles. They also claim that although attitudes have changed and more husbands make an effort to help their wives with household activities, the responsibility still lies on the wife's shoulder to make sure that things are done timely and in an appropriate manner. It is also suspected that some wives refuse help from their husbands because of their acceptance of traditional family roles. Research has discovered that many of these wives somehow feel they are a failure as a wife if they don't manage the household, even though they work full time outside the home thereby contributing to a significant level of distress among them (Bruce and Tim 1999).

The profusion of dual-career couple has also spawned a new dimension in personnel recruitment. According to Muchinsky (2000), dual-career couples are often reluctant to move unless there are meaningful jobs for both the members. He also believed that the organizations that seek to attract one member are at a strategic advantage if they can help secure a job for the other member. Some organizations, particularly in urban areas, have formed networks or alliances to help recruit dual-career couples (Muchinsky 2000).

10.2 Literature Review

With regard to the debate on whether or not organizations should adopt a flexible approach in the employment of couples, Elango (2010), chief human resources officer, MphasiS believes that "organizations must allow and encourage couples to work in the same organization (provided they don't have a reporting relationship). Studies have proved that individuals who have their spouse working with them tend to stay longer with the same firm. This could prove to be a good retention strategy." Tyagi (2010), COO, DMC International on the other hand, holds somewhat different opinion about the matter. According to him, "the couples (working together) are more sensitive to potential problems than their co-workers. The couples want to be thought of as professionals whose personal lives will not interfere with their professional abilities and judgments."

Malhotra (2010), VP HP, CSC (in India), on the other hand maintains a middle way. She claims that, "generally, the sense of belongingness of such employees is more as opposed to the rest. Their loyalty quotient gets embedded in the organizational culture, which is good for the organization. Some organizations stay aloof from hiring couples, especially for the same department, as there could arise a potential conflict at some point in time. For couples who work in same organization, it is easier for them to be able to relate to each other's experiences in the office. The communication process is optimized at work situations because both of them know the company. Maintaining a sense of individuality and professionalism is vital for the couple when they are working in the same organization. It is important for them to know where to draw the line between their personal and professional lives. By being mindful and respectful of each other's professional space, they can ensure that work ethos remain undisturbed."

An undisputable answer to this question is not yet suggested but there have been plenty of studies in the related field, where each study attempted to answer this question in its own unique way. The results of some studies are in line with the others while few propose an entirely different view. A study on the role of couple similarity in spouses' marital satisfaction indicated that similarity between partners is associated with higher levels of marital satisfaction and lower levels of negative affect (Gaunt 2006).

Graham et al. (1985) from their study concluded that wife's employment has negative effects on husband's job and life satisfaction. Whereas, Barling (1984) in her study suggested that husbands' perceptions of the organizational climate and their job satisfaction were related to their wives' marital satisfaction in a significant, positive, and linear manner. On the other hand, Sotile and Sotile (2004) proposed that, more than the number of hours worked, the manner in which the spouses treat each other when they are not working determines the quality of marriage.

Kinnunen et al. (2004) found out that for women, the work-to-family conflict significantly predicted job dissatisfaction, parental distress along with other psychological symptoms. However, among men, a low level of satisfaction or well-being functioned as a precursor of work-to-family conflict.

Focusing solely on one's work, the role of involvement and work-family conflict in job and life satisfaction is one area that has not been left unexplored. Tiwari et al. (2005) suggest a positive correlation between job involvement and job satisfaction where job involvement significantly interfered with one's family life.

10.2.1 Rationale

After an in depth study of available literature on the subject as well as issues related to it, it is clear that there is not much work is done encompassing both the areas—job satisfaction as well as marital quality directly, though studies relating job and life satisfaction (which broadly includes marital quality along with family and overall wellbeing) are quite abundant. One could find studies on effect of husband's/wife's job on his/her spouse's marital quality. Similarity between couples leading to marital satisfaction has also been studied over time. Work-family conflict along with gender differences in marital satisfaction and job satisfaction are studied time and again. But the aspect of job satisfaction and marital quality among couples whose spouse works in the same organization or different organizations, needs further exploration. This study unravels the relationship between job satisfaction and marital quality among men and women whose spouse works in the same organization or in different organizations thereby correlating the two concepts in a more practical way in order to help recruiters decide on whether to adopt such highly flexible policies of recruiting couples in *their* organization or not.

10.3 Methodology

10.3.1 Aim

To assess the job satisfaction and marital quality among men and women whose spouse works in the same or different organizations.

10.3.2 Objectives

1. To assess and compare the job satisfaction and marital quality level among men and women whose spouse works in the same and different organizations.
2. To find out the relationship between job satisfaction and marital quality among men and women whose spouse works in the same organization or different organizations.

10.3.3 Hypotheses

1. There is no difference in job satisfaction level among men and women whose spouse works in the same or different organizations.
2. There is no difference in marital quality level among men and women whose spouse works in the same or different organizations.
3. There is no correlation between job satisfaction and marital quality among men whose spouse works in the same or different organizations.
4. There is no correlation between job satisfaction and marital quality among women whose spouse works in the same or different organization.

10.3.4 Operational Definition of Variables

Job Satisfaction

Locke (1976) defines job satisfaction as a pleasurable or positive emotional state resulting from the appraisal of one's job experience.

Marital Quality

Marital quality according to Vannoy and Philliber (1992) includes the components of marital happiness, marital interaction, marital disagreement and other marital problems.

Couples Who Work in Same Organization

Men and women whose spouse works in the same organization, i.e., Group I participants.

Couples Who Work in Different Organizations

Men and women whose spouse works in a different organization, i.e., Group II participants.

10.3.5 Research Design

The research was exploratory in nature and quantitative research methods were used to understand the research findings.

10.3.6 Sample Details

Sample Size

The sample consisted of a total of 60 participants (30 married heterosexual couples; 15 couples working for the same industry/organization and 15 couples working for different organizations/industries).

Inclusion Criterion

- The profession of the couples taken for the study should be same or similar.
- The couples should be married for a minimum of 1 year.
- The couples should not be married for more than 12 years.
- The participants should not have had divorce or marital separation.
- The minimum educational requirement is graduation.
- The participants should be working for a minimum of 1 year.

Exclusion Criterion

- Couples with different profession.
- If either of the spouses suffer form any sort of serious illness, the couple is excluded from the research.
- Foreign nationals.
- Homosexual couples.

Sampling Technique

Snow ball sampling technique was used for the selection of sample.

10.3.7 Tools Used

1. **Job Satisfaction Scale:** The job satisfaction scale developed by Singh and Sharma (1999) was used to assess the job satisfaction level of the participants. It is comprehensive and omnibus in nature. It was used as it is brief, reliable and valid and can be administered to any type of workers. The test-retest reliability of this scale is 0.978 with the validity of 0.743 and coefficient of correlation is 0.81.
2. **Marital Quality Scale:** The marital quality scale developed by Shah (1991) was used to assess the marital quality of the participants. It consists of 50 items in

statement form, with a four point rating scale of 'usually', 'sometimes', 'rarely' and 'never', indicating the frequency of occurrence of various phenomenon in the marriage. Higher scores are indicative of a poorer quality of married life. The scale has high internal consistency (coefficient alpha) of 0.91 and high test-retest reliability of 0.83 over a 6 weeks interval. It has well established content and construct validity.

10.3.8 Procedure

The main phase of the research was preceded by a pilot phase, administered on two participants. This helped in to see if any subsequent changes have to be made before the main phase of the research was undertaken.

Enrolment of the Participants

The sample was selected keeping the inclusion and exclusion criterions in mind. The participants were then grouped into two groups (I and II) depending on whether their spouse works in same or different organization/industry. Group I included men and women whose spouse works in the same organization/industry whereas Group II included the men and women whose spouse works in organization/industry.

Administration of Tools

A rapport was established with the comfortably seated participants. The scale was given to the participants and they were asked to respond to the statements. It was ensured that the participants understood the instructions well. The participants were encouraged to respond spontaneously without taking much time in each question so as to get their correct response.

Nature and Number of Sessions

An effort was made to collect data from the participant by face-to-face interactions but in cases where the participants were unavailable, data collection was done using the online method.

Number of Sessions

The study required two sessions with each participant where the first session included signing of the informed consent form by the participant followed by the second session in which the participants were required to fill up the questionnaire.

Table 10.1 Comparing the job satisfaction scores of men whose spouse works in the same organization and men whose spouse works in different organization using Mann–Whitney U test

	Level	N	Mean of job satisfaction	Std. deviation	Z score	'*p*' value	Significance
Men	Same organization	15	73.47	11.594	−0.498	0.618	No significant difference
	Different organizations	15	75.87	13.506			

10.3.9 Ethical Considerations

It was ensured that the participants' identity is not revealed anywhere in the test or after the test thereby maintaining the confidentiality of the test. The participants in not a single way were harmed physically, mentally or psychologically. The results were not looked at with any sort of prejudice or stereotype, trying to get a bias-free result. Also, the sample consisted of volunteer participants who were by no means forced to participate in the study. The participants were well informed about the procedure and nature of the test and were included in the study only after they signed the informed consent form.

The copyright laws will be abided and neither the scales nor the participants' results will be misused. The scales and results are used solely for academic purpose(s) and will not be duplicated or reproduced for any other purpose(s).

10.3.10 Analysis of the Data

The quantitative data was analyzed using the Mann-Whitney U test and Spearman Correlation method.

10.4 Results and Discussion

Job satisfaction level was assessed and compared among men and women whose spouse works in the same organization followed by the same for men and women whose spouse works in different organization. The assessment and comparison of marital quality was followed in a similar fashion. And finally, the relationship between job satisfaction and marital quality was explored.

The research explored whether there is a significant difference in job satisfaction level among men whose spouse works in the same or different organizations (Group I men and Group II men) in order to see whether working with or without one's spouse, affects one's experience of job satisfaction in any way. In order to facilitate this comparison statistically, the mean score on job satisfaction for Group I men and Group II men were calculated. Referring to Table 10.1, one could infer that

Table 10.2 Comparing the job satisfaction scores of women whose spouse works in same and different organizations using Mann–Whitney U test

	Level	N	Mean of job satisfaction	Std. deviation	Z score	'*p*' value	Significance
Women	Same organization	15	68.27	12.725	−1.805	0.071	No significant difference
	Different organizations	15	76.33	12.315			

for Group I men, the mean is 73.47 with a standard deviation of 11.594. Also, for Group II men, the mean was found to be 75.87 with a standard deviation of 13.506.

Referring to Table 10.1 once again, one could infer that the '*p*' value for the two groups of men using Mann Whitney U test was 0.618. The results of the test were in the expected direction and not significant, $z = -0.498$, $p > 0.05$; therefore the null hypothesis can be accepted. This would mean that there is no difference in the experience of job satisfaction among the two groups of men.

Also, to discover whether there is a significant difference in job satisfaction level among women whose spouse works in the same or different organization, job satisfaction level was assessed and compared among the two groups of women (Group I women and Group II women).

Referring to Table 10.2, one could infer that the mean job satisfaction of Group I women is 68.27 and a standard deviation of 12.725 and that for Group II women is 76.33 with a standard deviation of 12.315. The difference between means of the two groups appears to be relatively high, but in order to see if the difference between the mean ranks of both the groups was significant, Mann Whitney U test was conducted.

Table 10.2 also shows the 'p' value for the two groups of men using Mann Whitney U test was 0.071. The results of the test were in the expected direction and not significant, $z = -1.808$, $p > 0.05$; therefore the null hypothesis can be accepted. This would mean that there is no difference in job satisfaction among the two groups of women.

The results show that there is no significant difference in job satisfaction level experienced by either men (Group I and II) or women (Group I or II); this is probably because the participants were able to keep their work responsibilities distinct from home demands and responsibilities.

Coming to the second dimension of the study, the research went on to compare the experience of marital quality among men whose spouse works in the same organization (Group I men) and men whose spouse works in different organization (Group II men).

The global marital quality scores were calculated for these two groups of men. Table 10.3 describes the mean marital quality for Group I and Group II men. The mean of marital quality for the Group I of men is 102.60 and that for Group II men is 82.27. Also, the standard deviation of Group I men is 21.938 and that of Group II men is 22.037. The difference between means of the two groups appears relatively

Table 10.3 Comparing the marital quality scores of men whose spouse works in the same organization and men whose spouse works in different organization using Mann–Whitney U test

	Level	N	Mean of marital quality	Std. deviation	Z score	'*p*' value	Significance
Men	Same organization	15	102.60	21.938	−2.428	0.015	Significant difference
	Different organizations	15	82.27	22.037			

Table 10.4 Comparing the marital quality scores of women whose spouse works in the same organization and women whose spouse works in different organization using Mann–Whitney U test

	Level	N	Mean of marital quality	Std. deviation	Z score	'*p*' value	Significance
Women	Same organization	15	92.64	24.352	−2.078	0.038	Significant difference
	Different organizations	15	76.47	22.084			

high, but in order to see if the difference between the mean ranks of both the groups was statistically significant, Mann Whitney U Test was conducted.

As one can infer from Table 10.3, the '*p*' value for the two groups of men using Mann Whitney U Test was 0.015. The results of the test were not in the expected direction and were significant, $z = -2.428$, $p < 0.05$; therefore the null hypothesis cannot be accepted. The results indicate that there is a significant difference in marital quality among the two groups of men.

Also, to discover whether there is a significant difference in the experience of marital quality among women whose spouse works in the same organization (Group I women) and women whose spouse works in different organization (Group II women), marital quality was assessed and compared among these two groups of women.

The global marital quality scores were calculated and compared for two groups of women. One could infer from Table 10.4 that the mean marital quality of Group I women is 92.64 with a standard deviation of 24.352 and that for Group II women is 76.47 with a standard deviation of 22.084. The difference between means of the two groups appears relatively high, and the Mann Whitney U Test was conducted in order to see if the difference between the mean ranks of both the groups was significant.

One could infer from Table 10.4 that the '*p*' value for the two groups of men using Mann Whitney U test was 0.015. The results of the test were not in the expected direction and were significant, $z = -2.428$, $p < 0.05$; therefore the null hypothesis cannot be accepted. This would mean that there is a significant difference in marital quality among the two groups of women.

After all these comparisons in the experience of job satisfaction and marital quality, one could infer from the results that though, there is no significant difference in job satisfaction between both the groups, they differ significantly with regard to the marital quality experienced; where the marital quality of couples working with their

Table 10.5 Showing the correlation between job satisfaction and marital quality among men whose spouse works in the same organization using Spearman's Correlation test

	Level	N	Mean of men	Std. deviation	Spearman's correlation value 'ρ'	Level of correlation
Same organizations (Men)	Job satisfaction	15	73.47	11.594	0.788	High positive correlation
	Marital quality	15	102.60	21.938		

spouse as colleagues was significantly lower than that of the couples whose spouse works in a different organization. It must be noted that higher scores in the marital quality scale indicate poor marital quality. Thus the couples in Group I can be said to be exhibiting poorer marital quality than those in Group II. The result findings support Tyagi's (2010) view that "the couples (working together) are more sensitive to potential problems than their co-workers."

As the results suggest that the marital quality of couples working with their spouse is significantly lower than those who work in different organizations than their spouse works in, the current study negates Gaunt's (2006) view that greater similarity between partners (job and organizational similarity) would lead to greater marital satisfaction.

Also, this difference is seen more in men than in women, i.e., men who work with their wives as colleagues show a poorer marital quality than their female counterparts. These results are in line with the study by Graham et al. (1985) which suggested that wife's employment has negative effects on husband's job and life satisfaction.

The research also explored the relationship between the two dependent variables, i.e., job satisfaction and marital quality among men and women whose spouse works in same organization or different organizations, these two variables were first computed followed by their statistical correlation using the Spearman's correlation test.

The global job satisfaction and marital quality scores were calculated for men whose spouse works in the same organization. Table 10.5 shows the mean job satisfaction and marital quality scores of men whose spouse works in the same organization. Spearman's Correlation test was done to find out the relationship between job satisfaction and marital quality among men who work with their spouses as colleagues.

Table 10.5 also indicates the Spearman's Correlation Value, 'ρ' for job satisfaction and marital quality in men who work with their spouses as colleagues was 0.788. The results show that there is a high positive correlation between job satisfaction and marital quality among this group of men. But, according to the marital quality scale, high scores indicate poor marital quality. Thus the high positive correlation between job satisfaction and marital quality in Group I men means that an increase in job satisfaction leads to decrease in marital quality. Therefore, the results indicate that, there are 78.8% chances that marital quality of participants would decrease with an increase in his job satisfaction.

Hence, the null hypothesis cannot be accepted. Therefore, an alternate hypothesis stating that 'job satisfaction and marital quality are negatively correlated among men whose spouse works in the same organization' is suggested.

Table 10.6 Showing the correlation between job satisfaction and marital quality among men whose spouse works in different organization using Spearman's Correlation test

	Level	N	Mean of men	Std. deviation	Spearman's correlation value 'ρ'	Level of correlation
Different organizations (Men)	Job Satisfaction	15	75.87	13.506	0.21	Low positive correlation
	Marital quality	15	82.27	22.037		

Table 10.7 Showing the correlation between job satisfaction and marital quality among women whose spouse works in the same organization using Spearman's Correlation test

	Level	N	Mean of women	Std. deviation	Spearman's correlation value 'ρ'	Level of correlation
Same organizations (Women)	Job satisfaction	15	68.27	12.725	0.334	Low positive correlation
	Marital quality	15	92.64	24.352		

Similarly, Spearman's Correlation Test was done for Group II men after calculating the global job satisfaction and marital quality scores for them. Table 10.6 shows the mean and standard deviation for job satisfaction and marital quality scores of Group II men.

Referring to Table 10.6, one could conclude that the Spearman's Correlation Value, 'ρ' for job satisfaction and marital quality in men who do not work with their spouses as colleagues was 0.21. The results show that there is a low positive correlation between job satisfaction and marital quality among Group II men. High scores on marital quality scale as discussed above, indicates poor marital quality. Therefore the low positive correlation between job satisfaction and marital quality in this group of men indicates that increase in job satisfaction leads to decrease in marital quality. Such results imply that, there are 21% chances that marital quality of participants would decrease with an increase in his job satisfaction.

The research continued to assess the correlation between job satisfaction and marital quality among women whose spouse works in the same organization (Group I women) followed by the same among women whose spouse works in the different organization (Group II women).

To explore whether there is a correlation between job satisfaction level and the marital quality level among Group I women, the Spearman's Correlation Test was done on this group of women.

The global job satisfaction and marital quality scores were calculated for women who work with their spouses as colleagues in the same organization. Table 10.7 shows the mean and standard deviation for job satisfaction and marital quality scores of Group I women along with the correlation coefficient between the two variables.

Table 10.7 also throws light upon that the Spearman's Correlation Value, 'ρ' for job satisfaction and marital quality among women who work with their spouses as colleagues was 0.334. The results show that there is a low positive correlation between job satisfaction and marital quality among Group I women. As discussed

Table 10.8 Showing the correlation between job satisfaction and marital quality among women whose spouse works in different organization using Spearman's Correlation test

	Level	N	Mean of women	Std. deviation	Spearman's correlation value 'ρ'	Level of correlation
Different organizations (Women)	Job satisfaction	15	76.33	12.315	0.275	Low positive correlation
	Marital quality	15	76.47	22.084		

above, high scores on marital quality scale indicate poor marital quality. Thus the low positive correlation between job satisfaction and marital quality in this group of women would mean that increase in job satisfaction leads to decrease in marital quality. These results indicate that, there are 33.4% chances that marital quality of participants would decrease with an increase in her job satisfaction.

Hence, the null hypothesis cannot be accepted suggesting that job satisfaction and marital quality are negatively correlated among women whose spouse works in the same organization.

Finally, the study unraveled the correlation between the job satisfaction level and the marital quality level among women whose spouse works in different organization (Group II women) using the Spearman's correlation test.

The global job satisfaction and marital quality scores were calculated for Group II women whose spouse works in different organization. Table 10.8 shows the mean job satisfaction and marital quality scores for Group II women. Also, one can infer the standard deviation for job satisfaction and marital quality among Group II women from the table. Spearman's Correlation Test was done to find out the relationship between job satisfaction and marital quality among this group of women.

One can infer from Table 10.8 that the Spearman's Correlation Value, 'ρ' for job satisfaction and marital quality in women who work with their spouses as colleagues was 0.275. The results show that there is a low positive correlation between job satisfaction and marital quality among Group II women. As per the marital quality scale, high scores indicate poor marital quality. Thus the positive correlation between job satisfaction and marital quality in women whose spouse works in different organization would mean that an increase in job satisfaction would lead to the decrease in marital quality. Results from the study suggest that there are 27.5% chances that increase in job satisfaction of the participant would lead to a decrease in her marital quality.

Hence one could infer that job satisfaction and marital quality are negatively correlated among women whose spouse works in different organization.

All the four correlations between job satisfaction and marital quality for men and women independently are in accordance with the results of Barling (1984) who in her study suggested that excessive work involvement or negative work-related experiences would have an adverse influence on the marital relationship.

The current study suggests that job satisfaction and marital quality are negatively correlated, i.e., high work involvement though increases one's job satisfaction, cuts down the time given to one's family resulting in the lowered quality of family life

especially that with one's spouse as suggested by Tiwari et al. (2005). Gradually this dissatisfaction at home leads to dissatisfaction at work as well via the spill-over effect wherein, one stops enjoying tasks he/she once loved doing and loses interest in work. This might be a warning sign to industries and organizations to ensure a healthy life of their employees which eventually benefits the organization in long run.

To summarize, results of the current study suggest that there is no significant difference in job satisfaction level experienced by men and women as couples working with or without their spouses. However, the study shows a significant difference in marital quality among both men and women in both the groups. Additionally, a negative correlation was found between job satisfaction and marital quality among men and women of both the groups. Also, considering the significant difference in the marital quality among the two groups, it was seen that the disparity occurred more in couples working in the same organization than those who work in different organizations. This could be an alarming issue concerning the HR team and the organizations where they might need to reframe and re-structure their recruitment policies because high degree of flexibility of an organization in this sphere is questionable.

10.5 Summary and Conclusions

After a thorough analysis of results and an in depth review of the literature available, one can be sure about the interaction between one's work and other personal life realms in today's globalized world. Also, this interaction accommodates the work/family conflict that arises when the demands of one domain are incompatible with demands of the other domain. Workplace in the current scenario is populated with dual-career couples where both the spouse works in order to earn their living. This interests researchers to a great extent, as today there is a legitimate linkage between the two spheres of work and family.

Analyzing the literature available on the current issue, one can see the need to encompass both the areas—job satisfaction as well as marital quality as there are insufficient studies catering to these points in a direct manner. This study explored job satisfaction and marital quality among men and women whose spouse works in same and different organizations followed by the comparison of both the groups; where Group I consisted of men and women whose spouse works in the same organization and Group II consisted of men and women whose spouse works in different organizations. This study also discovered the correlation between job satisfaction and marital quality in both the groups.

The sample constituted of heterosexual married couples who were into same or similar professions. Depending upon the organizations/industries they work in, they were grouped into two groups, Group I and II; where Group I comprised of men and women whose spouse works in the same organization/industry and Group II comprised of men and women whose spouse works in different organizations.

Job satisfaction and marital quality were the two dependent variables assessed and compared among men and women independently within and between various groups. And finally, the correlation between job satisfaction and marital quality among various groups was evaluated.

The results indicate that there is no significant difference in job satisfaction among men whose spouse works with them in the same organization or works in the different organization altogether; the same holds true for women as well, where no significant difference in job satisfaction was found among women whose spouse works in same or different organization.

But, contradictory results were obtained when marital quality was compared between couples of the two groups. In this case, a significant difference was found in the experience of marital quality among men whose spouse works in the same organization and men whose spouse works in the different organization. Similarly, the results point out that there is a significant difference in the experience of marital quality among women whose spouse works in the same organization and women whose spouse works in the difference organization. Therefore, organizations are advised not to adopt such high degree flexibility in dealing with delicate issues like these as the ethical grounds for doing so can be questioned. Also, such policies can ultimately hamper the employee's overall wellbeing resulting in the organization's failure in terms of both effectiveness and efficiency.

Finally, the research concluded that the two dependent variables i.e., job satisfaction and marital quality are negatively correlated among men and women in both the groups (Group I men and women along with Group II men and women). This would imply that with an increase in job satisfaction, one's marital quality decreases significantly.

10.5.1 Implications of the Study

This study would help resolve an ongoing debate on whether or not organizations should adopt a flexible approach in employing couples; as it answers relevant issues like employee's job and marital satisfaction as a result of working with one's spouse as a colleague or not a colleague, especially when the couple is into the same profession. The study looks at a broader picture which is not restricted to one's performance at work but how satisfied an employee is in work and life. It aims at the overall wellbeing of the employees, suggesting ways to elevate job satisfaction level along with marital quality via changing their organization.

The research findings indicate that men and women whose spouse works in the same organization have significantly poorer marital quality when compared to those whose spouse works in a different organization; this might influence other areas of their work, hence organizations are suggested not to employ couples. This is probably the reason why most of the organizations do not employ couples and even when any of their employees chooses to marry another employee, either of them is encouraged to leave or change the organization or at least, shift to a different branch of the same organization.

10.5.2 Limitations of the Study

The main limitation of the study is the sampling technique used, i.e., snow ball sampling which is a type of non probability sampling which does not give equal chance to all the participants to get selected in the study. This technique was used as such a sample is not easily available mostly because the population is small.

Also, more sincere response could have been obtained if the data were collected in person rather than using the online method of data collection. Also, the research has not looked into other techniques whereby organizations by adopting a more flexible or inflexible approach could elevate the total wellbeing of their employees.

10.5.3 Suggestions for Future Research

There is an unlimited scope of further research in the area of total employee welfare including his work and family life. Further research could be done on a larger sample, selected randomly which might be useful for further generalization of the research findings. Also, there is an advantage of getting better responses from the participants with the administration of test in person rather than using the online method of data collection and the same is suggested for future research.

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Chapter 11
Leadership and Effective Integration of Information and Communication Technology for the Age of Restructuring

Joseph Sebastian Thekedam

11.1 Introduction

Leadership plays a vital role in leading change in an educational institution, providing vision and objectives, as well as professional development initiatives in using ICT to bring about pedagogical changes (Yuen et al. 2003; Schiller 2002; Yee 2000). Technology infrastructure is important, but strategic ICT leadership is even more necessary for effective ICT implementation and for long-term sustainability of college improvements. Effective leadership is of paramount importance among other goals or proposals. The success of other goals depends largely on whether leaders of institutions are capable of leading, planning, implementing and sustaining changes, including ICT, in an institution. It is their responsibility to adopt appropriate changes that ensure an effective integrated education system to keep abreast with the demands of the 21st century. For fundamental changes to take place, it is essential that principals have a clear purpose linked to a sustainable vision for the educational institutions. Since the principal's leadership and management influence the teaching and learning in the college, they should have a pertinent understanding of what actions and strategies to take, and which leadership and management style to apply to have a positive influence on teachers' information and communication technology integration into their teaching and students' learning practices. The technology standards and technology competencies of the principal as an information and communication technology leader have a significant influence on the quality and effectiveness of the technology programme in an educational institution. An effective principal can enable the teachers to perform at their best and create an environment where teachers are willing to bring about appropriate change in order to ensure that effective teaching and learning takes place. Students benefit from information and communication technology if the college environment is technology-rich and if the staff and principal have a shared vision of how and why information and communication technology is integrated into educational environment.

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The ultimate aim of ICT adoption is to facilitate effective transformation of learning. Any plan of implementation which deviates from this aim will result in futility. It should be curriculum driven instead of technology driven, in view of future curriculum reform. The mistake of the past is too much emphasis on technology—e.g. fast computers, expensive multimedia centers and broadcast stations, but with little attention to how they can effectively transform learning. Educational institutions were wrong in adapting students to technology instead of adapting technology to students (Creighton 2003). Many teachers use ICT to support or supplement traditional mode of teaching, or as a remedial tool to reinforce basic skills and adopt a 'teacher centered' approach. For example, they use power point slides to replace chalkboard notes and the data projector like the overhead transparency projector. They distribute electronic materials instead of printed copies. These practices are good in enhancing a teacher-centered approach. However, it is hard to find that ICT has brought a significant change in the students' mode of learning. Without pedagogical change, teachers still use old methods to teach with the new ICT tool (Tong and Trinidad 2005). Worse still, some bad teaching can be disguised as "good practice" under the hood of ICT (e.g. using flashy power point to cover the poor lesson preparation). Despite many studies done, effective practices of ICT in education are in shortage. It is important to establish a learner-centered environment based on learning, rather than teaching, with ICT. We are fast in building the technology infrastructure, but slow in connecting it to aspects of curriculum and institutional culture. Some heads of institutions even think that investing in high-end facilities or expensive hardware/software shows their institutions are technologically advanced. Actually they may be "putting lipstick on a bulldog" as ICT only brings cosmetic change to colleges without really transforming learning and teaching. Educational innovations in ICT should be increasingly embedded within a broader framework of education reforms that aimed to develop students' capacities for self-learning, problem solving, information seeking and analysis, and critical thinking, as well as the ability to communicate, collaborate and learn.

To facilitate change, the institutional heads can adopt the strategy of distributed or shared leadership by which leaders of the secondary level emerge and get involved in the ICT policy-making process. Resulting policies should be adopted, adapted and improved in a culture of trust and support by the institutional heads. The institutional heads should empower teacher-led teams to explore, formulate and spread good ICT practices. Teachers will change their patterns of interaction, attitudes and beliefs, from being isolated, silent and autonomous to being collaborative, adaptive and innovative, because they have a say and involved in the decision-making process.

11.2 Review of the Literature

This review provides a summary of the literature that is relevant to the educational leadership needed to facilitate the integration of information and communication technology into the teaching and learning process. Few studies have been done to

explore the methods and strategies that college principals use to lead information and communication technology integration in their colleges where information and communication technology is viewed as an instructional strategy and part of larger college reform efforts. Wilmore and Betz (2000) in their research study pointed out that "information technology will only be successfully implemented in an educational institution if the principal actively supports it, learns as well, provides adequate professional development and supports his/her staff in the process of change". Diane Yee (2000) in her research on principals' leadership and technology integration found that the educational institutions that integrated information and communication technology in the most constructive way were those where the principals shared an unwavering vision that information and communication technology had the potential to improve student learning. Similar to Yee's research, Schiller's findings highlight the key role that the principal must play not only in supporting technology, but also facilitating change and intervention strategies in the teaching and learning process (Schiller 2003). Hughes and Zachariah (2001) investigated the relationship between effective administrative leadership styles and the use of technology and they found that it is the teacher's pedagogy that needs to change and that the leaders needed to align the changes into productive future directions. Kearsley and Lynch (1994) noted in their study that the technology is a powerful tool that supports educational institutional reform and facilitates student learning. The potential benefits of good leadership can include improved academic achievement by students, improved student attendance and reduced attrition, better vocational preparation of students, more efficient administrative operations, and reduced teacher/staff burnout and turnover.

11.3 Objectives of the Study

With relatively few studies specifically addressing evaluation of principals' information and communication technology leadership, this area necessitates future exploration so that current and future leaders can be prepared to deal more effectively with information and communication technology and to successfully implement information and communication technology policy. The main objective of this study is to empirically investigate principals' information and communication technology leadership practices in their respective colleges. The supplementary objectives of the study are:

- To analyze the methods and strategies do principals use to integrate information and communication technology into the educational environment.
- To probe how principals develop and spread effective information and communication technology practice in the teaching environment through teacher professional development.

- To investigate the principals' contributions to the successful and sustainable implementation of information and communication technology in education in their institutions.
- To examine the practical problems faced by principals while executing information and communication technology leadership in their colleges.

11.4 Theoretical Framework

Drawing from the empirical literature on principals' leadership in general and specifically their effectiveness as ICT leaders, seven primary dimensions/standards of principals' information and communication technology leadership will be examined and serve as the conceptual framework for this study: (1) vision and leadership; (2) learning and teaching; (3) productivity and professional practice; (4) support, management, and operations; (5) assessment and evaluation; (6) responsible decision making related to social, legal, and ethical issues and (7) interpersonal and communication skills. The aforementioned seven dimensions/standards are chosen because they are the principals' core tasks in dealing with teaching and learning as well as administrative operations with information and communication technology in their colleges.

11.5 Methodology

A mixed-method approach of both quantitative and qualitative methodology is used for this study. The quantitative methodology consists of the surveys sent to principals and teachers. The qualitative methodology includes the researcher's use of in-depth interviewing as a second source of data collection and analysis. This explorative study investigates the methods and strategies that principals use for information and communication technology integration as they relate technology use as a tool of instructional strategy. It also investigates what changes occur as a result of information and communication technology integration and how these changes may be connected to college reform efforts.

11.5.1 Sampling Methods

The population for this study was all the teachers and principals of the Professional Colleges in Kerala State. Participants were selected after the pilot study, and a questionnaire was sent to each teacher along with a cover letter explaining the purpose of the study and providing needed information to properly complete the questionnaire. Teachers were asked to evaluate their principal's role in leading and

facilitating technology use in their colleges. To encourage the return rate, follow up thank you postcards and personal contacts were made until a satisfactory percentage of participants completed the questionnaire. All surveys were collected anonymously unless the survey responded voluntarily offered his/her contact information. All presentation of data from survey responses and interviews use numbers or pseudonyms so as to not reveal the identity of any participant. Although the nature of the research questions could impact on a principal's job performance, the researcher will maintain participant anonymity and confidentiality at all times. The participants are informed of the research objectives, data collection methods and data collection devices. Two hundred questionnaires were sent randomly to selected teachers of the professional colleges in the State of Kerala. Of the 200 survey forms mailed, 103 were returned. The response rate was 51.5 %, normal for such research. Of these 103, only two survey forms were deemed unusable because the respondents answered incompletely. One hundred and one or 50.5 % of these survey forms were analyzed for this study. Data from some of the respondents were missing for some of the study questions, which accounts for discrepancies in total number of responses from one item to the next.

11.5.2 Design of the Instrument

To explore information and communication technology leadership, the researcher used the *Professional College Principals' Information and Communication Technology Leadership Questionnaire.* The survey instrument is a two-part questionnaire designed to collect data on factors associated with the role of principals as leaders of information and communication technology on their respective campuses. Part one of the instrument is designed to measure the information and communication technology leadership, information and communication technology standards and accompanying performance indicators of college principals. Part one asks seventy five questions using the Likert scale (five-point scales). Part two of the survey instrument is designed to collect demographic data of the respondents, including gender, educational level, age and number of years of teaching experience etc. Based on the preliminary analysis, the seven leadership dimensions showed consistency across the individual groups of assessment responses. The alpha coefficients (shown in parentheses) were calculated for each scale: (1) vision and leadership (0.917); (2) learning and teaching (0.919); (3) productivity and professional practice (0.942); (4) support, management, and operations (0.906); (5) assessment and evaluation (0.925); (6) responsible decision making related to social, legal, and ethical issues (0.909) and (7) interpersonal and communication skills (0.934).

For data analysis, the Statistical Package for the Social Sciences (SPSS version 11.5) software was chosen. Both descriptive and inferential statistics were calculated on all quantitative data. Descriptive statistics were used to manage the data in the form of frequencies, proportions, percentages, means, and standard deviations.

Table 11.1 Mean score of the leadership standards

Standards/dimensions	Mean	Standard deviation	Variance
Leadership and vision	3.6634	1.64485	2.706
Learning and teaching	3.3762	1.73696	3.017
Productivity and professional practice	3.4356	1.77998	3.168
Support, management, and operations	3.8317	1.66174	2.761
Assessment and evaluation	3.2970	1.71782	2.951
Social, legal, and ethical issues	3.1980	1.67940	2.820
Interpersonal and communication skills	3.2772	1.69186	2.862
Valid N (list wise): 101			

11.6 Findings

Of those teachers who responded to the demographic information on the instrument, respondent gender consisted of 47 (46.53%) males and 54 (53.47%) females; respondent age ranged from 28 to 60 years. Years of teaching experience varied, with 43 (42.57%) with less than 10 years, 38 (37.62%) with 10–20 years, and 20 (19.81%) with more than 20 years. Seventy eight respondents (77.23%) held basic degree (minimum requirements) to teach in the professional colleges and 23 respondents (22.77%) held a research degree or higher qualification.

Part one of the survey document contained 75 questions and each of the standards was measured using the responses to only those questions identified to measure that particular standard. The range of possible mean scores on the Likert scale responses on this instrument is 1.00–5.00. The following table presents the results of the survey instrument (Table 11.1):

Participant's highest mean score (3.8317) was for the standard: *Support, Management, and Operations*. The lowest mean score (3.1980**)** was for the standard: *Social, Legal, and Ethical Issues.* The largest amount for variance occurred in the mean scores for the standard: *Productivity and Professional Practice.*

Arithmetic mean scores were also tabulated for each performance indicator. Twenty eight of the performance indicators mean scores were higher than 3.00. One of the Performance indicators which asked participants "whether their principals provide for and ensure the faculty the technology management programs to take advantage of quality professional learning opportunities for improved learning and teaching with technology", received the highest combined mean score (3.971). The lowest score (2.573) was performance indicator dealing with "Assessment of Administrative Systems".

The method of in-depth interview was used to corroborate the survey data and provide more comprehensive, in-depth and detailed data collection from the principal's perspective in regards to the major research questions. Ten respondents were chosen for in-depth interviews. Each participant was asked 36 questions following a specific interview protocol. The principals presented multiple perspectives when discussing information and communication technology use and integration strategies. No matter what the perspective, principals all share three common themes,

(1) modeling technology use, (2) promoting technology use through baby steps and (3) creating technology trainers. Within these themes additional details and strategies are presented. When specifically asked about methods and strategies for information and communication technology integration, principals were able to more explicitly state what they were doing. Seven topics emerged: (1) providing more teachers training, (2) using information and communication technology to model expected teacher use, (3) obtaining additional software and hardware, (4) monitoring information and communication technology use, (5) creating more time for discussion about information and communication technology use, (6) planning with teachers to integrate information and communication technology, and finally, (7) using methods to shift paradigms. Three themes emerge to answer the question: "What changes result from information and communication technology integration?" They all stem from an increase in the use of information and communication technology as an instructional tool. This increase requires (1) changes in the education environment, (2) more support at all levels and (3) a commitment to the future. Changes in the education environment include communication processes, information access and most importantly, teaching and learning strategies. Support includes modeling by principals, staff development by technology leaders, support by leaders for changing paradigms and pedagogy and stakeholder involvement. A commitment to the future includes understanding the students that we are teaching today and reaching to understand the future that we are preparing our students to lead. Five themes emerge about information and communication technology methods and strategies for future information and communication technology goals. They are (1) modeling information and communication technology use, (2) providing more time for staff development, (3) reaching out to stakeholders, (4) providing more access to information and communication technology for teachers and (5) developing understanding in teachers about changing their paradigm.

11.7 Discussion

Principals' information and communication technology leadership has been measured as one construct comprising seven technology leadership dimensions. The first ICT leadership standard/dimension deals with "**Leadership and Vision.**" This study attempted to place a quantitative score on the abstract concept of leadership and vision. To do so, the *Information and Communication Technology Leadership Questionnaire* asked questions about *shared vision; technology plan process; innovation; use of data to make decisions; planning for research based technology practices.* The combined mean score for the first technology leadership standard/dimension is 3.6634. It is the second highest of all the standard mean scores. This indicates that out of the seven technology leadership standards, principals do well in the area of leadership and vision. The performance indicator scores for questions asking about technology planning are much higher, indicating that principals

incorporated technology into their own campus improvement plans and developed technology plans. The performance indicator scores also indicate that principals very much support their teachers in Research-based Technology Practices. These scores point out a continued strength on the part of principals to provide the necessary vision and leadership for technology. Previous research shows that articulating, sharing, and demonstrating technology visions are effective leadership behaviors (Aten 1996; Cory 1990; Ford 2000; Inkster 1998; Jewell 1998; Ray 1992).

The questions related to the second ICT leadership standard, "**Learning and Teaching**", were designed to measure *principals' support for teachers' innovative uses of technology for instruction, principals' willingness to provide technology based professional development for teachers, principals' willingness to provide learner centered tech environment, principals' support for the use of technology for higher-order thinking and the principals' evaluation of teachers technology use.* The combined mean scores for second ICT leadership standard is 3.3762. The results in this standard indicate that the teachers felt their principals moderately supported the use of technology for teaching and learning. Indeed, 72 % of the participants indicated that their principals provided technology staff development for the teachers, allocated additional budget money for technology, and reviewed classroom observations to evaluate the implementation of technology by teachers. This study indicates principals fairly support technology in the teaching learning process.

The ICT leadership dimension/standard three concerns "**Productivity and Professional Practice**". It was designed to measure the *model technology use; use of technology for communication; participation in tech learning communities; engagement in professional development; awareness of new technologies and use of tech for organizational improvement.*

This standard addresses how professional college principals use technology to make positive changes in productivity for themselves and others. For principals to be leaders in the use of technology, they first have to be knowledgeable about technology and model its use. The mean score for standard three is 3.4356. The performance indicator combined mean score for indicator, modeling technology use is 3.748. These scores indicate that the principals are technologically competent and to some extent frequent users of technology. This study confirmed that principals are becoming much more technologically literate and using technology more often. Communication technologies seem to be especially important to participants of this study.

The fourth ICT standard is "**Support, Management, and Operations.**" This standard is concerned with *the guidelines for tech compatibility; use of technology management programs; allocation of resources for technology; integration of tech plan with other plans; and implementation of continuous system improvement plans.* Principals combined mean score for this standard is 3.8317. The survey data also indicate 67 % of the principals regularly use student management software program. This data shows that a good number of principals are very proficient in this area.

The ICT leadership standard five refers to "**Assessment and Evaluation**" which specifically targets *the use of tech to analyze data; assessment of tech resources; assessment of staff competency; and assessment of administrative sys-*

tems. The combined mean score for this standard is 3.2970. The combined mean score in the performance indicators: use of technology to analyze data and assessment of administrative systems are 2.952 and 2.573 respectively. The other two performance indicators in this standard dealt with assessment of the technology infrastructure and assessment of staff technology needs. Assessment of the technology infrastructure has a combined mean score of 2.895 while the combined mean score for assessment of staff technology needs is 3.768. These scores indicate that the principals in the study used existing technologies such as student management programs, computerized grade programs, and attendance programs to evaluate and report results.

The sixth ICT leadership standard deals with "**Social, Legal, and Ethical Issues**". This standard is concerned with *social, legal, and ethical practices; privacy, security, and safety practices; policies that enforce copyright; environmentally safe and healthy practices and equity of access to all*. Equal access pertains to the ability of all students being able to access the technology of a college regardless of their economic status, race, sex, educational program, or any other limiting factor. The combined mean score in the performance indicators equity of access and privacy, security and safety practices are 3.769 and 2.866 respectively. In fact, the combined mean score for performance indicator, policies that enforce copyright was the second lowest of the entire performance indicator scores (2.697).

The seventh ICT standard contains indicators dealing with "**Interpersonal and Communication Skills**". It was designed to measure how the principals *interact and communicate; demonstrate an understanding of needs and concerns; maintain positive relationships; encourages professional development; and improve communication and collaboration.* The combined mean score for technology leadership standard seven is 3.277. Principals' interpersonal and communication skills showed a significant and positive impact on principals' effective technology leadership. This finding supports previous research (Chang 2003) showing that to become effective technology leaders, principals must build positive working relationships, communicate change and new ideas well, and identify and support teacher needs and concerns.

The results of the study reveals that principals with higher levels of ICT competence and frequency of use tend to give stronger support for ICT integration into teaching. This result is consistent with similar results from previous research (Albirini 2006; Polizzi 2009; Venkatesh et al. 2003), which showed that individuals with higher levels of competence and frequency of use of a technological system have more positive attitudes towards its uses.

Principals with positive attitudes towards ICT integration into teaching give stronger support for such integration than principals with negative attitudes do. The research results are consistent with the ones from previous studies (Albirini 2006; Rogers 1995; Davis et al. 1989), which showed that attitudes affect the behavioural intention to use a technological system.

Principals who manage colleges where teachers already have higher ICT competence and frequency of use give stronger support for ICT integration into teaching. Research results are consistent with similar results obtained from the research

carried out on teachers in Palermo (Polizzi 2009), which found that teachers with higher ICT competence and frequency of use tend more to put ICT integration into the curriculum in practice, and such behaviours can reinforce principals' support for ICT integration into teaching, so creating a virtuous circle between teachers' competence and principals' supportive behaviours.

11.8 Conclusions

Leadership plays a major role in ICT implementation at colleges, especially in its integration into the curriculum. ICT training received by teachers is not sufficient to an effective ICT integration in the curriculum if teachers are not supported by the leadership of their college principals. Principals with very positive attitudes towards the usage of ICT tended to influence their teaching staff by emphasizing the importance of ICT integrated learning. Principals are expected to display active leadership in any kind of innovation at college level, including technological changes in the process of teaching and learning and consequently, it is inevitable for college principals to have new roles as IT classrooms increase. The policies in ICT integration required an active intervention by college principals, namely: the presence of an ICT policy plan, leadership supporting the process of ICT integration, college internal support, evaluation of ICT use, and cooperation. This study discloses that ICT integration as an instructional strategy needs to be learned in the wider context of changing pedagogy and models of thought about technology use in education. Overwhelmingly principals noted that teachers needed to change their teaching style to integrate technology. Furthermore, this integration is not just about using technology but about creating student-centered constructivist learning environments where technology is used as a tool for inclusive development of the students.

To conclude the following standards/dimensions are essential for college principles for effective ICT leadership and for a comprehensive and appropriate use of ICT in colleges:

- Principals should inspire a shared vision for comprehensive integration of technology and foster an environment and culture conducive to the realization of that vision.
- Principals have to ensure that curricular design, instructional strategies, and learning environments integrate appropriate technologies to maximize learning and teaching.
- Principals ought to apply technology to enhance their professional practice and to increase their own productivity and that of others.
- Principals ensure the integration of technology to support productive systems for learning and administration.
- Principals use technology to plan and implement comprehensive evaluation systems of effective assessment and evaluation.

- Principals must understand the social, legal, and ethical issues related to technology and model responsible decision making related to these issues.
- Principals have to be able to get along with teachers and staff members as they begin to integrate new learning technologies.

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Part III
Information Systems Flexibility

Chapter 12
Factors Affecting the User Acceptance of ERP and the Impact on the Individuals: A Conceptual Model

Christy Angeline Rajan and Rupashree Baral

12.1 Introduction

The role of Information Technology (IT) in industries has increased rapidly during the last century. IT now represents about half of all capital investments on a global basis while much of the developed workforce in the developed world relies on telecommunications and computer based Information systems (Martinsons and Chong 1999). Information systems (IS) have been developed in an ad-hoc manner focusing on their corresponding business units. This creates islands of information in the organization making information sharing difficult (Chang et al. 2008). Enterprise Resource Planning or ERP are implemented in Organizations to provide an integrated management approach. ERP systems promise to improve organizational performance and competitiveness by streamlining business processes and eliminating duplication of effort and data (Kwahk and Ahn 2010). But despite the various benefits promised more than two thirds of ERP system projects result in failure (Chang et al. 2008). A closer look at the nature of reported problems clearly suggest that the ERP implementation issues are not just technical, but encompass wider behavioral factors (Skok and Doringer 2001). The most critical determinant of the success of an information system is the human element (Martinson and Chong 1999). If users are not willing to use it due to their negative attitude toward change, the ERP system would not bring the expected benefits to the company (Kwahk and Kim 2008). It is important for the organizations to understand the system adoption from the user's perspective to prepare their employees to face new challenges and learn how to make good use of the technology by translating into tangible benefits (Chang et al. 2008).

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The strategies on ERP adoption must address cultural differences and localized strategies (Liang et al. 2004) The implementation in developing countries face specific difficulties over and above those found in industrialized countries (Kamhawi 2007; Soja 2008) because of differences in the sophistication of IT use, and in the cultural and social contexts (Tarafdar and Roy 2003). This distinction between cultures suggests that information technology and management practices should be modified for different cultural contexts (Anandarajan, Igbaria & Anakwe, 2002).

Thus it is essential to understand the influence of the various factors influencing the acceptance of ERP in the Indian context. Based on the review of extant literature, this study is done to identify those factors and the effect of those on the acceptance and usage. With little research existing to study the impact at the individual level, this study also seeks to find the impacts of usage of ERP system on the user.

12.2 Literature Review

12.2.1 ERP Implementation

Kumar and Hillegersberg (2000) defined enterprise resource planning (ERP) systems as ‘‘configurable information systems packages that integrate information and information based processes within and across functional areas in an organization’’. It integrates all aspects of a business promising one database, one application and a unified interface across the entire enterprise (Bingi et al. 1999). ERPs such as SAP/R3, PeopleSoft, and Oracle are software packages that promise the seamless integration of all information flowing through a company including information on finance and accounting, human resources, supply chains, and customers (Davenport 1998). When an ERP system is introduced and applied, the organization may receive many benefits, such as reduced cost, improved response time to customers, as well as enhanced organizational performance (Lee et al. 2010). It can deliver a great reward but the risks they carry are equally great (Davenport 1998).

A major difference between ERP systems and traditional information systems comes from the integrated nature of ERP applications. Implementing an ERP system causes dramatic changes that need to be carefully administrated to reap the advantages of an ERP solution (Al-Mudimigh et al. 2001). It requires changes not only in systems but also in processes and other social dimensions (Kwahk and Kim 2008) and in the coordination and corporation among the members of the organizations to make it work (Chang et al. 2008). It is a socio-technical challenge that requires a fundamentally different outlook from technologically-driven innovation (Al-Mudimigh et al. 2001). The causes for failures arise from the interactions among people, tasks, environment and technology (Kwahk and Ahn 2010) and also since ERP software being developed in technically advanced countries, standards are often too high for under developed or developing countries (Botta-Genoulaz et al. 2005).

To find out why these ERP projects fail, many researchers have tried to identify the critical success factors of ERP systems., these include committed leadership (Sarker and Lee 2003), Organizational support, organizational fit of the ERP (Hong and Kim 2002), computer self efficacy (Compeau and Higgins 1995), Training (Aladwani 2001; Somers and Nelson 2001), project communication (Nah et al. 2001), system quality and information quality (DeLone and Mclean 1992), user involvement (Amoako-Gyampah and Salam 1999). Social factor is found significantly influencing the usage of ERP system therefore; experience sharing should be arranged for employees so that the nonuser can see the benefits of using the ERP system as told by the users. This may motivate them to use the ERP system (Rogers 1995). When adopting an ERP system, there is also a need to recognize the unique Asian context concerning cultures as most of the existing business models typically reflect Western practices (Hong and Kim 2002).

While research has examined aspects of business process change, little research has focused on the individual employee and has studied the drivers of process adoption by employees, the factors influencing resistance, the impacts of process change on employees of complex technology solutions like the ERP (Venkatesh 2006).

12.2.2 Technology Acceptance

With the growth in use of Information Technology by organizations, user acceptance of information system has becomes an important management issue for better management of resources and needs (Kanwal and Manarvi 2010). There are several theoretical models to explain the user acceptance towards information systems such as Technology acceptance Model (Davis 1989), Computer Self efficacy (Compeau and Higgins 1995), Task–Technology Fit (Goodhue 1995), Motivational Model (Davis et al. 1992) and adapted Theory of Planned Behavior (Mathieson 1991; Taylor and Todd 1995).

Technology Acceptance Model or TAM is a widely applied IS model to explain end user adoption of IT. It is a powerful model of user acceptance of computer technology (Igbaria et al. 1997). This model explains the potential user behavioral intention to use a technological innovation. TAM is based on the theory of reasoned action (TRA) (Ajzen and Fishbein 1980).

It theorizes that an individual's behavioral intention to use the system is determined by two beliefs: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) (Venkatesh and Davis 2000).

Perceived Usefulness: Davis (1989) defined PU as "the degree to which a person believes that using a particular system would enhance his or her job performance." PU has two dimensions: PU for the organization and PU for the individual. PU for the organization means economic benefits (e.g. product quality and cost savings) resulting from adopting a new technology. On the other hand, PU for the

individual is most likely the result of improved job performance and user motivations (Robey and Farrow 1982). Studies have reported that PU is positively associated with system usage (Igbaria 1994; Thompson et al. 1991)

Perceived Ease of Use: PEOU is defined as "the degree to which a person believes that using the system will be free of effort". According to TAM, perceived usefulness is also influenced by perceived ease of use because, other things being equal the easier the system is to use and the more useful it can be. People with PEOU are more likely to believe in the ease and usefulness of the system (Robey and Farrow 1982) and in the ease of access for using the system (Amoako-Gyampah 2007).

Recently, the Technology Acceptance Model (TAM) has been applied to ERP systems to explain the complex implementation and adoption issues of stakeholders and end users (Amoako-Gympah and Salam 2003; Gefen 2004).

12.2.3 Role of External and Contextual Variables on Use of ERP

TAM predicts that external variables are expected to influence technology acceptance behavior indirectly by affecting beliefs, attitudes, or intentions (Szajna 1996). Orlikowski (1993) demonstrated that adopting and using a specific IT is not solely dependent on the characteristics of the IT but is also dependent on other aspects such as organizational or social context and individual characteristics and attitudes.

Individual Characteristics

Some individual characteristics of information system users have been empirically shown to be associated with different levels of information or information system usage (Szajna 1993) which are discussed below.

Computer Self-efficacy Venkatesh and Davis modeled and empirically tested the determinants of PEOU and found that an individual's computer self-efficacy is a strong determinant of PEOU and behavioral intention (Compeau and Higgins 1995). Self-efficacy is a measure of a user's confidence in their ability to use a technology (Taylor and Todd 1995). It is the people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances (Bandura 1986). In the context of using computers and IT, computer self efficacy, therefore, is defined as a judgment of one's capability to use a computer and is an important antecedent of perceived usefulness (Compeau and Higgins 1995).

Absorptive Capacity Zahra and George (2002) suggested that absorptive capacity was an important factor for an organization to implement new IS successfully. Cohen and Levinthal (1990) defined it as the ability of an organizational member to value, assimilate and apply new knowledge. At the level of the individual, absorptive capacity refers to memory development, in which accumulated prior knowl-

edge enables the ability to store new knowledge into one's memory and to recall and use it (Cohen and Levinthal 1990). ERP users are often unwilling to change to the ERP mode of operation and the individual users' absorptive capacities of understanding, assimilating and applying knowledge influences the performance of ERP users (Park et al. 2007).

Organizational Characteristics

Some of the organizational characteristics like Top management support (Bingi et al. 1999), training of employees (Aladwani 2001) are identified as important to the successful implementation of ERP systems.

Organizational Support In organizations with using a technical system, organizational support affects behavioral intention to use the system (Fishbein and Ajzen 1975). Organizational support was identified as two broad areas, technology support and management support (Lee et al. 2006). Ralph (1991) defined technical support as people assisting the users of computer hardware and software products, which can include hotlines, online support service, machine-readable support knowledge bases, faxes, automated telephone voice response systems, remote control software and other facilities. Technical support had a significant effect on perceived ease of use and perceived usefulness (Ngai et al. 2007). Top management support is defined as the willingness of top management to provide the necessary resources and authority or power for project success (Slevin and Pinto 1987). It has been identified as the most important and crucial success factor in ERP implementation projects (Bingi et al. 1999; Nah et al. 2001; Somers and Nelson 2001). Organization support has been found to be crucial for successful adoption of a new system but little work has been done on the effect of internal technical support on technology acceptance (Lee et al. 2006).

Training Education and training refers to the process of providing management and employees with the logic and overall concepts of ERP system (Yusuf et al. 2004). ERP systems are extremely complex and demand rigorous training and therefore an important factor for successful implementation (Bingi et al. 1999). Lack of training has been one of the important reasons for failure of ERP systems (Gupta 2000; Somers and Nelson 2001). Training and education will reduce employees' anxiety and stress about the use of the ERP system and provide better understanding about benefits of the system for their tasks (Lee et al. 2010). It influences user beliefs toward the systems and training programs increases the user confidence in their ability to use (Gist 1987; Igbaria et al. 1995). It also provides managers with a mechanism to disseminate useful and pertinent information about the ERP system and how it fits in with the existing and proposed system (Amoako-Gyampah and Salam 2004).

Technological Characteristics

Literature shows that technological characteristics also play an important role in influencing the usage (Lederer et al. 2000).

Complexity ERP systems, similar to other management information systems, are often perceived as very complex and difficult to be implemented (Liang et al. 2007). Aiman-smith and Green(2002) defined technology complexity as the extent to which a new technology is more complicated for its user than the previous technology used for the same or similar work and represents an increase in the number of things the user must do at once. Higher complexity results in higher mental workload and stress (Sokol 1994). Complexity is found to have a negative impact on the adoption of information technologies (Igbaria et al. 1995).

Compatibility If the system is highly capable and more compatible with the organization, end users will have a more positive perception towards the technology (Kerimoglu et al. 2008). Information systems that are incompatible with the culture and convention of the organization may fail (Yusuf et al. 2004). ERP packages are only compatible with some companies' databases and operation systems and procedural and data compatibility are crucial to the acceptance of the system by the employees (Zhang et al. 2005).

12.2.4 Impact of ERP Usage

In addition to understanding the factors which influence technology acceptance, it is also important to examine the impact of accepting or rejecting IT from an individual or social system perspective (Rogers 1995). The impacts and the outcomes on the usage of ERP should be investigated from different perspectives especially with a view to study how the human factor influences success and how users can improve ERP's performance significantly (Botta-Genoulaz et al. 2005). Little research has addressed the link between user acceptance and individual and organizational outcomes and there has been no systematic investigation of the impact of technology on employee job characteristics (Venkatesh et al. 2003). A major issue in previous studies, is their reliance on organizational level data to evaluate the impacts of IS on performance (Abugabah and Sanzogni 2009).

The post-ERP implementation environment has revealed the considerable impact of these systems on user behavior, both among managers and among their subordinates (Decoster and Zwicker 2009). Hanseth et al (2001) claims that ERP systems are the ideal managerial control technology. ERP systems are capable of providing simultaneously both management with ample visibility (and, consequently, greater control) and also contribute to employee empowerment by providing access to information (Elmes et al. 2005).

Panoptic Empowerment

IS was shown to support employees by providing information or promoting the delegation of decisions, while at the same time IS can be used to control (Psoinas et al. 2000). The contradiction between control and empowerment arises when control is viewed in the bureaucratic sense of a supervisor exercising power over a subordinate, and empowerment is viewed as the transfer of power from managers to workers (Elmes et al. 2005)

The ERP system has not only increased the ability of organizations to gather more information in greater detail and in real time, but also brings about more widespread dispersal of information throughout the organization. This expanded access to information not only gives them added flexibility, but also allows them to make decisions which used to be formally referred upwards or to other departments due to a lack of information (Sia, Tang, Soh & Boh, 2002). The central concept of empowerment is the delegation of power to staff/employees in order to make and implement their own decisions (Psoinas et al. 2000). Thus empowerment is defined as any increase in worker power that enables workers to achieve institutional objectives with greater efficiency and effectiveness (Elmes et al. 2005).

ERP enables a much greater visibility if one's workplace behavior and the performance is enhanced as management can analyze data in real time, in finer granularity, and in multiple dimensions. Thus the ERP systems create an information panopticon through the visibility of information they provide, giving employees decision-making power while simultaneously making them visible to management, thereby leading to employee empowerment (Sia et al. 2002).

The Panopticon is an early nineteenth century design for prisons, developed by Bentham. The principal effect of the Panopticon is to induce in the prisoners a state of conscious and permanent visibility that assures the automatic functioning of power and they begin to act as if they are being observed because they cannot tell when or whether they are being observed (Foucault 1979). An ERP similarly employs a gaze because it records all user actions, which can be observed in real-time and also stored for later observation. Thus, with no extra effort ERP surveillance is essentially continuous (Sia et al. 2002).

The greater visibility of information provided by the common shared database not only empowers workers to do their work more efficiently and effectively but also makes them more visible to others throughout the organization who can then easily exercise process and outcome control (Elmes et al. 2005). This is referred to as panoptic empowerment which combines the concept of empowerment and multi-directional visibility. There is simultaneous increase in control and empowerment occurs through the mediating effects of information visibility (Elmes et al. 2005). These results contrast with Sia et al's (2002) study. More research is required to generalize the findings to other organizations.

Job Satisfaction

One of the established theories of job satisfaction was developed by Hackman and Oldham (1980). They defined job satisfaction as a positive emotional state of contentment arising from the presence of certain characteristics in a job (Hackman and Oldham 1980).

Job satisfaction is an important outcome in its own right and has been linked to other key job outcomes, such as organizational commitment, turnover intentions, and job performance (Kumar 2002). ERP system implementations have the potential to drastically alter jobs, thereby changing people's reactions to their work situation. The job perception and the implementation of an ERP system will interact to influence employees' job satisfaction (Morris and Venkatesh 2010). Attitudes towards IT is related to acceptance and therefore to the employees' job satisfaction (Korunka and Vitouch 1999). The amount of design of employee training and the management of implementation affects employee's satisfaction. Some studies have shown that computer based Information systems have a positive effect on the job satisfaction and motivation of end users (Ryker 1995) while some other have showed that there was no impact (Ang and Soh 1997) or a negative impact (Korunka and Vitouch 1999) which needs to be further examined.

Individual Performance

With the rapid growth in use of computing, academics and practitioners have recognized that IT success can be measured by its impact on an individual's work (Law and Ngai 2007). Organizations that spend millions of dollars on IT are primarily concerned about how their investment will influence organizational and individual performance. IT impact on work at the individual level is a direct consequence of system use, which in turn is a major factor of determining organizational impact (Torkzadeh and Doll 1999). Goodhue and Thompson (1995) argued that IT was more likely to be used in organizational settings and would have a positive impact on individual performance if the capabilities of the IT matched the tasks that the user had to perform. The system quality of the ERP system influences user's work performance and their satisfaction (Wu and Wang 2006). Performance and user satisfaction are both caused by the extent to which requirements are met (Gelderman 1998). Users would adopt an ERP system if they perceived ERP would assist them to attain desired performance outcomes (Amoako-Gyampah and Salam 2004).

There had been very few empirical studies involving individual performance in ERP environments (Donalds 2010). Some of these studies have stated positive relationships between IS and performance (Venkatesh 2000) while other studies have stated otherwise (Millman and Hartwick 1987).

12.3 Proposed Model

The review of literature shows that there has been no study to find the combined effects of individual, organizational and technical characteristics to form a comprehensive construct of the usage. Also there has been little research existing to find the impacts on the employees on the acceptance of ERP. Many of the existing research on ERP adoption is primarily undertaken by developed countries and very few on the developing countries. Based on this research gap, the following research model (Fig. 12.1) is proposed to study the effects of the various factors affecting the usage of ERP and its impacts on the employee attitude and behaviors in the Indian context. The following propositions are developed from the review of literature.

The relationships between the TAM variables are replicated in our model in the context of ERP system.

Proposition 1: There is a positive relationship between the perceived usefulness of ERP system and the intention to use the ERP system.

Proposition 2: There is a positive relationship between the perceived ease of use and intention to use the ERP system

Proposition 3: There is a positive relationship between perceived ease of use of ERP system and perceived usefulness of ERP system.

Proposition 4: There is a positive relationship between the intention to use and usage of ERP.

The acceptance of ERP is influenced by various external variables. Though previous research have considered the external variables in their research, there was no clear pattern with respect to the choice of the external variables considered (Legris et al. 2003). In this study we have categorized the external variables in three dimensions as individual, organizational and technological characteristics and we propose the following:

Proposition 5a: There is a positive relationship between the individual characteristics (computer self efficacy and absorptive capacity) and the perceived usefulness of ERP system

Proposition 5b: There is a positive relationship between the individual characteristics (computer self efficacy and absorptive capacity) and the perceived ease of use of ERP system.

Proposition 6a: There is a positive relationship between the organizational characteristics (organizational support and training) and the perceived usefulness of ERP system.

Proposition 6b: There is a positive relationship between the organizational characteristics (organizational support and training) and the perceived ease of use of ERP system.

Proposition 7a: There is a negative relationship between the technological characteristic (complexity) and the perceived usefulness of ERP system.

Proposition 7b: There is a positive relationship between the technological characteristic (compatibility) and the perceived usefulness of ERP system.

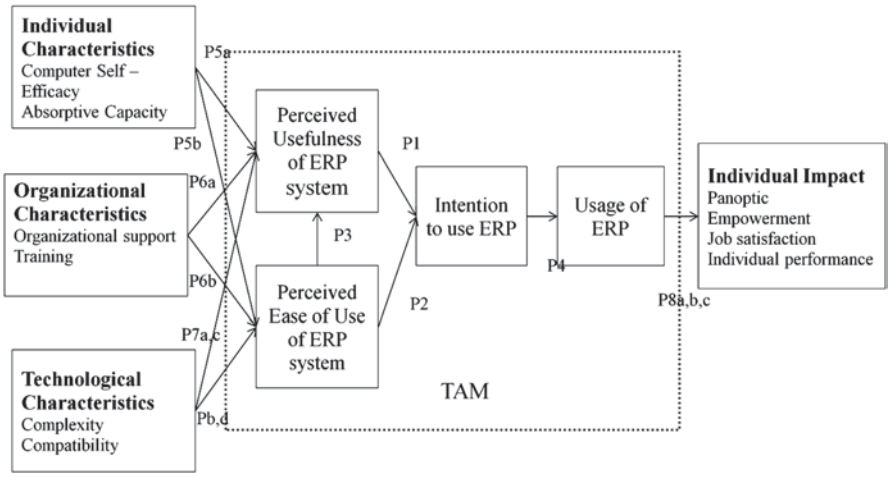

Fig. 12.1 The proposed research model

Proposition 7c: There is a negative relationship between the technological characteristics (complexity) and the perceived ease of use of ERP system.

Proposition 7d: There is a positive relationship between the technological characteristics (compatibility) and the perceived ease of use of ERP system.

Literature suggests that the acceptance and usage of ERP system will have an outcome at the individual level however little research has empirically examined this link. Hence panoptic Empowerment, job satisfaction and individual performance have been considered as the outcome variables measured at the individual level. The following are the propositions developed.

Proposition 8a, b,c: There is a positive relationship between the usage of ERP and the outcomes (panoptic empowerment, job satisfaction and individual performance).

12.4 Implications and Conclusion

The proposed study aims to provide insights for managers to manage efficiently to adopt ERP software across the organization. The management should understand the critical effects of the characteristics of the individual, technological and organizational characteristics on the acceptance of ERP. Managers should have the goal of not just making use of the system but to make employees satisfied with using the system, to improve their performance by using their time and energy and also to empower them to make decisions. This in turn has positive impact on the organization's performance and success of ERP.

The main purpose of this paper was to gain an understanding of the various factors affecting the acceptance of ERP by the employees in the organization and the impacts of the usage on the employees. The review of literature provides the evidence that may support the proposed model structure.

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Chapter 13
Information Systems Flexibility for Green Technologies

Krishnadas Nanath and Radhakrishna R. Pillai

13.1 Introduction

One common challenge faced by the IT organizations in the modern context is to cope up with the trends in the industry. One of the recent trends in IT industry is Green IT, where different organizations adopt/provide Green Solutions in innovative ways. Green IT is a synonym to environmentally sound Information Technology. It includes technologies like grid computing, virtualization and concepts like e-waste management, green coding, smart clients etc. Some technologies like cloud computing demand a change of computing architecture, moving away from legacy systems. They offer tremendous business opportunity but needs to be carefully implemented. Grafting or accommodating these technologies (Green Tech in particular) in the business process of an organization could be a cumbersome process and taxing for the IT managers. The information systems of an organization should be flexible to incorporate Green Technologies without negatively impacting the business. This comes from a strong support of literature and practice which states that flexibility is the key for coping up with dynamic, uncertain and complex environment (Alter 2000; Chakravarthy 1997; Overby 2001).

Green IT adoption in organizations demand flexible information systems architecture with adaptable application systems and it remains critical issue for IS managers (Prahalad and Krishnan 2002; Sambamurthy et al. 2003). The main feature of information system flexibility is to constantly cater to the changing business trends and dynamically adapt to the volatile environment. The importance of efficiently responding to dynamic environment is evident from the rapid changes in business model brought by technologies like Cloud computing. There is also a possibility of existing technologies becoming obsolete because of new models in place. Therefore, it becomes extremely important for organizations to develop an organizational

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readiness to incorporate Green technologies and earn business opportunity gain an edge over their competitors (Leana and Barry 2000). This shows the importance of information systems flexibility.

The problem of adopting Green Technologies is not limited to IT alone. It has a wide scope across domains in literature. Last decade has shown a much greater concern for environment in terms of contribution to management academic literature (Elkington and Burke 1989; Purser 1994; Prothero and McDonagh 1997). The responsibility of modern day organizations to reduce the impact on environment and create a sustainable society has led to the most important question of how to face the dynamic environment and implement the green initiatives. Management research has played an important role in formulating prescriptions for green initiatives and it is concerned with various aspects of management. Research in Operations Management (OM) has dealt with adoption of environmental quality standards (Corbett and Kirsch 2001), green production (Irwin and Hooper 1992) and sustainable supply chains (Klassen and Vachon 2003). Studies have been conducted in marketing area examining the consumer adoption of green products and promoting sustainable business (Belk et al. 1981; Collins et al. 2007) and other green marketing studies like Charter and Polonsky, 1999. Other areas include accounting (Gray et al. 1993) and Information Technology (Murugesan 2008). Literature on Green IT and the role of Information Systems in environmental sustainability has been taken up in the upcoming sections.

The purpose of this study is to come up with a model that deals with Information Systems flexibility for Green Technologies. From the review of studies in information systems flexibility, it was known that research on environmental changes and change management is at its infancy stage. Therefore, the model attempts to explore the kind of changes that an organization must respond to when implementation of Green Technologies is concerned. It is also suggests possible methods of responding to different types of changes.

Further, in order to maintain Information Systems flexibility, it is important to deal with the change and work out a proper model for bringing about organizational change to embrace flexibility in Information Systems. This study aims at coming up with a change model that can effectively and practically demonstrate different stages of adoption in context of Green technologies. Many models have been discussed in literature that talk about change management and organizational changes (Hunt and Auster 1990; Schot 1991; Greeno 1993). Some studies have also discussed the organizational changes in the context of sustainability. However, research on sound and practical approach to bring about a change for Green IT implementation is at its infancy stage. Therefore, this paper attempts to bridge the gap by taking up the Post-Altman Corporate Greening Model (Post and Altman 1992) and applying it to Green IT implementation to come up with sound Green IT change model for embracing Information Systems Flexibility.

This paper proceeds as follows. Section 13.2 describes the literature review of Information System flexibility with details on definitions and types of flexibility. Section 13.3 brings up the role of Information Systems and environmental sustainability along with the literature review on Green IT. Section 13.4 proposes a model

of Information Systems flexibility for Green IT and elaborates on different aspects of the model in the context of Green IT. This section also talks about a sound Organizational change process for Green IT implementation that could lead to better information systems flexibility.

13.2 Information Systems Flexibility: Literature Review

In order to understand information systems flexibility in the context of Green IT, it is important to understand the concept of flexibility. The term flexibility is often considered a vague term because of its wide use in various disciplines. Some studies view it as response capability to changes in organization and environment (Golden and Powell 2000), while other view it as inherent property of an entity (Avison et al. 1995). However, there had been debates on using the word flexibility because of the difficulty in determining how quickly the response should be to call it flexible (Golden and Powell 2000; Avison et al. 1995). The wide use of the term flexibility leads to the problem of the way it has been defined in various disciplines. It is closely related to terms like adaptability, elasticity, versatility, agility etc. Perhaps the best way is to understand the different metrics of flexibility from the research literature. Four metrics were identified by Golden and Powell (2000): efficiency, responsiveness, versatility, and robustness. They collectively give a fair idea about flexibility in general.

Moving from flexibility in general to Information Systems flexibility, active support of Information Systems is needed in order to tackle the changes that environment brings in an organization. Not only IS should quickly adapt to the changes, but it should also be done in a cost-effective way. Various definitions of Information System Flexibility have been explored in literature and some of them are presented in Table 13.1. It is clear from these definitions that IS Flexibility represents the capacity of Information Systems to change/adapt/adjust in response to changes in environment/new conditions/demands/circumstances form the organization. Moreover, Information Systems should do this without a radical change in the existing systems. The response to the crisis should be quick and accurate and IS should bring in good adaptability to environmental changes (Bruns and MacFarlan 1987).

It is clear from the analysis of definitions that IS flexibility plays a major role in adoption of Green technologies. It is important to discuss Information Systems Flexibility in the context of Green IT because IS is viewed as a concoction of several components. It does not focus on a technology alone, but it consists of IT components such as hardware, software, process and data. It is important for any complex IT initiative like Green IT to get aligned with the business process. It has been proved in literature that organizational performance is related to alignment between organizational structures, business strategies and information systems (Chan et al. 1997). In undertaking an initiative like Green IT, the organizational structure and business strategies are bound to change because of the changing trends in the IT industry. Therefore, it is extremely important for the information systems to adapt to these changes and be flexible enough to concert with strategies and structures.

Table 13.1 Information systems flexibility: literature insights

Source	Definition/insight
Mensah (1989)	The ability to respond and adapt to changing business conditions both within and outside the organization
Duclos et al. (2003)	The ability to align information system architectures and systems with the changing information needs of the organization as it responds to changing customer demand
Palanisamy and Sushil (2003)	The capacity of the information systems to change or to adapt and adjust in response to new conditions, demands, or circumstances from the organization
Duncan (1995)	IT infrastructure flexibility consist of three components: technological components, flexibility characteristics, and types of indicators
Byrd and Turner (2000)	Measured IT infrastructure flexibility in terms of technical and human IT infrastructure
Gebauer and Schober (2006)	Factors/measures for the built-in flexibility of information systems: system functionality, scope of the underlying database, user interface, and processing capacity
Michelis et al. 1998	Change related issues for information systems arise from three areas of concern: systems, group collaboration, organization and the interactions among them

Practical issues in is flexibility: As a concept literature has defined Information Systems Flexibility to a good extent. However, practical measures and steps in order to introduce flexibility in information systems is at its infancy stage. This section takes up the case of a data warehouse information management system which operates across business units and geographical locations. This would prove insights on how flexibility is practically introduced in information systems. Flexibility is needed in this environment because multiple business units have to make quick decisions by accessing the database to cope with the fast-growing and competitive markets. The information generated from the database must be timely and accurate.

One flexible feature of the warehouse is to store consolidated data from different business units and geographical locations. This would enable consolidated reporting and analysis for different units. Another step to introduce flexibility was the decoupling of process. This is important because in order to adapt to changes quickly and accurately it is important to gain access over some process without affecting other processes. It allows the ease of technological implementation unlike tightly coupled integration of processes which leads to inflexibility. Moreover, operating databases should be able to use the data in warehouse by excellent design. These independent operating databases might have different design, but they should be able to interact well to access the warehouse.

Information Systems Usage: Flexible Information systems influence the way technology and IS is used in an organization. Usage is an important element for teams and organizations to realize and experience the benefits from new technologies. Many organizations are concerned about the usage of information systems and the absence of it creates no value. Information systems flexibility should ensure

that the effective usage of IT & Systems is maintained or enhanced in an organization. With the rapid changes in environment, new systems and technologies are introduced which comes with an important issue of usage. The status of IS usage is further an important measure of IS adoption (He et al. 1998). Literature has defined measure of IS usage- duration of use, frequency of use, number of application and tasks supported (Igbaria et al. 1995). Therefore, usage forms an important component of information systems flexibility.

13.3 Green IT: Information Systems and Environmental Sustainability

Studies on Information Systems and Environmental Sustainability have been made in the past. However, it dealt mostly with the use of Information System to deal with the environmental problems. Very few studies focused on measures/changes/models to avoid the environmental impact of Information Technology. Information Technology has changed the perception of people of the human nature relationship (Bolter 1984). It is one of the important areas to be considered for the study on ecological sustainability due to its revolutionary effects. The term Green IT was coined recently, though the roots of it reside in the earlier studies of IS and environmental sustainability.

Green IT is a synonym to environmentally sound Information Technology (Murugesan 2008). It includes multiple aspects like environmental sustainability, energy efficiency economics, cost of disposal/recycling etc. Broadly, there are two sides of Green IT; one dealing with IT being the cause of environmental problem and the other using IT/IS to solve the environmental problems. It captures the **technical capability** including choices related to applications, data, technological configurations etc (Broadbent and Weill 1997) as well as human/managerial capability including experiences, competencies etc of IT personnel (Byrd and Turner 2000).

Many organizations are altering their business practices to become more environmentally stable (Hendry and Vesilind 2005) and this has led to the Green IT adoption. It becomes a Herculean task at times in IT industry to go green and a significant change is required in the organization culture and thought process. Hence, the technical expertise of Green IT implementation would not suffice; it is important to study the organization change and green culture with respect to IT. In order to understand the role of IS in forming a green organization culture and how it can drive Green IT, it is important to understand the basic roles of Information Systems. The roles in literature haven been classified as automate, informate and transform (Schein 1989). These roles can be understood by the relationship explored by Cash et al. (1994). Automation occurs when IT substitutes human effort followed by informate wherein IT augments the human effort. However, when IT restructures, it transforms a set of tasks/processes. Many organizations adopt ecologically responsive measures to avert negative public attention or penalties (Dillon and Fischer 1992). Information Systems is used by such organizations to facilitate the spread

of ecological consciousness and also to take issues to the top management so that green activities are embedded in the business process. The studies dealing with change process models and the organizational barriers in Green IT implementation is in its infancy stage. This paper tries to fill in the gap by understanding the literature of Green Practices in general and applying it in context of Green IT.

13.4 Proposed Model: IS Flexibility for Green Technologies

This section attempts to come up with a model that deals with IS Flexibility for Green technologies. Flexibility aims at responding to the changes in environment and therefore 'change' forms an important focus of this model. It is important to understand different types of changes before dealing with the methods to deal with the change. The strategy to deal with the change will depend of the type of change caused in the environment. Further, a change process model would help strengthen the model of IS flexibility for Green technologies.

The proposed model concentrates on the changes that IS Flexibility must respond to in order to create a flexible organization. The environmental dynamism plays an important role in changing the way organizations work. Both internal and external environments demand flexible organizations and they should be able to adapt in the face of environmental discontinuities (Ciborra 1993). Flexible Information Systems is one of the important elements of Organizational Flexibility and IS should be capable of adapting to new circumstances quickly and inexpensively (Frazelle 1986). Several studies have shown the importance of IS in organizational flexibility (Palanisamy and Sushil 2003; Robey and Boudreau 1999). IS Flexibility should respond to Business Changes and Technological Changes. These changes should be handled with a proper change model so that organizations can leverage upon the IS Flexibility to gain competitive edge. Therefore, the presented model has five components: (1) Environmental Dynamism (2) organizational Flexibility (3) IS Flexibility (4) Business and Technological changes and (5) Change model.

The model presented in this section is applicable for any strategic IS initiative but it is discussed in the context of Green Technologies. However, the last component of the model is applicable only in context of Green IT because the review of change models was done keeping in mind the context of Green IT and the best one was chosen for the same. Therefore, extension of this model for any strategic information systems initiative is left for the future scope of this study. The model is presented in Fig. 13.1.

The first component of the model is environmental dynamism. It is defined as unexpected, hard to predict and continuous changes of the environmental forces (Dess and Beerd 1984). It makes an impact on the organization which might result in volatility of the net sales, operating income etc. There are uncertain forces like increased competition, global challenges, market shifts, technological shits etc and environment is conceptualized with them. Environmental dynamism is affected by both external and internal environment. While former deals with issues like

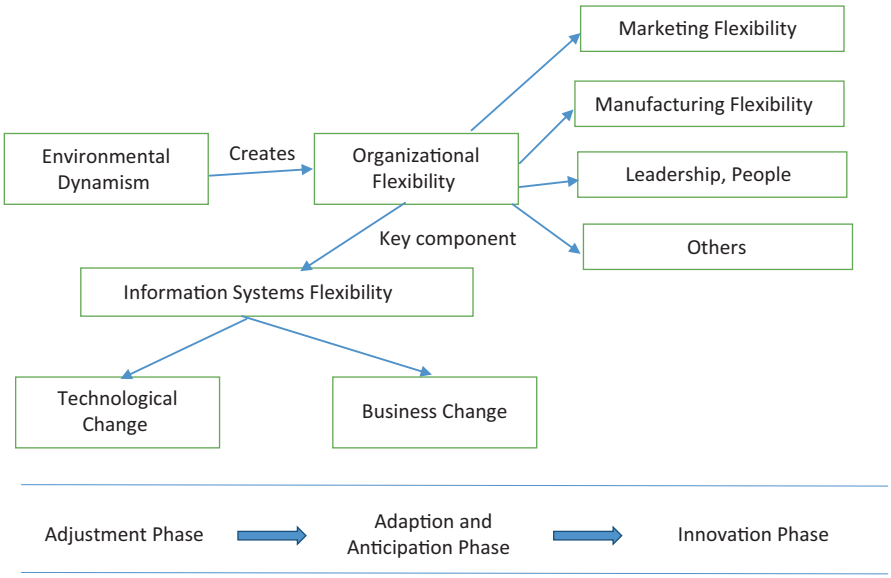

Fig. 13.1 Model- IS flexibility for green technologies

competition, customers, supply chain and geographical locations, latter deals with communication, speed and responsiveness. One of the best measures available to capture the construct of environmental dynamism was given by Powell (1993). It is measured by five items: (1) rapid growth in the demand (2) more need for R&D innovation compare to other industries (3) the growth stage of the industry (4) industry characterization such as high-tech and (5) more unstable industry changing more quickly and unpredictably.

Next component of the model focuses on organizational flexibility. In order to deal with the environmental discontinuities, it is important for an organization to be flexible and adaptable (Ciborra 1993). Leeuw and Volberda (1996) say "organizational flexibility is the degree to which an organization possesses a variety of actual and potential procedures, and the rapidity by which it can implement these procedures, in order to increase the control capability of the management and improve the controllability of the organization and environment." The speed with which organizations adapt to dynamic environment determines the success of an organization (Hammer and Champy 1994). There are wide and diverse aspects that come under organizational flexibility that include manufacturing/marketing flexibility, people, and leadership.

Four item can be used to measure organizational flexibility: (1) Frequency of organizational skill-upgrade in traditional and advanced areas (2) Frequency of organizational response for competition in a more reactive and proactive way (3) Number of strategies oriented towards organization's stability and growth and (4) Frequency of organizational technology-upgrade by indigenous development and import. This scale has been adopted from (Palanisamy and Sushil 2003)

Out of many important components of organizational flexibility, this paper focuses its study on Information Flexibility. Literature has shown the importance of IS in organizational flexibility and how the role of IS in adopting new circumstances quickly and inexpensively (Frazelle 1986). Several studies have been conducted to understand the impact of IS Flexibility on Organizational Flexibility and efficiency (Palanisamy and Sushil 2003; Robey and Boudreau 1999). In the context of Green IT, it is very clear that world is now facing extreme problem of climate change and IT has contributes to 4 % of the Global Carbon Emissions. Hence, it is becoming an important aspect of IT organizations to incorporate Green Solutions in their business process to make it more effective, efficient and eco-friendly. Rigid information systems cannot explore the business opportunities like Green IT and they restrict the organizational capability to exploit opportunities by not allowing changes in the business strategy. Better adapted Information Systems with integration to organization increases possibility of IS implementation success.

Measurement of IS flexibility is adopted from Palanisamy and Sushil (2003). It uses a four item scale for measuring IS Flexibility: (1) Frequency of IS support for operational and strategic management (2) Frequency of IS support for organization's strategic changes in a more passive and active way (3) Frequency of IS application development for individual and workgroup and (4) Frequency of proactive and reactive type of information availability for strategic changes.

Next component of the model is one of the most important aspects of this study. It talks about the changes which IS Flexibility should respond to and therefore sets a path for building a change model that can guide effective IS Flexibility in Green IT. Though the types of changes and its aspects are generic in nature, it has been discussed in the context of Green IT. As already discussed, there are changes constantly occurring in the environment and they need to be addressed effectively with the opportunities presented by the changes (Fitzgerald and Siddiqui 2002). Therefore, there is significant pressure on organizations to respond to the changes. Changes in IS environment include both internal & external business environment as well as Technology changes after the implementation of strategic IS initiatives like Green IT.

Responding to change has always been key feature of IS Flexibility. Rate of change & Unpredictability of Change are the major constituents of environmental dynamism which has been found to moderate the relationship between flexibility and performance (Lee 2003). Some of the changes like business & technological change, changes in scope/objectives and instability of technological architecture introduce major risk in IT implementation initiatives (Schmidt et al. 2001). For example- Cloud Computing is taking the IT industry by storm and it involves a complete shift of architecture from legacy in house servers to cloud servers. It involves many changes and issues like security, efficiency, business objective, resource utilization etc. We discuss two major changes that organizations must respond to: Business Changes and Technological changes.

Business Changes: System Providers are one of the major stakeholders in IS Flexibility. They should provide built-in flexibility in the Information Systems to

accommodate unpredictable changes in future. The systems should be designed in such a way that that business changes would result in inexpensive and quick accommodation when IS is concerned. In rapidly changing technological world, Green Technologies might direct the business objectives and IS should efficiently adopt new Green technologies in their architecture. One method is to integrate sustainability in the business process of organization. This would increase flexibility in terms of Green Technologies which are mere fixtures rather than permanent solution. It is important to understand the Business Changes because it results in changes in user requirements (Jalote 2000; Whitten et al. 2001). These changes can be in technical/non-technical requirements, logical internal/interface files, external inquiries etc.

Business changes have been talked about in literature. One of the classifications is given by Lee and Xia (2005) where three groups of business changes have been defined (1) changes in the setup of an IS development project such as system delivery date and budget for the project; (2) changes in the functional requirements such as system objectives, system scope, input data, output data, business rules/processes, data structure and user interface; and (3) changes in non-functional or operational requirements, such as system throughput, system response time, system reliability, and documentation.

The first group in the classification of business changes essentially deals with characteristics of project's setup. In Green IT, when the trend of projects is moving towards eco-friendliness, it is necessary to involve the aspects of sustainability in the IS Setup. It might also affect the business process and functional requirements which is mentioned in the second group. User might prefer a greener product with efficient resource utilization and hence it becomes important to change the system scope right from the design phase. Green IT has great influence in the third group where operational requirement changes. It becomes important in Green IT to provide justification of return on investment and hence the operational changes bring in business value by effective resource utilization, less carbon emissions, less wastage and reduced time.

Technological changes: It is not only the business changes that IS flexibility must respond to. It is important to understand that there are there are technological changes during and after the implementation of strategic Information Systems initiatives like Green IT. Stakeholders of System Development deal with changes in s/w development tools and infrastructure technologies (Cooprider and Henderson 1991). There are three groups of technological changes given by Lee and Xia (2005): (1) changes in software programming languages/tools, systems analysis/design methods, and CASE tools; (2) changes in technology architecture, hardware platform, operating systems, network/telecommunication, and infrastructure; and (3) changes in the other systems that the application under development will interface with, and in the enterprise master data that the application will use.

In the context of Green IT, where IT firms are looking forward to adopt cloud computing. There is a potential technological change involved in moving from traditional in-house software development method to performing action in cloud. Salesforce.com is an example of Customer Relationship Management software based in cloud. In case an organization opts for developing CRM software on salesforce.com it has to face a potential shift from traditional software development life cycle

to cloud. This will involve changes in tools, architecture and other system changes defined in the classification of technological changes.

The next step in the model provides an important insight on the process bringing about a change in Organization to implement Green IT initiatives. IS flexibility must not only respond to business and technological changes but it should also incorporate a sound change model to accommodate the changes. This step of the proposed model highlights a sound change process to strengthen the IS Flexibility. Various models were reviewed in literature keeping in mind the context of Green IT and the best of literature have been incorporated in the proposed change process.

The first step towards developing a model for change process is to understand the how adequate are the organizational conditions. These conditions include organization's technology, structure and culture (Zelenovic 1982) and they collectively define organization's responsiveness to dynamic change. It is important to design adequate conditions by identifying the type of structural and cultural change required to accommodate the changes. IS flexibility thus plays a major role in effectively designing the conditions.

Responding to the changes often involve change in organization structure. Therefore, effective flexible systems must take into account the changes in structure. It comprises not only of hierarchal distribution of responsibilities but also the control mechanisms for decision making. The changes might involve movement from mechanistic to organic (Burns and Stalker 1961) or from matrix to divisionalized. Performance oriented planning and control systems are important in different structures. It becomes important for implementation of flexible systems that could map the change to the kind of structure required and make the transition as smooth as possible.

One of the most important components of change in an organization is organizational culture. It is defined as set of beliefs and assumptions held commonly throughout the organization and taken for granted by its members (Bate 1984). Culture in an organization might vary from conservative to innovative. Flexible information systems must take into account the different leadership styles to deal with different cultures. Innovative culture is generally more preferred over conservative because the latter has a closed external orientation that is short-term and reactive. The former style on the other hand has long term orientation and would likely benefit accommodation of new technologies like Green IT.

Though literature supports innovative culture in better leeway for strategic flexibility within an organization, the change essentially starts at individual level. The change is thought process and mindset of the employees marks the start of any change process. Sudden change from conservative to innovative culture is not possible and therefore it happens in different phases. During all the phases, employees should devote themselves to support the change and this happens only with the understanding of values and beliefs of the organizational culture. It plays a central role in understanding the dynamism of the environment and configuring relevant strategic responses (Johnson 1987). Therefore, this paper reviewed the change models in literature keeping in mind the important concepts of structure, culture and values/beliefs.

Many models exist in literature, which talk about general change models like Lewin Three-Stage model (Lewin 1951) and also environmental change process (Hunt and Auster 1990; Schot 1991; Greeno 1993). However, when Green IT is concerned, there are only some guidelines suggested by Murugesan (2008) which sets a base for change models in Green IT. Hence, this paper takes up the Post-Altman Corporate Greening Model (Post and Altman 1992) due to its consistency with the guidelines for change suggested in Green IT literature. Each stage of the model is analyzed from Green IT perspective that could provide an insight for organizations looking to implement Green IT. Also, the key criteria for corporate sustainability have been described for each stage from literature.

Post-Altman Corporate Greening Model linked concepts from corporate responsiveness and organizational learning literatures. The study behind the development of this model concluded that the sample companies went through a development process of response to environmental factors that included important elements of organizational learning. This learning resulted in the transformational change model of corporate greening, the three phases of which are described below.

Adjustment Phase: This marks the beginning of the process, wherein the green implementation kick starts by modifying certain current practices on a need basis. It might be attributed to the market driven pressures where environmental staffs have narrow technical focus. The effort is reactive and incremental in nature directed more towards compliance reporting requirements. In Green IT implementation, this phase is the Tactical Incremental Approach suggested my Murugesan (2008). It is the basic step towards implementation of Green IT, where the enterprise preserves its basic IT infrastructure and policies. It goes for simple measures to create awareness in organization abut Green practices. It involves practices like power management, switching off computers, screen saver practices etc. It is easy to implement and has low cost associated with it, however creating a change in organization is the major concern here. The vision at this stage should be to go beyond incremental adjustments and to exceed the compliance requirements. The key criterion for corporate sustainability at this stage is "eco-efficiency". It is one the three criterion (others being eco-equity and eco-effectiveness) suggested by Dyllick and Hockerts (2002). Eco-efficiency basically reflects an organization's ecological impact in economic terms (Schaltegger and Sturm 1998). It utilizes the same systems in place and tries to remove the basic problems and make the overall system more eco-friendly and efficient.

Adaption and Anticipation Phase: Here, the linking of environmental value to other corporate values takes place. Old assumptions are questioned and the environmental goals are aligned with the business goals. In green IT, this phase would be the strategic approach. This is a much detailed implementation strategy where an enterprise conducts an audit of its present IT infrastructure with relation to its impact on environment. It develops a comprehensive plan to cater to the broader requirements like using energy efficient systems in the entire organization. The central goal of adaption and anticipation phase remains cost efficiency and reduced carbon foot print. It also contributes to branding, image creation, and marketing (positioning as an eco-friendly firm). Leadership is an important aspect here; however the role of internal champion

would boost up the process. The criterion for corporate sustainability at this stage is "eco-equity". It requires fair distribution of natural resources between current and future generations. It is necessary to transcend the compliance and conformity to environmental standards or else the results could be superficial (Meyer and Rowan 1977).

Innovation Phase: It requires considerable examination and evaluation of environmental goals which become truly embedded in all parts of the company. This stage has an integrated vision (both economic and environmental) incorporating all product/processes in a firm. Apart from clarity of vision, the performance goals should be clear and innovative opportunity development should be encouraged through organizational incentives (Bringer and Benforado 1993). This would involve a Deep Green Approach in Green IT. This approach is an add-on to the strategic approach, where further initiatives like carbon offset policy, buying carbon credits etc are taken up. This gives them a competitive advantage is terms of positioning their firm as "Green Firm", to attract customers supporting green initiatives. This stage sets up the platform for IT product/process innovations. The criterion for corporate sustainability here is "eco-effectiveness" which aims beyond merely reducing the negative impact on environment. It seeks ultimate solution to the problem as embeds it in the organization process requiring a major shift of mindset and transformation of business models.

13.5 Conclusion

This paper has considered Information Flexibility from Green IT point of view. It has touched upon the importance of IS Flexibility and its role in Organizational Flexibility. It proposes a model for IS Flexibility for Green Technologies. This model brings in an important aspect of Business/Technological changes which IS Flexibility must respond to. Further, it proposes a change process to bring in a sound change when Green IT is implemented to strengthen the Information Systems Flexibility. The paper hints at the fact that success of Green IT initiatives could depend upon integrating environmental issue with corporate strategy. Many executives declared themselves committed to the same (Adams 1992; Walley and Whitehead 1994). Also, the commitment from top management is crucial in such change process (Post and Altman 1992).

Future research would involve applying the suggested model in an IT firm and observing the results. For most of the components of the presented model, the measures for measuring the construct is also provided. This could lead to development of potential hypothesis in the field of IS Flexibility and Green IT. A strong empirical support to the model could enhance the generalizability of the same.

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Chapter 14
Assessment of Electronic-based Integrated Marketing Communication for Rural Areas in North India

Kavita Chauhan

14.1 Framework of an Electronic Integrated Marketing Communication

In this knowledge era, businesses must articulate its mission to a certain desired target audience and with accountability to public. However this could only be made possible when different marketing tools works in integration to support each other to create greater message impact. Internet has contributed significantly in enhancing this relationship replacing need for traditional media with fast, proactive and cheap medium. Increasingly people are looking at different media sources to extract information relying less on traditional media sources and on one single medium. This has facilitated an electronic-based environment where almost everyone on network is a communicator on thousands of websites, chat rooms and micro-sites having specialized forums and social media. Target audiences have learned to chuck out the piles of information on the websites with control on their choice of information they are interested in receiving or responding to. Thus e-IMC or Electronic Integrated Marketing Communication is a marketing approach to make use of internet-based media for communication of marketing activities to the target segment. This has altogether created a new channel, called online marketing, requiring a separate marketing-mix on the internet. Due to which the competition has increased, markets have become more widened, bargaining power of buyers has increased and differentiators among competitors have reduced. It is therefore IMC is identified as an agent that gives function, purpose and future direction to the business. It revolves around corporate vision, competitive advantage and scope to expand organization's activities. *Let us know further what does an e-IMC model looks like.*

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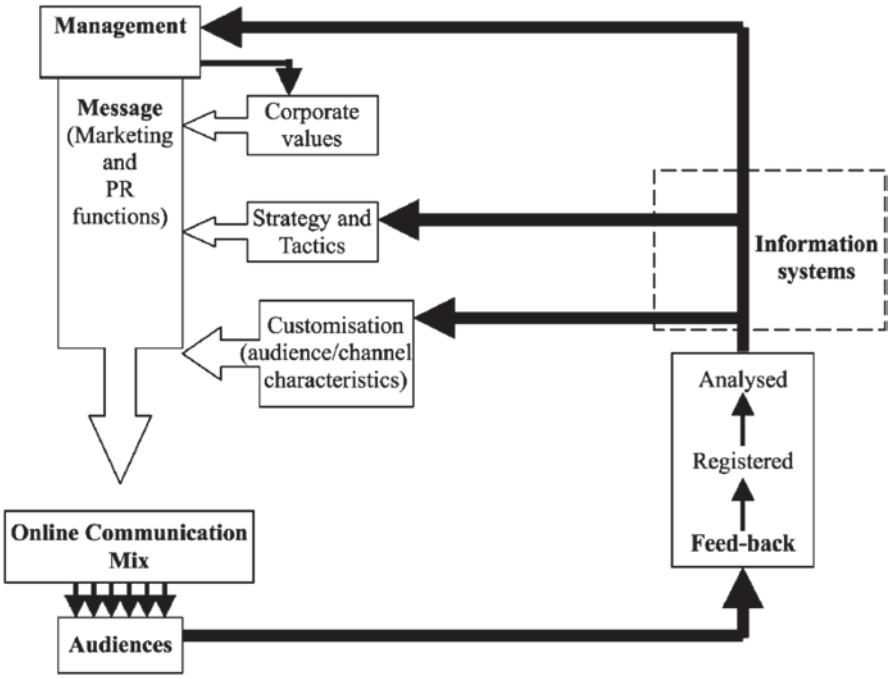

Fig. 14.1 An e-IMC Model

14.2 Design of an e-IMC Model

Gurau (2008) proposed a model for online integrated marketing communication. The message has to be designed keeping in view 3 things: corporate values, strategic-tactical objectives and characteristics that defined customer segment possess. The message should be designed as based on—cover for transparency, interactiveness and memory—as defined earlier as well. These shall give scope for personalization/customization of message requirements as per to audience needs or even in case of un-targeted audiences as well. This could only be possible through such a model that gathers data and generate response for an effective CRM. This has been represented in the Fig. 14.1.

After understanding of the model, let us look at few approaches to build an e-IMC model for the different purposes a business might have.

14.3 Approaches to Integrating e-IMC

An e-IMC model encompasses of marketing campaigns on the internet and mobile; which include activities like e-mail banners, blogs, webinars, podcast, internet t.v and mobile-based communication like SMS, MMS, WAP-based applications and

GPRS. Integration of marketing tools, approaches and resources to maximize consumer interest for most effective cost-benefit ratio is what labeled as electronic internet based marketing communication. In fact it integrates multiple form of communication for marketing purpose in simpler words; and otherwise it is the integration of highly specialized media i.e. internet. Its existence has caused major shift in the internet-based marketing tools (e.g. social networking sites) and applications (like 3G, MPEG-4) for corporate to find their target market in every nook and corner, 24 × 7; and continuous pestering with messages for top-of-the-mind recall, brand associations, developing client loyalty, and instant feedbacks.

This integration could be categorized as horizontal and vertical and, internal and external. Horizontal signify an integration between marketing-mix and other business functions like production, distribution etc. Vertical means an integration of marketing objectives with corporate philosophy and vision. Internal integration focuses upon motivating the employees and keeping them informed about official developments like new advertising campaign, new corporate identity, change in service standards and addition of new strategic partners. External, on contrary, is integration with advertising and publicity agencies. Thus, IMC is a holistic approach that makes use of vertical and horizontal; internal and external integration of communication to reach marketing objectives.

Below mentioned are some of the benefits that impacts and influences the customers in their decision-making and thus total value to them.

14.4 Some Underlying Benefits

So the question might arise why these should work in integration. The answer is to—develop sustainable competitive advantage—through optimizing customer value and costs to the company. IMC influences the consumer buying process positively by developing a dialogue and nurturing relationship (e.g. loyalty programs) with consumers creating a favourable image for the corporate (e.g. share value). IMC acts as catalyst to infuse possibility of marketing message. Stretching the message through different marketing tools and approaches creates high chances for corporate to arouse consumer interest, help them in decision-making in different buying stages, and to buy products or services. The message could thus be communicated in the form of timely reminders (like paying bills), information updates (like brand or product comparisons), offers and schemes (like certain discounts) thus moving through buying process stages to help consumer make decision in the clutter (of messages, products and services). The advantage is it shortens the buying cycle by reducing the search for products with re-assurance (dissonance reducing behaviour). Not just this, with precise database on consumption behaviour, corporate can market their product well by knowing well what set of audience need what sort of product. Competitiveness for corporate do not rest on just one function and its functional efforts rather it an integration of activities of a corporate (Christiannse and Kumar 2000). Thus, IMC proves to be a great tool of competitiveness for corporate in terms of market share, visibility and brand image using online environment as ideal platform (Gimenez and Lourenco 2008).

But benefits don't come without obstacles. Few of these are discussed in the section below.

14.5 Common Obstacles in Designing e-IMC

The biggest of all problems is with communication itself. A vast variety of consumer-set requires designing different communication; tailor made to suit what rather would appeal to them. Decoding simple messages are easy but interpretation rests with the receiver whose demographic profile affects its interpretation. Thus messages could be misunderstood, or ignored or not delivered on-time. It is also because relevance of message depends upon target audience's needs, emotions, interests etc.

Not just this, message has to be designed to meet brand objectives, corporate vision, enhancing stockholder's value, offset competition, responds to pressure groups and overall creates a favourable effect for corporate (Gronroos 2004). A multi-cultural set of audience requires message to be adapted to meet language barrier posed due to socio-economic and culture factors. Then challenges are also posed by need for message to be designed interesting in terms of interactive-ness with static and dynamic web pages (Ashcroft and Hoey 2001).

Grove, Carlson and Dorsch (2002) pointed out single but adequate challenge in designing the IMC in services due to intangibility issue attached. The intangibility for services corporate makes it difficult for marketing to create positioning of the product in target segment's mind, and therefore consistent communication become a challenge.

After understanding the conceptual framework of e-IMC, its benefits and challenges, let us proceed to gain a view of present use of IMC and the developments further in the modern India before embarking our research.

14.6 IMC and Indian Experience in Rural Areas

According to India Business Weekly (2008), India has more than 50 million online user base in which there is 1 out of every 5 is a rural-area user. The statistics reveal that there are 82% online users in India come from urban population, while remaining 18% from rural areas. However, the total internet penetration stands at 4.5% of total population in India.

Being at the helm, with IT outsourcing and exports of software services, India still don't have greater internet penetration but has progressed from being at 0.4% penetration (in the year 2000) (Kiggen 2001) to today at 4.5% and from 38.5 million in 2005 to 100 million in 2007 and estimation of 96 million in 2013 (eMarketer 2010). There is a continuous focus on internet (broadband) with belief that it will empower the rural population, improve their lives and contribute larger sales volume for corporate (Jhunjhunwala et al. 2009).

Connecting villages for balanced growth and distribution of equitable welfare among the rural regions is most prominent criteria for socio-economic development of rural India. Not just this but rural market are deemed to be of worth of million in sales volumes but rate of reaping benefits and focus area is quite slow and limited respectively. The integration of marketing communication (IMC), and in particular, internet based, has known to be evolved as the most contemporary subject for tapping rural mass potential vastly distributed in regions extensively.

The question—why (e) IMC, holds special relevance for mass markets in rural and remote areas, is due to facts (FAO 2008) as stated hereunder:

1. It improves vertical (communication with decision-makers) and horizontal (communication between agencies linked to rural development) communication information flow constantly. This improves the quality of the decisions and interventions that impact upon the rural people.
2. It extends the application of Marketing Information Systems, in concurrence with existing and more widely used communication media such as rural radio enables the broad enhancements of information and communication resources for rural people.
3. Electronic enabled IMC or e-IMC provides a rural connectivity model at state and national levels, hence accessing a large volume of virtual information is easy without being impeded by geographic barriers.
4. Some models may include e-commerce based trading networks, local business information systems, portals and community financing or even health management programmes.
5. Another important desired use of IMC is integrating the efforts of governments and various institutions associated in bringing the socio-economic development in rural communities by bridging the knowledge gaps.
6. IMC synonyms for new ideas, discussion groups, access to expert advice, education resources, global understanding, cultural awareness, and more specifically here, product-market issues viz. product placements and locating medium for promotions electronically.

The core of this paper is to dipstick to analyze the awareness level of rural population about marketing communication, its major sources, and its impact on their lives.

Before we dipstick and analyse the source of marketing communication and its impact on rural lives, let us briefly look at the developments in the rural areas.

14.7 Growth Story of Rural India

The Indian growth story is now spreading itself to Indi's hinterlands. Rural India, which accounts for more than 70 % of the country's one billion population (according to the Census of India 2001), is not just witnessing an increase in its income but also in consumption and production. Rural areas constitutes of more than 70 % of

population in India who lives in villages with adult literacy rate at 58.8% (World Bank 2002), which is approximately 65% now (Indian National Literacy Mission 2009). The size of rural market was estimated at 42 million households and rural market has been growing at five times the pace of the urban market. Also, there is increasing agricultural productivity leading to growth of rural disposable income and finally, the lowering of difference between taste of urban and rural customers (Bhattacharya 2008; Bansal and Easwaran 2004).

The rural consumer market, which grew 25% in 2008 when demand in urban areas slowed due to the global recession, is expected to reach US$ 425 billion in 2010–11 with 720–790 million customers, according to a white paper prepared by CII-Technopak (National Commission on Population 2010). According to a Rabobank report, the agri-biotech sector in India has been growing at a whopping 30% since the last five years, and it is likely to sustain the growth in the future as well (Rao 2004). The report further states that agricultural biotech in India has immense potential and India can become a major grower of transgenic rice and several genetically engineered vegetables by 2010.

According to Chatterjee (2002), modern information and communications technologies (ICTs) and web based marketing of agricultural (e-IMC) produce hold great promise for the socio-economic development of rural hinterlands in India and at grass root level, their implementation must be carefully localized (Ramirez 2007). However there exist limitations on the type and quantity of resources available in rural areas (Daly and Avant 1999; Tiwari 2008). But based on close ties of family and friendship, people know each other; they help each other; and, frequently live out their lives in close interaction with a small group of people with similar norms and values (Daley and Avant 2004; Martinez-Brawley 2000), the relationships in rural community can prove beneficial for sharing resources and accessing services that connect them to family, groups, organizations and communities within and outside the rural area. Figure 14.2 represents the connect between roles that e-IMC could perform for agricultural development in rural areas.

Going by the proposed model of e-IMC, it is clear that functions of e-IMC have major impact on enhancing the productivity related to agriculture. It gets reflected in managing productivity through being aware on government policies and regulations, and support on the same for stable income throughout year (Raj and Selvaraj 2007). It reduces the role of intermediaries to bring maximum advantage to the farmer (Kanungo 2004). It also helps in controlling the price variations of the yields which should actually be based on real-time demand and supply and discourages hoarding of produce and thus reaching of the same to common man or rising thereby superficial inflation of commodities. It has slowly eliminated the need for *mandi* by the local intermediaries that have motive to purchase farmer's yield at lower costs, to re-sell the same as raw material to other producer at a higher cost (Nikam et al. 2004).

Figure 14.3 presents an interface of e-IMC and the bodies associated to communicate with rural communities. However not all of these are active at the same time for all the regions.

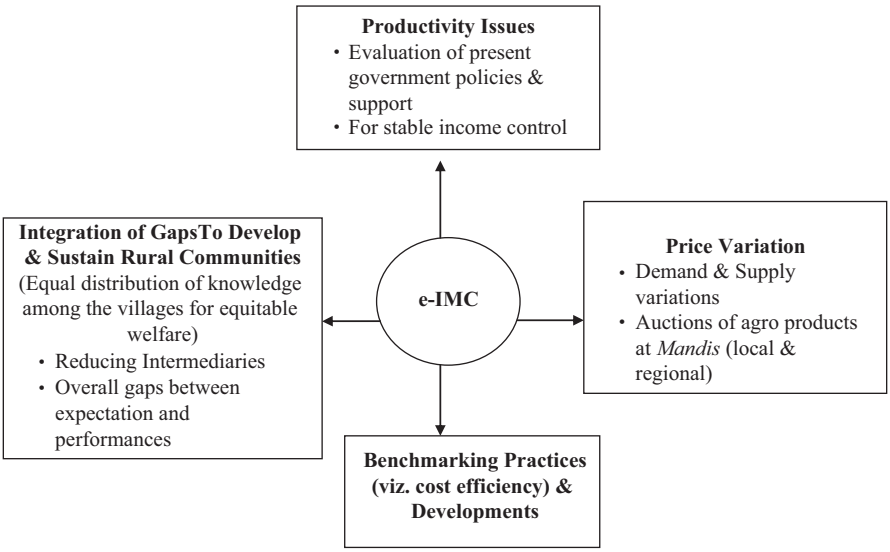

Fig. 14.2 Concerned Roles of e-IMC for Rural Development

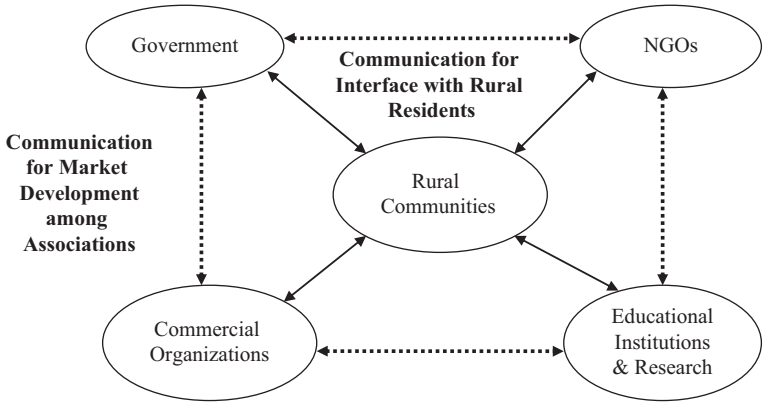

Fig. 14.3 An Interface Model for e-IMC

Figure 14.4 presents an information dissemination model describing how the information dissemination takes place. The objective of information disseminate is 3 fold: a) to share knowledge and skill related to agriculture; b) making it cost effective; and c) utilizing it for enhancing the output. Both horizontal and vertical communication takes place. While horizontal is among the villagers mostly and constitutes tacit part of information through informal discussions the vertical communication is instant, largely explicit and more of routine.

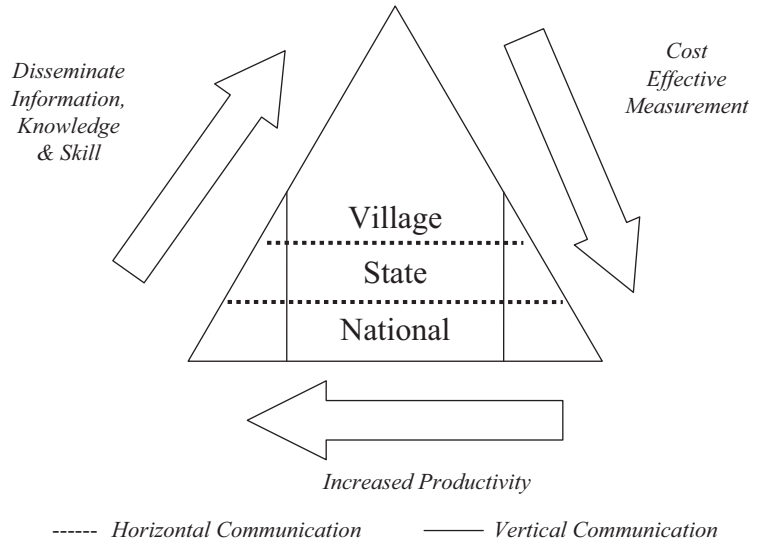

Fig. 14.4 Information Dissemination through e-IMC

14.8 Objectives of this Research

The broad objective of the research is focused around present experience of rural population with marketing communication in online environment, registering the impact of such communications on their produce and the lifestyle.

This has been studied under 3 objectives:

1. To study the relevance of electronically enabled Integrated Marketing Communication (e-IMC) for rural areas in selected states and villages of Northern India.
2. To study the relevant requirements for a useful e-IMC for these areas for the rural respondents.
3. To assess the impact of IMC on standard of living of rural consumers and farmers.

Based on the above stated objectives a review of e-IMC in Indian context is presented below with focus on ongoing e-IMC projects in various villages in Northern India.

14.9 Research Methodology Followed

For this purpose, sample is collected from the states of Punjab, Haryana, Uttar Pradesh and Uttarakhand 320 rural households are taken as sample size, on the basis of average population, consumption patterns and competition prevailing in markets. The selected villages have proper ICT facilities with minimum one ICT-based mar-

keting project ongoing. The total sample qualifies for the present study is 320 rural households from 5 states (out of 500 estimated). A total of 90 samples from Punjab, 73 samples from Haryana, 103 samples from U.P and 54 from Uttarakhand were taken. In this case respondent's primarily are farming households with income upto Rs. 7,000 per month however irregular due to seasonal incomes. The literacy rate is not required due to the fact that the study do not undertake to establish any relationship between literacy rate and incomes. However the due effort was taken to ensure that respondent understands the communication terminologies to respond the most preferred communication media. The information about respondent's detail is captured under heads like yield, average monthly turnover, mode of sales, and education level. The eligibility criteria respondent should have to be minimum higher secondary degree holder with exposure to mediums defined in the questionnaire annexed. For information gathering, state government offices were approached at Block Development Officers (BDO) level through e-mails and personal visits, requesting for the data through the use of questionnaire. The internet was also used to refer to statistics available on official website of the Indian government like National Commission on Population; Telecom Regulatory Association of India; Internet Service Providers Association of India and; Indian Council for Research on International Economic Relations. The questionnaire used had 3 sections. **Section A** captures the respondent's details like socio-economic details; **Section B** analyses the level of information access to the respondents, and **Section C** details about the benefit of online environment in communication in terms of living standards. Mainly the questionnaire was 'close-ended' in nature except section A which is open-ended. Detailed questionnaire has also been annexed at the end of the study as *Annexure—I*.

14.10 Questionnaire Analysis and Findings

The analysis is done question-wise and divided into three sections like Section A, Section B and Section C. It starts with the Section A that basically highlights the respondent's profile. Next follows the analysis of Sec B that presents the analysis for the sources of information to the respondents. The most used source of information is Project office which represents 37% of the sample. Section C explores the benefits of online format.

SAMPLE					
Sampling Units	**Punjab**	**Haryana**	**Uttar Pradesh**	**Uttarakhand**	**TOTAL**
Sample No.	90	73	103	54	320

SEC A						
Education Classification	**Upto Higher Secondary**	**Upto Senior Secondary**	**Under Graduate**	**Graduate**	**Post Graduate**	**TOTAL**
	199	61	24	29	7	320
Monthly Economic Status	**Upto Rs. 5000**	**< 5000 but > 10000**	**> 10000 but > 15000**	**> 15000 but > 20000**	**> 20000**	**TOTAL**
	11	76	189	40	4	320
Average Monthly Spending	**Upto Rs. 2000**	**< 2000 but > 5000**	**< 5000 but > 7500**	**< 7500 but > 10000**	**> 10000**	**TOTAL**
	22	201	80	12	5	320

SEC B						
Sources of Information	**Village Communities**	**State/Centre Assistance/ Institution**	**Self-Help Group/NGO**	**Project Office**	**Others**	**TOTAL**
	108	33	31	119	29	320
Medium of Information Access	**Face-to-face discussion**	**Internet**	**TV/Radio**	**One-to-one/many advice**	**TOTAL**	
	162	13	49	96	320	
Internet Awareness and Sources	**Aware, Can't Operate**	**Aware, Operate Regularly**	**Operate Occasionally**	**Not Aware At All**	**TOTAL**	
	69	10	27	201	307	
Membership to online Community	**Yes**	**No**	**Don't Know**	**Total**		
	41	64	14	119		

Information Exchange on Different Levels	**Village-level**	**State-level**	**National-level**	**Global-level**	**TOTAL**	
Without Internet	94	141	64	21	320	
With Internet	44	23	33	19	119	
Frequency and Intensity of information Access	**Rapid & Fast**	**Slow but Available**	**Available with Delay**	**Not at all Available**	**TOTAL**	
	45	23	34	17	119	
Challenges in Accessing information from Project Office	**Technology Related**	**Manpower Related**	**Cost Related**	**Infrastructural Related**	**TOTAL**	
	9	32	11	67	119	
Complexity Issues	**Too Technical**	**Hardware Complexity**	**Information Clutter**	**Non-reliable or Re-usable Content**	**TOTAL**	
	57	37	4	21	119	
Infrastructural Bottlenecks	**Electricity**	**Telephone**	**Location**	**Computer Per Person**	**TOTAL**	
	51	33	16	19	119	
Analysis of Internet Based interaction	**Local discussions**	**Lecture/ Workshop**	**Educational Tours**	**TV/Radio Based**	**TOTAL**	
Human Interaction	162	111	34	13	320	
	Websites	**Podcast/ Webinars**	**Specialized Online Resource**		**TOTAL**	
Internet Interaction	34	12	73		119	

Analysis of Resource based Information for decision making	Available Prompt	Available in Less than Day's Time	Available in Week's Time	Available in Month's Time	TOTAL	
	33	68	15	3	119	
Language based information Accessibility	English Only	Hindi Only	Vernacular Only	All of these	TOTAL	
	2	93	22	2	119	
Information Type and quality	Very Good Information with Aptly Supported Recommendations	Good Information	Average Information	Poor Information	TOTAL	
	32	74	11	2	119	
Online Vs. Offline Communication in terms of Costs/Margins	Saves Cost with High Margins (< 30%)	Saves Cost with Moderate Margins (>10%)	Save Cost but offers Less Margins (3-5%)	Do not Save Cost/No Margin	TOTAL	
Offline View (320 Respondents)	21	102	176	21	320	
Online View (119 Respondents)	6	64	39	10	119	

SEC C: Total 119 Respondents	STRONG (=3 Marks)	MEDIUM (=2 Marks)	WEAK (=1 Marks)
1. Online format improves the quality of decisions:	53	46	20
2. Online format reduces the transaction costs:	50	61	8
3. Online format is an easy to use information and communication resource:	44	69	6
4. Online format provides instant access to large volume of information:	39	68	12
5. Online format helps locate and connects to a buyer:	34	77	8
6. Online format makes the information sharing easy:	38	69	12
7. Online format gives the expert advice:	59	52	8
8. Online format readily makes useful information available as and when desired:	62	52	5
9. Online format lets prompt discussion on issues pertaining:	67	44	8

10. Online format makes aware on product-market situation:	45	72	2
11. Online format allows for product placements and locating medium for promotions electronically:	45	57	17
TOTAL:	**536**	**667**	**106**
SCORE OBTAINED:	**1608**	**1334**	**106**
TOTAL SCORE POSSIBLE:	3927	2618	1309
PERCENTAGE	**40.95**	**50.95**	**8.10**

Section C table presents the summary of internet-aware and/or user 119 respondents of the total 320 respondents. Based on the 11 statements above, the scores of the respondents can be presented as 41, 51 and 8% against *Strong, Medium and Weak* respectively. These statements and scores against the classification described as strong, medium and weak depict the respondent's score overall for the statements. 41% of respondents 'Strongly' believe the usefulness of internet as information source and a great communication source. However 51% respondents which are more than half of the respondents perceive online environment on an average (Medium) as contributing positively to their information-based needs for decision-making or in directly enhancing the productivity.

14.11 Concluding Observations

Respondents are mostly engaged in face-to-face discussions with the representative of project offices and there is low internet-based information penetration. Only 119 respondents have claimed to be aware of internet or have used it as medium for information through these project offices. Initially only 13 respondents confirmed, however after cross verification, it is found that there are as much as 119 respondents who have known about the internet or have used/seen as being used as information resource. While mostly respondents admitted of not being part of any online community; but have agreed that using internet through project offices, their level of information has moved beyond village level though mostly is at State-level.

Using internet the village level interaction has been further augmented. Most of the respondents agree that intensity and frequency of information through internet is rapid and fast, and that it is made available in majority of cases in one working day's time to make use of most of it in prompt decision-making. However not without challenges, most respondents supported the need for better infrastructural requirements to support online environment, electricity being the most crucial followed by broadband based fixed telephony. Contrary the respondents also agreed that the process of retrieving information through internet is "too technical". In non-internet case, majority of respondents reported that the source of information and its dissemination takes place mostly through local discussions among the village communities, followed by lectures or workshops organized by the project office. However for internet-aware respondents, the internet-based interaction mostly takes place

using specialized online resource centre made available by project office, followed by websites, and webinars/podcasts.

The major language in use for communication is Hindi, and usually good quality of information is available with aptly supported data or recommendations to the respondents. The comparison between online and offline communication in terms of impact on saving costs and boosting margins (for their yield) revealed that for offline, project offices using the traditional communication has helped in saving costs and improving margins by 3–5 %. The same in case of internet-aware respondents is moderate cost savings upto 10 % of more margins on their yield. This proves internet or e-IMC has an effective and better edge over traditional communication channel for being rapid and fast enough to make information available the same day on issues related to productivity. This is evident in the scores obtained from 119 respondents to understand the percentage contribution of online environment in enhancing their productivity and thus the incomes. 41 % strongly supported the use of internet while 61 % found its use satisfactory in enhancing their margins and saving costs, thus improving incomes. Only 8 % found no contribution of internet based information format in enhancing their standard of living which is very miniscule percentage.

The research thus proves the use of internet-based communication or electronic integration of respondents through project offices for information on their yield or managing the costs.

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Chapter 15
Improving Competitiveness of IT Companies by Leveraging Flexibility

K. S. Raghuveer, Ranjit Kuppili and Parimi Nikhil

15.1 Current Situation in Indian IT Industry

In today's dynamic world with increasing complexity and competition, being good is no longer good enough and change is the only constant! In this context, flexibility to adapt to challenges has assumed great significance for today's IT companies; especially across offerings, processes and people. This enables the IT companies to make the necessary changes and thereby adapt to the changes in the environment. Indian software companies have been helping in boosting the Indian Economy by taking up various projects that were outsourced to India. For the year 2012, NASSCOM has predicted that the revenues for India's information technology and outsourcing industries are poised to reach a whopping $ 100 billion, which is a highly substantial 14.8 % increase from last year (NASSCOM, Strategic Review 2012—Complete Report). It further predicts that the revenues will reach the mark of $ 225 billion by the year 2020 (NASSCOM, Strategic Review 2012—Complete Report).Yet; the experts say that the Indian IT Industry has immense scope to grow by incorporating flexibility in their stride in terms of the process, people and offerings. It helps them to truly make a mark for themselves on the global front.

The success of Indian IT companies on the global scale has been widely recognized and top research firms like Gartner/Forester have repeatedly recognized their contribution as part of multiple research analysis (Fig. 15.1).

The SWOT analysis provided below gives us a good idea of the evolution of Indian IT companies so far and the challenges that lie ahead for them (Table. 15.1).

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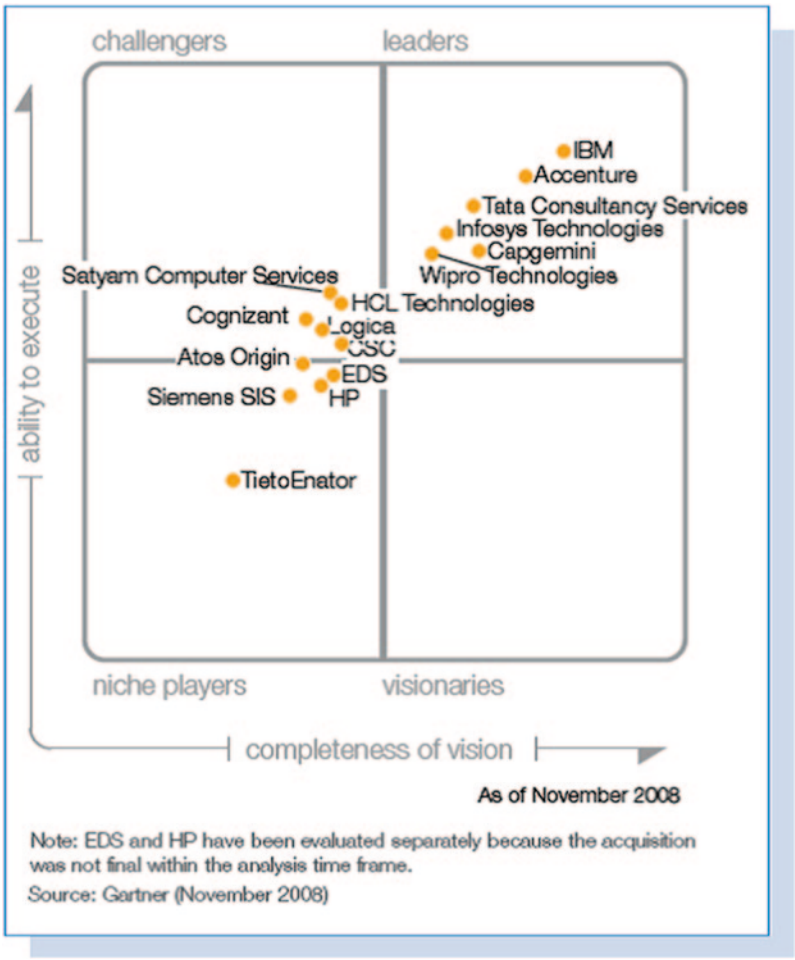

Fig. 15.1 Gartner's magic quadrant for European offshore application services. (Source: Gartner Research 2008)

Another interesting data point to analyze is where Indian IT companies stand on Revenue/Headcount terms when compared to their global counterparts (Table. 15.2).

A large part of the divide in revenue/employee between foreign multinationals (e.g., IBM/Accenture) and Indian IT companies can be explained in terms of the flexibility in their higher margin offerings such as consulting or product development. The analysis above clearly highlights that Indian IT companies need to strategically evolve by leveraging flexibility in terms of the higher value- added services that will not only enhance their top lines but also offer increased margins thereby having a positive effect on their bottom line.

Table 15.1 SWOT analysis: Indian IT companies (Infosys, TCS and Wipro). (Source: Forrester Research, analysis based on inputs from multiple sources quoted in the references section)

Strengths	Weaknesses
They aggressively compete for leadership positions in overall cost/value proposition for IT services.	They have difficulty articulating clear long-term strategic objectives without reverting to generalities.
They have invested heavily in delivery processes.	Strategic marketing capabilities could be improved.
Strong metric-driven management teams focus on ensuring predictable growth and earnings.	Metric-driven approach leads to a risk-averse corporate culture.
India leads many offshore competitors in cultural alignment with West.	They rely heavily on North American financial services, manufacturing, and retail but lack expertise in emerging hot verticals like government and healthcare.
Intense focus on vertical market strategies will position the companies for deeper penetration with line-of-business leaders.	Strategic consulting, transformation, and innovation capabilities still do not match Western counterparts.
They have platform BPO and other nonlinear solutions.	Despite stated goals at geographic diversification, expansion in regions like Europe has been slow.
	Rising operating costs (wages, real estate costs, attrition) leading to increasing pressure on bottom lines.
	Threat of other low cost offshore destinations.
Opportunities	*Threats*
They are strongly positioned in wake of financial turmoil to capitalize on cost/value concerns of IT departments.	The intense focus on verticals in strategy and go-to-market approach will create some inefficiency and may lead to the development of organizational silos.
They are well positioned for expansion in emerging geographic markets, particularly home turf India.	Without strategic evolution into higher-margin services, growth models will continue to be stressed.
They can steadily move into large IT/business services market within existing accounts—areas still dominated by Western firms.	Shift to highly standardized cloud- and SaaS based services will likely expose product marketing shortcomings.
Strong financial positions will help these companies expand through acquisition in the wake of global financial market turmoil—if they choose to seize the opportunity.	

In order to differentiate themselves, the IT companies need to offer higher value added services that involve innovation and thought leadership. This involves moving from providing only IT services to Business and Strategy services eventually as displayed in the figure below (Fig. 15.2).

Flexibility can be achieved by incorporating non-linear growth, which refers to measuring performance by the number of value-added services offered, intellectual property (IP) created rather than by the increase in employee head count. Over the last few years, Indian IT companies have been focusing on the non-linear growth

Table 15.2 Revenue/headcount. (Source: Analysis based on data from Annual Reports)

Company	Revenue (in billions of $)	# of employees (millions)	Revenue/employee ($)
	2010	2011	2012
IBM	99.87	0.43	23402.64
Accenture	23.00	0.21	10747.66
Wipro	6.03	0.12	5025.00
Cognizant	4.59	0.10	4413.46
TCS	6.67	0.20	3333.33
Infosys	4.89	0.13	3760.68

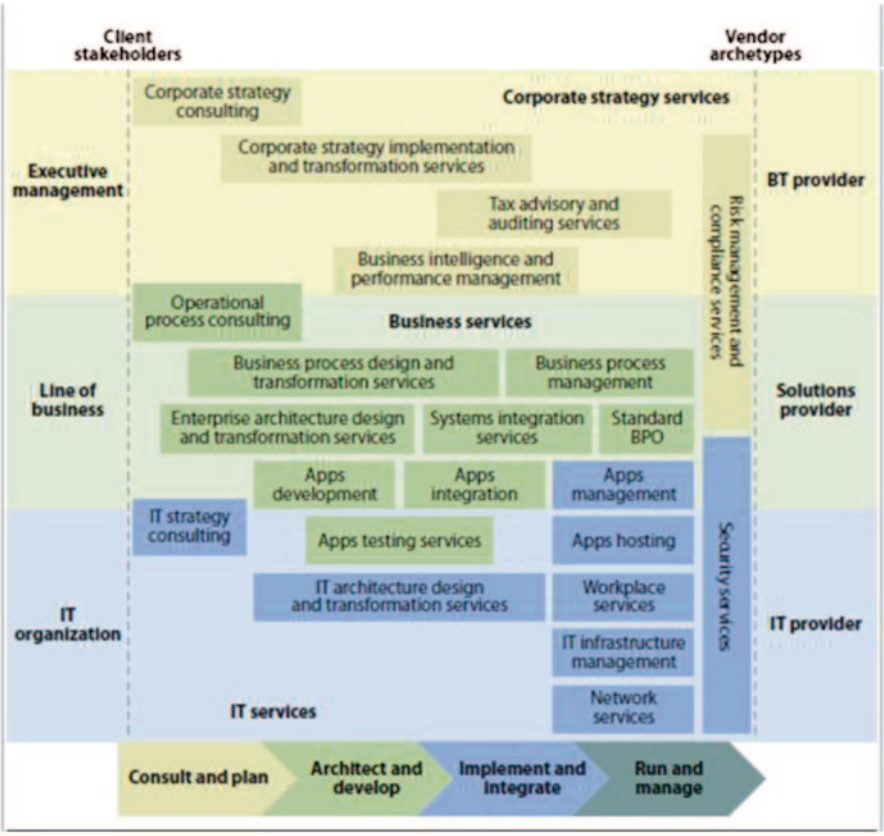

Fig. 15.2 Forrester Research, Inc. Forrester's Business and IT Services Taxonomy. (Source: Forrester Business and IT Services taxonomy)

strategy as a pertinent tool for achieving flexibility and have achieved varying degrees of success.

While the Tier 1 Indian IT companies like Wipro (Wipro Annual Report 2010), Infosys (Infosys Annual Report 2010) and TCS (TCS Annual Report 2010) have

obtained around 4% of business through non-linear growth HCL Technologies obtained about 12% of its revenues. On an overall basis, achieving flexibility through sustained non-linear growth has its fair share of challenges. In this regard, the next section provides some interesting examples of the challenges faced by Indian IT companies and the initiatives/innovations undertaken by them.

15.2 Key Challenges

While the concept of achieving flexibility by moving up the value chain and managing non-linear growth has been recognized by Indian IT companies as a key differentiator in the industry, they need to overcome certain key challenges in order to achieve it. The challenges are a combination of intrinsic factors like ability to manage internal organizational cultures, ability to stay focused on long term rather than more immediate short term growth, building robust knowledge management frameworks, collaborative platforms to share information freely amongst associates across the globe and extrinsic factors like managing client perceptions as they move up the value chain, limited product market in certain segments and geographies and branding limitations in case of joint product component implementations.

Some of the key issues have been highlighted (see diagram below) (Fig. 15.3).

15.3 Innovations to Incorporate Flexibility

Attaining flexibility in true sense of the word has been an integral part of the IT companies' business strategy over the recent few years. They have taken up various people, process and technology initiatives that positively impact revenue, directly or indirectly. Various initiatives in this space have ranged from Managed Infrastructure Services, Product Development; re-use of IP/Asset base, focus on Fixed bid projects, building of Process clouds etc. The diagram below highlights some key initiatives with their corresponding qualitative/quantitative impacts (Fig. 15.4).

15.3.1 Flexibility in Terms of the Services Offered by the IT Companies

Apart from the quintessential and traditional services, managed Infrastructure Services has been a key growth area for Indian IT companies since the year 2008. Over the past 2 years, Wipro has grown its revenues from infrastructure outsourcing business at over 40% with a work force increase of less than 10% to deliver such services (Wipro Annual Report 2010). Increased automation and use of same

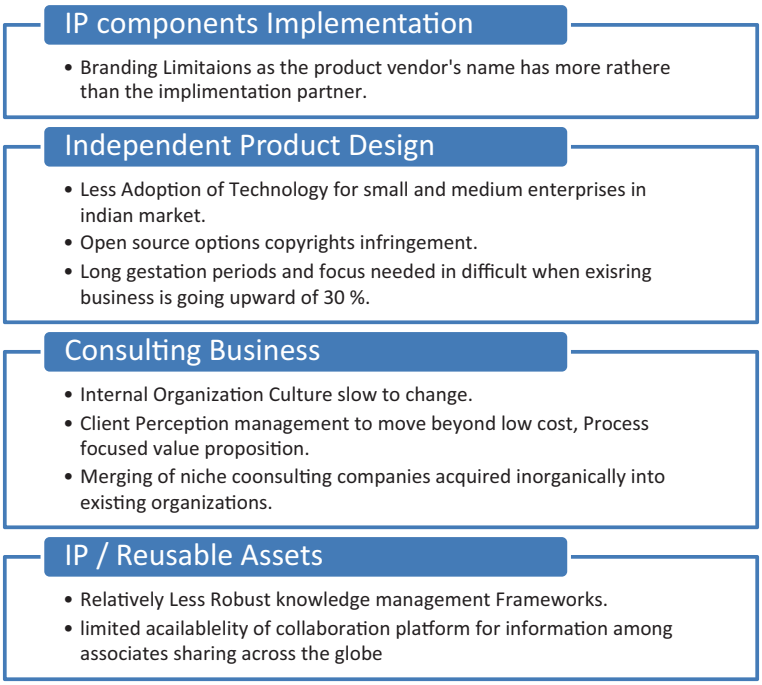

Fig. 15.3 Key challenges for non-linear growth. (Source: author's analysis based on data from multiple sources mentioned in References section)

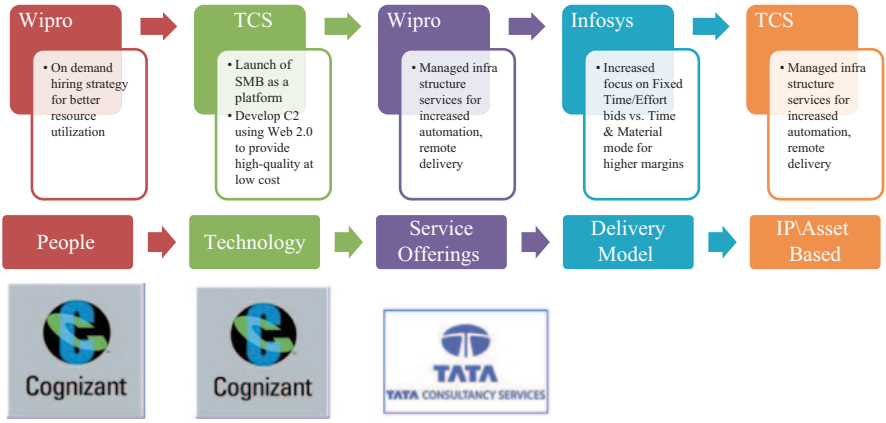

Fig. 15.4 Flexibility in management using innovation. (Source: author's analysis based on data from multiple sources mentioned in References section)

Table 15.3 Flexibility in pricing strategies. (Source: TCS, Infosys, Wipro and Cognizant's Annual Reports 2010)

Company	Revenue from fixed bid projects (%)		Revenue from time and material bid projects (%)	
	2010	2009	2010	2009
TCS	47.82%	44.79%	52.18%	55.21%
Infosys	40.80%	37.60%	59.20%	62.40%
Wipro	41.50%	34.00%	58.50%	66.00%
Cognizant	31.50%	30.30%	68.50%	69.70%

platform to deliver services to multiple customers can help the companies bring down additional number of staff required by over 40%.

- Product Development has also been an area of focus and TCS product business contributed 3.3% of revenues in 2009–2010 and also registered a growth of 23.3% yoy (TCS Annual Report 2010)
- Flexibility in the pricing strategies offered have augmented the case in favor of the IT companies. Increased execution of projects in outcome based projects (fixed time/effort bid) vs. time and material mode also helps for increased profitability while simultaneously establishing/growing the Indian IT brand in the global market as one that can undertake complete responsibility to execute a project in a fixed time and effort (Table. 15.3).

15.3.2 Flexibility in Delivery Initiatives

Wipro has been offering multi-tenanted managed services like the Flex Delivery Model which has gained wide acceptance among customers for its unique value proposition of just-in-time capacity and predictable high quality. Most Indian IT companies are also building solution accelerators to improve effort and delivery schedules through investments in Centers of Excellence, third party tools and creation of re-usable IP.

15.3.3 Flexibility in Business Model

Focus on service outcome-based business model rather than an effort-based to drive operational efficiencies. The Centre for Integrated Management of Applications (CIGMA), an initiative in this direction by Wipro won the NASSCOM (NASSCOM, Strategic Review 2012—Complete Report) IT Innovation Award in the process innovation category for the year.

Table 15.4 Inorganic growth through acquisitions. (Source: Reproduced from Andrew C. Steinerman and David Emerson Lane. IT Services. Bear, Stearns & Co. Inc., July 2007, p. 19)

Company	Target	Description of Acquisition
Cognizant	AimNet	U.S—based infrastructure services firm
Wipro	Saraware Oy	Finland-based telecom design and engineering firm
Wipro	Enabler	Portugal-based, retail-industry focused consulting and package implementation firm
Wipro	Quantech	U.S—based engineering design firm
Wipro	NewLogic	Austria-based semiconductor design services firm
Satyam	Knowledge Dynamics	Singapore-based business intelligence consultancy
Cognizant	Fathom Consulting	U.S—based consulting firm focused on telecom space

15.4 Innovations to Incorporate Flexibility

- Indian IT companies are following a combination of organic and inorganic growth in an effort to be flexible and offer value-added software services that differentiates them from the rest. This has resulted in either an acquisition of smaller niche players or internal investments in fields like Business/Technology Consulting/System Integration Consulting, PMO, Business Intelligence etc. Cognizant Business Consulting offers a good example of incorporating flexibility (Cognizant Annual Report (2010) by catering to the huge potential of non-linearity in terms of the revenue offered by consulting.
- With around 2% of the global workforce (Cognizant Annual Report (2010) (2200 consultants), Cognizant Business Consulting accounted for close to 5% of its revenue. Given the end to end list of services that Indian IT companies offer, being flexible and investing in consulting also makes sense from the inherent potential to generate significant downstream revenue.
- Inorganic growth has taken place through a series of acquisitions in segment-specific IT and consulting companies in the U.S. and elsewhere. (See below for a partial list of such acquisitions) (Table. 15.4)

Organic growth, by being flexible and moving up the value chain, has also taken place to varying degrees across various Indian IT companies. For example, in the year 2010, Infosys Consulting Inc (Infosys Annual Report 2010). Incorporated a wholly-owned subsidiary, Infosys Consulting India Limited and invested US $ 10 million in the subsidiary (Infosys Annual Report 2010). In an article on "Evolution of IT Service Providers", Forrester noted that Cognizant is driving deeper into business processes in an attempt to leverage its flexibility for its advantage and suggests that Cognizant is well poised for this leap given its clear focus on vertical market expertise. However, from an overall perspective, the share of consulting revenue in the total revenue is still only around 2–5% across these companies.

15.5 Recommendations for Incorporating Flexibility

Having analyzed the various challenges and initiatives undertaken so far by Indian IT companies, the authors feel that the Indian IT companies are on the right path towards building higher business value offerings and creating sustainable competitiveness through flexibility in their offerings and business processes. The authors would like to highlight three key focus areas for the Indian IT companies that would help them to propel forward and attain success.

15.5.1 Flexibility in Offering Higher Margin Services

Consulting Services

This should be a key area of focus for the Indian IT companies as managing this will help them in generating more revenue. The additional advantage of increasing Consulting services is the potential downstream revenue that it could generate that complements the value offerings of Indian IT companies.

Infrastructure Management Services

An In-Stat (www.in-stat.com) research predicts that the IaaS (infrastructure as a service) revenues are poised to take a propelling growth to roughly $ 4 billion by the year 2015 and the overall public cloud computing which includes the IaaS, SaaS, and PaaS are expected to grow by a staggering 153 % from 2010–2015 (In-Stat research, Cloud Computing and Managed Hosted Services: US Business Spending by Size of Business and Vertical, 2010–2015– #IN1105027VSMSE). It is a sure shot and a definite sign that while the quintessential and the traditional IT application management and development sector is getting increasingly saturated, Infrastructure Management services will drive the next wave of growth.

15.5.2 Flexibility in Pricing Offered (Outcome Based or Fixed Bid Projects)

Increasing the percentage of projects that are executed in an outcome based manner rather than on time and material will help in generating more revenue. Though the data around the exact difference in bottom-line due to these different projects is not available, outcome based pricing definitely helps as the pricing can be done

based on a mutually agreed set of deliverables rather than on individual employee presence. Driving such projects independently will also help in providing the organizational scale to a project rather than in time and material projects that usually involves considerable involvement from the client side.

15.5.3 Flexibility in Terms of Tools/Frameworks Offered to Employees

Providing delivery platforms and knowledge management frameworks (portals, blogs, and internal wiki's) is an effective way to enhance levels of collaboration among employees in remote locations. This will help bring together professionals from around the globe with complementary skill sets to form virtual teams tasked with delivering client solutions and help leverage IP/documentation from projects executed in the past.

15.6 Conclusion

With the intense proliferation of competition within the IT sector, the authors suggest that the companies need to be flexible in its various business processes/services that it extends to its stakeholders. This can be achieved by taking up Higher-Value Added Consulting Services, Infrastructure Management Services, adopting a flexible stand in its pricing formulation as well as in tools/framework offerings to its employees and thereby, the Indian IT companies can achieve the remarkable transformation from being a lumbering elephant to a roaring tiger and truly make a mark for themselves on the global front as leading IT service and solution providers**.**

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Part IV
Financial Flexibility and Risk Management

Chapter 16
Real Option Valuation for Mumbai Metro Rail Project: Evaluating Financial Flexibility for Reliance Infra

B. K. R. Naik, Rameez Raja Shaik and Niketa Narain

16.1 Introduction

Metro Rail or the rapid transit was introduced in India in 1984 with Kolkata Metro Rail. Currently it runs 1 line of 25 km with the Indian Railways possessing the majority stake. Next in line, Delhi Metro Rail Corporation (DMRC) was setup in 1995 for construction of rapid transit transport systems in Delhi. Presently there are six lines with 142 stations serving over 11 lakh passengers daily (DMRC Annual Report 2009–10). On similar lines metro rail construction has been undertaken in Bangalore, Mumbai and Chennai. Other cities like Hyderabad, Kochi, Jaipur and Lucknow also are part of the queue.

The construction of Delhi Metro is seen as remarkable owing to work efficiency and scheduled competition of projects. However, the figures in the annual report show that in the last 10 years, DMRC has been in the red. The losses have been carried forward despite the increment in lines and commuters. Both Delhi and Kolkata Metro Railway Systems are public sector enterprises and do not incorporate any concept of project finance. However, the recent spurt in the metro rail construction has been under the umbrella of private sponsors eager to reap benefits of the new transport system. The Mumbai Metro has both Indian and foreign players as equity partners. Michelle (2003) explains that most project finance transactions rely heavily on debt, with corporate sponsors typically providing only 20–40 % funds necessary (equity) to finance a project. As a matter of fact, all of these metro projects too involve a high concentration of debt (Fig. 16.1).

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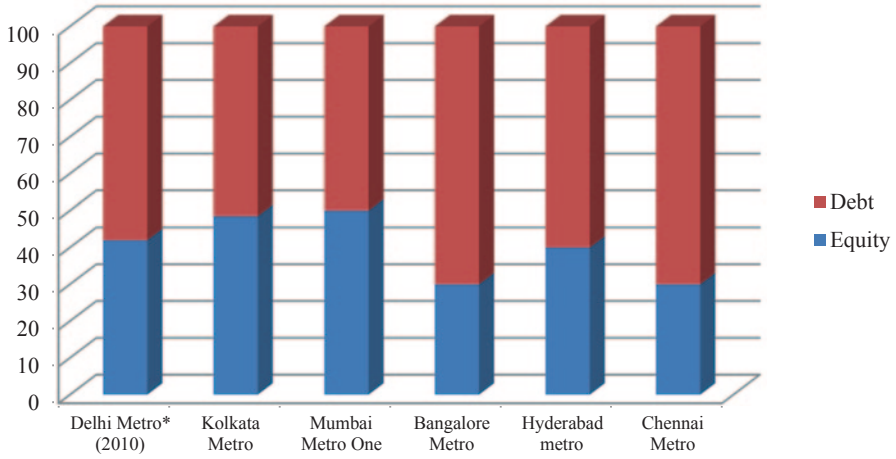

Fig. 16.1 Exhibit 1: Share of debt and equity in the project cost. (Source: Wikipedia)

Due to the debt and high capital expenditure in such projects, the cash flows remain negative for many years. The traditional financial projections' considers these cash flows. But, it does not incorporate factors like revenue volatility and interest rate fluctuations which are crucial for financial flexibility. Real option analysis gives an investor such details that cannot be derived from methods based on net present value (NPV). The flexibility can be of strategic importance as it provides the investor the choice to exercise, delay and abandon a project (an option).

The project is evaluated using its present cost and the value obtained after the execution of the project. This comparison is made using the expected volatility of the project (obtained from similar projects). The option value is obtained for the given circumstances. The investor can decide on delaying the project in case it provides a higher option value. The assessment of project risks and associated opportunity cost enables better decision making and gives enhanced returns to the investor.

16.2 Literature Review

Risk can be defined as the uncertainty or the probability of incurring losses. An organization faces many kinds of risks, some of which are externally driven whereas some internally. These risks can be broadly categorized as financial risks, operational risks, strategic risks and hazard risks. Most of these risks are dynamic and keep changing with time. Hence organizations need to have a strong and flexible risk management system in place.

Firms having **financial flexibility** will be able to make the best use of unforeseen opportunities and would be able to deal with unexpected events. The financial structure and financial policies of a firm will determine its financial flexibility (Gamba and Triantis 2006).

Table 16.1 PV for line 2

D/V	0.608695652	β Lev (Mumbai Metro—line 2)	0.32178
E/V	0.391304348	R_m	21.28%
R_f	7.49%	K_e using CAPM	11.93%
T	45 years		
PV for equity sponsors		*INR 2,888.03 crore*	
PV RInfra (48% of equity)		*INR 1,386.25 crore*	

Big infrastructure projects are capital intensive and companies prefer **project finance** rather than corporate finance while taking up such projects. Some of the advantages (Suresh 2006) in going for project finance are: large debt can be raised without affecting the leverage ratios of the parent firm; creditors have limited or no recourse to the sponsors; greater discipline due to strict covenants and the segregation of project assets and cash flows from that of the sponsor; contractual agreements re-distribute the risk to various stakeholders; greater tax shield due to high leverage etc.

16.3 Real Options and Flexibility

Wiley (2005) suggests that traditional approaches for valuation are not incorrect, they are incomplete when modeled under actual business conditions of uncertainty and risk-but complement it with more advanced analytics to obtain a much clearer view of the business reality. They assume that the investment is an all-or-nothing strategy and do not account for managerial flexibility. Real options take into account management's ability to create, execute and abandon strategic and flexible options. Mauboussin (1999) explains that real options approach applies financial option theory (the best-known form is the Black-Scholes model) to real investments, such as manufacturing plants, line extensions, and R&D investments. This approach provides important insights about businesses and strategic investments, insights that are more important than ever, given the rapid pace of economic change.

Managerial flexibility induces asymmetry (Table 16.1) in the probability distribution of NPV (Trigeorgis 1996) as management can limit the down-side risk of loss, but retain the upside potential for profit (Smit and Trigeorgis 2004). Trigeorgis (2000) gives the strategic or expanded NPV written as; Expanded (Strategic) NPV = Passive NPV + Option Premium (Fig. 16.2).

Trigeorgis (1996) also suggests that theories given by Black Scholes and Merton to price financial options can be used for pricing and managing real assets. Black and Scholes (1973) provides the formula for options to be exercised at the end of the term (European option). To overcome this hurdle, Cox et al. (1979) provided binomial model to price options at any point before the expiry (American option). Mumbai Metro incorporates the project finance structure for the construction using a special purpose vehicle (SPV). Nevitt and Fabozzi (2000) claim that, Project financing can sometimes be used to improve the return on the capital invested in a project by leveraging the investment to a greater extent than would be possible in a straight commercial financing of the project.

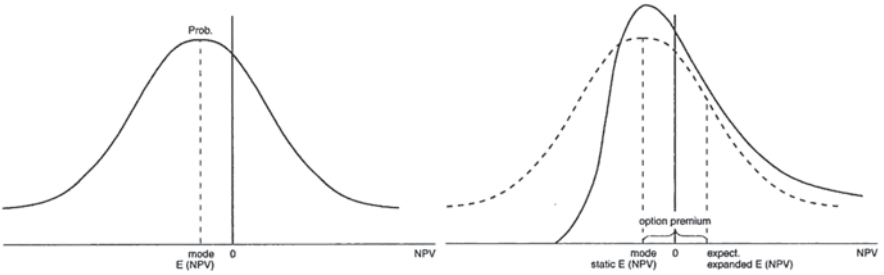

Fig. 16.2 Exhibit 2: Expanded (strategic NPV)—Trigeorgis (2000)

16.4 Mumbai Metro Rail

The Mumbai Metro is planned to be constructed in three phases, at a total cost of INR 36,000 crore. The nine lines of the system are projected to have a total length of 146.5 km, including 32.5 km of underground track. Phase 1 involving three lines was initially given a time frame of 2006–2016. It includes Versova–Andheri–Ghatkopar (VAG) (11.07 km), Charkop–Bandra–Mankhurd (31.8 km) and Colaba–Bandra (20 km). Presently the construction is largely delayed and three stations of VAG line are expected to start functioning by March 2012.

Line 1: The project that has an estimated cost of INR 2,356 crore is being undertaken by the SPV Mumbai Metro One Project Limited (MMOPL). The project has a debt component of INR 1,194 crore, equity of INR 512 crore and viability gap fund (VGF) of INR 650 crore from the Indian Government. The equity sponsor, RInfra holds 69%, MMRDA 26% and remaining 5% is held by Veolia Transport, France. This metro line encompasses a length of 11.07 km and will feature 12 stations along the corridor. The consortium of equity sponsors have the project under B-O-T (build-operate-transfer) scheme for 35 years after which it will be transferred to a new operator.

Line 2: A special purpose vehicle named Mumbai Metro Transport Private Ltd. (MMTPL) has been formed for line 2 running from Charkop to Mankhund with a length of 31.8 km encompassing 27 stations. The project costs INR 11,550 crore and includes a concession period of 35 years (with a 10 year possible extension). The Corridor is expected to be commissioned by 2013–2014. The financial closure for the project was obtained on 14th March 2011. The equity sponsors for the project are RInfra holding 48% of share capital, SNC Lavlin Inc, Canada holding 26% and Reliance Communication Ltd. with another 26% of the capital. The project would obtain VGF from the Government of India for the amount of INR 2,298 crore. RInfra has pledged almost INR 1,400 crore for the Mumbai Metro Rail projects (line 1 and line 2).

16.5 Methodology

The financial projections are made for line 1 which is currently under-construction. Using free cash flow to equity (FCFE) method, the net present value (NPV) for RInfra is calculated. Thereafter, we make projections for line 2. The SPV for line 1 was incorporated in 2006 while that of line 2 in 2009. Hence RInfra had less than and equal to 3 years to make the decision regarding investing again in the metro project, this time for line 2. The FCFE method is used to obtain its present value (PV). Using PV and the cost of the project (defined by the SPV), the option value for the line is calculated.

16.6 Black Scholes Option Pricing Model

The Black-Scholes (Hull 2005) formula to compute the European call and put option values on a non-dividend-paying stock is given by:

$$c = S_0 N(d_1) - Ke^{-rt} N(d_2)$$

where,

$$d_1 = [\ln(S_0/K) + (r + \sigma^2/2)T]/\sigma\sqrt{T}$$
$$p = Ke^{-rt} N(-d_2) - S_0 N(-d_1)$$
$$d_2 = [\ln(S_0/K) + (r - \sigma^2/2)T]/\sigma\sqrt{T} = d_1 - \sigma\sqrt{T}$$

c = European call option value
K = Strike Price
p = European put option value
r = Continuously compounded risk-free rate
S_0 = Value of underlying asset at t = 0
σ = Volatility of underlying asset
T = Time to maturity of the option

16.7 Binomial Option Pricing Model

The Binomial model uses an iterative procedure and a risk neutral approach during valuation. The formula for the option value is given by:

$$C = e^{-rt}\left[pC_u + (1-p)C_d\right]$$

where,

$$u = e^{\sigma\sqrt{t/n}}$$

$$d = 1/u = e^{-\sigma\sqrt{t/n}}$$

$$p = (e^{rt} - d)/(u - d)$$

σ = volatility
p = Risk-neutral probability of up move
r = risk free rate
u = factor by which the asset price can go up
t = time to expiry of the option
d = factor by which the asset price can go down
n = number of steps/periods
C = value of the option

In the case of Mumbai Metro,

S_0 and K are the PV of cash-flows and the investment required for line 2, r is the risk free rate for the project, σ is the average volatility or standard deviation of revenues of Delhi Metro (64.89 %). Thereafter the strategic NPV is obtained as:

Strategic NPV for RInfra = NPV for line 1 + Option value for line 2

16.8 Benefits from Project Implementation to Mumbai

Mumbai has always had the distinction and advantage of a high modal share of 78 % for public Transport system. Currently, 11 million people travel daily by Public Transport with modal share of Rail—52 %, and Bus—26 %. Metro Rail Transit System would provide a new means of transport running across the breadth of the city unlike the existing local rail covering Mumbai lengthwise. Covering the vast and densely populated stretch between Versova and Ghatkopar, the Metro Rail will help reduce travel time in the section from 71 to 21 min. The project aims to become Asia's first Green Metro right from the construction stage. Possibilities on LEED certification are being looked into through a detailed environmental impact assessment and feasibility study. Metro system would require 1/5th energy per passenger km compared to road based system. It will provide a reliable, safe and comfortable means of transport to the inhabitants of Mumbai.

Table 16.2 Ticket fare and income projections. (Source: Projections made by MMRDA for line 1)

Year	2009		2011		2021		2031		
Daily boarding (lakh)	4.75046		5.13338		6.64703		8.82533		
Growth in passengers	3.95%		2.62%		2.88%		2.86%		
	Fares (INR)								
	2013–2014	2014–2015	2015–2016	2016–2017	2017–2018	2018–2019	2019–2020	2020–2021	2021–2022
0–3 km	8	8	9	9	9	9	10	10	10
3–8 km	10	10	12	12	12	12	14	14	14
>8 km	14	14	16	16	16	16	18	18	18
Daily boarding (lakh)	5.547	5.692	5.841	5.994	6.151	6.312	6.477	6.647	6.838

16.9 Cash Flow Analysis

The revenue sources are traffic (Tables 16.2 and 16.3), feeder bus service (Table 16.4), rental income (including advertising) (Tables 16.5 and 4), carbon credits (Table 16.6) and lease of land (Tables 16.4 and 16.5). The expenses are due to traffic operations (Tables 16.4 and 16.5), interest payment (Tables 16.7 and 16.8), loan repayment (Tables 16.5 and 16.8), capital expenditures (Table 16.9) and working capital requirements (Table 16.10) which drag profits down to considerable losses.

Projections for line 1 have been made from 2007–2008 to 2022–2023, a period of 16 years thereafter the terminal value is obtained using a terminal growth rate of 8% for the number of years remaining in the concession period. Projections for line 2 are made from 2010–2011 to 2030–2031. Ke is computed using Capital Asset Pricing Model (CAPM), by unlevering the industry beta (Table 16.11) and re-levering it for the SPV. The PV and the NPV of FCFE is computed by using Ke as the discount rate (Tables 16.1, 16.4, 16.5 and 16.12). Finally the option value (Table 16.13) is computed using Black Scholes and Binomial Option Pricing Models.

16.10 Option Value Analysis

Strategic NPV for RInfra = NPV for line 1 + Option value for line 2

16.11 Sensitivity Analysis (Using Black Scholes Option Pricing Model)

The Black-Scholes (Black and Scholes 1973) model uses the price of the underlying asset (S), strike price (K), time to maturity (T), interest rate (r) and Volatility (σ) to compute the option premium. Sensitivity measures for the option price can be

Table 16.3 Ticket fare and income projections. (Source: Projections made by MMRDA for line 2)

Year	2011				2021				2031				
Daily boarding (lakhs)	12.75				18.77				22.16				
Growth (%)	0.0394				0.0167				0.03				
Average trip length (km)	7.50				7.40				7.40				
Growth (%)	−0.0013				0.0000								
	Fare (INR)												
	2016–2017	2017–2018	2018–2019	2019–2020	2020–2021	2021–2022	2022–2023	2023–2024	2024–2025	2025–2026	2026–2027	2027–2028	2028–2029
0–3 km	9	9	9	10	10	10	10	12	12	12	12	14	14
3–8 km	12	12	12	14	14	14	14	16	16	16	16	18	18
8–12 km	15	15	15	17	17	17	17	19	19	19	19	22	22
12–15 km	17	17	17	19	19	19	19	22	22	22	22	25	25
15–20 km	19	19	19	22	22	22	22	25	25	25	25	28	28
20–25 km	23	23	23	26	26	26	26	29	29	29	29	33	33
25–30 km	26	26	26	29	29	29	29	33	33	33	33	37	37
>30 km	28	28	28	32	32	32	32	36	36	36	36	40	40
Daily boarding (lakhs)	16.1	16.7	17.4	18.1	18.8	19.1	19.4	19.7	20.1	20.4	20.7	21.1	21.4

Table 16.4 Discounted cash flows for Line 2 (INR)

		2011–2012	2012–2013	2013–2014	2014–2015	2015–2016	2016–2017	2017–2018	2018–2019	2019–2020	2020–2021	2021–2022	2022–2023	2023–2024	2024–2025	2025–2026	2026–2027	2027–2028	2028–2029	2029–2030
Initial investment	11500																			
Income from operations	Fare						1316	1368	1421	1675	1741	1770	1799	2069	2103	2139	2174	2486	2527	2570
	Feeder bus						11.74	12.20	12.68	14.94	15.53	15.79	16.05	18.46	18.76	19.08	19.40	22.18	22.55	22.92
	Rental						277.5	288.5	299.9	353.3	367.2	373.4	379.6	436.4	443.7	451.2	458.7	524.4	533.2	542.2
	Lease of land						73.02	77.40	82.04	86.96	92.18	97.71	103.6	109.8	116.4	123.9	130.8	138.6	146.9	155.7
	Consulting											23.55	23.94	27.53	27.99	28.46	28.93	33.08	33.63	34.19
	EPW						23.90	25.33	26.85	28.46	30.17	31.98	33.90	35.93	38.09	40.38	42.80	45.37	48.09	50.97
Other income	Carbon credit						0.35	0.37	0.39	0.41	0.44	0.46	0.49	0.52	0.55	0.58	0.62	0.66	0.69	0.74
	Tender docs						41.18	32.94	26.35	21.08	16.87									
Total income							1743	1804	1870	2180	2263	2313	2357	2697	2749	2802	2856	3250	3312	3376
Exp.	Traffic operations						82.62	87.58	92.83	98.40	104.3	110.6	117.2	124.2	131.7	139.6	148.0	156.8	166.3	176.2
	Misc expenses						12.81	13.58	14.39	15.26	16.17	17.14	18.17	19.26	20.42	21.64	22.94	24.32	25.78	27.32
Total exp.							95.43	101.2	107.2	113.7	120.5	127.7	135.4	143.5	152.1	161.2	170.9	181.2	192.0	203.6
Operating profit	Inc.—exp.						1648	1703	1762	2066	2143	2185	2222	2554	2597	2640	2685	3069	3120	3173
Dep.							259.1	259.2	259.4	259.5	259.7	291.6	291.7	291.6	292.0	306.9	380.3	380.5	380.7	380.9
Interest	Total debt	752.5	752.5	752.5	752.5	752.5	752.5	707	656.5	600.7	538.8	470.3	394.4	310.3	217.3	114.2				
FCFE																				
PBT		−752.5	−752.5	−752.5	−752.5	−752.5	636.3	736.9	846.5	1205	1344	1423	1535	1951	2087	2219	2304	2688	2739	2792
CumPBT		−752.5	−1505	−2258	−3010	−3763	−3126	−2389	−1543	−336.9	1007	1423	1536	1952	2088	2219	2304	2688	2740	2791
Tax	(11%)										110.8	156.6	168.9	214.7	229.7	244.2	253.5	295.7	301.3	307.1
PAT	PBT-tax	−752.5	−752.5	−752.5	−752.5	−752.5	636.3	736.9	846.5	1206	1233	1267	1367	1737	1858	1976	2050	2392	2438	2484
OCF	PAT+depreciation	−752.5	−752.5	−752.5	−752.5	−752.5	895.4	996.1	1106	1466	1493	1558	1658	2029	2150	2282	2431	2773	2819	2866
Cap ex							1.67	1.77	1.91	2.06	2.22	10010	2.50	2.65	325.5	676.9	20.15	3.34	3.54	3.76
NWC							478.3	507	537.4	569.6	603.8	640.0	678.4	719.1	762.3	808.0	856.5	907.9	962.4	1020
Change in NWC								28.70	30.42	32.24	34.18	36.23	38.40	40.71	43.15	45.74	48.48	51.39	54.47	57.74
Total P paid							423.7	469.2	519.7	575.5	637.4	705.9	781.8	865.9	958.9	1062				
Terminal value (8%)—2030–2031	44009																			
FCFE		−752.5	−752.5	−752.5	−752.5	−752.5	470.1	496.4	553.9	855.7	819.2	−9195	835.7	1120	822.3	497.5	2362	2718	2761	2804

Table 16.5 Discounted cash flows for Line 1(INR)

		2008–2009	2009–2010	2010–2011	2011–2012	2012–2013	2013–2014	2014–2015	2015–2016	2016–2017	2017–2018	2018–2019	2019–2020	2020–2021	2021–2022
Initial investment (2007–2008)	2356														
Income from operations	Fare collection					44.64	245.50	251.93	299.23	307.06	315.10	323.35	376.95	386.82	397.94
	Rental income					0.00	12.79	15.34	18.41	22.10	26.52	31.82	38.18	45.82	54.98
	Lease of land					0.00	3.37	3.64	3.93	4.24	4.58	4.95	5.34	5.77	6.23
Other income	Sale of carbon credit					0.00	0.50	0.54	0.58	0.63	0.68	0.73	0.79	0.85	0.92
	Sale of tender docs					0.00	0.19	0.15	0.12	0.10	0.08				
Total income						44.64	262.34	271.59	322.27	334.12	346.95	360.84	421.27	439.26	460.07
Expenditure	Traffic operations					6.04	33.23	35.88	38.75	41.85	45.20	48.82	52.72	56.94	61.50
	Misc expenses					2.11	11.59	12.52	13.52	14.60	15.77	17.03	18.39	19.87	21.45
Total expenditure						8.15	44.82	48.40	52.27	56.46	60.97	65.85	71.12	76.81	82.95
Operating profit	Total income-total expenditure					36.49	217.52	223.19	269.99	277.66	285.98	294.99	350.15	362.45	377.12
Depreciation						0.00	75.47	75.52	75.56	75.62	75.67	87.63	87.69	87.76	87.84
Interest and finance charges	Sum of INR and foreign debt interest	125.18	124.36	124.90	123.22	114.95	106.24	96.55	85.47	71.52	60.35	43.48	22.79	0	0
FCFE						0	0	0	0	0	0	0	0	0	0
PBT	Op. profit-(depreciation + interest)	−125.18	−124.36	−124.90	−123.22	−78.47	35.81	51.13	108.96	130.53	149.95	163.88	239.66	274.69	289.29
Cumulative PBT		−125.18	−249.53	−374.43	−497.65	−576.12	−540.31	−489.18	−380.22	−249.69	−99.74	64.14	239.66	274.69	289.29
Tax (11%)	For cum. PAT + ve					0.00	0.00	0.00	0.00	0.00	0.00	7.06	26.36	30.22	31.82
PAT	PBT-tax	−125.18	−124.36	−124.90	−123.22	−78.47	35.81	51.13	108.96	130.53	149.95	156.83	213.30	244.48	257.47
OCF	PAT + depreciation	−125.18	−124.36	−124.90	−123.22	−78.47	111.28	126.64	184.53	206.15	225.62	244.46	300.99	332.24	345.30
Cap ex							0.54	0.59	0.63	0.69	0.74	187.06	0.86	0.93	1.01
NWC						400.68	432.74	467.36	504.75	545.12	588.73	635.83	686.70	741.64	800.97
Change in NWC							32.05	34.62	37.39	40.38	43.61	47.10	50.87	54.94	59.33
Total P paid					86.89	95.33	104.51	114.76	126.36	140.08	153.13	170.39	202.56	0.00	0.00
Terminal value (8%)	5457														
FCFE	OCF-(capex + NWC + P paid-initial investment)	−125.18	−124.36	−124.90	−210.11	−173.79	−25.82	−23.32	20.15	25.00	28.14	−160.10	46.70	276.37	284.96

Table 16.6 Carbon credits. (Source: Projections using Delhi Metro Rail Corporation financials)

Means of transport	CO_2 (gms) emitted per passenger per 10 km	Savings (gms) for 10 km/pssgr	Savings (gms) per pssgr (total dist)	No. of passengers per day	Total savings (gms of CO_2)/day
Bus	1300				
Delhi Metro	1200	100	1650	1,100,000	1815000000
Mumbai Metro: line 1	260	1040	1151.28	494,000	568732320
Mumbai Metro: line 2	260	1040	3314.48	494,000	1637353120

calculated by varying each of these variables (except the strike price, which remains constant over the life of an option). Consider the function,

$$C = C(S, K, T, r, \sigma)$$

The first order differentiation will be,

$$C(S+\delta S, K, T+\delta T, r+\delta r, \sigma+\delta\sigma) = C(S, K, T, r, \sigma) + \delta S \frac{\partial C}{\partial S} + \delta T \frac{\partial C}{\partial T} + \delta r \frac{\partial C}{\partial r} + \delta\sigma \frac{\partial C}{\partial \sigma}$$

These sensitivity measures are called Greeks (Ederington and Guan 2004). The major ones are delta, gamma, lambda, theta, rho and vega (Fig. 16.3).

a. **Delta** (Δ): Delta (Hull 2005) is the measure of the change in option price per unit change in the price of the underlying asset.

$$Delta\ (\Delta) = \frac{\partial C}{\partial S} = N(d_1)$$

If Δ is large, then price of the option is very sensitive to change in price of the underlying asset.

The Δ for the Black-Scholes Model comes out to be 80.54%, which indicates that the option value increases by 80.54% for 1% increase in the value of PV (cashflows) of line 2. (If PV of cash flows of line 2 increases by 1%, then the option value shoots up by INR 489.31 crore). The sensitivity is relatively high (Fig. 16.4).

b. **Gamma** (Γ): Gamma is the measure of the change in Δ per unit change in the price of the underlying asset. It is the second order partial derivative of option price with respect to the underlying asset value.

$$Gamma\ (\Gamma) = \frac{\partial \Delta}{\partial S} = \frac{\partial^2 C}{\partial S^2}$$

For European call or put option on a non-dividend paying stock, gamma (Hull 2005) is given by,

$$Gamma\ (\Gamma) = \frac{e^{\frac{-d_1^2}{2}}}{S\sigma\sqrt{2\pi T}}$$

Table 16.7 Debt for line 1. (Source: Projections made by MMRDA for line 1)

Debt (INR)		1194 crore			Years		12 (Principal repayment starts after 3 years)					
INR loan		895.5 crore			Exchange rate		79.011 INR/GBP					
UK loan (INR)		298.5 crore			UK loan (GBP)		37,779,549.682956					
Interest (INR)		12.25%			Interest (UK loan)		LIBOR+3.5%					
Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
INR loan (INR crore)												
Debt	895.5											
P+I	109.70	109.7	109.7	169.67	169.67	169.67	169.67	169.67	169.67	169.67	169.67	169.67
I	109.70	109.7	109.7	109.7	102.35	94.11	84.85	74.46	62.80	49.71	35.01	18.52
P paid	0.00	0.00	0.00	59.97	67.31	75.56	84.82	95.21	106.87	119.96	134.65	151.15
Foreign loan (INR crore)												
Debt	298.5											
P paid	0	0	0	26.92	28.01	28.95	29.94	31.15	33.21	33.17	35.74	51.41
I	15.48	14.66	15.20	13.52	12.60	12.13	11.70	11.01	8.72	10.65	8.47	4.28

Table 16.8 Debt for line 2 (INR crore). (Source: Projections made by MMRDA for line 1)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
D	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000
P+I	1176.178	1176.178	1176.178	1176.178	1176.178	1176.178	1176.178	1176.178	1176.178	1176.178	1176.178	1176.178	1176.178	1176.178	1176.178
I	752.500	752.500	752.500	752.500	752.500	752.500	706.955	656.513	600.649	538.780	470.260	394.373	310.330	217.251	114.166
P	0	0	0	0	0	423.678	469.223	519.665	575.528	637.398	705.918	781.804	865.848	958.927	1062.011

Table 16.9 Capex for line 1. (Source: Projections using Delhi Metro Rail Corporation financials)

(INR crore)	2018–2019	2023–2024
Signaling and telecom equipment	141.265	207.564
Automatic fare collection	35.740	52.514
IT systems	4.014	5.897
Office equipment	1.650	2.425
Feeder bus	1.596	2.345
Intangible assets	1.997	2.934
Temporary structures	Value from 2013 to 2014 is incremented annually by inflation	
Total cap ex	187.061	274.854

Table 16.10 Net working capital (NWC). (Source: Projections using Delhi Metro Rail Corporation financials)

Year	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001
Net current assets (NWC)	289.12	696.58	555.19	363.18	−322.33	−316.38	404.44	122.86	598.42	789.67

The average NWC is taken as the value for 2010 for Mumbai metro and projections are made for both the lines keeping inflation in mind

Table 16.11 Comparable beta. (Source: Stock Exchange websites)

Symbol		Exchange	β lev	D/E	β(unlevered) = β levered/(1 + D/E)
CNI	Canadian National Railway Co	NYSE	0.42	0.52	0.2763158
CP	Canadian Pacific Railway Ltd.	NYSE	0.78	0.84	0.423913
JP 9022	Central Japan Railway Co	Tokyo Exchange	0.48	2.5	0.1371429
JP 9020	East Japan Railway Co	Tokyo Exchange	0.39	1.89	0.1349481

Table 16.12 NPV for line 1

D/V	0.506791171	β Lev (Mumbai Metro—line 1)	0.8115
E/V	0.493208829	Rm	16.86%
Rf	6.94%	Ke using CAPM	14.99%
T	35 years		
NPV for equity sponsors		*INR (247.64) crore*	
NPV RInfra (69% of equity)		*INR (170.87) crore*	

Table 16.13 Option value for line 2

S	PV of cash flows for line 2		INR 1,386.25 crore
K	Investment for line 2		INR 1,056.96 crore
T	Number of years between formation of SPV for line 1 and line 2		3 years
Rf	Risk free rate		6.94%
σ	Volatility		64.89%[a]
(INR crore)	*NPV of line 1*	*Option value (Line 2)*	*Strategic NPV*
Black-Scholes model	−170.87	779.516	*608.646*
Binomial model		779.592	*608.722*

[a] Average volatility or standard deviation of revenues of Delhi Metro

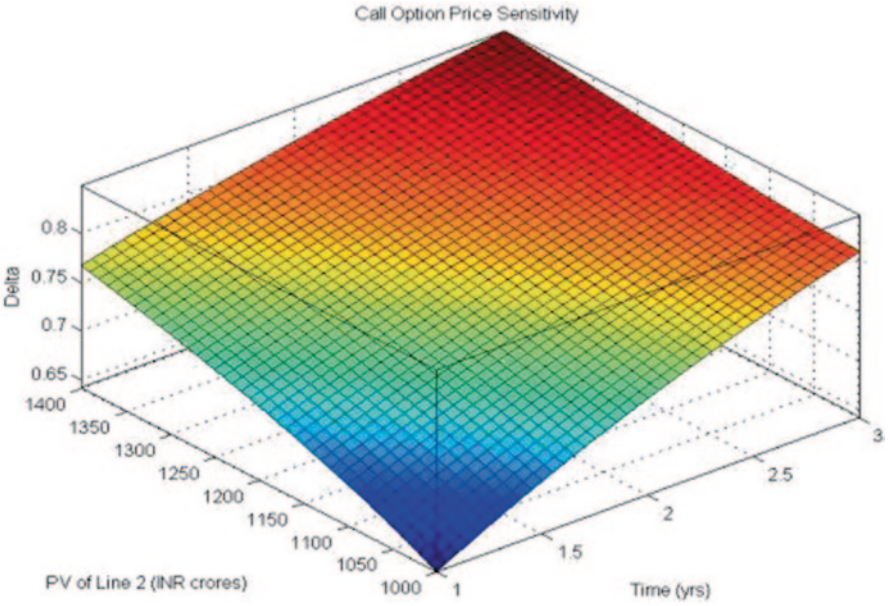

Fig. 16.3 Exhibit 3: Delta value—call option price sensitivity

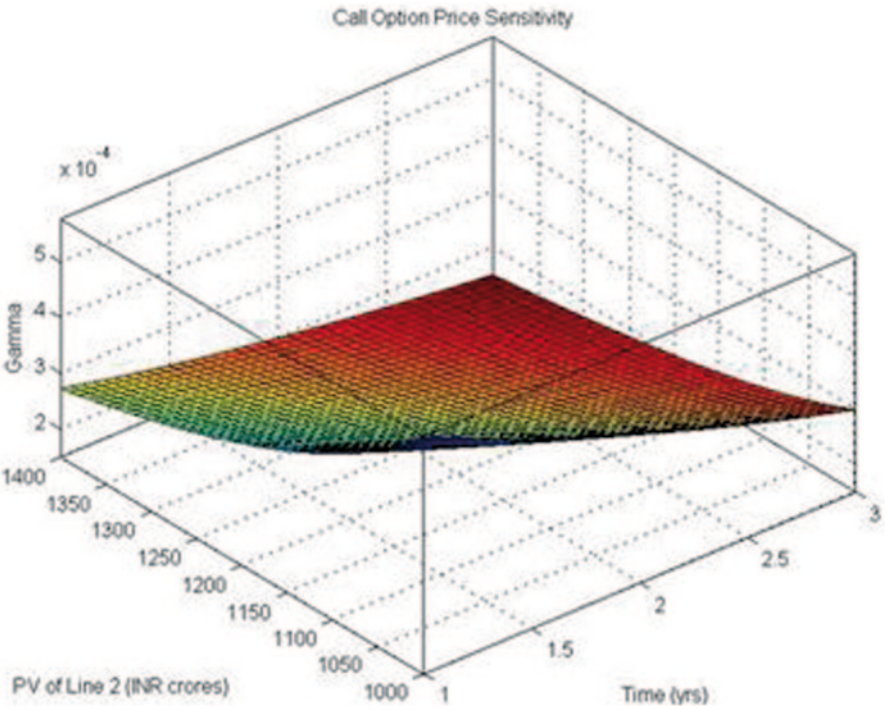

Fig. 16.4 Exhibit 4: Gamma value—call option price sensitivity

High Γ indicates that delta is very sensitive to changes in value of underlying asset. The Γ for Black-Scholes model comes as 0.02106 which is low. The figure indicates that Γ gradually decreases as the PV (line 2) increases. Γ is high initially, and it decreases with the time left for making the decision regarding investment in line 2 (Fig. 16.5).

c. **Theta** (θ): Theta is the measure of the change in option value in response to change in options time to expiration.

$$Theta\ (\theta) = \frac{\partial C}{\partial T}$$

For European call option on a non-dividend paying stock, theta (Hull 2005) is given by,

$$Theta\ (\theta) = -\frac{S\sigma e^{\frac{-d_1^2}{2}}}{2\sqrt{2\pi T}} - rKe^{-rT}N(d_2)$$

θ is negative, as the option value becomes less valuable when time to maturity decreases. For the Black-Scholes model, $\theta = -86.38$ per calendar year, which indicates that the call option value falls by INR 86.38 crore per annum. The figure indicates that θ increases swiftly as PV (line 2) increases. Also, θ falls gradually indicating that the fall in option value is much greater as time to maturity decreases (Fig. 16.6).

d. **Rho** (ρ): Rho is the measure of the rate of change in option value in response to change in interest rates.

$$Rho\ (\rho) = \frac{\partial C}{\partial r}$$

For European call option on a non-dividend paying stock, rho (Hull 2005) is given by,

$$Rho\ (\rho) = TKe^{-rT}N(d_2)$$

For Black-Scholes model the ρ value of the call option is 11.39, which indicates that 1% increase in risk free rate increases the call option value by 11.39%. (If the risk-free rate increases by 1%, then the option value increases by INR 60.02 crore). The figure indicates that ρ is almost zero initially, and it gradually increases with increase in either PV (line 2) or the time to maturity (Fig. 16.7).

e. **Vega** (υ): Vega is the measure of change in option value in response to changes in volatility.

$$Vega\ (\upsilon) = \frac{\partial C}{\partial r}$$

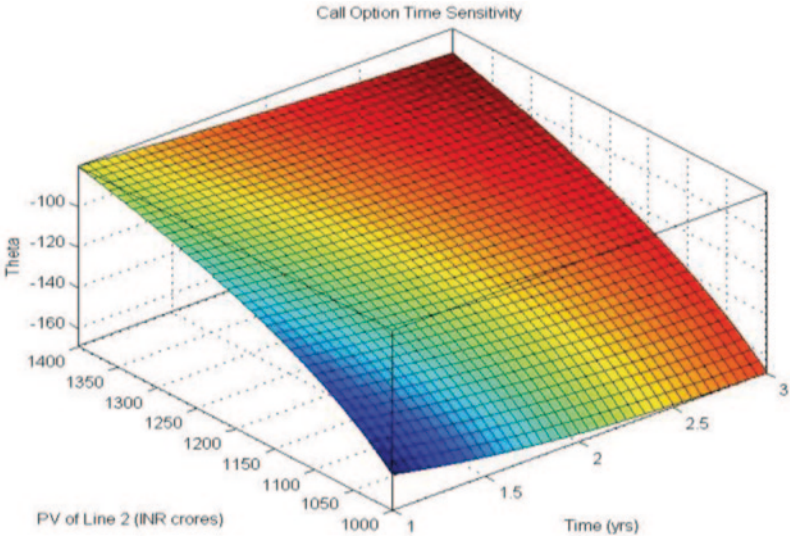

Fig. 16.5 Exhibit 5: Theta value—call option time sensitivity

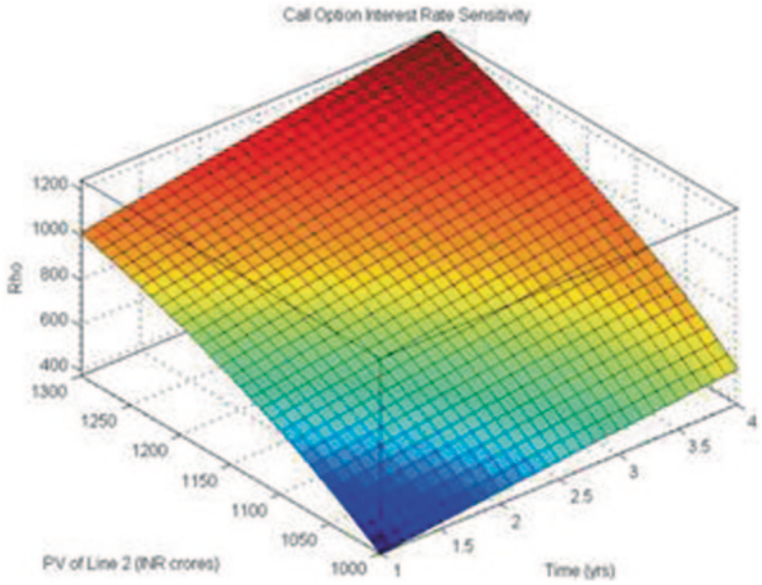

Fig. 16.6 Exhibit 6: Rho value—call option interest rate sensitivity

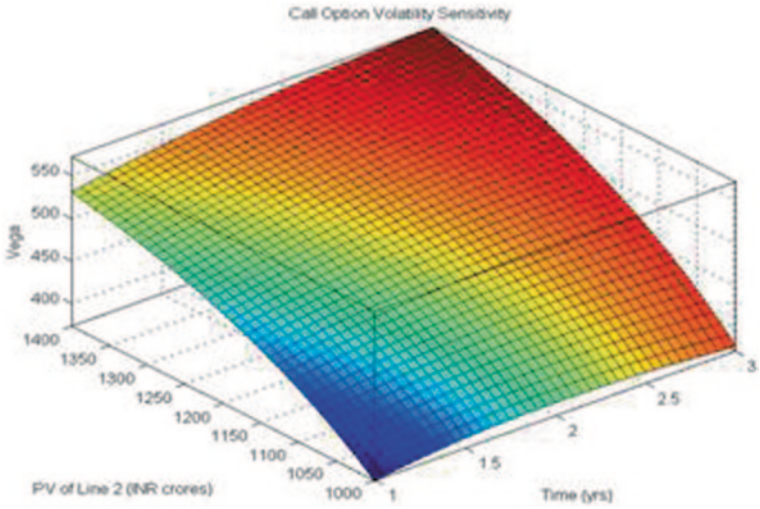

Fig. 16.7 Exhibit 7: Vega value—call option volatility sensitivity

For European call or put option on a non-dividend paying stock, vega (Hull 2005) is given by,

$$Vega\ (\upsilon) = \frac{S\sqrt{T}e^{\frac{-d_1^2}{2}}}{\sqrt{2\pi}}$$

Higher υ indicates that the option value increases drastically with changes in volatility. For the Black-Scholes model, $\upsilon = 5.55\,\%$ which indicates that the call value increases by 5.55 % when the underlying volatility increases by 1 %. (If the volatility increases by 1 %, then the option value increases by INR 33.72 crore). The figure indicates that the call value increases drastically as the PV (line 2) increases and that the call value decreases as time to maturity decreases (Fig. 16.8).

16.12 Sensitivity Analysis Using K_e

The figure shows that option value increases as k_e decreases. This is because, as k_e decreases, the value of the underlying asset, i.e., PV of FCFE will increase, and hence the option value will increase. The k_e used for line 2 is 11.93 %, which gives a PV of INR 1,386.25 crore and option value of INR 779.516 crore for RInfra. Historical data shows that Reliance Infrastructure has an average ROE of 9.2 %.

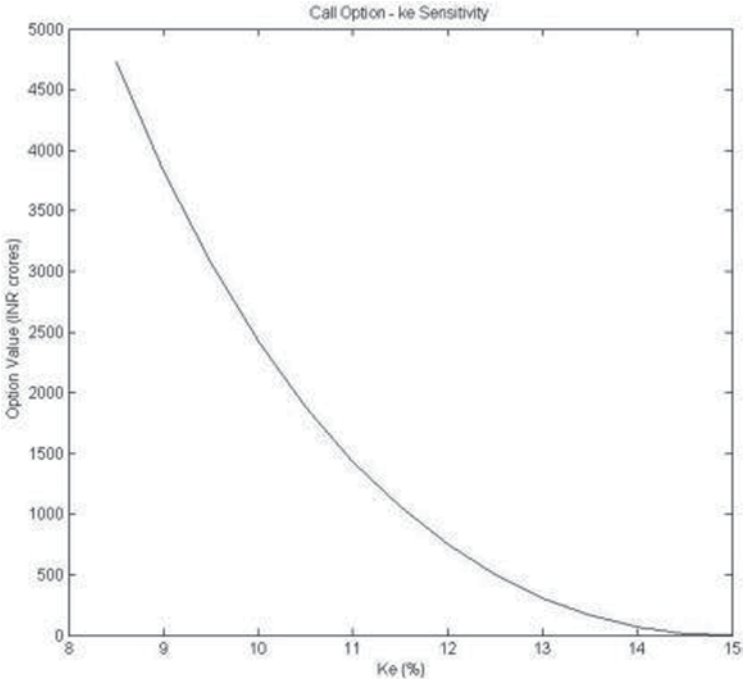

Fig. 16.8 Exhibit 8: Option value vs. K_e

16.13 Conclusion

This paper illustrates how major firms like Rinfra choose project finance over corporate finance for redistributing and mitigating the risks involved in such high capital intensive infrastructure projects. After taking up line 1, RInfra had the option whether to take up line 2 or not. This option was valued using Black-Scholes and Binomial Option pricing models, and the values were INR 779.516 crore and INR 779.592 crore respectively. These option values are large due to the high volatility (64.89%) in such projects. The financial projections made for line 1 provide us with a negative NPV for RInfra. Like other existing metros, we expect Mumbai Metro One, line 1 to be incurring losses mainly due to the heavy expenditure and loan repayment. However, the projections for line 2 indicate a high option value which on addition to NPV of line 1 gives a positive strategic NPV. The sensitivity analysis indicated that a rho of 9.88% could increase the call option value by INR 60.02 crores and the vega of 5.55% could increase it by INR 33.72 crore. The option value is most sensitive to PV of line 2 cash flows (high delta: 80.54%), followed by risk-free rate and then volatility. The strategic NPV of INR 608.646 crore (Black-Scholes) justifies the decision of RInfra of investing in line 2.

16.14 Assumptions

Revenue Revenues for Line 1 start from 2012–2013 when the 3 km stretch of metro rail starts functioning. For line 2, the inflows begin from 2016–2017.

Fare collection (Source: MMRDA website)

Lane I		Lane II	
Distance	Metro fare (INR) (2007–2008)	Distance	Metro fare (INR) (2003–2004)
0–3 km	6	0–3 km	7
3–8 km	8	3–8 km	9
8–12 km	10	8–12 km	11
		12–15 km	13
		15–20 km	15
		20–25 km	18
		25–30 km	20
		>30 km	22

(Fares shall be fixed by the Government of Maharashtra, through a notification. 11% fare increases will reportedly take place every fourth year)

- Feeder bus (Table 16.5): Considered only for line 2. Revenue was taken using proportion of feeder bus revenue/ticket revenue from DMRC Annual Report 2009–2010 for the FY ending March 2010.
- Rental income (Tables 16.2 and 16.5): Revenue was taken using proportion of number of stations of Mumbai and Delhi Metro and Rental income from DMRC Annual Report 2009–2010 for the FY ending March 2010.
- Lease land (Tables 16.2 and 16.5): Revenue was taken using proportion of number of stations of Mumbai Metro and Delhi Metro and Lease land revenue from DMRC Annual Report 2009–2010 for the FY ending March 2010. This is a limitation to the study as Mumbai and Delhi present varied land availability and rates issues.
- Other income: Sale of Carbon Credits (Table 16.6):
- The value of revenue from carbon credit sale was obtained from the proportion of savings for Mumbai and Delhi Metro and Carbon credit revenue from DMRC Annual Report 2009–2010 for the FY ending March 2010. An annual inflation of 8% was also added.
- Sale of Tender docs (Table 16.4): Income for 2013–2014 was taken using proportion of sale of tender docs/ticket revenue from DMRC Annual Report 2009–2010 for FY10. Thereafter it was decreased by 20% each year for 5 years and then made null.
- **Expenses**—Traffic Operations (Tables 16.4 and 16.5): Traffic expense was taken from DMRC Annual Report (FY10) and proportionate value is taken for Mumbai Metro based on number of stations in Delhi Metro and Mumbai Metro. Thereafter annual inflation of 8% was applied.

Table 16.14 Depreciation: this is done on a straight line basis for line 1 and line 2. (Source: Projections using Delhi Metro Rail Corporation financials)

Asset	DMRC values (2009–2010)	Value in 2013–2014 for Mumbai Metro (line 1)	Value in 2016–2017 for Mumbai Metro (line 2)	Life of Asset	Depreciation rate
Building (lease hold)	285415416	30383765.45	93007749.29	35	2.86%
Building (free hold)	38417973918	4089767557	12519188124	35	2.86%
Structures (wire, duct, bridge and tunnels)	32541199181	3464158234	10604135324	35	2.86%
Temporary structures	51103084	5440155.06	16652859.51	1	100%
Plant and machinery	11770541243	1253027497	3835642672	10	10.34%
Rolling stock	27177289251	2296894669	8976677046	32	3.17%
Signaling and telecom equipment	11375733096	961422622.5	3757412346	5	0.2
Track work (permanent)	7323599614	618955656.5	2418989912	61	1.63%
Traction equipment	5836032541	493233593.2	1927645501	9	11.31%
Escalators and elevators	2146243324	228477335.5	699392008.3	32	3.17%
Automatic fare collection	2284935196	243241714.3	744587250.5	5	0.2
IT systems	256602249	27316473.15	83618460.33	5	0.2
Office equipment	105512384	11232271.8	34383109	5	0.2
Furnitures and fixtures	282367843	30059337.49	92014642.79	11	9.50%
Vehicles	40016364	4259923.43	13040052.29	14	7.07%
Survey equipment	2838604	239905.25	937592.8237	14	7.07%
Safety equip	209620204	17716098.34	69237695.35	32	3.17%
Feeder bus	99992690	10644675.34	32584417.38	5	19%
Intangible assets	127665249	13590544.74	41602018.69	5	0.2

- Miscellaneous Expenses (Tables 16.4 and 16.5): Average of 7-year values from DMRC Annual Report (2009–2010) is taken and proportionate value was taken for Mumbai metro based on number of stations. Thereafter annual inflation of 8% was applied.
- **Interest payment**—Line 1 (Table 16.7): The cost of borrowing for the rupee loan, which constitutes about 75% of the total debt, is 12.25%, while the foreign currency loan is at 3.5% above LIBOR. We have assumed the debts to be of 12 year duration. Also, the principal is not paid back during the first 3 years as there are no revenues.
- Line 2 (Table 16.8): The cost of borrowing on the debt amount of INR 7,000 crore is 10.5–11%. The debt is assumed to be for 15 years. Annual interest payments are made from the first year, however, principal repayment begins only in 2016, 5 years after the loan was taken.

- **Tax**: Tax is taken as 11 % (from DMRC). Tax savings from previous year is carry forwarded to the next year in the case of negative profits.
- **Capital Expenditure (capex)**—(Table 16.9): We consider the capex based on the assets used for calculating depreciation. We assume that when an asset gets fully depreciated, it is bought again in the next year as part of capex.
- **Net working capital (NWC)**—(Table 16.10): An average of 10-year values for NWC is obtained from DMRC Annual Report (2009–2010). This is adjusted in proportion to the number of stations for year 1 and then inflated annually.
- **Beta of the company**—(Table 16.12): We use the asset beta of metro rail companies listed worldwide.
- **Market Risk premium ($\mathbf{R_m - R_f}$)**: BSE Sensex returns and the yield on 364 day T-bills were used to compute (R_m) Market Return and (R_f) Risk free rate (Varma and Barua 2006).

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Chapter 17
Impact of Takeover Code 2011 on M&A Scenario in India: A Study of Share Buyback as a Takeover Defense

B. K. R. Naik, Rameez Raja Shaik and Ritesh Jain

17.1 Introduction

M&A scenario in India has been quite inactive when compared to the developed world. As the developed nations have become mature, growth has become stagnant. Hence, the major growth is seen in emerging and developing nations like India. This has led to the entry of many foreign players in India. Pepsi and Coca-cola have almost taken over the entire beverage industry in India, by eliminating the local players. Government of India has tried to protect the local players from the global ones, and at the same time it has kept its door open for foreign players. With the entry of foreign firms and also the growth of local firms, the M&A activities in India has gone up and its essential for the Government to keep reviewing the Takeover Code from time to time. This paper analyses the impact of the changes in the Takeover Code 2011. It also examines the use of share buyback as an effective takeover defense by the firms.

17.2 Literature Review

Prior to 1991, Mergers and Acquisitions (M&A) activity in India was quite dormant (Patankar and Chavan 2011). After the economic liberalization, Indian economy opened up to foreign players (Kar and Soni 2008). Though India saw an increase in

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M&A deals, it was mostly friendly takeovers. The first hostile takeover attempt was in 1984, when Swaraj Paul tried to takeover Escorts and DCM (Mathew 2007). The bid failed as the companies failed to register Paul's shares. In most of such takeover attempts, the promoters have the soft corner of the government and the financial institutions (Mathew 2007). Moreover, the Foreign Direct Investment (FDI) laws in India were quite stringent. Hence, it becomes difficult for a foreign company to takeover an Indian company. Things are changing and the laws are amended periodically to match global standards and to bring about a competitive environment in Indian firms (Parekh 2009). The amendments to the Takeover code in 2011, has made it easy for acquirers to takeover Indian firms. Therefore firms need to adopt various takeover defense strategies to safeguard themselves.

Mergers and Acquisitions: When two or more firms combine or, when one firm takes over or acquires a considerable stake in another firm, it is broadly called as merger and acquisition (M&A). Merger is the combination of two companies when one goes out of existence. Acquisition is the purchase of one company by another, in which no new company is formed. There are many reasons for M&A: Strategic, Financial and capability acquisition. Financial reasons may include tax savings, cost savings etc. Strategic reasons include economies of scale and scope, achieving growth, survival, focus on core competencies etc. Capability acquisition includes diversification and growth through inorganic route. Mostly M&A turns out to be beneficial to both the target and the acquirer as the synergy is shared by both. In such deals, the acquisition is mostly a friendly takeover. But, in certain scenarios the target is not willing to sell itself to the acquirer. Such takeover attempts are known as *hostile takeover.*

Hostile bids are unsolicited offers that challenge current management's strategic direction and leadership. Firms apply *defense strategies* against hostile takeover attempts to protect their independence. These measures also ensure that the hostile bidders present their best offers.

Preventive Anti-takeover Strategies: Preventive strategies are constructed when management believes that the company is vulnerable to a takeover attempt because of its depressed stock price, competitive weakness, market condition or financial exigencies. Such strategies are constructed prior to takeover attempts. These strategies signal that board and management are united to pursuit the goal of company autonomy.

Poison Pills: Its intent is to make acquisition expensive by diluting the stock in case of a takeover attempt. This strategy involves offering preferred stock of the merged firm at a highly attractive rate to the existing shareholders, if the takeover happens.

Poison pill with flip-over rights—distributes rights rather than shares of preferred stock.

Flip-in poison pills—provision that gives current shareholders (other than acquirer firm) right to purchase additional shares in targeted firm at discounted price.

Corporate charter amendments: This strategy involves staggering the election of the board of directors. It ensures that all of them are not elected during the same year. This prevents installation of sympathetic directors to facilitate the strategic transition in the aftermath of the takeover by the acquiring firm.

Golden parachutes: This clause mandates distribution of lucrative compensation packages to a selected group of senior executives of firm, if a pre-specified threshold of outside stock ownership is acquired in a takeover bid. This additional cost of paying off such obligation can inhibit some takeover attempts.

Shark Repellents: The company may include conditional covenants that gives the lender the right to accelerate the debt or terminate the contract, in the event of the company passing under the control of a third party.

17.2.1 Reactive Anti-takeover Defenses

Litigation: Mostly used to stall hostile attempts by legal injunction and restraining orders against a pursuer to bar that company from acquiring additional shares of the target firm. It gives buffer time to the target firm for developing other strategies. The consequences of litigation defenses are more conclusive than those of other strategies because, according to Jarrell (1985), approximately one-third of all tender offers are challenged by the litigation defense.

Greenmail (targeted repurchase): This defense involves buy back of shares that have been acquired by the aggressor at a premium, in exchange of an agreement that the aggressor will no longer target the firm for takeover. It is simple and effective strategy for fending off takeover attempts when aggressor's goal is short term profit than long term corporate control.

Standstill agreements: A contract between parties in which, pursuer agrees not to acquire further stock of target firm. The target firm has to pay some fee in exchange for this agreement.

Capital Structure Changes: A firm can restructure its capital to defend against hostile takeover by making firm unattractive or creating long term liabilities. Some of these could be:

1. Paying shareholders super dividend which is financed through additional debt.
2. By issuing additional share to employees as ESOPs to increase control of executives.
3. Issuing additional shares keeping current level of debt forcing the bidder into a costlier battle to buy shares to gain control.
4. Buy back shares from open market in an attempt to ward off an attack.

Crown Jewels: A disinvestment strategy involving sale of certain assets or divisions of the target especially coveted by bidder. This makes the target less attractive to a bidder and encourages abandonment of the bid.

Table 17.1 Defense strategy analysis

Defense strategy	Category	Popularity among firms	Effectiveness as defense	Stockholder wealth effect
Poison pills: plus flip-over rights and flip-in options	Preventive	High	High	Positive
Corporate charter amendment	Preventive	Medium	Very low	Negative
Golden parachutes	Preventive	Medium	Low	Negligible
Litigation—antitrust, fraud, inadequate disclosure	Reactive	Medium	Low	Positive
Greenmail	Reactive	Very low	Medium	Negative
Standstill agreements	Reactive	Low	Low	Negative
Capital structure changes—recapitalization, new debt stock selling, share buybacks	Reactive	Medium	Medium	Inconclusive

White Knights: Management of Target Company approaches another firm to place a rival bid. This bidding contest helps the target to get a higher bid for itself. If the white knight wins, the target will get into the hands of the white knight rather than the hostile acquirer.

Pac-Man Strategy: As a last resort, the target company can make a tender offer to acquire the stock of the hostile bidder. This is a very extreme type of anti-takeover defense and usually signals desperation.

In India, the companies are able to access lesser anti-takeover defenses in comparison to the American companies. For the purpose of preventing a takeover effort, the Indian companies currently adopt the following anti-takeover defenses (Table 17.1):

1. Effecting creeping enhancement.
2. Making preferential allotment.
3. Selling the Crown Jewels.
4. Amalgamating group companies.
5. Searching for a White Knight.

Share Buy Back as defense strategy: Share buyback can be used as a credible signaling mechanism or as a defensive strategy against hostile takeover. As per Companies Act Section 77A: Buy Back may be used as a defense to a hostile takeover.

Reasons for Undertaking Share Buy-Backs:

1. Leverage: Companies with additional debt capacity may buy back shares in order to move towards optimal capital structure.
2. Information signaling: It's a credible signaling mechanism adopted by the firms' management. It shows their confidence on the firms' future performance, the future cash flows and it also indicates that their stock might be undervalued.
3. Wealth transfer: A buy-back that is undertaken when shares are undervalued transfers wealth from participating (selling) shareholders to non-participating.

4. Free Cash Flow: This theory of buy-backs is based upon the work of Jensen (1986). Jensen analyses the problems that exist when a company generates substantial "free cash flow" (i.e., funds that cannot be efficiently invested on behalf of shareholders because of a lack of profitable investment opportunities). For such companies, share buy-backs are an efficient means of returning funds to shareholders who can make better use of these funds than can the company.
5. Earnings per Share: It can be an attempt to increase EPS of company stock by decreasing free floated equity.
6. Anti-takeover mechanism: A buy-back may be used as a defensive tactic in a hostile takeover by increasing the leverage of the company and reducing the liquidity and common stock available for acquisition.

It is still debated whether share buy-back as a defense strategy is beneficial to the shareholders (Bielawski 1990). Economists typically evaluate two hypotheses. First is Management entrenchment hypothesis which suggest that management is working in self-interest of prevention of control by using share buy back as a takeover defense mechanism. In contrast, the shareholders' interest hypothesis states that when managers undertake share buybacks as a takeover defense they are acting in the interests of shareholders. This is because when managers are confronted by the threat of a hostile takeover they may adopt a short-term focus with respect to investment decisions (Drucker 1986). This may not be in the interests of all shareholders. Therefore, defensive tactics, including buy-backs, decrease the threat of a hostile takeover, and hence allow managers to make long-term investment decisions.

SEBI—TRAC—Takeover code: Securities and Exchange Board of India (SEBI) had formulated the Takeover Regulations in 1994. In 1995, SEBI appointed a committee to review the Takeover Regulations of 1994. Justice P. N. Bhagwati was appointed as the chairman of this committee. In 1997, SEBI repealed Takeover Regulations of 1994 and formed Takeover Regulations of 1997 by taking into consideration the recommendations of the Bhagwati committee. Bhagwati committee was reconstituted in 2001 and the Takeover Regulations of 1997 were reviewed in 2002. Since then it was continuously reviewed and amended. Till date, the Takeover Regulations of 1997 have been reviewed 23 times (Achuthan 2010).

Over the last decade, the M&A activity in India have surged. The number of takeovers of listed Indian companies has increased from an average of 69 per year during 1997–2005 to 99 a year during 2006–2010 (Achuthan 2010). Hence, SEBI once again decided to review its Takeover Regulations. It constituted the Takeover Regulations Advisory Committee (TRAC) on September 4, 2009 to review the Takeover Regulations of 1997 and to suggest amendments in it. Mr. C. Achuthan, the Former Presiding Officer of the Securities Appellate Tribunal was appointed as the Chairman of TRAC. TRAC came up with its recommendations in 2010. In 2011, SEBI formulated the Takeover Regulations of 2011 taking into consideration the recommendations of TRAC. The impact of the Regulations is enlisted in Table 17.2.

Table 17.2 Impact of takeover code 2011

Existing regulations	New changes to takeover code	Impact
An acquisition of 15% or more shares/voting rights will trigger an open offer.	15% has been raised to 25%. Hence, open offer is triggered when the shareholding/voting rights reach 25%.	Limit has been increased to bring it in line with international markets. Increase in trigger limit will help the smaller firms to raise capital easily from external investors. Investors and financial institutions can invest more.
Once the 15% trigger is reached, the acquirer has to make an open offer for acquisition of minimum 20% voting capital from public.	Once the 25% trigger is reached, the acquirer has to make an open offer for acquisition of minimum 26% voting capital from public. Holdings due to the open offer has a cap of 75% and 90% depending on the firm.	Makes it easy for hostile takeovers. Acquirers can increase stake up to 25% without triggering an open offer. After reaching 25%, they can acquire 26% additional stock through open offer and, hence, they gain majority shareholding (51%).
Promoters can increase their holding by creeping acquisition of 5% per year, permissible for holders having 15% or more shares. They can increase their holding till 55%. Additional 5% (one time) can be acquired by promoters having 55–75% stake (upto a maximum of 75% stake).	The cap of 15% has been raised to 25%. Hence, promoters can increase their holding through creeping acquisition of 5% per year up to maximum permissible limit under Securities Contract Regulation Rules ("SCRR"): i.e. 75 or 90% (public sector undertaking).	Promoters can now increase their holding up to 75% of total equity compared to earlier 55%. Promoters will try to increase their holdings to 25% before the new code is implemented.
Provides an outer limit of 25% premium for non-compete payments to promoters at the time of sale. This fee is excluded while calculating the minimum offer pricing.	All payments, including the non-compete fee are considered while calculating the negotiated offer price for public shareholders.	Brings all shareholders on the same level. Justice to minority shareholders. Promoters are at a loss, as they are not rewarded for their efforts and risk.
Board of Directors can send a recommendation letter to shareholders with their take on the current acquisition proposal.	It's the obligation of the board of directors to send a reasoned recommendation letter to its shareholders about their take (if needed, they get experts' advice) on the current acquisition proposal.	More power and responsibility to Board of directors. Removes asymmetry of information by making their recommendation letter as mandatory. Staggered Board of Directors can prove to be a good defensive strategy.
Acquirer holding 25% or more shares to make a voluntary open offer, should at least offer to buy at least 20% shares.	Acquirer holding 25% or more shares to make a voluntary open offer, should offer to buy at least 10% shares subject to certain conditions.	New voluntary code will keep the raiders away, as the conditions for a voluntary offer have become stringent.

Table 17.2 (continued)

Existing regulations	New changes to takeover code	Impact
Change in control is exempted from an open offer if exempted by the shareholders.	Irrespective of acquisition of shares, the acquisition of control will trigger an open offer.	In terms with international standards.
Common treatment for all indirect acquisitions irrespective of the size of target and acquirer.	New code, prescribes certain parameters like revenue, asset value, market capitalization etc. for determining treatment of indirect acquisition.	Brings more clarity and enables better scrutiny.
Automatic exemption route in the open offer has many gaps.	Overhaul of exemptions from open offer made more stringent.	Ensures that selected firms get the exemption from open offer.

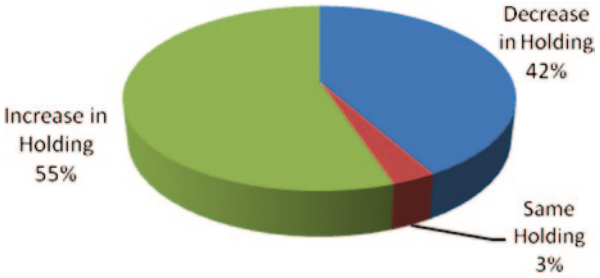

Fig. 17.1 Change in promoter shareholding pattern (2001–2011)

17.3 Data Analysis

Data was taken from Prowess Database (Release 3, CMIE). The promoter shareholding pattern in the year 2001 and 2011 were analyzed for a sample of 2145 listed Indian companies. In anticipation of changes in the Takeover code, promoters had started consolidating their stake in order to safeguard their ownership against hostile takeover attempts. This hypothesis has been proved by the analyzing the data in 2001 and 2010. Among the 2145 firms analyzed, promoters in 55.1% of the firms have increased their stake, whereas 41.82% of them have reduced their stake (Fig. 17.1). The reduction in stake in the 41.82% firms seems to be against our hypothesis.

But further analysis of these firms show that the reduction of promoter's stake was less than 1% in all the cases. In fact 56.56% of the firms which showed reduction in stake had actually reduced their stake by less than 0.25% (Table 17.3). Hence, we conclude that the reduction in stake among firms is very negligible and might be due to various factors affecting each company.

The data shows a whopping 55.1% of firms which have shown trends of increasing promoters share. This falls in line with our hypothesis. Due to the amendments in the criteria of creeping increments in promoters' stake, Indian promoters would

Table 17.3 Reduction in promoter shareholding (split-up)

Decrease in holding (2001–2011) (%)	Number of firms	Percentage of firms
0–0.25	487	56.56
0.25–0.5	190	22.07
0.5–0.75	96	11.15
0.75–1	88	10.22
≥1 %	0	0.00
Total	861	100.00

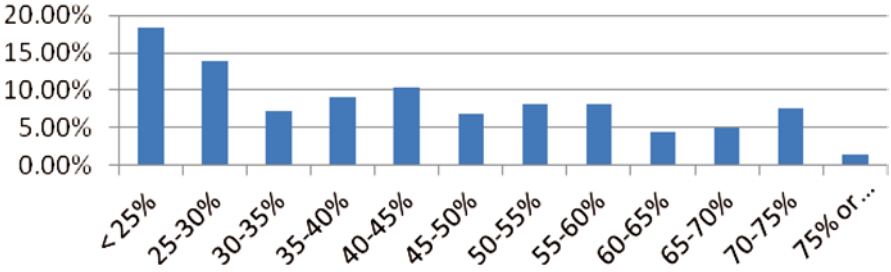

Fig. 17.2 Promoter stake of firms in 2011 whose stake was < 25 % in 2001

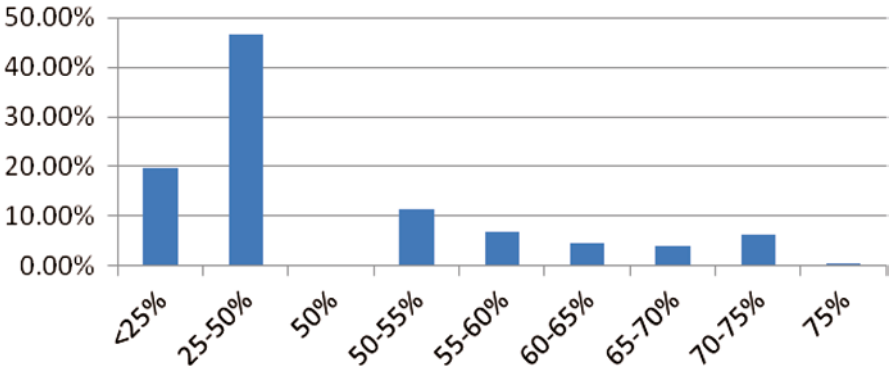

Fig. 17.3 Promoter stake of firms in 2011 whose stake was < 50 % in 2001

have tried to increase their stake to 25 % before the implementation of the New Takeover Code in order to avoid triggering the open offer.

Firms with promoter shareholding less than 25 % in 2001 were analyzed. By 2011, only 18.39 % of the firms remained less than 25 %. Promoters in 81.61 % of the firms have increased their stake to more than 25 %, and 34.53 % of them have increased it to more than 50 % (Fig. 17.2).

Firms with promoter shareholding less than 50 % in 2001 were analyzed. By 2011, promoters in 33.6 % of the firms increased their stake to more than 50 %. This move completely eliminates hostile takeover threats (Fig. 17.3).

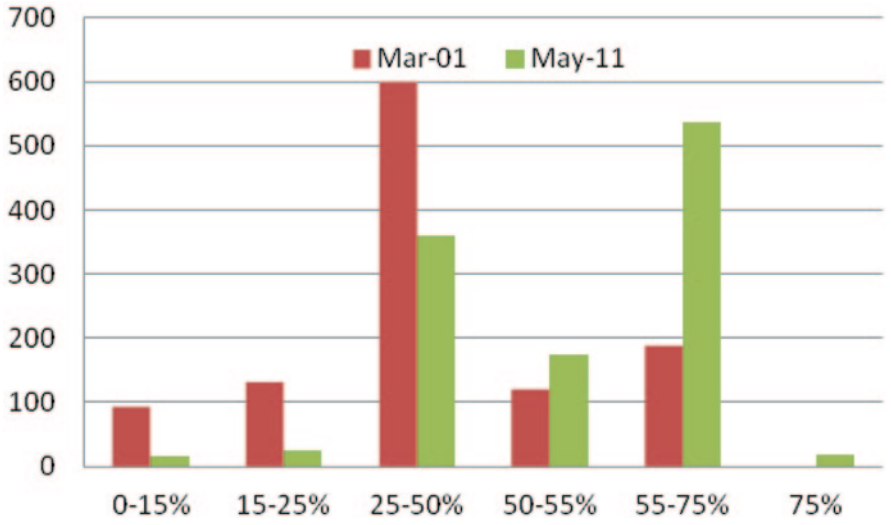

Fig. 17.4 Promoter shareholding of firms that increased its holding

Figure 17.4 shows that overall there has been an increase in promoter shareholding percentage. The shift in ownership from low stake to high stake can be observed in the graph.

17.4 Conclusion

M&A trends in India have been changing. From a closed economy prior to 1991, India has opened up and has been amending its M&A laws to bring it on par with global laws. Though hostile takeovers were rare in India earlier, it can increase drastically after the introduction of the Takeover code 2011. The changes in the code have made acquisition of Indian companies relatively easy. In anticipation of such an amendment, the promoters have increased their stake over the years so as to ward of any potential takeover threats in future. Our analysis of 2145 listed firms in India showed that 55.1% of them have increased their promoter's stake by a decent margin. The increase in open offer trigger to 25% has resulted in promoters trying to increase their stake to more than 25% before the new code gets implemented. Analysis has shown that 81.6% of such firms have increased their promoter's stake to more than 25%. We conclude that the Takeover code is good for the Indian economy as it opens up avenues for new M&A's and hence makes the scenario competitive. Those promoters who wish to safeguard their firms need to adapt to takeover defense mechanisms like share buyback, shark repellent etc. to ward off potential takeover threats.

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Part V
Operations and Marketing Flexibility

Chapter 18
Measurement of Flexibility and Its Benchmarking Using Data Envelopment Analysis in Supply Chains

G. P. Kurien and M. N. Qureshi

18.1 Introduction

Managing Supply Chain (SC) operations is critical to any organization's ability to compete effectively in today's global and dynamic environment. Good Supply Chain Management (SCM) practices results in a variety of advantages such as increased customer value, increased profitability, reduced cycle times, less inventory levels (William et al. 2007) and increased flexibility (Hoek et al. 2001). Flexibility is increasingly mentioned as one of the major challenges to the business world, given volatile markets and increasingly varying performance requirements (Li et al. 2009). Companies are becoming increasingly aware that for competing in continuously changing environment, it is necessary to monitor, understand and control their flexibility capabilities.

Nomenclature

SC = Supply chain
SCM = Supply chain canagement
PMS = Performance measurement system
SCPM = Supply chain performance measurement
SCPMS = Supply chain performance measurement systems
DEA = Data envelopment analysis
DMU = Decision making unit
HCU = Hypothetical composite unit
E = Relative efficiency score

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Literature survey indicates that interest on performance measurement of SCs has notably increased in the last two decades (Taticchi et al. 2010). Various performance metrics are in place for measuring effectiveness of SC. Different perspectives of Supply Chain Performance Measurements (SCPM) are available in literature. Flexibility and agility in SC have been considered as one of the performance parameters in many studies; however detailed study focusing on measurement of flexibility in SC is limited (Li et al. 2009). The measurement of flexibility in large, complex systems, such as supply chain systems, has rarely been addressed. The reason for this is that unlike other performance measures which demonstrate it in ongoing operations, flexibility need not be a demonstrated measure but a potential capability to meet a future need. There have been attempts to create a framework for agile supply chain and its measurement (Hoek et al 2001) and development of an instrument to measure supply chain agility (Li et al. 2009). Beamon (1999) has proposed a framework for measurement of flexibility in SC and identified performance measures for flexibility in SC.

The present research is examining the Performance Measurement aspects of flexibility in SC and suggesting a methodology for bench marking of Flexibility capabilities in SC using Data Envelopment Analysis (DEA). DEA is a performance measurement technique developed by Charnes et al. (1978) and is used for determining the relative efficiency of a set of comparable businesses and it can also be used for benchmarking. DEA results provide decision makers with improvement potentials, targets, and peer organizations as bench marking units. The paper also demonstrates the methodology of using DEA to measure flexibility and its bench marking of similar SCs.

This paper is organized into the following sections: (1) Performance Measurement in SC; (2) Measurement of Flexibility in SC; (3) DEA for Performance Measurement and Benchmarking; (4) Demonstration of using DEA for benchmarking flexibility in SC.

18.2 Performance Measurement in SC

Supply Chains (SC) are increasingly depending on Performance Measurement Systems (PMS) as a means to align their processes and resources with strategy and to achieve their organization objectives (Neely 2005). Literature review indicates that a number of frameworks and models for performance measurement have been developed since 1980s. Tangen (2004) suggests that a major objective of such PMSs is to encourage proactive rather than reactive management. Gunasekaran et al. (2001) adds that performance measures can facilitate a greater understanding of the Supply Chain (SC) and improve its overall performance therefore achieving organisational objectives.

Much progress has been made since last two decades in establishing PMSs which include a portfolio of measures aimed to balance the more traditional, single focus view on profitability (Taticchi et al. 2010). Neely (2005) defined PMS as a balanced

and dynamic system that enables support of decision-making processes by gathering, elaborating and analyzing information. Bititci et al. (1997) defines SCPM as the reporting process that gives feedback to employees on the outcome of actions. Tangen (2004) proposed that performance should be defined as the efficiency and effectiveness of action.

Effective SCPM has been associated with a variety of advantages including increased customer value, increased profitability, reduced cycle times and average inventory levels and even better product design (William et al. 2007). The objective of SCPM therefore has to facilitate and enhance the efficiency and effectiveness of SCM. The main goal of SCPM models and frameworks is to support management by helping them to measure business performance, analyze and improve business operational efficiency through better decision-making processes (Tangen 2005). An effective, integrated and balanced SCPM can engage the organisation's performance measurement system as a vehicle for organisational change. It also provides insight to reveal the effectiveness of strategies and to identify potential opportunities. It makes an indispensable contribution to decision making in SCM, particularly in re-designing business goals and strategies, and re-engineering processes (Charan et al. 2008).

The most widely cited Supply Chain Performance Measurement Systems (SCPMS) are the SMART (1988), the performance measurement matrix (1989), the Balanced Scorecard (1992), the integrated dynamic PMS (1997) and the Performance Prism (PP) (2001). In the Indian context, there have been many attempts to measure the performance at the organizational level, but very few attempts have been made to measure the performance at inter-organizational level and measure flexibility at SC level.

18.3 Measurement of Flexibility in SC

Review of related literature on flexibility indicates that majority of research in flexibility measurement has been done in the field of Manufacturing Flexibility Sethi and Sethi 1990; Schmenner and Tatikonda 2005. Measures for flexible manufacturing systems (FMS) on the machine and plant levels exist and have been well-studied. There has also been work done in the area of Strategic Flexibility at organizational level, however, literature on flexibility at SC level are comparatively less. The reasons for limited work on SC flexibility performance measurement are attributed to the multiple dimensions of flexibility in SC and the fact that flexibility is not a demonstrated measure in SCs, but a potential attribute (Beamon 1999). SC flexibility should incorporate both within the firm and between-firms flexibility. Literature indicates several advantages of flexible SCs (Beamon 1999; Hoek et al. 2001; Li et al. 2009). Significant of them are enumerated as under:

1. Reductions in the number of backorders.
2. Reductions in the number of lost sales.

3. Reductions in the number of late orders.
4. Increased customer satisfaction.
5. Ability to respond to and accommodate demand variations, such as seasonality.
6. Ability to respond to and accommodate periods of poor manufacturing performance.
7. Ability to respond to and accommodate periods of poor supplier performance.
8. Ability to respond to and accommodate periods of poor delivery performance.
9. Ability to respond to and accommodate new products, new markets, or new competitors.

In an uncertain environment, SCs must be able to respond to change. Flexibility measures the ability of the SC to adapt to volume and schedule variations from other partners of the SC. Beamon (1999) discussed two types of flexibility: (1) Range flexibility and (2) Response flexibility. Range flexibility measures the extent the operation can be varied. Response flexibility measures the ease (in terms of cost, time, or both) with which the operation can be varied. The SC need to adapt adequately to the uncertain environment by incorporating range flexibility and response flexibility in its design.

Hoek et al. (2001) conducted an audit of agility in the SC and introduced agility as an emerging management concept centered on responsiveness to dynamic, turbulent markets and customer demand. Based on this audit it was established that customer sensitivity is the key element in SC agility. The other factors of SC agility constructs are Virtual integration, Process integration and Network integration. Li et al. (2009) developed an instrument for measuring supply chain agility. They developed a 12-item instrument with six dimensions per item. The instrument has been validated through research. The proposed methodology can be used to examine the links between SC agility-related variables, SC agility, and outcomes of agility.

The key elements in SC performance measurement, according to Beamon (1999), are measurement of: (1) *Resources,* (2) *Output* and (3) *Flexibility. Resource measures* concentrate on efficiencies, are related to costs and targets effective utilization of resources. *Output measures* emphasize on customer responsiveness and aims at providing high level of customer service. *Flexibility* measures how well the system reacts to uncertainty and its ability to respond to a changing environment. *Resources measures* and *Output measures* have been widely used in existing SCPMS models. However *Flexibility* has been limited in its application to SCPMS.

Flexibility measures are different from resource and output measures in many aspects. Slack (1983) indicates that flexibility measures potential behavior, whereas other operational objectives are actually demonstrated by the system's operating behavior (performance). Therefore, flexibility does not have to be demonstrated by the system in order to exist. This aspect of the absence of performance demonstration of flexibility in ongoing operational situations makes its measurement challenging and necessitates different approach. Beamon (1999) identified four types of SC flexibility; they are:

1. **Volume flexibility (Fv)**. It is the ability to change the output level of products produced. The volume flexibility measure, Fv, measures the proportion of

demand that can be met by the supply chain system within range of volumes that are profitable.
2. **Delivery flexibility (Fd)**. It is the ability to change planned delivery dates. Delivery flexibility is measured as the percentage of slack time by which the delivery time can be reduced.
3. **Mix flexibility (Fm)**. It is the ability to change the variety of products produced. Mix flexibility measures either the range of different product types that may be produced during a particular time period, or the response time between product mix changes.
4. **New product flexibility (Fp)**. It is the ability to introduce and produce new products which also includes the modification of existing products. It is measured as either the time or cost required to add new products to existing production operations.

18.4 DEA for Performance Measurement

DEA is a non parametric performance measurement technique developed by Charnes et al. (1978) and is used for determining the relative efficiency of a set of comparable business called Decision Making Units (DMU). It has been applied to a wide range of problems in the fields of management, economics and business operations. In DEA, efficiency is defined as:

$$\text{Efficiency} = \frac{\text{Weighted sum of outputs}}{\text{Weighted sum of inputs}}$$

The weights attached to each input and output is not specified a priori. Instead they are computed to show each unit under comparison in its most favorable light. The envelope, or frontier, becomes the surface linking all units whose relative efficiency cannot be exceeded. By definition units on that surface are then assigned 100% efficiency. The best possible efficiency for other units in the sample then brings them as close as possible to the envelope. The efficiency score computed by DEA is a numerical value that describes a system's relative efficiency in terms of inputs and outputs.

If there are 'n' DMUs, each with 'm' inputs and 's' outputs, the relative efficiency score of a test DMU 'p' is obtained by solving the following model (Talluri 2000).

$$Max \left(\frac{\sum_{k=1}^{s} v_k \, y_{kp}}{\sum_{j=1}^{m} u_j x_{jp}} \right)$$

S.t.

$$\left(\frac{\sum_{k=1}^{s} v_k\, y_{ki}}{\sum_{j=1}^{m} u_j x_{ji}}\right) \leq 1 \quad \forall i$$

$$v_k, u_j \geq 0 \quad \forall j, k \tag{18.1}$$

Where:

k = 1 to s; j = 1 to m; I = 1 to n
y_{ki} = Amount of output 'k' produced by DMU 'i'.
x_{ji} = Amount of input 'j' used by DMU 'i'.
v_k = Weight given to output 'k'.
u_j = Weight given to input 'j'.

The fractional program shown as above at Eq. 18.1 can be converted to a linear program for ease of solving as an LPP. The linear formulation of the DEA problem is given as follows (Talluri 2000):

$$\begin{aligned} &Max \left(\sum_{k=1}^{s} v_k\, y_{kp}\right) \\ &s.t. \sum_{j=1}^{m} u_j\, x_{jp} = 1 \\ &\left(\sum_{k=1}^{s} v_k\, y_{ki} - \sum_{j=1}^{m} u_j\, x_{ji}\right) \leq 0 \quad \forall i \\ &v_k, u_j \geq 0 \quad \forall j, k \end{aligned} \tag{18.2}$$

The above problem is run '*n*' times (one run per DMU) to calculate the relative efficiency scores of the DMUs. A DMU is considered to be efficient if it obtains a score of 1 and a score of less than 1 implies that it is inefficient. Each DMU selects input and output weights that maximize its efficiency score. So the v_k and u_k values gives output and input weight ages corresponding to max relative efficiency possible for the DMU considered.

18.4.1 Benchmarking in DEA

For every inefficient DMU, DEA identifies a set of corresponding efficient units that can be utilized as benchmarks for improvement. The benchmarks can be obtained from the dual of the DEA LPP formulation given above at Eq.18.2.

Min E

Subjected to:

$$\sum_{i=1}^{n} \lambda_i y_{ki} \geq y_{kp} \quad \forall j$$
$$\sum_{i=1}^{n} \lambda_i x_{ki} \leq E.x_{kp} \quad \forall k$$
$$\lambda \geq 0 \quad \forall i \tag{18.3}$$

Where:

E = Efficiency score
λ_i = Dual variable

These dual variables (λ_i) can be used to construct an efficient Hypothetical Composite Unit (HCU). HCU can be used to measure excess use of inputs and potential increase in outputs.

There are two basic DEA orientation models; viz. input reduction, and output augmentation. The former, also known as input-oriented model emphasizes how to use minimum input resources to achieve a given level of output. The latter, known as output-oriented model, focuses on using a given level of input to achieve the maximum possible output.

DEA is receiving increasing importance as a tool for evaluating and improving the performance of manufacturing and service operations. It has been extensively applied in performance evaluation and benchmarking. DEA approach has the following benefits which make it suitable for its application in flexibility performance measurement and bench marking in SC:

1. DEA deals with individual cases (Madu and Kuei 1998).
2. It can produce a single measure for each company (Madu and Kuei 1998).
3. It places no restriction on the functional form of the input-output relationship.
4. Able to handle disproportionate multiple inputs and outputs (George and Rangaraj 2008)
5. Does not requiring the decision maker any priory arbitrary weights (George and Rangaraj 2008).
6. It focuses on revealed best-practice frontiers rather than on central tendency properties of empirical data (Madu and Kuei 1998).
7. It can provide an indication of the levels of improvement needed before an inefficient company could be considered efficient (Talluri 2000).

18.5 Demonstration of Using DEA for Benchmarking Flexibility

18.5.1 SC Model

A simplified and generic approach to SCPMS has been adopted to demonstrate using of DEA for bench marking Flexibility. The supply chain model considered is shown in Fig. 18.1 which contains four echelons. The four echelons; supply,

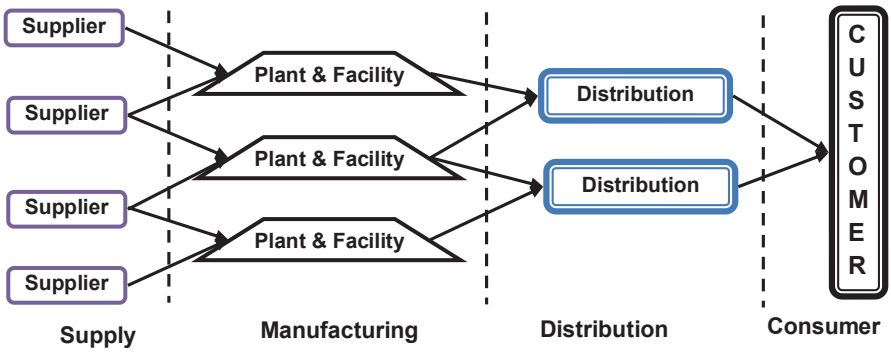

Fig. 18.1 Supply chain

manufacturing, distribution, and consumers comprise of numerous facilities. DEA methodology considers relationship between multiple inputs with multiple outputs.

18.5.2 Performance Measures Considered

The present study considers the *'Resources'* consumed in the SC as the input parameters and the *'Flexibility'* measures as the outputs. Resource parameters and Flexibility parameters as proposed by Beamon (1999) are summarized at Table 18.1.

DEA is effective when organizations operating under similar conditions are compared. SCs with similar processes and features can only be compared to establish benchmarking. In the current case four input parameters (Capital, Distribution costs, Manufacturing cost, and Inventory) and two output parameters (Volume flexibility and Delivery flexibility) are considered.

The flexibility parameters Volume flexibility (F_v) and Delivery flexibility (F_D) are calculated based on the procedure suggested by Beamon (1999).

$$F_v = P\left(\frac{O_{\min} - \bar{D}}{S_D} \le D \le \frac{O_{\max} - \bar{D}}{S_D}\right) \tag{18.4}$$

$$F_D = \frac{\sum_{j=1}^{J} (L_j - E_j)}{\sum_{j=1}^{J} (L_j - t^*)} \tag{18.5}$$

Where:

O_{min}, O_{max} – Minimum and maximum profitable output volume.

Table 18.1 List of input and output parameters

Input: Resources		Output: Flexibility	
Input parameter	Explanation	Output parameter	Explanation
Capital	Total cost of resources used. Measure of capital	Volume flexibility	The ability to change the output level of products produced
Distribution costs	Total cost of distribution, including transportation and handling costs	Delivery flexibility	The ability to change planned delivery dates
Manufacturing cost	Total cost of manufacturing, including labor, maintenance, and re-work costs	Mix flexibility	The ability to change the variety of products produced
Inventory	Costs associated with held inventory	New product flexibility	The ability to introduce and produce new products (this includes the modification of existing products)

D – Demand volume which is a random variable with an approximate normal distribution with D as the arithmetic mean and S_D as the standard deviation.
P – Indicates probability of meeting the demand between O_{min} and O_{max} based on normal probability distribution.
L_j – Latest time period during which the delivery can be made for job j
E_j – Earliest time period during which the delivery can be made for job j.
j – 1 to j jobs in the system.
T* – Current time period (Modal value of time taken to complete the job).

18.5.3 Data Set

Data set for the six SCs under consideration (DMU) are given at Table 18.2. The six SCs are hypothetical and the data is representative sample.

18.5.4 DEA Formulation

The benchmarking is done by solving the dual of the DEA given at model Eq. 18.3. The dual variables (λ_i) correspond to HCU and E the efficiency measure of the DMU under consideration. HCU can be used to measure possible improvements in terms of reduction in inputs and increase in outputs of the DMU.

The mathematical formulation for the case under study is given at Appendix. The DEA model is solved using the *DEAFronti*er which is a Microsoft Excel Add-In developed by Joe Zhu. The DEA model is solved as *'Input-Oriented'* and *'Constant Return to Scale (CRS)'*.

Table 18.2 Data set

SC (DMU)	Capital (Rs in crores)	Manufacturing cost (Rs in crores)	Distribution costs (Rs in crores)	Inventory (Rs in crores)	Volume flexibility (in percentage)	Delivery flexibility (in percentage)
	Input	Input	Input	Input	Output	Output
SC-1	7.85	4.74	1.25	0.95	71	77
SC-2	6.00	4.35	1.33	0.85	74	85
SC-3	5.75	3.87	1.45	1.12	62	95
SC-4	6.55	4.02	1.33	0.95	55	85
SC-5	7.00	4.34	1.12	0.85	65	97
SC-6	7.25	5.00	1.31	0.97	66	63

Table 18.3 Relative efficiency core

SC (DMU)	Relative efficiency
SC-1	98.43%
SC-2	100.00%
SC-3	100.00%
SC-4	90.74%
SC-5	100.00%
SC-6	88.31%

18.5.5 Efficiency Score

DEA calculates relative efficiencies of SCs based on the multiple input and output parameters. The relative efficiency score (E) of SCs evaluated is given at Table 18.3. The relative efficiencies indicate that SC-2, SC-3, and SC-5 are relatively efficient in terms of flexibility whereas there is scope for improvement in case of SC-1, SC-4, and SC-6.

18.5.6 Improvements Possible

The weights attached to each input and output is not specified in advance (priory). The DEA estimates ideal weights of each input and output parameter to maximize relative efficiency score. Based on relative efficiencies and the weights improvements possible at each of the measurement parameter are obtained. The results are tabulated at Table 18.4. It indicates, for inefficient SCs, the ideal combination of inputs and outputs possible. For example for SC-1, the delivery flexibility can be improved from 77 to 99.2% with Capital reduced from Rs 7.85 to 7.39 Cr; Manufacturing cost from Rs 4.74 to 4.66 Cr; Distribution costs from 0.95 to 0.91 Cr and Inventory from 0.95 to 0.91 Cr. Similar improvements are possible other inefficient SCs viz. SC-4 and SC-6.

Table 18.4 Improvements possible

SC (DMU)	Capital (Rs in crores)	Manufacturing cost (Rs in crores)	Distribution costs (Rs in Cr)	Inventory (Rs in Cr)	Volume flexibility (in %)	Delivery flexibility (in %)
	Input	Input	Input	Input	Output	Output
SC-1	7.85 to 7.39	4.74 to 4.66	1.25 to 1.23	0.95 to 0.91	71 to 71	77 to 99.2
SC-2	6 to 6	4.35 to 4.35	1.33 to 1.33	0.85 to 0.85	74 to 74	85 to 85
SC-3	5.75 to 5.75	3.87 to 3.87	1.45 to 1.45	1.12 to 1.12	62 to 62	95 to 95
SC-4	6.55 to 5.68	4.02 to 3.64	1.33 to 1.125	0.95 to 0.86	55 to 56.28	85 to 85
SC-5	7 to 7	4.34 to 4.34	1.12 to 1.12	0.85 to 0.85	65 to 65	97 to 97
SC-6	7.25 to 6.40	5 to 4.19	1.31 to 1.15	0.97 to 0.82	66 to 66	63 to 89.38

Table 18.5 Optimal lamda values indicating benchmark units

DMU name	Input oriented CRS efficiency	Sum of lamdas	Return to scale	Optimal lamdas with benchmark DMU	
SC-1	0.98429	1.075	Decreasing	0.127: SC-2	0.948: SC-5
SC-2	1.00000	1.000	Constant	1.000: SC-2	
SC-3	1.00000	1.000	Constant	1.000: SC-3	
SC-4	0.90745	0.885	Increasing	0.408: SC-3	0.477: SC-5
SC-5	1.00000	1.000	Constant	1.000: SC-5	
SC-6	0.88313	0.966	Increasing	0.358: SC-2	0.608: SC-5

18.5.7 Benchmarking

The optimal Lamdas (Dual variable corresponding to HCU) with Benchmarks is given at Table 18.5. The result indicates the corresponding efficient units which are related to the inefficient DMUs; SC-1, SC-4 and MU-6. So it can be seen that for SC-1; the benchmarking Units are SC-2 and SC-5. The significance of SC-5 compared to SC-2 as benchmark Unit for SC-1 will be higher since SC-5 has higher Lamda value. This indicates that adopting processes and systems of SC-5 will be beneficial for SC-2 to achieve increased outputs with reduced inputs.

18.6 Conclusion

Flexibility is a significant parameter in SCM in today's dynamic environment. Measuring flexibility is necessary to monitor, control and improve SC effectiveness. Flexibility measures for SC have been identified through literature as volume flexibility, delivery flexibility, mix flexibility and new product flexibility. Methodology for measurement of these flexibility measures has also been described.

DEA is a suitable tool for evaluating relative efficiencies of similar organizations. An attempt has been made to use DEA for benchmarking flexibility in SCs. The procedure has been demonstrated with a sample case of six similar SCs. The demonstration shows how DEA can be used for benchmarking and evaluating possible improvements in inefficient SCs. DEA results provide management with improvement potentials, targets, and peer DMUs as bench marks. Hence, DEA offers a detailed steering and controlling tool to specify possible changes in structure and resource allocation.

The limitation of the methodology is that, it can be employed only for SCs with similar processes. DEA is primarily a diagnostic tool and does not prescribe any reengineering strategies to make inefficient units efficient (Talluri 2000). Such improvement strategies must be studied and implemented by managers by understanding the operations of the efficient units. Also further study is required to validate that the sufficiency of inputs selected, appropriate for the selected outputs and establish correlations.

Appendix

DEA Formulation for the Case Under Study

E = Efficiency score of DMU under evaluation and
λ_{ij} = Dual variable corresponding to the efficient Hypothetical Composite Unit (HCU).

For SC-1 (1st DMU), the LPP formulation:

Min E
s.t.

$$7.85\,\lambda_{11}+6.00\,\lambda_{12}+5.75\,\lambda_{13}+6.55\,\lambda_{14}+7.00\,\lambda_{15}+7.25\,\lambda_{16}\geq 7.85 \quad \text{(i)}$$
$$4.74\,\lambda_{21}+4.35\,\lambda_{22}+3.87\,\lambda_{23}+4.02\,\lambda_{24}+4.34\,\lambda_{25}+5.00\,\lambda_{26}\geq 4.74 \quad \text{(ii)}$$
$$1.25\,\lambda_{31}+1.33\,\lambda_{32}+1.45\,\lambda_{33}+1.33\,\lambda_{34}+1.12\,\lambda_{35}+1.31\,\lambda_{36}\geq 1.25 \quad \text{(iii)}$$
$$0.95\,\lambda_{41}+0.85\,\lambda_{42}+1.12\,\lambda_{43}+0.95\,\lambda_{44}+0.85\,\lambda_{45}+0.97\,\lambda_{46}\geq 0.95 \quad \text{(iv)}$$
$$71\,\lambda_{51}+74\,\lambda_{52}+62\,\lambda_{53}+55\,\lambda_{54}+65\,\lambda_{55}+66\,\lambda_{56}\leq 71E \quad \text{(v)}$$
$$77\,\lambda_{61}+85\,\lambda_{62}+95\,\lambda_{63}+85\,\lambda_{64}+97\,\lambda_{65}+63\,\lambda_{66}\leq 77E \quad \text{(vi)}$$

For SC-2 (2nd DMU), the LPP formulation:

Min E
s.t.

$$7.85\,\lambda_{11}+6.00\,\lambda_{12}+5.75\,\lambda_{13}+6.55\,\lambda_{14}+7.00\,\lambda_{15}+7.25\,\lambda_{16}\geq 6.00 \quad \text{(vii)}$$
$$4.74\,\lambda_{21}+4.35\,\lambda_{22}+3.87\,\lambda_{23}+4.02\,\lambda_{24}+4.34\,\lambda_{25}+5.00\,\lambda_{26}\geq 4.35 \quad \text{(viii)}$$
$$1.25\,\lambda_{31}+1.33\,\lambda_{32}+1.45\,\lambda_{33}+1.33\,\lambda_{34}+1.12\,\lambda_{35}+1.31\,\lambda_{36}\geq 1.33 \quad \text{(ix)}$$

$0.95\,\lambda_{41}+0.85\,\lambda_{42}+1.12\,\lambda_{43}+0.95\,\lambda_{44}+0.85\,\lambda_{45}+0.97\,\lambda_{46}\geq 0.85$ (x)
$71\,\lambda_{51}+74\,\lambda_{52}+62\,\lambda_{53}+55\,\lambda_{54}+65\,\lambda_{55}+66\,\lambda_{56}\leq 74E$ (xi)
$77\,\lambda_{61}+85\,\lambda_{62}+95\,\lambda_{63}+85\,\lambda_{64}+97\,\lambda_{65}+63\,\lambda_{66}\leq 85E$ (xii)

For SC-3 (3rd DMU), the LPP formulation:

Min E
s.t.
$7.85\,\lambda_{11}+6.00\,\lambda_{12}+5.75\,\lambda_{13}+6.55\,\lambda_{14}+7.00\,\lambda_{15}+7.25\,\lambda_{16}\geq 5.75$ (xiii)
$4.74\,\lambda_{21}+4.35\,\lambda_{22}+3.87\,\lambda_{23}+4.02\,\lambda_{24}+4.34\,\lambda_{25}+5.00\,\lambda_{26}\geq 3.87$ (xiv)
$1.25\,\lambda_{31}+1.33\,\lambda_{32}+1.45\,\lambda_{33}+1.33\,\lambda_{34}+1.12\,\lambda_{35}+1.31\,\lambda_{36}\geq 1.45$ (xv)
$0.95\,\lambda_{41}+0.85\,\lambda_{42}+1.12\,\lambda_{43}+0.95\,\lambda_{44}+0.85\,\lambda_{45}+0.97\,\lambda_{46}\geq 1.12$ (xvi)
$71\,\lambda_{51}+74\,\lambda_{52}+62\,\lambda_{53}+55\,\lambda_{54}+65\,\lambda_{55}+66\,\lambda_{56}\leq 62E$ (xvii)
$77\,\lambda_{61}+85\,\lambda_{62}+95\,\lambda_{63}+85\,\lambda_{64}+97\,\lambda_{65}+63\,\lambda_{66}\leq 95E$ (xviii)

For SC-4 (4th DMU), the LPP formulation:

Min E
s.t.
$7.85\,\lambda_{11}+6.00\,\lambda_{12}+5.75\,\lambda_{13}+6.55\,\lambda_{14}+7.00\,\lambda_{15}+7.25\,\lambda_{16}\geq 6.55$ (xix)
$4.74\,\lambda_{21}+4.35\,\lambda_{22}+3.87\,\lambda_{23}+4.02\,\lambda_{24}+4.34\,\lambda_{25}+5.00\,\lambda_{26}\geq 4.02$ (xx)
$1.25\,\lambda_{31}+1.33\,\lambda_{32}+1.45\,\lambda_{33}+1.33\,\lambda_{34}+1.12\,\lambda_{35}+1.31\,\lambda_{36}\geq 1.33$ (xxi)
$0.95\,\lambda_{41}+0.85\,\lambda_{42}+1.12\,\lambda_{43}+0.95\,\lambda_{44}+0.85\,\lambda_{45}+0.97\,\lambda_{46}\geq 0.95$ (xxii)
$71\,\lambda_{51}+74\,\lambda_{52}+62\,\lambda_{53}+55\,\lambda_{54}+65\,\lambda_{55}+66\,\lambda_{56}\leq 55E$ (xxiii)
$77\,\lambda_{61}+85\,\lambda_{62}+95\,\lambda_{63}+85\,\lambda_{64}+97\,\lambda_{65}+63\,\lambda_{66}\leq 85E$ (xxiv)

For SC-5 (5th DMU), the LPP formulation:

Min E
s.t.
$7.85\,\lambda_{11}+6.00\,\lambda_{12}+5.75\,\lambda_{13}+6.55\,\lambda_{14}+7.00\,\lambda_{15}+7.25\,\lambda_{16}\geq 7$ (xxv)
$4.74\,\lambda_{21}+4.35\,\lambda_{22}+3.87\,\lambda_{23}+4.02\,\lambda_{24}+4.34\,\lambda_{25}+5.00\,\lambda_{26}\geq 4.34$ (xxvi)
$1.25\,\lambda_{31}+1.33\,\lambda_{32}+1.45\,\lambda_{33}+1.33\,\lambda_{34}+1.12\,\lambda_{35}+1.31\,\lambda_{36}\geq 1.12$ (xxvii)
$0.95\,\lambda_{41}+0.85\,\lambda_{42}+1.12\,\lambda_{43}+0.95\,\lambda_{44}+0.85\,\lambda_{45}+0.97\,\lambda_{46}\geq 0.85$ (xxviii)
$71\,\lambda_{51}+74\,\lambda_{52}+62\,\lambda_{53}+55\,\lambda_{54}+65\,\lambda_{55}+66\,\lambda_{56}\leq 65E$ (xxix)
$77\,\lambda_{61}+85\,\lambda_{62}+95\,\lambda_{63}+85\,\lambda_{64}+97\,\lambda_{65}+63\,\lambda_{66}\leq 97E$ (xxx)

For SC-6 (6th DMU), the LPP formulation:

Min E
s.t.
$7.85\,\lambda_{11}+6.00\,\lambda_{12}+5.75\,\lambda_{13}+6.55\,\lambda_{14}+7.00\,\lambda_{15}+7.25\,\lambda_{16}\geq 7.25$ (xxxi)
$4.74\,\lambda_{21}+4.35\,\lambda_{22}+3.87\,\lambda_{23}+4.02\,\lambda_{24}+4.34\,\lambda_{25}+5.00\,\lambda_{26}\geq 5.00$ (xxxii)
$1.25\,\lambda_{31}+1.33\,\lambda_{32}+1.45\,\lambda_{33}+1.33\,\lambda_{34}+1.12\,\lambda_{35}+1.31\,\lambda_{36}\geq 1.31$ (xxxiii)
$0.95\,\lambda_{41}+0.85\,\lambda_{42}+1.12\,\lambda_{43}+0.95\,\lambda_{44}+0.85\,\lambda_{45}+0.97\,\lambda_{46}\geq 0.97$ (xxxiv)
$71\,\lambda_{51}+74\,\lambda_{52}+62\,\lambda_{53}+55\,\lambda_{54}+65\,\lambda_{55}+66\,\lambda_{56}\leq 66E$ (xxxv)
$77\,\lambda_{61}+85\,\lambda_{62}+95\,\lambda_{63}+85\,\lambda_{64}+97\,\lambda_{65}+63\,\lambda_{66}\leq 63E$ (xxxvi)

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Chapter 19
Development of Framework for Analyzing Flexibility in Supply Chain

R. K. Singh and P. B. Sharma

19.1 Introduction

In globalized economy, market has become highly uncertain. Requirements of customers are fast changing in terms of cost, quality and delivery. Therefore to sustain in such an environment, organizations need to have flexible supply chain. Supply chain is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers. Supply chains exist in both service and manufacturing organizations. Figure 19.1 shows a simple supply chain for a single product, where raw material is procured from suppliers, transformed into finished goods in a single step, and then transported to distribution centers, and then to retailers and ultimately, to customers. Realistic supply chains have multiple end products with shared components, facilities and capacities. Various modes of transportation may be considered, and the bill of materials for the end items may be both deep and large. Complexity of the chain may vary greatly from industry to industry and firm to firm (Chopra and Meindl 2003).

Flexibility is the ability of a system to perform proactive and reactive adaptations of its configuration in order to cope with internal and external uncertainties. Increasing complexity of the value-added processes and the shortening of response times to demand changes are the main causes for having flexibility in supply chains (Wilding 1998). A fast response to changing demands is necessary for competitive advantage in today's markets. Customers expect their needs to be satisfied at the time of their expression. Companies therefore must have quick response times to changing needs, in order to gain or hold market-shares (Talluri et al. 2004). Thus, flexibility is necessary to stay in this competitive environment. The complexity of business processes is increasing as companies attempt to respond to their customers' needs with an increasing number of highly customized products. At the same time, the offered products themselves are becoming increasingly complex. This complexity results

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Fig. 19.1 A supply chain network

from the different embedded technologies. A single company can no longer produce or handle these technologies alone. The general trend of outsourcing and decreasing the vertical range of manufacturers intensifies the need of flexibility.

The objective of this paper is to identify different attributes of flexibility and develop a structural relationship between them. This paper is organized as follows. Sect. 19.2 discusses literature review. Sect. 19.3 discusses research methodology. It is followed by results and discussions and finally concluding remarks.

19.2 Literature Review

In today's scenario, survival and growth of the organization depend on competitiveness of the supply chain. Consumers are highly sophisticated. They demand customized quality products, timely delivery and low cost. Therefore in order to compete in this scenario, organizations and their respective supply chain need to be more flexible. Flexibility reflects the ability of a system to respond rapidly to changes that occur inside and outside the system. Vickery et al. (1999) defined five supply chain flexibilities which include product, launch, volume, access and responsiveness flexibility. They considered flexibility dimensions that directly impact firms' customers and share responsibilities of two or more functions along the supply chain. Information plays a key role in decision making regarding changes in customers' needs, delivery dates, storage and transportation (Duclos et al. 2003; D'Souza and Williams 2000; Martinez and Perez 2005).The promptness and the degree to which the supply chain changes its speed, destinations and volumes in response to changes in customer demands gives the benefits of mass customization and positive relationship between each node of the supply chain (Das and Abdel-Malek 2003; Garavelli 2003; Lummus et al. 2003). Motivation and growth of employees (Efstathiades et al. 2002) and adoption of TQM culture in the organization leads to better understanding among the workers in the organization thereby developing sound relationship with the suppliers and distribution personnel. Combination of the entire flexibilities give rise to supply chain flexibility should be seen as a tool for competitive advantage to the company and gaining success in all areas as well as satisfying customers.

Present study tries to develop a framework for managing the flexibility in the supply chain. For this, twenty nine enablers of flexibility in supply chain have been identified. For developing the framework, interpretive structural modeling (ISM) has been used. These enablers have been categorized into seven groups. These groups are:

1. Information flow flexibility
2. Suppliers' Flexibility
3. Organizational Flexibility
4. Production System Flexibility
5. Transportation and Warehousing Flexibility
6. Product Design and Development Flexibility
7. Flexible Supply Chain

These groups along with the enablers have been shown in the Table 19.1.

19.3 Research Methodology

To develop structural relationship between different groups of flexibility in supply chain, interpretive structural modeling is used.

19.3.1 Interpretive Structural Modeling

Interpretive structural modeling (ISM) is an interactive learning process, which systemizes the different and directly related elements into a structured system (Warfield 1974; Sage 1977). It transforms a complex problem into visible, well-defined models serving the purposes (Sage 1977). It helps in identifying the inter-relationships among variables and to impose order and direction on the complexity of the relationships among elements of a system. It is very difficult to handle all the enablers of a complex problem if the number of enablers is large. ISM develops collective understanding of relationships among the enablers. ISM is a modeling technique in which the specific relationships of the variables and the overall structure of the system under consideration are presented in a digraph model. It is primarily intended as a group learning process, but it can also be used individually. Jharkharia and Shankar (2005) applied ISM for understanding the barriers in IT—enablement of supply chains. Singh et al. (2007a, b) applied ISM for improving SMEs competitiveness and for implementation of advanced manufacturing technologies (AMTs) in firms. The various steps involved in the ISM technique are:

1. Identification of elements, which are relevant to the problem or issues, this could be done by any group problem solving technique.
2. Establishing a contextual relationship between elements with respect to which pairs of elements will be examined.
3. Developing a structural self-interaction matrix (SSIM) of elements, which indicates pair-wise relationship between elements of the system.
4. Developing a reachability matrix from the SSIM, and then checking the matrix for transitivity. Transitivity of the contextual relation is a basic assumption in ISM which states that if element A is related to B and B is related to C, then A will be necessarily related to C.

Table 19.1 Enablers of flexibility in supply chain

Flexibility Factors	References
(a) Suppliers' Flexibility	
• Ability to meet changes in volume requirement on short notice	Kumar et al. (2008)
• Ability to alter the supply of products in line with customers' demand	Duclos et al. (2003)
• Ability to change delivery dates of raw materials to the suppliers	Duclos et al. (2003) Kumar et al. (2008)
(b) Transportation and Warehousing Flexibility	
• Ability to serve distinct customers' shipping requirements	Koste and Malhotra (1999)
• Ability to vary warehouse space	Martinez and Perez (2005) Garavelli (2003)
• Ability to vary transportation carriers	Garavelli (2003)
(c) Production System Flexibility	
• Ability to reconfigure assets (equipments) in line with customer needs	D'Souza and Williams (2000)
• Ability to change processes as demand changes	Das and Abdel-Malek (2003)
• Ability to adjust capacity	Das and Abdel-Malek (2003)
• Ability to produce parts in different ways	Vickery et al. (1999)
• Ability to produce a part by alternate routes through the system	Duclos et al. (2003) Martinez and Perez (2005)
• Ability to reduce the machine downtime	Lummus et al. (2003)
(d) Organizational Flexibility	
• Flexibility of top management	Lummus et al. (2003)
• Motivation and growth of employees	Efstathiades et al. (2002)
• Training and empowerment of employees	Efstathiades et al. (2002)
• Development of multiskills and capabilities of workforce	D'Souza and Williams (2000)
• Ability to form personal links with other nodes	Duclos et al. (2003)
• Cultural flexibility	D'Souza and Williams (2000)
(e) Information Flow Flexibility	
• Ability to get point of sales data	D'Souza and Williams (2000)
• Ability to synchronize information systems with supply chain partners	Duclos et al. (2003) D'Souza and Williams (2000)
• Ability to share information across internal departments	Duclos et al. (2003) D'Souza and Williams (2000)
• Ability to pass information along the supply chain	Duclos et al. (2003) Martinez and Perez (2005)
(f) Product Design and Development Flexibility	
• Ability to introduce and design new product	Vickery et al. (1999) Martinez and Perez (2005)
• Ability to mass customize	Lummus et al. (2003)
• Postponement of final product	Martinez and Perez (2005)
(g) Flexible Supply Chain	
• Ability to change the volume	Duclos et al. (2003) Martinez and Perez (2005)
• Ability to change delivery time	Duclos et al. (2003) D'Souza and Williams (2000)
• Ability to change design of product	Martinez and Perez (2005)
• Ability to adapt processes to specific products	Duclos et al. (2003)

Table 19.2 Structural self-interaction matrix

S.No.	Factors	1	2	3	4	5	6	7
1	Information flow flexibility		V	V	V	V	V	V
2	Suppliers' flexibility			X	X	V	V	V
3	Organizational flexibility				X	V	V	V
4	Production system flexibility					V	V	V
5	Transportation and warehousing flexibility						O	V
6	Product design and development flexibility							V
7	Flexible supply chain							

5. Partitioning of reachability matrix into different levels.
6. Based on the relationships given above in the reachability matrix draw a digraph, and remove transitive links.
7. Convert the resultant digraph into ISM, by replacing element nodes with statements.
8. Review the ISM model to check for conceptual inconsistency, and make the necessary modifications.

Above described steps, which lead to the development of ISM model, are discussed below.

Structural Self-Interaction Matrix (SSIM)

For analyzing the criteria a relationship of "leads to" is chosen here. For developing contextual relationships among variables, expert opinions based on various management techniques such as brainstorming, nominal group technique, idea engineering, etc. were considered. For expressing the relationship between different critical factors, four symbols have been used to denote the direction of relationship between the parameters *i* and *j* (here *i*, *j*):

1. V: parameter *i* will lead to parameter *j*;
2. A: parameter *j* will lead to parameter *i*;
3. X: parameters *i* and *j* will lead to each other; and
4. O: parameters *i* and *j* are unrelated.

Considering above notations, SSIM is developed in Table 19.2.

Initial Reachability Matrix

The SSIM has been converted into a binary matrix, called the initial reachability matrix by substituting V, A, X and O by 1 and 0 as per the case. The substitution of 1s and 0s are as per the following rules:

1. If the (*i*, *j*) entry in the SSIM is V, the (*i*, *j*) entry in the reachability matrix becomes 1 and the (*j*, *i*) entry becomes 0.

Table 19.3 Initial reachability matrix

S. no.	Factors	1	2	3	4	5	6	7
1	Information flow flexibility	1	1	1	1	1	1	1
2	Suppliers' flexibility	0	1	1	1	1	1	1
3	Organizational flexibility	0	1	1	1	1	1	1
4	Production system flexibility	0	1	1	1	1	1	1
5	Transportation and warehousing flexibility	0	0	0	0	1	0	1
6	Product design and development flexibility	0	0	0	0	0	1	1
7	Flexible supply chain	0	0	0	0	0	0	1

Table 19.4 Final reachability matrix

S. no.	Factors	1	2	3	4	5	6	7	D.P.
1	Information flow flexibility	1	1	1	1	1	1	1	7
2	Suppliers' flexibility	0	1	1	1	1	1	1	6
3	Organizational flexibility	0	1	1	1	1	1	1	6
4	Production system flexibility	0	1	1	1	1	1	1	6
5	Transportation and warehousing flexibility	0	0	0	0	1	0	1	2
6	Product design and development flexibility	0	0	0	0	0	1	1	2
7	Flexible supply chain	0	0	0	0	0	0	1	1
	Dependence	1	4	4	4	5	5	7	

2. If the (i, j) entry in the SSIM is A, the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry becomes 1.
3. If the (i, j) entry in the SSIM is X, the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry also becomes 1.
4. If the (i, j) entry in the SSIM is O, the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry also becomes 0.

Following above rules, the initial reachability matrix for the critical success factors is shown in Table 19.3.

Final Reachability Matrix

The final reachability matrix is obtained by incorporating the transitivity as enumerated in Step (4) of the ISM methodology. This is shown in Table 19.4. In this, the driving power and dependence of each factor are also shown. The driving power of a particular factor is the total number of factors (including itself), which it may help achieve while the dependence is the total number of factors, which may help achieving it. On the basis of driving power and dependencies, these factors will be classified into four groups of autonomous, dependent, linkage and independent (driver) factors.

Table 19.5 Iteration 1

Factors	Reachability set	Antecedent set	Intersection set	Level
1	1,2,3,4,5,6,7	1	1	I
2	2,3,4,5,6,7	1,2,3,4	2,3,4	
3	2,3,4,5,6,7	1,2,3,4	2,3,4	
4	2,3,4,5,6,7	1,2,3,4	2,3,4	
5	5,7	1,2,3,4,5	5	
6	6,7	1,2,3,4,6	6	
7	7	1,2,3,4,5,6,7	7	

Table 19.6 Iteration 2

Factors	Reachability set	Antecedent set	Intersection set	Level
1	1,2,3,4,5,6	1	1	II
2	2,3,4,5,6	1,2,3,4	2,3,4	
3	2,3,4,5,6	1,2,3,4	2,3,4	
4	2,3,4,5,6	1,2,3,4	2,3,4	
5	5	1,2,3,4,5	5	
6	6	1,2,3,4,6	6	

Table 19.7 Iteration 3

Factors	Reachability set	Antecedent set	Intersection set	Level
1	1,2,3,4	1	1	III
2	2,3,4	1,2,3,4	2,3,4	
3	2,3,4	1,2,3,4	2,3,4	
4	2,3,4	1,2,3,4	2,3,4	

Table 19.8 Iteration 4

Factors	Reachability set	Antecedent set	Intersection set	Level
1	1	1	1	IV

Level Partitions

From the final reachability matrix, the reachability and antecedent set for each factor are found. The reachability set consists of the element itself and other elements to which it may help achieve, whereas the antecedent set consists of the element itself and the other elements which may help achieving it. Then the intersection of these sets is derived for all elements. The element for which the reachability and intersection sets are same is the top-level element in the ISM hierarchy. The top-level element of the hierarchy would not help achieve any other element above their own. Once the top-level element is identified, it is separated out from the other elements. Then by the same process, the next level of elements is found. These identified levels help in building the diagraph and final model. From Table 19.5, it is seen that the performance improvement is found at level I. Thus, it would be positioned at the top of the ISM hierarchy. This iteration is repeated till the levels of each factor are found out (Tables 19.5–19.8).

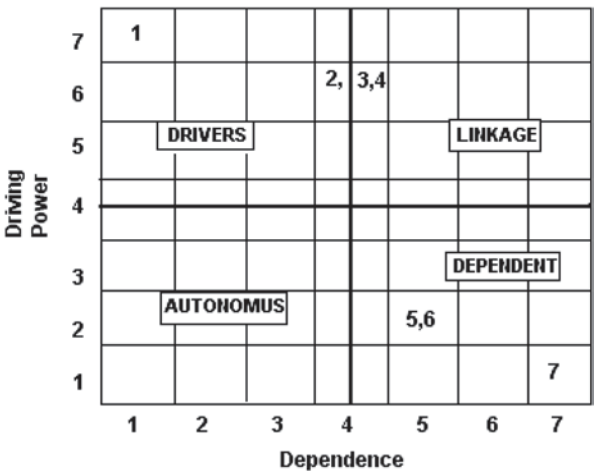

Fig. 19.2 Driving power and dependence diagram

Classification of Factors

In this section, the critical success factors described earlier are classified into four clusters (Fig. 19.2). This classification is similar to that made by Mandal and Deshmukh (1994). The first cluster consists of the "autonomous factors" that have weak driving power and weak dependence. These factors are relatively disconnected from the system, with which they have only few links, which may not be strong. The "dependent factors" constitute the second cluster which has weak driving power but strong dependence. Third cluster has the "linkage factors" that have strong driving power and strong dependence. These factors are unstable due to the fact that any change occurring to them will have an effect on others and also a feedback on themselves. Fourth cluster includes the "independent factors" having strong driving power but weak dependence. The driving power and dependence of each of these factors are shown in Table 19.4. In this table, an entry of "1" added along the columns and rows indicates the dependence and driving power, respectively. Subsequently, the driver power-dependence diagram is constructed as shown in Fig. 19.2. For illustration, the factor five having a driving power of 2 and dependence 5 is positioned at a place corresponding to driving power of 2 and dependency of 5 in the Fig. 19.2. Similarly all other factors considered in this study are positioned on different quadrants depending on their driving power and dependency.

Formation of ISM-Based Model

From the final reachability matrix (Table 19.4), the structural model is generated by means of vertices or nodes and lines of edges. If there is a relationship between the flexibility factors *i* and *j* this is shown by an arrow which points from *i* to *j*. This graph

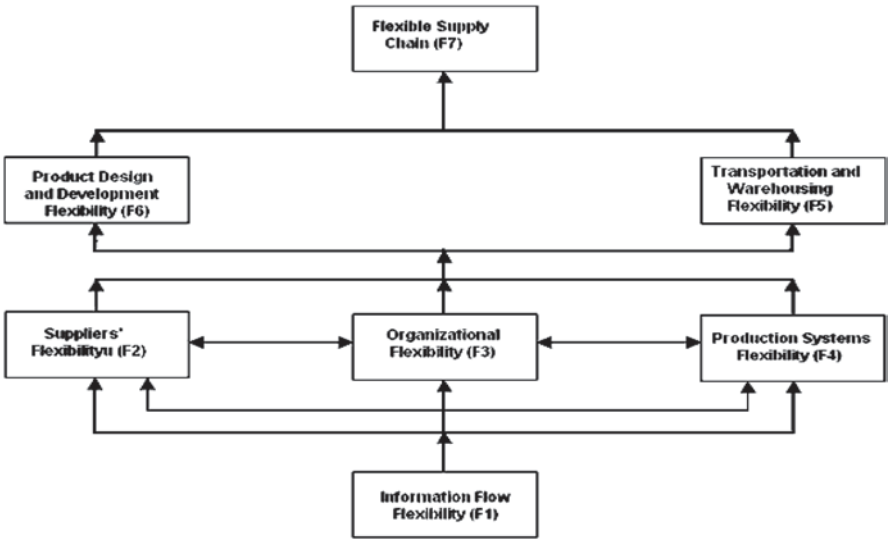

Fig. 19.3 ISM based model for enablers of supply chain flexibility

is called a directed graph or digraph. After removing the transitivities as described in ISM methodology, the digraph is finally converted into ISM as shown in Fig. 19.3.

19.4 Results and Discussion

The main objective of the ISM model in this research is to develop a digraph of factors that would help to increase flexibility in supply chain. These various flexibilities are analyzed to judge the performance of supply chain according to their driving power and dependencies. The driver power-dependence matrix provides the information about the interrelationship among the factors. Some of the observations are:

1. The driver power-dependence matrix shows that there is no autonomous factor for flexibility in supply chain.
2. Information flow flexibility has the strong driving power and is capable to lead the organization to achieve the desired objective independently.
3. Suppliers' flexibility, Organizational flexibility and Production system flexibility have strong driving power and medium dependence. Thus they also acts as driver next to Information flow flexibility. They are categorized as linkage variables.
4. Dependence increases as we move from Transportation and Warehousing flexibility to Product design and development flexibility till Flexible supply chain. Flexible supply chain has the highest dependence and represents the ultimate goal to be achieved in the supply chain.

19.5 Conclusions

In today's scenario, the demand of the customer changes very rapidly and there is lots of complexities in the products. Also, the competition is very high. So, in order to survive, flexibility is necessary in the supply chains which allow them to adapt to market uncertainties. This paper has identified important enablers of flexibility in supply chain. These enablers are categorized into seven flexibility sub-groups and ISM approach has been applied to develop a structural relationship between these groups for managing flexibility in supply chain. Information flow flexibility has emerged as major driving force for flexibility in supply chain. It implies that organization should focus on generating accurate information and its availability at the right time.

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Chapter 20
Improving Flexibility in Autonomous Cooperating Food Chains

Verena Brenner, Michael Hülsmann and Philip Cordes-Berszinn

20.1 Improving Flexibility in Food Chains

In view of today's globally interconnected and volatile food markets, the management of food chains is a difficult and challenging task. Soaring food prices, changing consumption patterns and food scandals foster the unpredictability of demands for food (Nellemann et al. 2009). Managers of food chains have therefore to adjust quickly to changing market requirements and to assure flexibility in order to avoid excessive stock, food waste and to fulfill customer's expectations. However, food products additionally limit the flexibility of supply chains, due to their specific characteristics. Factors such as sensitivity to temperature changes, or limited shelf life reduce the choice of transport mode, duration of the journey, and initiation time of transport. Other determinants are for example seasonality or the length of production cycles, which further hinder fast adaptability to changing environmental conditions (van der Vorst et al. 1998).

The question is thus, how the flexibility of food chains can be improved to allow for an efficient and fast reaction to changing demand for food products. In comparison to other performance drivers in supply chains, such as costs and customer responsiveness, little attention has been paid to flexibility in the supply chain related research (Chan 2003). However, the importance of flexibility should not be neglected, since it reflects how well companies are prepared to deal with uncertainties in their environment (Beamon 1999; Aaker and Mascarenhas 1984). Furthermore, flexibility fosters the creation of competitive advantages through retaining, developing and regenerating competences (Hülsmann et al. 2006). A recent concept

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to enhance flexibility in supply chains is the autonomous cooperation of logistic entities (e.g. Wycisk 2009; Windt and Hülsmann 2007; Hülsmann et al. 2006). By transferring decision-making, communication and information exchange (e.g. by integration of RFID and sensor networks) from the management level to the level of logistic entities, such as containers or packages, the flexibility of the entire system shall be enhanced (Wycisk 2009). Therefore, this paper aims for an assessment of the effects of one autonomous cooperation technology, namely the intelligent container, on the flexibility of food chains.

In order to achieve this overarching aim, the first sub aim is the description and operationalization of the relevant concepts, hence of flexibility in supply chains, food chains and autonomous cooperation. The second sub aim is the analysis of cause-and-effect relationships between these components. The third sub aim finally is the deduction of hypotheses on the contributions and limitations of autonomous cooperation technologies for the improvement of flexibility in food chains.

Following the research aims, Sect. 20.2 will begin with a description of different understandings and indicators of flexibility. Then, characteristics of food chains will be illustrated for the case of supply chains for bananas, to reveal challenges encountered in this sector. Following this description, flexibility will be analyzed in the context of supply chains for bananas to identify areas for improvement. In Sect. 20.2.1, the concept of autonomous cooperation will be introduced as a solution approach, followed by the explanation of a concrete example, namely the intelligent container. Section 20.2.2 is dedicated to the assessment of the potential contributions and limitations of the intelligent container to enhance flexibility in food chains. Finally, in Sect. 20.3, implications and constraints of the solution approach to enhance flexibility in food chains will be discussed and starting points for future research will be depicted.

20.2 Flexibility in Supply Chains

Flexibility is a strategic factor for the competitiveness of companies. It is the basis to adapt activities to changing environments by generating alternative action possibilities and by allowing their prompt realization (Burmann 2002; Aaker and Mascarenhas 1984). According to several authors, flexibility in supply chains is a key to success (Hülsmann et al. 2006; Beamon 1999; Chan 2003). It implies advantages, such as increased customer satisfaction, the ability to adapt to demand variations, as for example due to seasonality, and the ability to respond to poor supplier or delivery performance (Beamon 1999). However, the concept of flexibility is in contrast to other performance indicators such as for example costs, a qualitative measurement and difficult to quantify (Chan 2003). Nevertheless, several approaches to quantify flexibility in supply chains exist, whereof some will be shortly presented in the next sub-section.

20.2.1 Flexibility Concepts and Quantification

First of all, flexibility of supply chains has no unique definition and may already therefore include different metrics. For example, Aramyan et al. (2006) state that "*Flexibility indicates the degree to which the supply chain can respond to a changing environment.*" (p. 54). Beamon (1999) understands flexibility as "[…] *how well the system reacts to uncertainties […]*" (p. 280). Prater et al. (2001) define flexibility as "*the degree to which the firm is able to adjust the time in which it can ship or receive goods*" (p. 824). And Chan (2003) summarizes that "*Generally, it is about the ability or the adaptability of the company to respond to diversity of change.*" (p. 539). In this paper, the definition of Beamon (1999) seems to be appropriate, since uncertainties are important performance drivers, especially in the case of perishable and seasonal food products (van der Vorst et al. 1998).

Because of the different understandings of flexibility, there is also a wide range of metrics to measure flexibility. For the purpose of this paper, the defined indicators have to be useful independently of real data, in order to allow for a general assessment of flexibility in food chains. Furthermore, they should be precise, thus measurable and comparable on the company and supply chain level. Prater et al. (2001) for example divide flexibility into the promptness, and the degree, to which a firm is able to amend the supply chain speed, destinations and volumes. This definition is not applicable in the context of this paper, since the metrics are not operationalized. Aramyan et al. (2006) in turn distinguish between customer satisfaction, volume flexibility, delivery flexibility, the number of back-orders, and lost sales. The authors elaborated a performance measurement concept explicitly for food chains and tested its suitability in case studies. Even though customer satisfaction was considered to be highly important by the participating companies, it turned out to be too unspecific, difficult to measure and ambiguous to allow for a comparison of companies (Aramyan et al. 2007). Therefore, the approach of Beamon (1999) is chosen, which divides flexibility in the components volume flexibility, delivery flexibility, mix flexibility, and new product flexibility. The author introduces quantifiable measures, which allows for an evaluation of the metrics also without data.

The indicators are defined as follows:

1. Volume flexibility measures the proportion of demand, which can be met by a supply chain, limited by the maximum and minimum profitable output levels.
2. Delivery flexibility is the percentage of slack time, by which the delivery time can be reduced.
3. Mix flexibility is on the one hand the number of different types of product, which can be produced in a given time period. On the other, it is the time required to produce a new product mix.
4. New product flexibility is either the time or cost it takes to introduce new products to the present product range (Beamon 1999).

These measures help to determine, in which aspects food chains differ from other supply chains. The performance indicators will therefore be analyzed in the context of a specific food product, to reveal possible barriers to flexibility in food chains.

20.2.2 Status-Quo of Flexibility in Food Chains

In terms of transport requirements, there exist three types of food commodities, namely dry, frozen and chilled foodstuffs (Littek 2005). For the purpose of this paper, chilled products are chosen, since they differ considerably from other products, which is mainly due to four reasons. First of all, they are natural commodities, implying that they need a certain period of growth, which is dependent on seasonal and weather conditions (van der Vorst et al. 1998). Secondly, perishables such as fruit and vegetables have to be transported within specific temperature ranges, to preserve their quality up to consumption (Frith 1991). Thirdly, as the products continue to respire after harvest, which produces respiration heat and ethylene, the supply of fresh air has to be assured (Heap et al. 1995). And fourthly, the shelf life of perishable food stuffs may be relatively short, as for example strawberries only last for about seven days (Nunes 1995). In consequence, the compliance with specific requirements of the food transported is of crucial importance, to deliver products with a decent shelf life and quality.

However, the requirements vary considerably between different food products, which might also change the level of flexibility of the food chain. Therefore, as an illustration case, this paper will try to assess the flexibility with regard to only one perishable product, namely bananas, for which the specific supply chain requirements will be shortly presented hereafter.

In 2008, more than 17 million t of bananas were exported on a global scale (FAO Stat 2011). Bananas are optimally stored between 12 and 14 degrees and emit a considerable amount of ethylene. At the same time, they are highly sensitive to this gas and should not be stored with other ethylene emitting fruits or vegetables. Furthermore, they are also sensitive to chilling injuries and should therefore not be stored at lower temperatures. The shelf life of green bananas is about 2 to 3 weeks, whereas yellow bananas stored at 20 °C can only be kept for about 2 days (Mercantila Publishers 1989). The question now is how these product characteristics may affect the flexibility of the food chain.

Volume Flexibility

Between 2001 and 2008, the imports of bananas by the European Union increased by approximately 32 % (FAO Stat 2011). Though the growth of trade in bananas is considerable, volume flexibility is assumed to be relatively low. Since it takes more than a year, from the breeding of the plant till the harvest of the fruit (Mercantila Publishers 1989), the production system cannot be quickly expanded to match rising demand. Neither can it be easily reduced, as the restricted shelf life does not allow for long-term storage. A reduction of the growth cycle or the ability to influence the speed of ripening would allow for a better adaptability to fluctuations in demand.

Delivery Flexibility

The ability to move the planned delivery date forward can be said to be limited. First of all, bananas are normally transported by ships from the producing countries to their destinations, due to their high demand and volumes (van de Kasteele 1998). These journeys take in general several weeks and frequently include stops at more than one harbour (van Dyk and Maspero 2004). Furthermore, food products have to undergo hygienic inspections at borders, which are also time consuming (Meier 1979). After customs clearance, bananas are stored for some days in ripening facilities, as they would otherwise arrive green at the supermarkets. During these processes, the owner of the bananas is generally unable to speed up the delivery. The only opportunity to accelerate the delivery is during the relatively short periods of transhipment, road transport and at storage or handling facilities. Nevertheless, it has to be assured that before changing the transport unit, the receiving unit is adequately pre-cooled, to guarantee a seamless cold chain (Hülsmann and Brenner 2011). This limited delivery flexibility may also imply quality losses, since a loss of shelf life during transport cannot be compensated by an earlier availability in retail. The implementation of methods to increase the delivery flexibility could result in optimized delivery and sales, based on first-expired-first-out (FEFO) principles.

Mix Flexibility

Sending bananas in mixed loads with other perishables is not recommended. As already indicated above, bananas emit a lot of ethylene and are at the same time highly sensitive to it (Mercantila Publishers 1989). Therefore, they should never be transported or stored with other fruits and vegetables, which produce ethylene or do not support it. This context does not only apply to bananas, but to a wide range of fruits and vegetables (Mercantila Publishers 1989). Apart from the emission of ethylene, different temperature requirements generally impede joint shipments in one container. To allow for mixed loads, containers would have to be modularised into different compartments, with individual temperature settings, monitoring equipment and fresh air channels.

There exist around 100 types of cultivated banana plants, which are in use for cooking, fresh consumption or textile production (Hambrusch and Ortner 2005). All together, there exist about 1100 named clones of bananas (Mercantila Publishers 1989). Since bananas belong to basic foodstuffs, the importance of breeding a new product variety seems to be negligible. In consequence, the mix flexibility of bananas also seems to be limited in both terms, hence regarding mixing with other products, and regarding the creation of new varieties.

New Product Flexibility

Following the diversification model of Ansoff (1958), new products can be either complementary to existing products for the same market (product development), or new products in new markets (diversification). The set-up of food chains, such as the purchase of reefer containers, ripening facilities, cooling equipment, etc. is expensive (Smith and Sparks 2004). Furthermore, their operation requires specific knowledge regarding product handling, application of cooling equipment and documentation requirements. Therefore, product diversification on the one hand can be associated with considerable sunk costs, which reduce new product flexibility. On the other hand, there exist many perishables, which demand the same conditions during transport (e.g. temperature control, fresh air circulation, temperature monitoring) and can therefore foster new product flexibility. Increasing the adaptability of the food chain to differing requirements of perishables could increase product flexibility further.

Having depicted the specific challenges in food chains, the question is thus, how they could be reduced or better controlled to foster flexibility. The concept of autonomous cooperation technologies in logistics has recently gained a lot of attention by researchers and aims at increasing the robustness and flexibility of supply chains (Windt and Hülsmann 2007; Wycisk 2009; Lang et al. 2011). The concept, as well as one specific realization of the concept will be introduced in Sect. 20.2.1.

20.3 Autonomous Cooperation

The invention of the reefer container was an important step for the improvement of temperature-sensitive food transport. The continuous cooling of perishables prolongs their shelf life, and is a key enabler of global food trade. Nevertheless, due to restricted temperature measurements inside the container, local hot spots and factual temperature of the produce are frequently left undetected (Hülsmann and Brenner 2011). Thereby, shelf life might be substantially reduced and possible quality issues are only detected upon opening the container, when it can be too late. Another trend is the development and application of Information and Communication Technologies (ICT) in food chain management. The use of ICT helps to inform supply chain actors well in advance about the status-quo of product deliveries and may result in a reduction of inventory levels (Stank et al. 1999). However, the use of ICT is still fragmented along the food chain, which impedes the coordination of the information flow and leads to a reduction of its use (Mondragon et al. 2009).

One concept, which is increasingly regarded as an enabler of flexibility in logistics systems, is the autonomous cooperation of logistic entities (e.g. Wycisk 2009; Hülsmann et al. 2006). According to Windt and Hülsmann (2007), autonomous cooperation can be defined as "[…] *processes of decentralized decision-making in heterarchical structures. It presumes interacting elements in non-deterministic systems, which possess the capability and possibility to render decisions. The objective*

of Autonomous Control is the achievement of increased robustness and positive emergence of the total system due to distributed and flexible coping with dynamics and complexity." (Windt and Hülsmann 2007, p. 8). This is primarily achieved by reducing the dependency of logistics entities on a centralized decision-making. By transferring parts of the information flow and decision making process to the logistics transport units, the decision-making becomes faster and shorter, which allows for a better ability to respond to changing environmental demands (Hülsmann and Wycisk 2005). Since there are many ways, autonomous cooperation principles can be applied and combined to logistics entities, this paper will focus on one concept, which is currently developed: the so-called intelligent container.

The intelligent container combines a distributed agent platform, RFID tags and a wireless sensor network for the monitoring and decentralized decision making of the logistics entity. The agent platform is used for quality supervision inside the container and logistics planning and coordination along the supply chain. RFID tags are required for the monitoring and tracing of the shipment, whereas the wireless sensor network in the container assesses temperature, humidity, acceleration, concentration of certain gases or just the door opening and closing (Gehrke et al. 2006).

After loading, the system adapts automatically to the requirements defined by the product to be transported. During transport, sensor information is locally interpreted and pre-processed inside the container (Lang et al. 2011). This implies that data such as temperature and humidity may be constantly supervised and changing environmental conditions, such as solar effect, door openings or temperature changes, are taken into account. Thereby, the shelf life of the commodity is continuously re-calculated and if the system predicts the shelf life to fall below a given threshold before arrival, the transport manager will receive a notification (Jedermann et al. 2007a).

For this communication, the intelligent container is equipped with a wireless system for external communication, which allows for the sending of transport information, quality information and an online access for the freight owner (Jedermann et al. 2006). If the shelf life reduction is risking the saleability of the product, the agent may then decide to re-direct the container to the next cooling facility, where the product can be re-cooled and the transport mode eventually changed (Jedermann et al. 2007b).

In summary, the intelligent container thus combines the advantages of reefer containers with those of ICT, which leads to more choices and more abilities to influence the transport conditions and routings. The question now is how these features may influence the flexibility of food chains.

20.4 Contributions and Limitations of the Intelligent Container to Improve Flexibility in Food Chains

If a manager has to decide on whether to invest in a new technology, he needs to compare the alternatives regarding their impacts on the strategic objectives of the company (Keeney 1994). Therefore, the different components of flexibility will be analyzed conceptually regarding positive or negative changes induced by the intelligent container in comparison to the current system. Consequentially, contributions and limitations of the intelligent container for improving the status-quo of flexibility of banana supply chains will be analyzed.

20.4.1 Impact of the Intelligent Container on Volume Flexibility

As has been shown for the case of banana supply chains, volume flexibility is relatively low due to the inability to quickly adapt the production of bananas to changing demand. However, the production does not end upon harvest, since during the following distribution the maturation of the bananas is firstly intentionally reduced by cold storage and then enhanced in the ripening facilities, to provide bananas in the right maturity to the supermarkets. In the case of China for example, the lack of adequate ripening facilities hampers the provision of bananas to match rising demand (van de Kasteele 1998).

The intelligent container may influence volume flexibility in a spatial and a timely dimension. First of all, the shipment can be re-routed if the demand declines at the destination, or rises at another location. Thereby, the number of potential customers could be even considerably increased, allowing for virtual market places and probably the achievement of better prices. However, this positive effect is limited by shelf life and distribution costs, which have to be considered in the decision upon re-routing.

Regarding the timely dimension, by optimizing the temperature maintenance during transport, the maturation process can be slowed down more effectively, which also allows for enhancing shelf life and product quality (Hülsmann and Brenner 2011). During phases of weak demands, the bananas could be stored longer to await rising demands and would thereby artificially reduce the supply. A more important aspect is the possibility, to transfer the ripening process from specialized facilities into the intelligent container. For example, if demand rises, shipments can be earlier pushed into the market, since the ripening can begin during transport. Furthermore, the dependency on ripening facilities decreases, which may also reduce distribution costs and change business patterns. However, the prolongation of shelf life may only be helpful during short slumps in demand, e.g. for some days. Additionally, intelligent containers are only capable to ripen a fraction of entire demand, whereas ripening facilities have a much larger capacity. The basic requirement to adapt the field production is also not influenced.

Nevertheless, in comparison to the status-quo, the intelligent container seems to be able to enhance volume flexibility in banana supply chains.

20.4.2 Impact of the Intelligent Container on Delivery Flexibility

As in the case of volume flexibility, slack time can be reduced by ripening the bananas during transport, which allows for an earlier delivery of the shipment to the customer. Furthermore, the constant traffic supervision helps for example the truck driver to adapt the transport route in the case of congestions. Another important factor is the timely provision of information on the shipment at points of transhipment or at customs clearance. Since the intelligent container is connected to an information and communication network, it can forward information about the product and further transport information well in advance, which allows the reduction of information-based delays. However, during ship transport and customs clearance, the delivery cannot be substantially accelerated. The container could in urgent cases try to find faster transport modes, or routes with fewer ports of call, but this would most likely also increase the distribution costs.

In comparison to reefer containers, the intelligent container might enhance delivery flexibility by faster forwarding of information and by adapting transport routes to external constraints.

20.4.3 Impact of the Intelligent Container on Mix Flexibility

The mix flexibility is most likely not affected by using the intelligent container. First of all, it does not have any impact on the production variety of bananas. Secondly, even though the modularization of the storage space into different compartments is theoretically possible, this would imply the need to add more cooling units to the container. This would either reduce the cooling space available, or would impede handling methods, which are based on the standard ISO container sizes. Additionally, since the equipment for the intelligent container is more expensive than for regular reefers, modularization would only make sense in the area of luxury, low-volume perishables (e.g. pharmaceuticals) and not in the case of standard products like bananas.

Consequentially, the intelligent container does not allow for a higher flexibility in the mixing of products in comparison to regular reefers. However, it does not reduce mix flexibility either.

Table 20.1 Contributions and limitations of the intelligent container to flexibility in banana food chains

Impact of the intelligent container	Volume flexibility	Delivery flexibility	Mix flexibility	New product flexibility
Contributions	X	X	–	X
Limitations	–	–	–	X

20.4.4 Impact of the Intelligent Container on New Product Flexibility

As already indicated in Sect. 20.2.2, product flexibility concerning the use of the same infrastructure is relatively high, if one only considers perishable food. For horizontal product development, the intelligent container does not offer a unique selling proposition, since regular reefers are also used for different perishable foodstuffs. Consequentially, product flexibility in this sense is not enhanced by using intelligent containers.

However, in the case of diversification, i.e. new products for new markets, there are some more options for offering a competitive advantage. For example, pharmaceuticals, such as vaccines have also to be transported in specific temperature ranges (WHO 2005). Currently, these products are normally shipped by air, but increased safety, traceability and temperature control, due to the wireless sensor network and ICT infrastructure of the intelligent container, might foster seaborne solutions. Thereby, distribution costs could be significantly reduced. Additionally, significant temperature variations during flight operations and freezing injuries by using cooling packs can substantially reduce the quality and effectiveness of pharmaceuticals (Matthias et al. 2007), which could be enhanced by the intelligent container. Considering the range and amount of perishable products flown, there might be some opportunities for amplifying the product range shipped by sea. Another advantage of diversification is that the food product flow, which is normally one-directional (Vega 2008), can be balanced by returning with other types of products, which reduces distribution costs for shipping back empty containers. Nevertheless, it has to be kept in mind that the container transport is only one part of the supply chain. The diversification of the entire supply chain, including pre-cooling facilities, ripening facilities, etc. is unlikely to be probable.

A limiting aspect regarding new product flexibility can be the higher costs of intelligent containers in comparison to reefer containers. For products having higher volumes and lower margins than the banana example, the use of more expensive transport modes would exceed the transport budget, which reduces the variety of products to be shipped.

Now that the four components of flexibility have been analyzed, Table 20.1 summarizes the potential impacts of the intelligent container on flexibility encountered for the supply chain of bananas.

20.5 Concluding Remarks

The intention of this paper is to analyze the effects of one autonomous cooperation technology, namely the intelligent container, on the flexibility of food chains. At this first stage of analysis, intelligent containers seem to enhance volume, delivery, and new product flexibility in banana supply chains. At the same time, they seem not to affect mix flexibility and may even limit new product flexibility.

The underlying indicators and application examples, which have been used to enable the deduction of statements, show firstly that the intelligent container can indeed be able to influence the flexibility in food chains. Secondly, there are some explanations supporting the assumption that the intelligent container fosters flexibility in terms of volume, delivery and new products (e.g. pharmaceuticals or cosmetics). In some cases, it may even create new business models and trading patterns (e.g. by using the intelligent container for the ripening process). Therefore, the implementation of intelligent containers in food chains should not only be regarded as a possible way to improve process flexibility, but may also be a way to generate new business opportunities.

Of course, there are some limitations to this statement. First of all, it has been shown that a positive impact on flexibility may be limited by other factors, e.g. shelf life. Which influence is more important, could not be clarified, yet. Secondly, the intelligent container may also reduce flexibility in terms of new product flexibility, by being more expensive than a reefer container. Whether even the trade in bananas chosen for illustration purposes allows for higher investments in the transport modes, can also not be answered at the moment. It is therefore the question, for which products the intelligent container represents a realistic option. Thirdly, the direction of impacts may be dependent on the kind of foodstuff, food chain, or autonomous cooperation technology. For example, the influences can be different in the case of ground transportation of fresh fish. A final statement on the effects of autonomous cooperation technologies on the flexibility of food chains has to take further constraints into account.

Hence, decision makers on investments to improve flexibility in food chains should evaluate, whether the advantages of the intelligent container, such as increased volume and delivery flexibility outweighs the risks of reducing the profit margin. Furthermore, they should analyze potential flexibility benefits on the basis of products to be transported, as they might considerably affect the resulting performance. One more aspect to be considered is the opportunity to enter new markets and to diversify services and product range.

Therefore, further research is needed regarding the net-effect of the intelligent container or other autonomous cooperation technologies on flexibility in food chains. Furthermore, more indicators could be included to provide a complete picture of the concept of flexibility. Then, other food chains should be analyzed, as well as different autonomous cooperation technologies. In order to quantify results and to show the effects in real-world food chains, empirical analyzes are also recommended.

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Chapter 21
Dynamic Capabilities Through Autonomous Cooperation in International Supply Networks?

Philip Cordes-Berszinn, Michael Hülsmann and Verena Brenner

21.1 Introduction

The risk of being trapped in a lock-in situation—an inflexibility to leave an inefficient system state—is something that all kinds of companies in different branches encounter (e.g. David 1994; Liebowitz and Margolis 1995). Logistics companies are thereby no exception. According to Smith et al. (2005) "*[...] inertia in the management of supply chains can seriously affect the operational efficiency and productivity of a company*" (Smith et al. 2005, p. 626). Moreover, today's logistics networks are not characterised by linear supply chain structures, but by the entanglement of several supply chains crossing each other. Therefore, several authors stated them to be complex adaptive systems (CAS) (Choi et al. 2001; Surana et al. 2005; Pathak et al. 2004, 2007), wherefore they are also called complex adaptive logistics systems (CALS) (McKelvey et al. 2009; Wycisk et al. 2008). These systems are characterised by the involvement of large amounts of autonomous, adaptive, heterogeneous companies (e.g. Wycisk et al. 2008), who however all face risks of path dependencies and resulting lock-ins. Therewith, not only the performance of the whole supply networks, but also of the single companies within the networks is endangered by the risk of managerial inertias.

The pre-dominant research paradigm for explaining a successful coping with such dominant logic-driven path dependencies and resulting lock-ins is the idea of dynamic capabilities (O'Reilly and Tushman 2008, Schreyögg and Kliesch-Eberl 2007). According to Teece et al. (1997) dynamic capabilities describe "*[...] the*

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capacity to renew competences so as to achieve congruence with the changing business environment […]" through "*[…] appropriately adapting, integrating, and reconfiguring internal and external organizational skills, resources and functional competences to match the requirements of a changing environment*" (Teece et al. 1997, p. 515). Burmann (2002) operationalises this through transforming the underlying idea into the two dimensions: Replication ability (the ability to codify and transfer knowledge) and reconfiguration ability (the ability to abstract and absorb knowledge) (Burmann 2002).

One approach that has been discussed in the associated literature for increasing the performance in logistics systems is the shift from a centralised control to a higher degree of the organisational principle autonomous cooperation via implementation of associated technologies, such as RFID-tags or sensor networks (e.g. Hülsmann et al. 2008; Hülsmann and Grapp 2005). Suchlike technologies allow non-human logistics entities to interact with others autonomously (Jedermann and Lang 2008), which led to the term of 'smart parts' in logistics (Wycisk et al. 2008). With an increasing usage of 'smart parts', the CAS-perspective would become not only useful on the interorganisational level—the supply network perspective—but also on the intraorganisational level: Organisations consisting of large amounts of heterogeneous, autonomous and interacting agents, capable of influencing the system's performance via learning algorithms can be regarded also as CALS. However, according to Mckelvey et al. "*Real-world smart parts supply networks do not yet exist […]*" (Wycisk et al. 2008, p. 116); the CAS perspective on the company level is still a vision. Therefore, the question arises, how the usage of 'smart parts' could contribute to a logistics company's or a supply network's ability to codify, transfer, abstract and absorb knowledge. In other words: How does the implementation of the organisational principle autonomous cooperation affect the evolvement of dynamic capabilities in a CALS?

In order to address this overarching research question, descriptive, analytical and practical objectives are pursued, which are guiding the further structure of this paper:

On a descriptive level the paper follows two subgoals: First, it intends to present the concept of dynamic capabilities as they are understood and operationalised by Burmann (2002) and their necessity in logistics networks (Sect. 21.1). Second, the vision of supply networks and involved organisations as CALS and the concept of autonomous cooperation as the basis for technological and organisational possibilities for its realisation in the 'real world' shall be depicted (Sect. 21.2). Both serve as the descriptive basis for the analysis of effects that emanate from the constitutive characteristics of autonomous cooperation on the dimensions of dynamic capabilities. On an analytical level, the causal interrelations between the constitutive characteristics of autonomous cooperation and the dimensions of dynamic capabilities shall be addressed. This serves the revelation of contributions and limitations that arise from an increased degree of autonomous cooperation in a CALS on the evolvement of dynamic capabilities (Sect. 21.3). On a praxeological level, first managerial implications shall be deduced and further research requirements regarding a concretisation of the developed hypotheses and their empirical validation shall be derived (Sect. 21.4).

21.2 The Need for Dynamic Capabilities in International Supply Networks

21.2.1 Risks of Strategic Inflexibilities in International Supply Networks

Practitioners in supply chain management indicate that overcoming inertia is one of the biggest leadership problems CEOs of logistics companies face (Pellet 2002). Hannan and Freeman (1984) describe structural inertia as follows: "*[…] structures of organizations have high inertia when the speed of reorganization is much lower than the rate at which environmental conditions change*" (Hannan and Freeman 1984, p. 151). The underlying idea is that companies face the risk of behavioural lock-in situations based on evolving path dependencies.

In the path dependency literature, a lock-in situation describes a situation in which one particular technology has been adopted, whereas other technologies are unlikely to be chosen by the respective users, independent on their superiority or inferiority (David 1985). Suchlike path dependencies and technological lock-ins are characterised by the peoples' increasing inflexibility to change technologies although others might be superior to the current one in use (David 1985). In analogy to that, a behavioural lock-in describes a situation in which only a restricted amount of all theoretically thinkable managerial options is effectively or at least seems to be selectable (Dievernich 2007; Schreyögg et al. 2003; Ackermann 2003). Hence, organisational lock-in situations are characterised by a strategic inflexibility.

Aaker and Mascarenhas (1984) define **strategic flexibility** as "*[…] the ability of the organisation to adapt to substantial, uncertain and fast-occurring* (*relative to required reaction time*) *environmental changes that have a meaningful impact on the organisation's performance*" (Aaker and Mascarenhas 1984, p. 74). That is, according to Ansoff (1984) as well as Thompson and Strickland (1983), the extent to which an organisation is free to change its strategies and policies (Ansoff 1984; Thompson and Strickland 1983.). It can be assumed that the changes in organisational environments have accelerated in the last decades due to—beside others—continuous and fast developments in information and communication technologies, like RFID or sensor networks (e.g. Angeles 2005; Spekman and Sweeney II 2006; Ngai et al. 2008). Hence, organisations are required to perpetually adapt their choices of actions to realise long-term organisational goals. This includes the need for a continuous adaptation of the organisations themselves (e.g. Hedberg et al. 1976; Nadler and Tushman 1986; Kilmann and Covin 1990).

If in a lock-in situation the extant managerial options—the organisational strategy—fit perfectly to the organisation's environmental requirements, a lack of flexibility respectively a lock-in situation does not have any negative effects on the organisational performance. In such a situation new competences would not have to be developed or regenerated; alternative strategic logics are not necessary, and so forth. However, logistics companies face highly dynamic competitive surroundings (Klaus and Kille 2008), which makes such a situation—regarded over time—very

unlikely. Hence, organisations, which are unable to alter their strategic behaviour according to environmental requirements, run the risk of becoming inefficient. This conforms to Barnes et al. (2004) who describe behavioural lock-ins as situations in which the respective agent—a certain decision maker or a whole organisation—is unable to alter her/its behaviour, which "*[…] is 'stuck' in some sort of inefficiency or sub-optimality*" (Barnes et al. 2004, p. 372). Consequently, an organisational lock-in situation can be defined as an inflexibility to leave an inefficient organisational state.

Logistics companies are usually not only involved in one or two single linear but in manifold different supply chains. Therefore, the resulting risk of inertias and lock-ins affects not only single companies but might affect also the whole underlying network of supply chains. These manifold supply chains create together highly complex and non-linear webs of logistics activities where information, products and finances are transferred between various suppliers, manufacturers, distributors, retailers and customers (Surana et al. 2005).

One example: Daimler Chrysler works with about 1,500 suppliers. One of their main first-tier suppliers for the "Grand Cherokee" Textron Trim, in turn, has about 300 suppliers and provides besides Daimler Chrysler its competitors such as BMW, Nissan, Toyota and Honda (Choi and Hong 2002). The involved supply chains are crossing each other at some points in the single value adding steps, which leads not only to direct interdependencies between the involved organisations, but as well to indirect ones (Hülsmann and Berry 2004). To take on the chosen example, in 2002 Textron Trim made 50 % of their sales with Daimler Chrysler (Choi and Hong 2002). If Daimler Chrysler would, for some reasons, change its main first tier supplier for the "Grand Cherokee", Textron Trim would probably have to decrease production units, which, in turn, might influence their costs- and therewith their price structures. Hence, other customers of Textron Trim, such as BMW, would be indirectly affected by the supplier decision of Daimler Chrysler. The manifoldness of existent, and potential interdependencies between involved organisations in supply networks is boosted by an ongoing trend of an increasing internationalisation of firm's activities (e.g. Hülsmann and Berry 2004; Whitley 1994; Lado and Maydeu-Olivares 2001). Hülsmann and Grapp (2005) speak in this context of international supply networks (Hülsmann and Grapp 2005).

Assuming the risk of inertia occurs in at least some of the participating companies, the resulting inflexibilities to leave an inefficient system state might affect also the efficiency of the whole international supply networks. Consequently, the question arises, how logistics companies and whole international supply networks can avoid and cope with lock-ins and underlying path dependencies.

21.2.2 Dynamic Capabilities for Overcoming Lock-ins in International Supply Networks

O'Reilly and Tushman (2008) state that overcoming "*[…] inertia and path dependencies is at the core of dynamic capabilities*" (O'Reilly and Tushman 2008, p. 187).

In its original concept Teece and Pisano (1994) and Teece et al. (1997) picked up the main assumptions of the resource-based view (based on Selznick (1957), Penrose (1959), Wernerfelt (1984), and Barney (1991)) and the competence-based view (Teece et al. (1997), based on Sanchez (2004) and Prahalad and Hamel (1990)) but argued that competitive advantages do not primarily originate from the resources and competences themselves (Teece et al. 1997; Teece and Pisano 1994). Instead, a firm's long-term success is dependent on the capabilities to "*[…] shape, re-shape, configure and reconfigure the firm's asset base so as to respond to changing technologies and markets*" (Augier and Teece 2007, p. 179).

Burmann (2002) took on these considerations and conceptualised dynamic capabilities as managerial and organisational processes that represent an organisation's ability to **replicate** (in Teece et al.'s (1997) words: to integrate) and **reconfigure** its resource base. The ability to learn in turn is regarded as an important component of replication and reconfiguration abilities. By managerial and organisational processes Teece et al. (1997) refer to "*[…] the way things are done in the firm, or what might be referred to as its routines, or patterns of current practice and learning*" (p. 518). These *processes* are influenced by and influence on the one hand the evolutionary *paths* of dynamic capabilities and on the other hand by the underlying resource *positions*.

The resource *positions* of an organisation determine its routines of actions, since they in turn develop out of repeatable combinations of resources (Burmann 2002). Thereby, Teece et al. (1997) deploy a wide definition of resources, which include material assets such as certain technology resources, but also a wide range of immaterial resources such as reputational, structural or institutional resources (Teece et al. 1997). The interplay between replication and reconfiguration abilities is regarded as a meta-ability, which determines the adaptivity, therewith the competitive advantages of an organisation and hence, its performance (Burmann 2002) (see Fig. 21.1).

The underlying meta-ability of dynamic capabilities, in turn, is based on knowledge of and within organisations, which is assumed to play a vital role for organisational success by a multitude of authors (e.g. Quinn 1992; Drucker 1993; Spender and Grant 1996; Kusunoki et al. 1998; Grant 2002). Therewith, dynamic capabilities can be defined as knowledge-based path dependent managerial and organisational processes of replicating and reconfiguring resources.

Replication Ability

Replication ability is described as the ability to replicate existent operative process-related abilities of the organisation's on-going operations. This enables first, a fast and efficient growth of firms. Second, it shows to what extent a firm is able to comprehensively understand the configuration and functionality of its capabilities (Burmann 2002), which in turn is the basis for their improvement and further development (Teece et al. 1997).

Referring to empirical studies such as Nobeoka and Cusumano (1997) and Teece (1987), Burmann (2002) states that a high replication-ability results in a higher

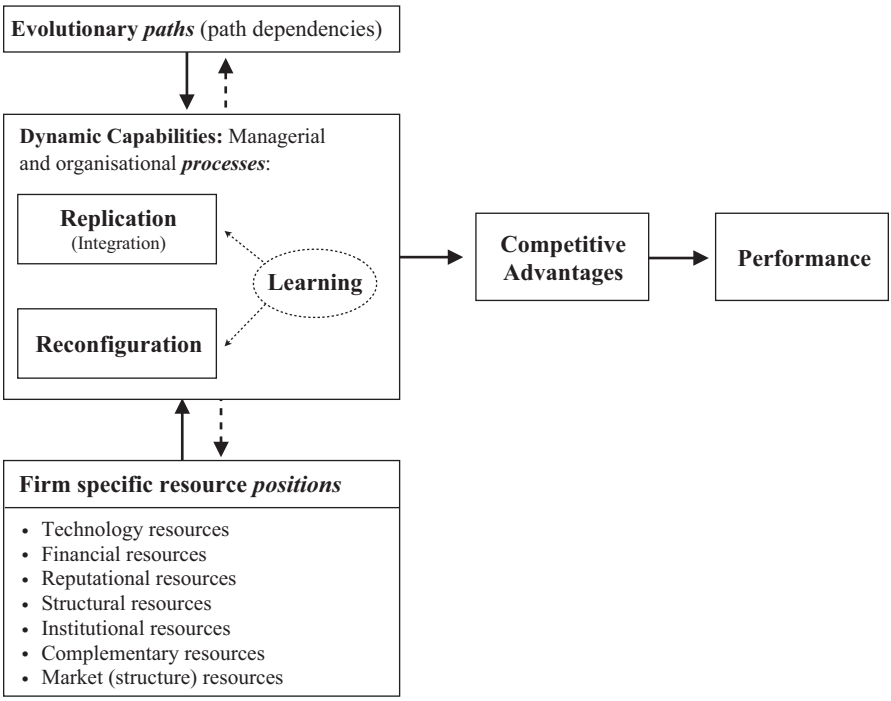

Fig. 21.1 Dynamic capabilities approach as an overview. (Based on Teece et al. 1997; Burmann 2002)

velocity of organisational (re-)actions (Burmann (2002), referring to Nobeoka and Cusumano (1997) and Teece (1977)). If an organisation is able to replicate patterns of action (i.e. routines) that proved successful in the past, it can react faster on environmental circumstances that demand for these patterns, compared to an organisation that needs to develop them first.

Burmann (2002) identifies two dimension of replication ability:

- Knowledge Codification
- Knowledge Transfer (Burmann 2002).

Knowledge Codification Ancori et al. (2000) state that "*to be treated as an economic good, knowledge must be put in a form that allows it to circulate and be exchanged.*" (Ancori et al. 2000, pp. 255–256). Hence, successful codification means to transform implicit (tacit) knowledge, which evolves over time through absorption of data, information and practical experiences (Burmann 2002), into explicit knowledge (Nonaka et al. 1997). Teece (1981) therefore understands the codification of knowledge as "*[…] the transformation of experience and information into symbolic form*" (p. 83).

Codifying knowledge in a way that individuals can learn from it in turn requires that the information receiver is able to understand the information. With recourse

to the action-orientation of relevant knowledge (Zahn et al. 2000), Zollo and Winter (2002) point out that the main effort of knowledge codification is "[…] *to understand the causal links between the decisions to be made and the performance outcomes to be expected*" (p. 342). In the words of Daft and Weick (1984) this corresponds to the ability of giving the data a meaning—an interpretation (Daft and Weick 1984). Hence, knowledge codification requires a shared understanding and interpretation of the messages within the organisation. Consequently, knowledge codification can be defined as the transformation of available knowledge into symbolic forms that are understandable and interpretable in the same way by the entire organisation and its members.

Knowledge Transfer Argote and Ingram (2000) describe knowledge transfer in organisations as "*[…] the process through which one unit* (*e.g., group, department, or division*) *is affected by the experience of another*" (p. 151). However, this understanding implies that knowledge is only based on experience. Simple information on cause-effects-relations, without personal experience would therewith be excluded from the transfer of knowledge. Szulanski (2000) refers to knowledge transfer "*[…] as a process in which an organization recreates and maintains a complex, causally ambiguous set of routines in a new setting*" (p. 10). This understanding focuses on routines as a special kind of knowledge and is therefore an also too narrow view, since it excludes knowledge that has not been solidified in routines yet.

In order to avoid such exclusions, it is reasonable to select a wider perspective. Bou-Llusar and Segarra-Ciprés (2006) refers to knowledge transfer as "*[…] the exchange of knowledge between units within a firm* (*internal transfer*) *or between different firms* (*external transfer*)" (p. 105). Furthermore, Szulanski (1996) argues that a transfer of knowledge has to pass different stages until it is completed: First, the transfer has to be initiated through a managerial decision. Second, the transfer has to be implemented through exchanges of resources between the source and the recipient of the knowledge. Third, in the ramp-up stage the recipient utilises the knowledge. Fourth, the received knowledge is integrated once first satisfactory results with the new knowledge have been achieved (Szulanski 1996, pp. 28–29). Not until all four stages have been passed, one can speak of a successful knowledge transfer. Furthermore, Zhao and Anand (2009) state that "*when firms transfer organizational capabilities from one unit to another, they transfer not only individually held skills, but also organizationally embedded knowledge or collective knowledge*" (p. 960). Following this understanding, knowledge transfer can be defined as the devolvement process of individual or collective knowledge from one application place to another within an organisation or within a cooperation between organisations, initiated by an organisation (Burmann 2002).

Reconfiguration Ability

According to Lavie (2006), a reconfiguration process entails the substitution of capabilities (Lavie 2006). Similarly, Tushman and Anderson (1986) advocate the

evolutionary mechanisms variation-selection-retention in the course of competence-destroying or competence-enhancing processes for the initiation of organisational change (Tushman and Anderson 1986). Old capabilities that become obsolete in a changed organisational environment are replaced by either entirely new capabilities or old capabilities that have been adapted. Hence, **the ability to reconfigure organisational capabilities results in a higher scope of managerial options** (Lavie 2006), since the higher scope of potential new or old and adapted capabilities enable the organisation's management to choose from a wider pool of managerial actions, based on potential capabilities.

Burmann (2002) identifies two dimension of reconfiguration ability:

- Knowledge Abstraction
- Knowledge Absorption (Burmann 2002).

Knowledge Abstraction Boisot (1998) describes knowledge abstraction as the ability to generalise knowledge suitable for a limited number of applications to a wider range of applications (Boisot 1998). In order to do so, the knowledge has to be reduced to its essentials, i.e. its underlying structure, which reveals certain cause-and-effect relationships (Burmann 2002) that are not directly observable in the knowledge's codification (Boisot 1998). Burmann (2002) states therefore that knowledge abstraction means to disengage knowledge from its prior context in order to make it applicable in other contexts. In its pure form, it leads to a complete decontextualisation (Burmann 2002). According to Nahapiet and Ghoshal (1998) the abstraction as well as the reflection of knowledge is the key to transform experience-based knowledge into theoretical knowledge on cause-and-effect-relations (Nahapiet and Ghoshal 1998).

Therefore, the essence of the ability to abstract knowledge can be interpreted as the flexibility to engage the underlying scheme of certain knowledge—whether it is on strategic logics, management processes, chains of resources, operations or application fields for skills and capabilities—to other fields of appliance than its original one. In other words, knowledge abstraction can be defined as the ability to disengage knowledge from their contexts and engage it to other contexts.

Knowledge Absorption The origins of the idea of knowledge absorption can be found in the work of Cohen and Levinthal (1990) on absorptive capacity. That is "*[…] the ability of a firm to recognize the value of new external information, assimilate it, and apply it to commercial ends*" (p. 128). They distinguish further between the absorptive capacity of an individual and an organisation (Cohen and Levinthal 1990). Zahra and George (2002) identified four dimensions of absorptive capacity: Acquisition, assimilation, transformation and exploitation of knowledge (Zahra and George 2002).

Thereby, the ability to acquire knowledge refers to "*[…] a firm's capability to identify and acquire externally generated knowledge that is critical to its operations.*" The ability to assimilate knowledge describes the organisation's ability to analyse, process, interpret and understand externally obtained information (Zahra

and George 2002, p. 189). The ability to transform knowledge reflects an organisation's capability to "*[…] develop and refine the routines that facilitate combining existing knowledge and the newly acquired and assimilated knowledge.*" Finally, the ability to exploit knowledge refers to the capability to incorporate acquired or transformed knowledge into the operations of an organisation in order to "*[…] refine, extend, and leverage existing competencies or to create new ones*" (Zahra and George 2002, p. 190).

Subsuming, these processes of knowledge acquisition, assimilation, transformation and exploitation lead to an internalisation of knowledge. According to Boisot (1995) that is the key element of knowledge absorption (Boisot 1995). Hence, knowledge absorption can be defined as the organisational process of internalising knowledge through its acquisition, assimilation, transformation and exploitation (Zahra and George 2002; Boisot 1995).

Figure 21.2 subsumes the dimensions and sub-dimensions of dynamic capabilities and their definitions.

Two developments illustrate the increasing necessity for logistics companies to develop dynamic capabilities in terms of replication and reconfiguration abilities: First, the risk of lock-ins is generally a large problem in the leadership of supply chains (Smith et al. 2005; Pellet 2002). Managers are always faced with the risk that the "way things are done" solidify without a contextual reason (Prahalad and Bettis 1986; Bettis and Prahalad 1995; Bettis and Wong 2003). Second, the performance of a logistics companies is often largely dependent on the performance of the supply networks in which they are operating. Ergo, logistics companies are not only endangered by inertias of their own managers, but also by inertias of other participants in the supply networks.

Hence, one important task for supply chain management is to enable both the own company as well as the whole supply network in which it is operating to avoid and to cope with the risk of lock-ins. Following Burmann (2002), it is therefore necessary that knowledge codification, transfer, abstraction and absorption happen on both levels: Intraorganisational, to keep the company competitive within a supply network, as well as interorganisational, to keep the whole international supply network competitive against other supply networks.

Consequently, the question arises, which determinants influence the evolvement of dynamic capabilities not only on one, but on two levels of perspective at the same time. More specific: How can logistics companies ensure that knowledge-based activities (codification, transfer, abstraction and absorption) are carried out within the company and between the company and their business partners in the supply network, without unwanted spillovers of knowledge (Ibrahim et al. 2009) to supply network participants that are at the same time competitors?

In order to address this research question, a complex adaptive systems perspective will be applied in order to reveal determinants of a modern supply network's structure, which can be varied by implementing technologies like RFID or sensor networks.

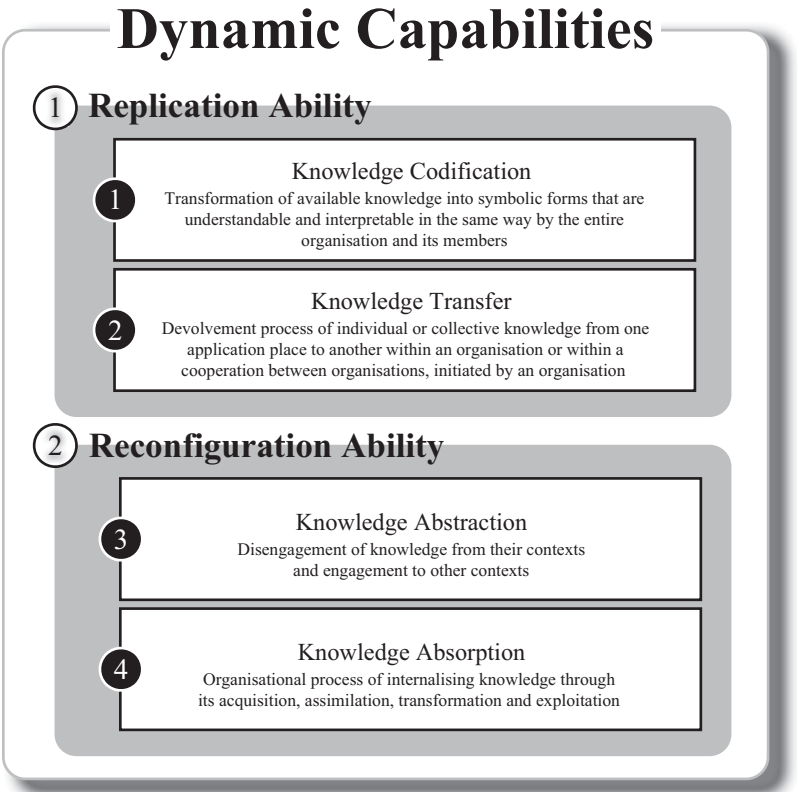

Fig. 21.2 Dimensions and sub-dimensions of dynamic capabilities. (Based on Burmann 2002)

21.3 Autonomous Cooperation for Realising Complex Adaptive Logistics Systems (CALS)

21.3.1 Dimensionalities of CALS

Modern perspectives on logistics systems look less on individual and isolated supply chains than on the underlying networks in which these supply chains are integrated (e.g. Choi et al. 2001; Surana et al. 2005; Pathak et al. 2004, 2007; McKelvey et al. 2009; Wycisk et al. 2008; Choi and Hong 2002). Several authors argue that supply networks can be regarded as Complex Adaptive Systems (Choi et al. 2001; Surana et al. 2005; Pathak et al. 2004, 2007; McKelvey et al. 2009; Wycisk et al. 2008). Thereby, it can be distinguished between the following two dimensionalities: the whole *supply network,* consisting of the involved companies and the single *companies,* consisting of single organisational entities.

Supply Network Dimensionality

This dimensionality describes logistics systems as international supply networks, consisting of a multitude of companies involved in national and cross-border logistics processes (Hülsmann and Grapp 2005).

On an **individual level**, many organisations **interact** with each other (Choi et al. 2001; Surana et al. 2005) (e.g. exchange of goods and finances between Daimler Chrysler and its 1,500 suppliers), they are **heterogeneous** (e.g. different suppliers have different resources, competences and goals) and they are **able to learn** (e.g. Daimler Chrysler would probably cut prices or change the supplier if the supplied products were of bad quality) (McKelvey et al. 2009; Wycisk et al. 2008).

On an **intra-systemic level**, the involved companies initiate their actions by themselves, as far as they are not controlled by another entity or organisation in the supply network (e.g. Daimlers first tie suppliers choose their suppliers without Daimlers direct control)—they are **autonomous**. Hence, the whole supply network **organises itself** without any top-down orders regarding its structure (Choi et al. 2001; Surana et al. 2005). Despite the absence of a central control entity of the network, it is neither in a state of total uncontrolled chaos nor leads the self-organisation to a state of total predetermined control. Rather, it exists in a so-called **'melting zone'** between the "edge of chaos" and the "edge of order" (Kauffman 1993) (e.g. although the supply network of Daimler is not fully controllable a supply network structure emerges at any time that ensures its operational capability).

On an **inter-systemic level**, it has to be taken into consideration that supply networks are not isolated from the rest of the world. Rather, they **co-evolve** with other logistics systems (McKelvey et al. 2009; Wycisk et al. 2008) (e.g. Textron's other supply networks) as well as non-logistics systems (e.g. the banking sector). New structures emerge and elapse all the time without any super ordinate controlling entity; in other words: **self-organisation** takes place (Choi et al. 2001; Surana et al. 2005; McKelvey et al. 2009; Wycisk et al. 2008). Therefore, suchlike logistics networks can be called **Complex Adaptive Logistics Systems (CALS)**.

Company Dimensionality

By zooming the perspective in the hitherto regarded individual level on which the single companies constitute the logistics system's elements, they, in turn, can also be regarded as Complex Adaptive Systems: Beside employees, the organisation-system's elements in a logistics context are the so-called 'smart parts'. According to Mckelvey et al. (2009) 'smart parts' describe "*[…] logistics entities, which posses the capabilities of interaction and autonomous decision-making through the usage of modern communication and information technologies, such as RFID, GPS, sensor networks and electronic markets […]*" (McKelvey et al. 2009, p. 478).

On an **individual level**, these technologies enable logistics entities like ships, containers or even single products to exchange information with each other (e.g.

a RFID-tagged product sends its routing goals to containers, whereas they, in turn, respond whether they fit into their routing plans or not); in other words, they **interact**. Differing characteristics (e.g. space of containers) or behavioural programming (e.g. preferring of fast vs. cheap routes) leads to certain **heterogeneity** between them. 'Intelligent features' implemented in the programming of the 'smart part's behavioural rules might **enable them to learn** to a certain degree (e.g. a RFID-tagged container equipped with the goal to go after the fastest route might remember previous routes and learn from whether they were fast or slow) (McKelvey et al. 2009; Wycisk et al. 2008).

On an **intra-systemic level**, logistics entities can be enabled to render their decisions about their next steps on their own (e.g. a RFID-tagged product might be allowed to render the decision about which routing option to take without the need for a confirmation of a central control entity)—hence, they are **autonomous**. A company that allows its elements to act autonomously, in turn, allows a certain degree of **self-organisation** (e.g. the evolvement of certain standard routes and routing alternatives for its products). A pre-condition for this is that the structure of the transportation system is neither pre-configured (e.g. the products are forced to take given routes or take pre-determined logistics service-providers) nor that it is totally uncontrolled (e.g. products take whatever routes they want and cannot be traced back)—rather it exists within the **'melting zone'**. Hence, companies, which feature these characteristics, can also be called **Complex Adaptive Logistics Systems (CALS)** (McKelvey et al. 2009; Wycisk et al. 2008).

According to authors like Choi et al. (2001), Surana et al. (2005), Pathak et al. (2004), Pathak et al. (2007), McKelvey et al. (2009) and Wycisk et al. (2008) is the existence of these characteristics in the supply network dimensionality not questionable. In the company dimensionality and especially referring to non-human logistics entities on the contrary this is largely dependent on two aspects: First, how much interaction, learning-abilities, heterogeneity, autonomy and self-organisation is firstly possible from a technological as well as from an organisational point of view? Second, how much is allowed by the management of the respective company or supply network?

21.3.2 Technological and Organisational Realisation of CALS Through Autonomous Cooperation

The technological realisation refers to the »possible smartness« of logistics entities in the real world. Although there are restrictions in, for instance, the parts' abilities to learn (Wycisk et al. 2008), ongoing developments in associated communication and information technologies lead to the assumption that these restrictions will more and more disappear in the future. This refers especially to developments in the logistics elements' abilities to process information, to render and to execute decisions on their own. The basis for suchlike artificial decision-making abilities is given by the use of technologies that enable logistic elements to get information about their

environment: For the logistics objects' identification RFID (radio frequency identification) can be used, for the positioning GPS (global positioning systems) and for the communication between them UMTS (universal mobile telecommunications system) or WLAN (wireless local area network) (Scholz-Reiter et al. 2004).

The underlying organisational principle is the idea of autonomous cooperation (Wycisk et al. 2008; Hülsmann and Grapp 2005; e.g. Scholz-Reiter et al. 2004; Hülsmann and Wycisk 2005; Philipp et al. 2006; Windt and Hülsmann 2007). According to Windt and Hülsmann (2007) autonomous cooperation can be described as "*[…] processes of decentralised decision-making in heterarchical structures. It presumes interacting elements in non-deterministic systems, which possess the capability and possibility to render decisions*" (p. 8). Hence, certain degrees of the following five constitutive characteristics can be observed in autonomously controlled logistics processes:

- Decentralised decision-making,
- Autonomy,
- Interaction,
- Heterarchy, and
- Non-determinism.

Decentralised Decision-making: Frese (1993) and Laux (1998) describe decision-making as the goal-oriented selection between action alternatives (Frese 1993; Laux 1998). In contrast to externally controlled systems, in which this selection is made by a centralised control entity (e.g. the supply chain management), in autonomously controlled systems single logistics entities (e.g. products, containers or ships) are technologically enabled and organisationally empowered to render decisions by themselves (e.g. selecting from different routing alternatives) (Windt and Hülsmann 2007).

Autonomy: Probst (1987) describes autonomy of a system's element as its ability to render decisions without having to ask a central, super-ordinate entity (Probst 1987). Hence, a certain degree of decentralisation of decision-making processes in a logistics system results directly in a certain degree of autonomy of the respective logistics entities (Windt and Hülsmann 2007).

Interaction: Staehle (1999) describes interaction as contacts between systems' elements in a way that certain reactions are induced (Staehle 1999). Hence, in autonomously controlled logistics processes information flows take not or not only place from top to the bottom and back (e.g. data that is sent from the supply chain management to containers in order to pre-configure their transportation routes), but also between the involved elements (e.g. data that is sent by products to containers in order to let them know about their desired destinations). This information, in turn, is the basis for their ability to decide on their own upon their next actions (Windt and Hülsmann 2007).

Heterarchy: Goldammer (2003) describes Heterarchy following McCulloch (McCulloch 1945) and in distinction to hierarchy as co-subordination (Goldammer

2003). Probst and Mercier (1992) points out that heterarchical systems are characterised by the absence of a permanently dominant entity (Probst and Mercier 1992). Hence, autonomously controlled logistics systems featuring a certain degree of heterarchy are therefore characterised by less dependencies of single elements (e.g. goods or containers) on central controlling entities (e.g. the supply chain management), and more interdependencies between the single elements with each other (Windt and Hülsmann 2007).

Non-determinism: Flämig (1998) describes non-deterministic systems as systems whose behaviours are impossible to predict although all system laws are known and current system states can be measured (Flämig 1998). This does also mean that it is impossible to pre-configure autonomously controlled logistics systems, which allows for a certain degree of flexibility (Hülsmann et al. 2006).

Whereas the technological development determines the »possible smartness« of logistics objects, the economic reasonability of a high »smartness« is still a not fully explored research field. Recurring to Sect. 21.1 in which the risk of lock-ins in logistics systems has been shown and the necessity for dynamic capabilities has been deduced, the following research question arises: How does an increase of autonomous cooperation through an implementation of associated technologies affect the evolvement of dynamic capabilities on both the company as well as the supply network dimensionality?

More specific, the question can be divided into a set of sub questions that represent on the one side the dimensions of dynamic capabilities and on the other side the constitutive characteristics of autonomous cooperation as a driver for the realisation of CALS. Therefore and in order to avoid redundancies it seems to be reasonable to build groups of characteristics: First, a decentralised decision-making results directly in autonomy of the system's elements. Therefore, the first group consolidates the constitutive characteristics decentralised decision-making and autonomy. Second, if the elements within a system are enabled to interact directly without having to rely on the indirect connections between them, a central entity and other elements, a heterarchic structure of exchange processes occurs. Therefore, in the second group, the constitutive characteristics interaction and heterarchy are consolidated. The last group entails finally the characteristic non-determinism.

Therewith, a new set of sub questions arises. Two examples: How does an increased decentralised decision-making and resulting autonomy of the system's elements affect the abilities for an effective and efficient knowledge transfer within and between companies within an international supply network? Or: How does an increased interaction between the logistics system's elements and a resulting heterarchy affect the abilities of an efficient and effective knowledge abstraction? With four dimensions of dynamic capabilities and three groups of constitutive characteristics of autonomous cooperation, there are six causal interrelations, which have to be analysed in order to reveal the effects of autonomous cooperation in logistics on the evolvement of dynamic capabilities (see Fig. 21.3).

		Dimensions of Dynamic Capabilities	
		Replication Ability	Reconfiguration Ability
Groups of Constitutive Characteristics of Autonomous Cooperation	Decentralised Decision-Making & Autonomy	1	4
	Interaction in Heterachical Systems	2	5
	Non-Determinism	3	6

Fig. 21.3 Interrelations to be analysed for investigating the effects of autonomous cooperation on dynamic capabilities

21.4 Contributions and Limitations of Autonomous Cooperation for the Evolvement of Dynamic Capabilities in CALS

21.4.1 Contributions and Limitations of Autonomous Cooperation to the Replication Ability in CALS

1. Decentralised decision-making and autonomy of the elements within a CALS means for the replication ability that the system's elements (i.e. employees, smart parts) can decide on their own, if they codify and transfer knowledge and if they do so, which knowledge they codify and transfer how. They do not have to ask a hierarchically higher super-ordinate entity for allowance to transform their knowledge into symbolic forms and therewith making it understandable, interpretable and achievable for other elements. Furthermore, the elements can select the form of codification on their own. Therewith they also determine to which other elements the knowledge will be transferred and if they will be able to understand and interpret the knowledge in the same way.

A resulting *contribution* to the replication ability of organisations and supply networks is based on the following assumption: The single elements of a logistics system know better, which of their knowledge would contribute to the organisation's goals when they are codified and transferred to other application fields, than a central management. The reason is that the single elements are "nearer" at the operational tasks and have therefore a deeper knowledge about it compared to a management, which does not accomplish the tasks itself (Burmann 2002). Hence, the effectiveness of knowledge codification and transfer increases with an increasing decentralisation of decision-making processes.

A resulting *limitation* is based on the risk of local optima: It might not be in the interest of the elements that their knowledge is understandable and interpretable by all other elements in the system and that it is transferred to them and other application fields, especially when the elements are in competition to each other. This is normally the case with companies within supply networks that can overtake the same tasks (e.g. transportation) (Hülsmann and Cordes 2009). On the company dimensionality, certain employees are in competition to each other and might not be interested in sharing their knowledge due to career intentions, which leads to "internal stickiness" and impedes the transfer of best practices within firms (Szulanski 1996). On the smart part level this is dependent on the respective design of the CALS. McKelvey et al. (2009) developed a system of design options that is derived from the financial market. Logistics objects act like they were traders and hence, are in competition to each other (McKelvey et al. 2009). Consequently, the risk of non-willingness to codify and transfer knowledge occurs.

2. Interaction between elements in a **heterarchic** CALS means for the replication ability first that the elements can learn from other elements how to codify knowledge and how to understand other symbolic forms. They do not rely on a central management and its willingness as well as ability to transfer knowledge on how to codify and read knowledge from other elements in the system. Second, knowledge transfer requires interaction. Whereas a system with non-interacting elements would need to transfer all available knowledge through a hierarchically higher entity, with interacting elements knowledge transfer can happen both on a vertical as well a horizontal level and cross lateral.

A resulting *contribution* is that the amount of knowledge that can potentially be codified and transferred will be higher. The reason is that a central management has restricted information processing capacities (Hülsmann et al. 2008) due to bounded rationalities (Simon 1991). Therewith, it has also restricted capacities for knowledge codification and transfer. Furthermore, the »distance« between elements might be smaller than between an element, a central entity and another element. Therefore, the costs of knowledge transfer can be assumed to be lower if the transfer can happen on a direct way.

A resulting *limitation* is based on the postulation that the benefits of knowledge codification and transfer should exceed their costs (Burmann 2002). Otherwise the knowledge codification and transfer would be inefficient. Thereby, the benefits ensue through the contribution of the knowledge codification or transfer to the achievement of the organisation's goals. If too much knowledge is codified and transferred, which would not contribute anymore to these goals, the associated costs are not fronted by associated benefits. Hence, a high interaction and resulting exchange of knowledge through codification and transfer could cause an excessive amount of costs without associated benefits.

3. Non-Determinism means for the replication ability of and within a CALS that neither the amount of knowledge that is codified and transferred, nor the way in which it is codified and transferred is in any way predictable. Even when the knowledge state of each single element and their abilities to codify and transfer that

knowledge are known, the amount of knowledge that is codified and transferred as well as the way of codification and transfer is not foreseeable.

One *contribution* to dynamic capabilities in a CALS resulting from a non-deterministic system structure is a higher flexibility to adapt the amount of codified and transferred knowledge to the environmental conditions. The reason is that less dynamic situations might require less knowledge transfer than highly dynamic situations in which it might be reasonable to accept high costs of knowledge codification and transfer. When more knowledge codification and transfer is all of a sudden necessary, the system can immediately adapt in contrary to a deterministic system, in which the amount and the way of knowledge based activities is fixed for a certain period.

An associated *limitation* is that a non-deterministic system structure precludes a planning of costs and resource requirements that will occur in the near future. Hence, the management of a CALS or a logistics company within a CALS has to rely on the adaptability of the non-deterministic system; that it always allocates the right amount of resources to the right resource positions. However, a long term planning of a company's future development is unfeasible.

21.4.2 Contributions and Limitations of Autonomous Cooperation to the Reconfiguration Ability in CALS

4. Decentralised decision-making and autonomy of the elements within a CALS means for the system's reconfiguration ability that its elements are enabled to decide by themselves, whether or not they decontextualise any knowledge and apply the underlying causal interrelations to other application fields and if as well as how they absorb any information from the organisational environment. In other words: The decisions, how much knowledge is absorbed and abstracted, which knowledge is absorbed and abstracted and in which depth processes of absorption and abstraction occur are no longer in the hands of a central management. Instead, the single employees and smart parts within a CALS decide on their own, e.g. which external knowledge sources they use and for which other application fields this knowledge might be useful.

A resulting *contribution* to the reconfiguration ability of organisations and supply networks is that in analogy to the given point 1, the single elements of a logistics system might know better, how to absorb external knowledge and how to decontextualise its underlying causal relations than a central management (Burmann 2002). The employees as well as the smart parts are in direct contact and interaction with employees and smart parts of other companies within a supply network. Hence, the absorption capacity and the capacity to abstract externally absorbed information might be greater compared to a central management, which is "farther" from the real knowledge absorption and abstraction processes and has a restricted capacity to absorb and abstract knowledge.

One associated *limitation* is, in analogy to point 1, based on the risk of local optima: the elements might not be interested in absorbing new knowledge or in abstracting their existing knowledge to other contexts. Employees might not be willing to change their working environment and hence, might fear that their knowledge is more useful in another context. In this case, they could prefer to keep the underlying causal relations to themselves instead of trying to unhinge it from its original context (based on Szulanski (1996, 2000)). Consequently, an appropriate system of incentives for both the decision rules in a system's smart parts as well as the employees is necessary in order to avoid suchlike limitations.

5. Interaction in a **heterarchic** system means for the reconfiguration ability first that the elements can learn from other elements how to abstract knowledge and how to absorb information from the organisational environment. Second, elements in a heterarchic CALS do not only interact with other elements in the same company but also with elements from other companies. That is the case for both, for employees that have to coordinate cooperative activities and resource exchanges in inter-organisational business operations, as well as for smart parts that have to interact with other smart parts in inter-organisational supply chains.

A *contribution* to the reconfiguration ability of a CALS or of organisations within a CALS arises from the restricted absorptive capacity of a central management: If all the elements are enabled to interact with other elements outside the organisation they belong to, the amount of knowledge that can be absorbed can be assumed to be higher than the amount a central management can absorb. The same is true for the abstraction: A central management has firstly restricted abilities to abstract knowledge by itself, and secondly, to give reasonable instructions to all the single elements, which information they should absorb and abstract and how to do it.

One possible *limitation* is that the elements might start to interact in order to absorb and abstract external knowledge without adequate opposite benefits. Since knowledge absorption and abstraction is time consuming and hence, generate costs or alternative costs, the processes might get inefficient without recognition of the elements. For instance, although a central management might be less capable to absorb as much knowledge as the whole population of smart parts, it might be more capable of appraising the reasonability of spending time and resources on information absorption processes, compared to single elements—i.e. smart parts or employees.

6. Non-Determinism implies that there is no possibility to forecast future needs of new externally absorbed knowledge or of decontextualising existing knowledge and apply it in other contexts. For the reconfiguration ability of a CALS or of a company within a CALS this means that all activities on knowledge absorption and abstraction emerge from the current interactions between the system's elements and not from a previously elaborated plan.

A *contribution* to dynamic capabilities in a CALS resulting from this is that the system is more flexible to adapt the abstraction and absorption processes to current needs based on environmental changes. In analogy to point 3, it can be assumed that some competitive situations require more information from the environment than others. Therefore, in these situations it is reasonable to accept also higher costs of

knowledge absorption and abstraction processes in favour of the associated benefits of being able to cope with the environmental dynamics. A non-deterministic system structure enables an invariable ability to adapt knowledge-based activities to current needs.

One *limitation* is that in a non-deterministic system structure it is impossible to plan how much costs will occur and how many as well as what kind of resources are needed in the near future for knowledge-based activities and therewith, how much capital has to be employed. Since capital acquisition might not be as fast as the development of the system and its needs for capital, the risk occurs that the system is not able to provide its employees and smart parts with the resources they require for enabling a fully adaptive system of reconfiguration processes.

21.5 Conclusions

Since logistics companies are—just as every other company—faced with the risk of dominant management logics, path dependencies and resulting lock-ins, there is a need for them to develop dynamic capabilities that allow to avoid or to cope with managerial inertia. One approach that has received increasing advertency in the logistics research (e.g. Hülsmann and Grapp 2005; Scholz-Reiter et al. 2004; Hülsmann and Wycisk 2005; Philipp et al. 2006; Windt and Hülsmann 2007) and that might influence the development of dynamic capabilities is the concept of autonomous cooperation. Based on technological developments such as RFID tags or sensor networks does an increase of the degree of autonomous cooperation allow single logistics entities to interact with each other and to render decisions by themselves. Authors speak therefore of logistics networks as complex adaptive logistics systems (CALS) that consist of a large amount of heterogeneous agents (e.g. smart parts or employees) that interact in a self-organised system structure (an international supply network) (McKelvey et al. 2009; Wycisk et al. 2008). Consequently, the overarching objective of this paper was to identify contributions and limitations of increasing the degree of autonomous cooperation to the evolvement of dynamic capabilities.

The qualitative analysis of the question how autonomous cooperation and an associate technological realisation would affect the evolvement of dynamic capabilities in CALS—understood as managerial processes of replication (knowledge codification and transfer) and reconfiguration (knowledge abstraction and absorption) of organisational resources (Burmann 2002)—reveals both contributions and limitations. Two examples: On the one hand it can be assumed that the amount of knowledge that can potentially be codified and transferred will be higher if the degree of autonomous cooperation increases. The reason lies in a restricted information processing capacity and hence, restricted ability to codify and transfer knowledge of a central management. On the other hand, an autonomous cooperating logistics system entails a non-deterministic system structure. That makes it

impossible to plan the amount of capital that has to be employed in the near future in forms of resources and resource allocations.

However, the analysis followed a solely qualitative approach with the aim to develop first considerations about underlying hypotheses that in total reflect the causal relationship between autonomous cooperation and the evolvement of dynamic capabilities. Hence, neither does the list of contributions and limitations claim for completeness nor have they been operationalised and empirically validated. A net effect, whether or not autonomous cooperation increases the replication and reconfiguration ability in a CALS has not been shown. Therewith further research requirements result from the demand for a further concretisation into operationalisable hypotheses that can be empirically validated. Not until then, the economic reasonability of investing in an increasing degree of autonomous cooperation in CALS can be finally evaluated with regards to the aim of an increasing competitiveness through dynamic capabilities.

Hence, managerial decisions about investments in technologies that enable autonomous cooperation or in organisational restructurings, which increase the constitutive characteristics of autonomous cooperation—decentralised decision-making, autonomy, interaction, heterarchy, non-determinism—have to consider both sides: The potential benefits that arise from an improved ability to codify, transfer, abstract and absorb knowledge, such as a higher flexibility on changing business environments; and associated direct costs, e.g. through purchasing and maintenance of technologies as well as indirect costs, e.g. risks of local optima and resulting sub-optimal system behaviour.

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Chapter 22
Genetic Algorithm Model for Multi Product Flexible Supply Chain Inventory Optimization Involving Lead Time

P. Radhakrishnan

22.1 Introduction

Global competition, shorter product life cycles, dynamic changes of demand patterns and product varieties and environmental standards cause remarkable changes in the market scenario thereby forcing the manufacturing enterprises to deliver their best in order to strive (Sarmiento et al. 2007). Decrease in lead times and expenses, enrichment of customer service levels and advanced product quality are the characteristics that determine the competitiveness of a company in the contemporary market place (Mileff and Nehez 2006). The above mentioned factors have made the business enterprises to contemplate about their supply chains. An ensemble of organizations providing products and services to the market may be called as a supply chain. The effective management of the supply chain has become unavoidable these days due to the firm increase in customer service levels (Beamon 1998). The supply chain cost was immensely influenced by the overload or shortage of inventories. Thus inventory optimization has transpired into one of the most recent topics as far as supply chain management is considered (Joines et al. 2008; Adams 2004; Golden Embryo Technologies Pvt. Ltd. 2004).

In this paper, a novel and efficient approach using Genetic Algorithm has been developed for muti-product flexible supply chain inventory optimization. This paper supplements the supply chain inventory optimization analysis without raw material and multi product lead time considerations (Radhakrishnan et al. 2010). As the lead time plays vital role in the increase of supply chain cost, the complexity in predicting the optimal stock levels increases. In order to minimize the total supply chain cost, the proposed approach clearly determines the most probable excess stock level and shortage level that are required for inventory optimization in the supply chain. In practice, the dynamic nature of the excess stock level and shortage level over all the periods is the typical problem occurring in inventory management. The proposed approach of genetic algorithm predicts the emerging excess/shortage

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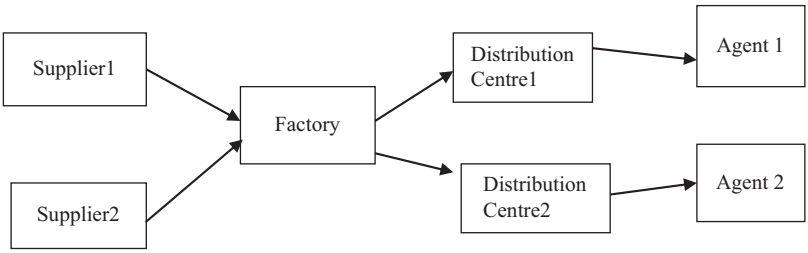

Fig. 22.1 Four stage-seven member supply chain

stock levels for the ensuing period by considering the stock levels of the past years, which is an essential information for supply chain inventory optimization as well as total supply chain cost minimization.

22.2 Method and Methodology

The proposed method uses the Genetic Algorithm to analyze the stock level that needs essential inventory control. In practice, the supply chain is of length *n*, means having *n* number of members in supply chain such as factory, distribution centers, suppliers, retailers and so on. Here the exemplary supply chain model consists of a four-stage supply chain having seven members as depicted in Fig. 22.1.

As illustrated in Fig. 22.1, the factory is the parent of the chain producing two products p1,p2 and it is having two distribution centers Distribution center 1 and distribution center 2, each having an agent. From the distribution center, the respective stocks will be moved to the corresponding agents. Also the raw materials required for manufacturing the products are sourced from 2 suppliers namely, Supplier1 and Supplier 2.

The methodology flow as illustrated in Fig. 22.2 is intended to determine the emerging excess or shortage amount of stock levels of the product at different members of the supply chain by analyzing the past records very effectively and thus facilitating efficient inventory management in order to minimize supply chain cost. The analysis flow is initiated by the selection of valid records. In the valid record set selection, records having nil values are neglected and the records having positive or negative values are selected for the analysis using clustering algorithm.

22.2.1 Generation of Individuals

A random individual generated along with the product representation for various members of the chain is illustrated in Fig. 22.3.

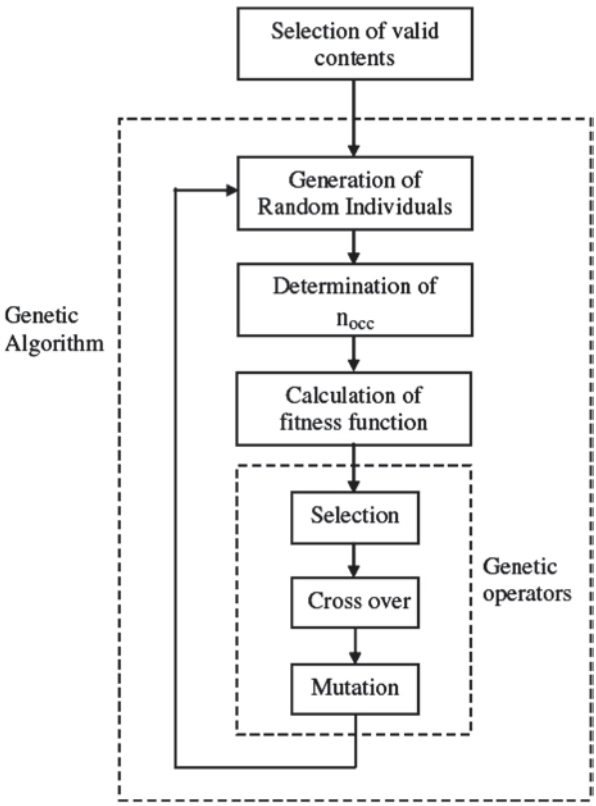

Fig. 22.2 Genetic Algorithm flow for the proposed inventory management analysis

Factory		Distribution center1		Distribution center2		Agent 1		Agent2	
p1	p2	p1	p2	p1	p2	p1	p2	p1	p2
100	−50	36	25	48	23	−79	100	−200	289

Fig. 22.3 The dataset format for the representation of a chromosome

In Fig. 22.3, the stock levels of the product at each member is represented with positive values representing excess stock levels of the product and the negative values representing shortage level of the product.

The database holds the information about the stock levels of products in each of the supply chain member, lead time of products in each supply chain member. For l members from factory to end-level-Agents, there are $l-1$ lead times for a particular product and these times are collected from the past records. Each and every dataset recorded in the database is indexed by a Transportation Identification (TID). For p periods, the TID will be $\{T_1, T_2, T_3, \cdots, T_p\}$.

Then each individual is queried into the database for obtaining the details regarding the TID and frequency of the individual. This will bring T_i and P(occ), number of periods of occurrence of that particular individual. This TID will be used as an

index in mining the lead time information. After all these queries, the lead time of stocks is obtained as follows

$$T_s = [t_1\ t_2 \cdots t_{l-1}]$$

And the lead time for raw materials is obtained as

$$T_s = [t_1\ t_2 \cdots\cdots t_r]$$

where, r is the number of raw materials required for the product.

Then, for each individual the evaluation function is calculated.

22.2.2 Determination of Evaluation Function

The evaluation function is determined for each randomly generated individual. The function is given by

$$f(a) = w_1\left(1 - \frac{P(occ)}{T(periods)}\right) + \log(w_2.t_{stock} + w_3.t_{raw}) \tag{22.1}$$

where $a = 1,2,3,\ldots\ldots,m$

P(occ) is the number of counts of past records that occurs throughout the period.

T(periods) is the total number of periods of records in database.

m is the total number of chromosomes for which the fitness function is calculated.

In Eq. 22.1, w_1, w_2 and w_3 are the weightings of the factors, stock levels, lead time of stocks and lead time of raw materials in optimization, respectively and they are determined as

$$w_1 = \frac{R_1}{R_1 + R_2 + R_3}$$

$$w_2 = \frac{R_2}{R_1 + R_2 + R_3}$$

$$w_3 = \frac{R_3}{R_1 + R_2 + R_3}$$

R_1, R_2 *and* R_3 are the priority levels of influence of stock levels, lead time of stocks and lead time of raw materials in optimization respectively. Increasing the priority level of a factor increases the influence of the corresponding factor in the evaluation function. Hence this R_1, R_2 *and* R_3 decide the amount of influence of the factors.

The lead time of the stocks t_{stock} is determined as follows

$$t_{stock} = \sum_{i=1}^{l-1} t_i \tag{22.2}$$

And the lead time required to fill the raw materials is given as

$$t_{raw} = \sum_{i=1}^{r} t_i \tag{22.3}$$

When the values of t_{stock} and t_{raw} from Eqs. 22.2 and 22.3 are also substituted in Eq. 22.1, it gives an evaluation value for each individual chromosome.

The fitness function is carried out for each chromosome and the chromosomes are sorted on the basis of the result of the fitness function.

In the fitness function, the ratio (P(occ)/T(periods)) plays the role of finding the probability of occurrence of a particular chromosome; and [1−(P(occ)/T(periods))] will ensure minimum value corresponding to the maximum probability; t_{stock} will find the total lead time of stocks and t_{raw} will find the total lead time of raw materials in optimization respectively for the chosen record.

So, the fitness function is structured to retain the minimum value corresponding to the various chromosomes being evaluated iteration after iteration and this in turn ensures that the fitness function evolution is towards optimization.

22.2.3 Genetic Operations

Once fitness calculation is done, Genetic operations are performed. Selection, Crossover and Mutation comprise the Genetic operations.

Selection

The selection operation is the initial genetic operation which is responsible for the selection of the fittest chromosome for further genetic operations. This is done by assigning ranks based on the calculated fitness value to each of the prevailing chromosome. On the basis of this ranking, best chromosome is selected for further processing. The chromosome generating value as minimum as possible will be selected by the fitness function since the objective is to minimize the inventory levels and lead times.

Crossover

Among the numerous crossover operators in practice, for our complex operation, we have chosen two point crossover. From the matting pool, two chromosomes are

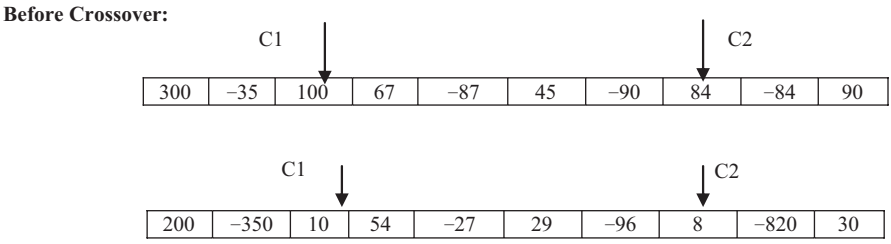

Fig. 22.4 Chromosomes before two-point crossover

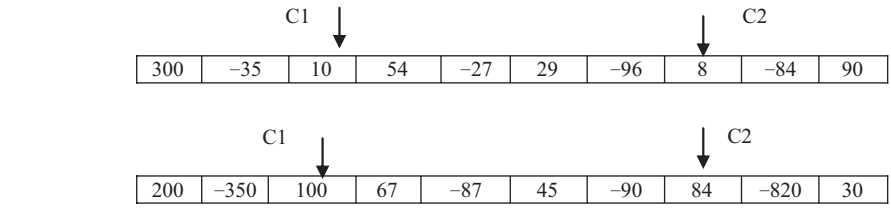

Fig. 22.5 Chromosomes after two-point crossover

subjected for the two point crossover. The crossover operation performed in our analysis is illustrated in Figs. 22.4 and 22.5.

As soon as the crossover operation is completed, the genes of the two chromosomes present within the two crossover points get interchanged. The genes before the crossover point C1 and the genes beyond the crossover point C2 remain unaltered even after the crossover operation.

Mutation

The crossover operation is succeeded by the final stage of genetic operation known as Mutation. In the mutation, a new chromosome is obtained. This chromosome is totally new from the parent chromosome. The concept behind this is the child chromosome thus obtained will be fitter than the parent chromosome. The performance of mutation operation is illustrated in the Figs. 22.6 and 22.7.

For mutation, four mutation points Mp1, Mp2, Mp3 and Mp4 are chosen randomly. The mutation is done on the particular gene present at the Mutation point. This pointing of gene is done randomly. Hence, the four mutation points may point any of the seven genes.

The mutation operation provides two new chromosomes corresponding to the initial two chromosomes from the crossover operation. Then out of the four chromosomes resulting from the first iteration, the chromosome with the minimum fitness function value will be chosen. To this chosen chromosome, another randomly

Before Mutation :

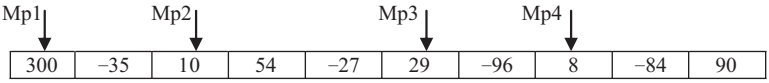

Fig. 22.6 Chromosome before mutation

After Mutation:

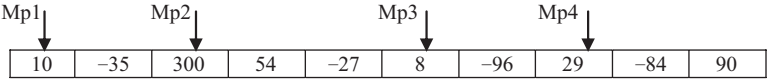

Fig. 22.7 Chromosome after mutation

Table 22.1 Sample data from database of different stock levels

TI	FP1	FP2	D1P1	D1P2	D2P1	D2P2	A1P1	A1P2	A2P1	A2P2
1	−12	−68	20	42	−91	−24	41	−32	02	50
2	−07	37	−81	−64	−31	99	−196	−146	−4	43
3	−12	−86	−20	42	91	24	41	−32	02	−40
4	−07	37	−81	−64	−31	99	−196	−146	−4	43
5	−07	37	−81	−64	−31	99	−16	−146	−4	43

generated chromosome will be added and subjected further to the genetic operations, crossover and mutation. This process repeats for a particular number of iterations or till convergence criteria is satisfied. Eventually the final best chromosome will represent the emerging excess or shortage of stock levels at different members of the supply chain thus giving the essential information for supply chain inventory optimization leading to cost minimization.

22.3 Implementation Results

The analysis based on GA for optimal inventory control is implemented in the platform of MATLAB using relevant past records in the format of Tables 22.1 and 22.2 which contain sample data of past records.

Table 22.1 is having the Transportation ID, the stock levels which are in excess or in shortage at each supply chain member. The transportation ID mentioned in table is used as an index in extracting the lead times for movements of stocks.

Table 22.2 depicts the sample data which is having the transportation ID and the lead times for stocks between the supply chain members.

Here T1 is the lead time of product1 from F to D1

T2 is the lead time of product2 from F to D1

T3 is the lead time of product1 from F to D2

Table 22.2 Sample data from database which is having lead times (number of days) for stocks

TI	T1	T2	T3	T4	T5	T6	T7	T8
1	2	4	5	1	4	6	2	4
2	4	5	2	4	1	6	7	2
3	3	5	2	8	5	7	9	6
4	4	6	2	7	9	10	3	8
5	3	4	5	10	4	6	12	3

Table 22.3 Sample raw material lead time (number of days)

TI	Supplier ID	RM1	RM2	RM3
1	1	20	7	19
	2	25	9	16
2	1	38	3	20
	2	25	25	9
3	1	38	4	15
	2	36	33	7
4	1	38	3	20
	2	25	23	9
5	1	38	4	15
	2	36	35	8

T4 is the lead time of product2 from F to D2
T5 is the lead time of product1 from D1 to A1
T6 is the lead time of product2 from D1 to A1
T7 is the lead time of product1 from D2 to A2
T8 is the lead time of product2 from D2 to A2

Table 22.3 represents the lead time to fill the raw materials which are essential to manufacture the products. In the Table 22.3, for Transaction period 1, for manufacturing the products three raw materials having the raw Material ID 'RM1', 'RM2' and 'RM3' are sourced and the lead times involved are '20', '7' and '19' respectively for Supplier 1 and the lead times involved are '25', '9' and '16' respectively for Supplier 2.

Table 22.4 describes two random individuals generated initially.

The simulation run on a large database of past records showing Fitness function improvement at different levels of iteration is as follows:

Simulation Result of GA showing Fitness function improvement with
$w_1 = 0.6250$; $w_2 = 0.3125$; $w_3 = 0.0625$;
For iteration 20: fitness = 5.7845
For iteration 50; fitness = 5.6450; Improvement: 2%
For iteration 70; fitness = 5.3749; Improvement: 5%
For iteration 100; fitness = 4.8220; Improvement: 10%

As for deciding the total number of iterations required, the criteria followed is that as long as minimization of the fitness function is still possible, then the iteration continues till such a time that no improvement in the fitness function value is

Table 22.4 Initial random individuals

FP1	FP2	D1P1	D1P2	D2P1	D2P2	A1P1	A1P2	A2P1	A2P2
300	−35	100	67	−87	45	−90	84	−84	90
200	−350	10	54	−27	29	−96	8	−820	30

200	−350	10	66	−120	46	−9	40	−8	20

Fig. 22.8 The final best chromosome obtained from the analysis

noticeable. After a certain number of iterations, if the fitness function value is not improving from the previous iterations, then this is an indication that the fitness function value is stabilizing and the algorithm has converged towards optimal solution. For greater accuracy, the number of iterations should be sufficiently increased and run on the most frequently updated large database of past records.

The best chromosome obtained as result after satisfying the above mentioned convergence criteria is depicted in the Fig. 22.8.

The final individual thus obtained represents the emerging excess or shortage stock levels at each of the seven members providing essential information for supply chain inventory optimization.

This final chromosome obtained from the GA based analysis shown in Fig. 22.8 is the inventory level that has the potential to cause maximum increase of supply chain cost including lead time considerations. By taking necessary steps to eliminate the identified emerging excesses/ shortages at different members of the supply chain, the supply chain cost can be minimized to that extent. Thus by following the predicted stock levels, we can avoid the increase of supply chain cost.

22.4 Conclusion

Inventory management is an important component of supply chain management. The members of the supply chain are responsible for minimizing the costs of a supply chain by managing inventory levels in a number of production and distribution operations associated with different chain stages. As the lead time plays vital role in the increase of supply chain cost, the complexity in predicting the optimal stock levels increases. We have proposed an innovative and efficient methodology that uses Genetic algorithm presented that is aimed at reducing the total supply chain cost as it undoubtedly established the most probable surplus stock level and shortage level along with the consideration of lead time involved in supplying the stocks that are required for inventory optimization in the supply chain such that the total supply chain cost is minimal. The proposed approach was implemented and its performance was evaluated using MATLAB 7.4. The performance of Genetic Algorithm was well as predicted. By following the proposed genetic algorithm based approach for inventory management, we determined the products due to which the members

of the supply chain incurred extra holding or shortage cost in the whole supply chain. The proposed approach of inventory management has achieved the objectives which are the minimization of total supply chain cost as well as lead time and the determination of the products due to which the respective supply chain members endured either additional holding cost or shortage cost with lead time consideration which is a vital information for supply chain inventory optimization.

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Chapter 23
High Impact Scales in Marketing: A Mathematical Equation for Evaluating the Impact of Popular Scales

Pooja Sehgal and Mahim Sagar

23.1 Introduction

Various models, theories and constructs in marketing have seen the creation and evolution of a range of scales and measures. The purpose of these is to provide a reasonable estimate and enable decision making across various aspects of the subject at hand. Marketing scales are being created for all kinds of measures, across multiple categories and attributes. The process of measuring marketing constructs is clearly larger than just assigning numbers to objects that represent a quantity of some attribute that is being measured. Rather, it aims to provide a mechanism to analyze a construct and enable informed and intelligent decision making through the actionable intelligence that a scale equips a decision maker with.

Scaling is the branch of measurement that involves the construction of an instrument that associates qualitative constructs with quantitative metric units. As defined by S.S. Stevens, Scaling is the assignment of objects to numbers according to a rule. It is a means to measure an entity or a subject. Sometimes we do scaling to test a hypothesis. We might want to know whether the construct or concept is a single dimensional or multidimensional one. Sometimes, we do scaling as part of exploratory research. We want to know what dimensions underlie a set of ratings. But probably the most common reason for doing scaling is for scoring purposes. When a participant gives their responses to a set of items, we often would like to assign a single number that represents that person's overall attitude or belief.

Scale development has evolved largely over the last few decades, and there has been considerable progress in the assessment of constructs, and also in the creation of the measurement methods. Path breaking work done by Churchill (1979) presented a framework for creating better measures of marketing constructs building on the research done by Cronbach (1951) and Nunnally (1967).

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Focus on creating measures has been towards better definition of the construct, greater validity and higher reliability. Various researchers have developed a plethora of methods for developing measurement scales refining or modifying Churchill's framework, and presenting alternate approaches to measuring various marketing subjects. Oczkowski and Farrell (1998) bring out the fact that following the development of Churchill's framework there has been a six-fold increase in the number of new scales published in premier marketing journals.

This study of scale development and their applications is an aim to understand how the highly cited and impactful scales are utilized in the practical world. The main object of the study is to understand the popular scales, their creation, limitations and application in the practical world covering the following subjects

- Popular scale development frameworks.
- Understanding and evaluation of selected scales
- An analysis of the strengths and weaknesses of the selected scales
- The development of Scale vs Attribute representation based on expert opinion.
- The development of Scale vs Attribute representation based on academic literature review

The study of the scale development and their application, however, is limited to few aspects of the field of marketing.

23.2 Understanding Frameworks, Models and Scales

The fundamental principles of marketing are grounded in theories around customer identification and building customer insights. Measurement and analysis of certain basic constructs that define these parameters therefore becomes a critical first step to taking any marketing decisions for business. In this paper, we identify some of these basic constructs and their measurement scales from a state of the art and contemporary validity perspective.

Oftentimes we see words such as framework and model being used interchangeably. At the onset, let us first clarify the difference from a measurements perspective. A framework is a set of assumptions, concepts, values, parameters or practices that constitute a way of viewing reality. One can develop a framework to understand a phenomena or a process by defining its parameters or identifying the elements that constitute or effect or enable that phenomena or process. A framework is developed with a set of assumptions about what aspects of the phenomena will enable its measurement, in a given context—hence different researchers offer different perspectives and frameworks to measure the same construct.

A model, however, is a simplified representation of a system or phenomena with any hypothesis required to describe the system or explain the phenomenon, often mathematically. It offers a human construct to help us better understand real world systems. All models have an information input, an information processor and an output of expected results.

The difference between a framework and a model is that a framework is used to identify various aspects of a situation and define their inter-relationships. A model is applied to a framework or a situation to derive some output or predict the behaviour of the parameters.

Scales are used to measure various parameters of a framework in order to determine a definitive assessment of a phenomenon in a specific situation or context. A scale represents a system of grouping or classification in a series of steps or degrees according to a standard of relative size, amount or rank. Scale is an ordered reference standard which helps judge the degree of a phenomenon and enables decision-making, judgment and analysis around it. Scaling involves construction and identification of a measure that associates qualitative constructs with quantitative metric units.

The theory and constructs of marketing necessitate the need for defining and conceptualizing frameworks that explain abstract phenomena. Oftentimes, the definition of a framework is constrained by its assumptions, context definition and dynamism of the environment or extraneous factors. The scales to measure these frameworks, therefore, need to evolve and also be applied in sync with the defined contexts. In this exploratory study we first explore various high impact measures applied in marketing and investigate their applications and limitations.

23.3 Literature Review

Churchill (1979) provided a methodical approach to creating these marketing measures, and then further ensuring that the developed measures meet the inherent requirements of validity and reliability. The process framework given by him translates the creation of marketing scales into a six step process of: (1) specify domain of the construct, (2) generate sample of items, (3) purify measure, (4) assess reliability of construct, (5) confirm validity of measure, (6) define norms for making the standards explicit.

The Churchill procedure lays out a step-by-step method for defining and empirically validating constructs. It has laid the foundation for improvement of the quality of measurement in marketing, Finn and Kayande (2005). Despite having been criticized for being biased and limited, it still remains the main scale development procedure that marketing researchers apply.

Viswanathan et al. (1996) propose the application of fuzzy set theory to scale development by conceptualizing response categories as fuzzy sets.

Rossiter (2002) proposes a new procedure for scale development that relies on logical arguments and the concurrence of experts, based on open-ended inputs from pre-interviews with raters. Christened C-OAR-SE, this six step process involves: (1) Construct definition, (2) Object classification, (3) Attribute classification, (4) Rater identification, (5) Scale formation, (6) Enumeration and reporting.

The author alleges that definition and measurements across various popular constructs in marketing are of suspect validity, and C-OAR-SE is a theoretical and procedural solution to the same.

A radical shift from the approach outlined by Churchill, it is seen as more flexible and open minded and provides a 'fresh breadth' of developing scales in marketing (Diamantopoulos 2005; Finn and Kayande 2005). C-OAR-SE is grounded in rationalism rather than pure empiricism and relies on logical arguments and concurrence of experts. However, C-OAR-SE puts a greater emphasis on context dependence and expert judgment, which might sometimes be suspect (Finn and Kayande 2005).

Finn and Kayande's offer the multivariate generalizability theory approach to developing measurement scales. This offers an opportunity to integrate the C-OAR-SE method to improve the conceptual rigor and empirical validation of constructs. Further, it applies statistical analysis to empirically test samples. This procedure, however, has been criticized for being too complicated and has seen limited application.

Use of multi-item scales, as against a single response category, has been fairly common in academic researches. "A single response category may not completely capture a response if the sets of response categories do not match the natural response of respondents" (Viswanathan et al. 1996). Further, use of contemporary techniques, such as structural equation modelling (SEM), allows researchers to objectively compare a theoretical model with empirical data. Several advantages of SEM have been described, most important ones being its ability to control for measurement error and to provide tests of construct validity (Terblanche and Boshoff 2006).

A basic layout of the process of Scale development is depicted in the Table below (Table 23.1).

23.3.1 Caveats in Scale development

Development of new scales has often been done without establishing any relationships with existing scales or showing justification for development of new scales, for areas where scales already exist. In fact, in many cases core concepts have been defined in multiple ways by scores of researchers, not building on existing definitions, but rather ending up confusing the basis of the construct. "More stupefying than the sheer number of our measures is the ease with which they are proposed and the uncritical manner in which they are accepted" (Jacoby 1978).

Unfortunately, scale proliferation has been rampant and research suggests that there have been many instances when existing scales are not used, but instead new scales are developed for each single instance of study or application. For most constructs, there is little agreement about which pre-existing scale to use, or does a situation warrant the creation of a new scale altogether (Bruner 2003). Oftentimes, scale validity and reliability are a question, and actual application of the scale in both research and business situations does not happen. Bruner has argued for increased use of standardized scales to avoid proliferation of duplicate scales

Table 23.1 Scale development process

Task	Activities involved	Reason
Define the subject	Search literature and substantiate with practical situations to define the construct to be measured	Clearly separate what is to be measured with what is to be left out, and what parameters are adequate to understand the subject
Elaborate the items	Use literature, secondary research and discussions with relevant audience to create universe of items that would address the parameters of the construct	Put together a list of statements or questions that, when responded to, would cover various aspects of the construct to be measured
Narrow down to the most relevant items	Assess internal homogeneity of the measure—calculations such as those of coefficient alpha and factor analysis can help in determining and separating out less relevant items. The researcher can also bring in expert judgment to eliminate less relevant items	Using a relevant sample data and calculating these statistics can enable the researcher to eliminate items which do not hold as strong a representation of the construct
Check for relevance and correctness	Ensure that the scale measures what it is set out to, and shows consistency across different methods	An internally homogeneous set of items is not sufficient, and it needs to be ensured that the measure is valid and reliable before it can be put into practice
Give a final shape to the items, construct and scale	Develop norms and processes to clearly lay out the marketing and scale value proposition	A formal definition needs to be imparted to the construct, elements of its scale and the analysis of its response

which in turn has been criticized as not being reflective of the different cultural and lifestyles that researchers are bound to find in different markets (Fletcher and Fang 2006).

23.3.2 Important Attributes of Scales

While elaborating on scales and their evaluation from a literary perspective, the following attributes have been seen as both academically and practically relevant. Therefore, these factors have been considered later in the study as well, to categorize scales as high or low impact. The factors are detailed below (Table 23.2):

23.4 Review of Chosen Scales

Having considered the critical and fundamental aspects of the marketing function, the following scales and models have been shortlisted as part of this exploratory study (Table 23.3).

Table 23.2 Important attributes of scales

Attribute	Definition	References
Validity	A measure is valid when the differences in observed scores reflect the true differences on the characteristic one is attempting to measure and nothing else	Churchill (1979); Jacoby (1978), others
Reliability	A measure is reliable to the extent that independent but comparable measures of the same trait or construct of a given object agree	Churchill (1979); Jacoby (1978), others
Utility	The word utility indicates 'usefulness or a potential capacity to provide a service'	Salway (1986); Jones et al. (2006)
Predictability	It should be possible to show, demonstrate or prove that requirements are met subject to any assumptions made	Srivastava (2002); Stankovic (2003)
Universality or generalizability	The degree to which one can generalize the data collected to a larger universe	Rentz (1987); Aaker (1996); Bruner (2003); Dadzie et al. (2002)

Table 23.3 List of chosen scales

S. No.	Name and description of scale	Author(s)	Year
1	MARKOR as a measure for market orientation	Ajay K. Kohli, Bernard J. Jaworski and Ajith Kumar	1993
2	VALS Framework for Psycho-graphic Segmentation	Arnold Mitchell, SRI Consulting Business Intelligence (SRIC-BI)	1983
3	Dimensions of Brand Personality	Jennifer Aaker	1997
4	SERVQUAL	Parasuraman A., Zeithaml Valarie A., Berry Leonard L.	1988
5	DAGMAR approach to measuring advertising effectiveness	Russell Colly	1962
6	SOCO scale for measuring sales person's customer orientation	Robert Saxe and Barton A. Weitz	1982

23.4.1 MARKOR as a Measure for Market Orientation

The market orientation concept has been instrumental in building the philosophy of the marketing subject. Market orientation, irrespective of industry category or vertical, has witnessed a lot of interest, both in research and in actual applications in the market (Han et al. 1998; Kohli and Jaworski 1990). Implementing the marketing concept is a reflection of an organization's intentions to deliver higher value to its customers (Slater and Narver 1994).

Market orientation refers to the organization-wide generation of market intelligence through decision support systems, marketing information systems, marketing research efforts, dissemination of the intelligence across company departments, and organization-wide responsiveness to the changes taking place in the environment (Kohli and Jaworski 1990).

The MARKOR scale is a maiden attempt to develop a measure for marketing orientation and assess its psychometric properties (Kohli et al. 1993). The three ba-

sic concepts of market orientation have been identified as—intelligence generation, intelligence dissemination and responsiveness. Measurement of market orientation, therefore, is an attempt to understand how much effort an organization puts into generating intelligence regarding its customers, their current and future needs, how the organization disseminates this information across its various stakeholders, and how well it responds to this information.

The MARKOR measure assesses the degree to which a business unit or an organization (1) engages in multi-department market intelligence generation activities, (2) disseminates this intelligence vertically and horizontally through both formal and informal channels, and (3) develops and implements marketing programs on the basis of the intelligence generated (Kohli et al. 1993).

Using the MARKOR assessment questionnaire, one can define a baseline level of market orientation for any organization. Based on how the organization plans its programs and marketing strategy, the measure offers a mechanism to check progress on this front. Comparative checks of this sort over a medium to long-term period will enable an organization to identify and isolate major challenge areas and plan for programs to address the same, in the process becoming more in sync with the marketing orientation philosophy.

Empirical evidence demonstrates the universal applicability of MARKOR scale in different settings (Spillan 2005). MARKOR is largely consistent with its definition. It is believed to be a good market orientation measurement because it provides an expanded focus on the market rather than customer intelligence, an emphasis on a specific form of inter-functional coordination with respect to market intelligence, and a focus on activities related to intelligence processing rather than the effect of these activities (Kohli et al. 1993). Academicians have argued, however, that using short-term financial measures of performance may not be complete and adequate to measure the impact of adopting a market orientation approach. There may be a need to improve the method of measuring the long-term effects of market orientation, as also incorporate elements that are not accounted for in this scale. Examples include situations where customer feedback might not give a complete and truthful representation of customer needs, such as in cases of highly innovative and revolutionary new products, or in situations that demand a high level of organizational creativity.

Findings suggest that MARKOR may lack generalizability across industries, economies and cultures and more fundamentally the conceptualization on which it is based may need to be reassessed. The fact that its statistical validity is questionable, which is acknowledged by the authors themselves, has invited researchers to improve the original instrument to make it more reliable and better connected with its conceptual foundations.

23.4.2 VALS Framework for Psychographic Segmentation

Probably the best-known psychographic segmentation tool is VALS, developed in 1978 by the research firm SRI International (Mitchell and others 1983). The VALS system was developed from a large study of the U.S. population that divided adults into nine segments based on similarities in their values (beliefs, desires, and preju-

dices) and their lifestyles. Grounded in the belief that mind-set and demographics work together to determine underlying consumer choices and preferences, VALS helps predict consumer behaviour. An individual's primary motivation pattern elements are isolated and that brings in predictability about how the person will behave in the marketplace.

According to the VALS Framework, people are categorized along two dimensions. The vertical dimension segments people based on the degree to which they are innovative and have resources such as income, education, self-confidence, intelligence, among others. The horizontal dimension represents primary motivations and includes three distinct types: Consumers driven by knowledge and principles or by demonstrating success to their peers or by a desire for variety, and risk taking are motivated primarily by self-expression. At the top of the rectangle are the Innovators, who have such high resources that they could have any of the three primary motivations. At the bottom of the rectangle are the Survivors, who live complacently and within their means without a strong primary motivation of the types listed above.

In 1990 SRI introduced VALS2 to reflect changes in the way decisions were made. Three self-orientation patterns included in VALS2 are principle-oriented (your choices are directed by your beliefs), status-oriented (your choices are directed by your desire for the approval of others), and action-oriented (your choices are directed by your desire for physical or social activity, variety, or risk taking).

VALS is used extensively in new product development, crafting communication strategies, identifying emerging market opportunities, and helping predict consumer attitude towards new policy development. VALS2 is a step ahead of the initial VALS framework, which takes into account changing dynamics.

However, inherently values are difficult to measure even within homogeneous cultures. Values are among the most abstract of social cognitions (Kahle 1984), thus rendering them elusive to highly concrete measure. Irrelevant needs, salience, super-ordination, impression management, social change, excessive abstractness, and ambiguity of meaning may all distort self-reports of values (Beatty et al. 1988).

The VALS approach has some inherent limitations associated with the measurement of values. Further, both the collection and analysis of data are a fairly tedious process, and is susceptible to a reasonable degree of cultural bias. The meanings and nuances of a set of attitudinal and behavioural statements leave room for a distortion and ambiguity. Some of the statements seem particularly tied to the U.S. culture and need considerable modification. VALS' heavy dependence on demographics suggests it is not a pure measure of values or psychographics, which reduces the theoretical importance of the methodology and conceptualization (Beatty et al. 1988).

23.4.3 Brand Personality

Brand Personality as conceptualized by Aaker (1997) is 'the set of human characteristics associated with a brand.' Brand personality gives the consumer something to relate to that is vivid, alive, and more complete than what is conveyed by the generic offering. A well-established brand personality can result in increased preference and usage, higher emotional ties to the brand, and trust and loyalty.

As organizations apply strategies to communicate a personality of a brand to its consumers, the idea is to create an impression that the consumer can identify with, or aspire for. Research suggests that higher the sync between the human characteristics that explain the behaviour of a target audience set, and those that describe a brand, the greater is the potential of preference for that brand (Malhotra 1988; Sirgy 1982; Aaker 1997). Therefore, a greater understanding of what the brand personifies, or should personify, helps a brand develop a better connect with its potential audience.

The Brand Personality scale is an attempt to systematically identify the dimensions that define brand characteristics, across various product categories. Using the scale, marketers can have a better comprehension of the symbolic nature of brands and also appreciate the details of how consumers buy brands for self-expressive purposes (Aaker 1997). Starting with a universe of 309 traits, five final dimensions were arrived at, representing concepts of Sincerity, Excitement, Competence, Sophistication and Ruggedness.

To apply the concept of brand personality as an important tool for modern brand management, marketing researchers and marketers are in need of a reliable and valid measurement instrument. Brand Personality scales have been applied in multiple contexts to understand how customers perceive brands and also compare competitive brands. An understanding of the brand personality is also a critical ingredient of the brand communication strategy with regard to a new target audience or a product repositioning plan. Brand Personality framework also have a huge implication in different cultural contexts, and the scale enables a deeper appreciation for the same.

It is widely acknowledged that "most of the research papers on brand personality are now based on Aaker's scale" (Azoulay and Kapferer 2003). However, the scale has its limitations with regard to the various aspects of personality it accounts for. For instance, the identified dimensions do not see universal applicability across all kinds of industries. The gender aspect has been found missing. The scale does not replicate well in other countries and consumer samples. Research has shown that the brand personality scale is sensitive to the cultural context in which it is used. Several studies have attempted to adapt the entire scale or parts of it to countries outside the US (e.g. Ferrandi et al. 2000; Aaker and Lee 2001; Smit et al. 2002; Chandon 2003). Applying standardized brand personality scales to single brands or specific product categories required rigorous scale testing, since the scale validity might be in question.

23.4.4 SERVQUAL

Service quality is an abstract and elusive construct because of three features unique to services—intangibility, heterogeneity and inseparability of production and consumption (Parasuraman et al. 1985). Quality, however, is measured as a consumer's judgment of an entity's overall excellence, or perceived quality (Zeithaml 1987), which is different from but related to the construct of satisfaction arising out of the use of a product or service experience. Perceived quality is an indicator of the discrepancy between consumer's expectations and perceptions after having gone through a service experience. A consumer would rate a service quality as high or

good, if his perceptions of service performance meet or exceed his expectations of what the service provider should provide.

Based on exploratory research on the elements that consumers use to assess quality, using detailed interviews and focus group discussions (Parasuraman et al. 1985) identified ten determinants of service quality. Adopting Churchill's approach to scale development, five final dimensions of construct were derived—tangibles, reliability, responsiveness, assurance and empathy—and a 22-item SERVQUAL scale was created. SERVQUAL offers a multiple item measure that enables organizations to understand what expectations its customers have from its services, and how they perceive the services offered to them. This also provides a huge opportunity for organizations to improve the service quality in line with the expectations. This application and measurement is even more pronounced in a competitive market—where competition is a big factor that drives organizations to offer better service quality and build a stronger bond and stickiness for the customers.

SERVQUAL has seen a wide range of applications. Among others, it has been used in different service situations, such as professional services (Freeman and Dart 1993), tourism (Tribe and Snaith 1998), information systems (Kettinger and Lee 1994), health care (Lam and Woo 1997), and hotel industry (Seyed 2008). Being a statistically valid instrument owing to extensive field testing and refinement, it has been the most generic and universally-applicable. However, the scale has also had its share of criticism—including a debate on whether it represents the perfect way of conceptualizing the construct of service quality and whether the parameters used in SERVQUAL do justice to measuring quality. Further, applicability of SERVQUAL in different industries has been questioned, since the parameters might not be as suitable. The use of difference scores in calculations further contributes to potential problems with reliability and validity of the measure. Other elements such as cultural nuances impact consumer expectations of service quality and also their expectations on each of the dimensions of service quality (Donthu and Yoo 1998). Further, Kang and James (2004) have argued the SERVQUAL measurement does not adequately explain a technical attribute of service, since it focuses more on the service delivery process.

Although a very useful analysis perspective for the service or quality manager, SERVQUAL by itself, does not provide a complete picture of needs, expectations and perceptions in a service organization context. As Gaster (1995) comments, "because service provision is complex, it is not simply a matter of meeting expressed needs, but of finding out unexpressed needs, setting priorities, allocating resources and publicly justifying and accounting for what has been done".

23.4.5 DAGMAR

Defining Advertising Goals for Measured Advertising Results, abbreviated DAGMAR, is a model for setting advertising objectives and measuring the results thereof. Proposed by Colley (1961), the DAGMAR approach proposes carrying a consumer

through four levels of understanding through advertising. that the ultimate objective of advertising must carry a consumer through four levels of understanding: from Unawareness to Awareness—the consumer must first be aware of a brand or company Comprehension—he or she must have a comprehension of what the product is and its benefits; Conviction—he or she must arrive at the mental disposition or conviction to buy the brand; Action—finally, he or she actually buy that product.

The underpinning basis of this model is that the effect of communication forms the logical basis for advertising goals and objective against which the degree of success should be measured. Under the DAGMAR approach, an advertising goal involves a communication task that is specific and measurable. In fact, the principal contribution of the DAGMAR model is in acknowledging that the effectiveness of advertising can only be validly assessed where specified criteria for judging effectiveness are derived from explicitly stated advertising objectives.

The DAGMAR approach has had significant visibility and influence, and considerable impact on the advertising industry—specifically with regard to advertising planning process. Experts apply this model as the basis for defining objectives and also assessing the effectiveness of their campaigns. This also helps bring in greater objectivity in the overall definition of the expectations, and measurements thereof. The four stages defined by Colley enable the advertiser to plan and position a specific campaign for a specific result, therefore also making the messaging task simple and explicit.

However, despite its widespread adoption, DAGMAR has not been completely accepted by all advertisers—a major criticism being its reliance on the hierarchy of effects model. Consumers do not always go through this sequence of effects—as has been widely proven—and their response depends on a specific buying situation. Given the time and effort that goes into implementation of the model, many critics argue that DAGMAR is practical only for large companies with big advertising budgets. Further, purists believe in a sales goal, since the ultimate objective of advertising is to increase sales and grow the business. The DAGMAR model leaves the sales goal out of the picture and assesses the communication objective—and is hence seen as incomplete or insufficient. Another criticism against the model is that it inhibits advertising creativity by imposing too much structure and quantitative measures.

23.4.6 The SOCO Scale for Customer Orientation of Sales People

Customer-oriented selling refers to the degree to which salespeople practice the marketing concept by trying to help their customers make purchase decisions that will satisfy customer needs. Highly customer-oriented salespeople engage in behaviours aimed at increasing long-term customer satisfaction. Developed by Saxe and Weitz (1982), the SOCO scale tries to measure this degree of customer orientation in sales people. Following the scale development guidelines recommended

by Nunnally (1978) and Churchill (1979), a pool of 104 items representing seven categories of characteristics was compiled to capture the attitudes and behaviours that distinguished high and low customer-oriented salespeople. A 24-item scale was finally created, which confirmed to all reliability and validity tests.

This twenty-four item scale has been used in a number of studies. Several authors have suggested a variety of modifications to the scale largely to adapt the scale to specific situations or markets or if some items may be inappropriate rather than as attempts to further refine the scale.

Various studies and applications of the scale have supported its dimensionality and reliability of the SOCO scale and its ability to measure the customer orientation of salespeople, from either a salesperson or a customer perspective. Some of these have used modified versions of the SOCO scale to adapt to the buyer-seller market situation, but all can be easily identified as variants of the original scale. However, if the SOCO scale is to be used to examine interrelationships with other constructs that have multiple-item scales, questionnaire length can become an issue (Ryan 2001).

23.5 Issues in Scale Development

Scale proliferation and issues in measurement of a single construct across multiple definitions have already been mentioned. Here we bring out some issues in scale development, and how they impact the measure of the construct.

23.5.1 Construct Definition

Multiple definitions exist in marketing literature for the same subject or phenomena, and often these are not interlinked or studied to bring one common perspective. With the result, the same subject has different interpretations, and ramifications, and a variety of measures estimating various aspects. Almost everyone has his own preferred measure and seems to blithely and naively assume that findings from one investigation can easily be compared and integrated with findings from investigations, which use other definitions (Jacoby 1978). Any decision based on a scale or measure which defines the subject in a sense different from the perspective at hand is bound to be either skewed or out of context, or both.

23.5.2 Methodology Applied

Multiple approaches have been suggested by researchers, on how best to create a valid and reliable measure. Methodologies suggested by Nunnally (1967), Churchill (1979), and Rossiter (2002), among others, have been considerably popular. While

most of these present a mechanism to develop a reliable and robust measurement technique, each of them also have their own process limitations, which if not accounted for adequately, will lead to an imbalanced measure.

23.5.3 Samples

Most scale development and creation is on the basis of sample data that is gathered by bringing in a representative sample of the actual population. In many cases, however, the sample selected is neither a truly representative sample, nor the best suited to address the construct or its implications. Most published literature does little to explain the sample details and how qualified the sample was to contribute to the development of the scale in question.

Student Samples

The correctness of a scale is oftentimes in question, since many scholars have used student population as a sample for various studies leading to scale development. The student community, though often willing, supportive and helpful in any such process of high academic relevance, is not the best candidate for creating scales for various marketing concepts, say for prices or brand positioning. The student population is not always as informed or a decision maker in many such real-life decisions, and therefore, represents a highly skewed and tunnelled impression of that construct. Even if scales developed on such information are found to be valid and reliable on statistical counts, their logical validity leaves much to be accounted for.

23.5.4 Interviewer and Respondent Bias

The interview process, by default, is inherently an artificial way of getting consumer or user information. A respondent is asked, in an unnatural setting, to respond to a set of queries which might not be top of the mind for him/her, or even a priority. There might be an incentive or motivation to respond, but people are highly likely to respond in a ‘what should be’ manner rather than ‘what is’. The process itself builds in bias into the data and information collected, and using this as a base for future decision making might not always be the best approach to a subject.

23.5.5 Validity

Poor or incorrect sample selection leads to an obvious conclusion—scale validity. Because of a poor sample or incorrect approach to scale creation, often validity is

not questioned. The scales are taken on face value and various aspects of validity, such as construct, predictive, cross and convergent validity, are assumed to exist, without a proper check.

23.5.6 The Single Measure

Marketing concepts have always been difficult to measure. Factors such as context, culture, economic environment, dependence on the respondent's frame of mind and many others have made it a challenge to create measures and scales for rather abstract phenomena and characteristics such as personality, positioning, image, quality etc. Given this background, an attempt to define and create a measure is a big feat—and many scholars have taken the plunge to take on such a tough task. Since they have created a measure, and it's the only one that seems to make sense, it tends to become a popular means to understand that specific construct. As much as there are instances of scale proliferation on many concepts, there are also cases where there is only a single scale, and no one has attempted to question it or offer an alternative. Being the only one, then, becomes a reason for being popular, accepted and used, despite any inherent flaws or limitations.

23.5.7 Culturally Skewed Representation

Most initial research on various aspects of marketing, over the past few decades, has addressed marketing constructs from a western audience perspective. The scholars, and the sample population they use for assessment of a concept, have been largely North American or European. There is relatively limited replication of these measurements in non-western environments and/or developing and less developed countries. This creates an inherent research gap in the determination of applicability of these measures in other geographies.

23.5.8 Scale Adaptation

In the marketing discipline, various scales have been developed and have been constantly modified and adapted for different uses over time (Bearden and Netemeyer 1999). As an example, Finn and Kayande (2004) provide a detailed discussion on the alternative approaches and consequences of scale modification in marketing using the Parasuraman et al. (1988) 22 item SERVQUAL scale. Marketing scales are often modified and adapted for use in different research scenarios. However this approach has often been criticized from a validity perspective as scales have been developed to measure a specific object of interest (Gerbing and Anderson 1988).

This adaptation approach entails researchers adapting established and validated marketing scales from 'western' markets for use globally. Scale adaptation would involve addition or deletion of items in scales which are considered to be irrelevant to specific market environments. Scale adaptation would allow researchers to draw on some theoretically grounded constructs that have been used in research, and this takes into account evidence of the universality of some marketing constructs which can be applied to different markets (Deshpande and Farley 2004). However, the question of whether modified scales actually measure what they are intended for in a new study or whether in fact they actually measure objects of interest which they were original designed for remains a key question that researchers have to ascertain in adapting scales thereby undermining the reliability of adapted scales (Finn and Kayande 2004).

23.6 Creating a Mathematical Equation

Once the scales were studied and the research work on them reviewed, it was time to get in touch with expert practitioners and check for their opinion and feedback on various usage related elements of these chosen scales.

The research methodology applied to arrive at an interpretation of the on-the-ground application of these high impact scales included extensive literature review and discussions with experts and practitioners, who use these scales for quantitative analysis and decision making.

For the latter, the sampling technique employed was Judgment Sampling wherein experts working in the marketing and consulting field were identified so that they were familiar with these scales and models and were in a position to comment on their utility and usage. A total of 31 professionals were interviewed and their opinions on these scales were sought.

Critical attributes of scales are the ones that pertain to its robustness, universal usability and applicability and statistical validity of the scale. Research elaborates on all these elements of these selected scales, albeit every academic writer has his/her own opinion, perspective and approach to understanding and applying the scale in question. The authors have attempted to interpret the academic perspectives on each of these scales on each of these critical attributes to help establish a guide for their analysis and evaluation (Table 23.4).

As mentioned above, 31 professionals were reached out to, in order to get a practitioner's feedback on the utility of these scales. Among these professionals, there was adequate knowledge of, and utilization of each of these scales.

Each one of them was given a list of these scales, along with a brief description of the actual scale, and asked to rate them on a scale of 1 to 5, 1 representing 'high' and 5 representing 'low'. In the final representation below, median scores for each of the scales is mentioned (Table 23.5).

As can be seen, these ratings are largely in sync with the academic interpretations, albeit with few deviations.

Table 23.4 Scale rating based on literature

Scale/attribute	Utility	Validity	Reliability	Predictability	Universality
MARKOR	Medium	Medium	Low	Low	Low
VALS	High	Medium	Medium	Medium	Low
Brand personality	High	Low	Low	Medium	Low
SERVQUAL	High	Medium	Medium	Medium	Medium
DAGMAR	High	Medium	Medium	High	Medium
SOCO	High	High	High	Medium	Medium

Table 23.5 Scale rating based on expert opinion

Scale/attribute	Utility	Validity	Reliability	Predictability	Universality	Impact
MARKOR	Medium	Medium	Low	Low	Low	Low
VALS	High	Medium	Medium	Medium	Low	High
Brand personality	High	Low	Low	Low	Low	Low
SERVQUAL	High	Medium	Medium	Medium	Medium	High
DAGMAR	High	Medium	Medium	High	Medium	High
SOCO	Medium	High	High	Medium	Medium	Low

A Discriminant Analysis was conducted to distinguish high impact scales from low impact ones. The predictor variables were utility, validity, reliability, universality and predictability.

Selected output from the analysis using SPSS is outlined here as under (Tables 23.6 and 23.7).

An eigen value indicates the proportion of variance explained. (Between-groups sums of squares divided by within-groups sums of squares). A large eigen value is associated with a strong function.

The canonical relation is a correlation between the discriminant scores and the levels of the dependent variable. A high correlation indicates a function that discriminates well. The present correlation of 0.891 is reasonably high (1.00 is perfect) (Tables 23.8 and 23.9).

The 'Canonical Discriminant Function Coefficients' indicate the unstandardized scores concerning the independent variables. It is the list of coefficients of the unstandardized discriminant equation. Each subject's discriminant score would be computed by entering his or her variable values (raw data) for each of the variables in the equation.

We now attempt to use the equation we have derived to check how the values pan out for each of the chosen scales, and how these compare with the literature review.

Note that to arrive at the discriminant equation, we have used only the two most impactful variables. Generally, just like factor loadings, 0.30 is seen as the cut-off between important and less important variables.

$$\mathrm{D} = a + \beta 1F1 + \beta 2F2 + \beta 3F3$$

Table 23.6 Decision process for identifying appropriate scales

		Utility	Validity	Reliability	Predictability	Universality
Covariance[a]	Utility	0.375	0.125	0.000	−0.125	−0.125
	Validity	0.125	1.188	0.875	0.500	0.375
	Reliability	0.000	0.875	0.750	0.250	0.250
	Predictability	−0.125	0.500	0.250	0.625	0.375
	Universality	−0.125	0.375	0.250	0.375	1.375

[a] The covariance matrix has 4 degrees of freedom

Table 23.7 Eigenvalues

Function	Eigenvalue	% of variance	Cumulative %	Canonical correlation
1	3.872[a]	100.0	100.0	0.891

[a] First 1 canonical discriminant functions were used in the analysis

Table 23.8 Wilk's lambda

Test of function(s)	Wilks' lambda	Chi-square	Df	Sig.
1	0.205	3.167	4	0.0530

Table 23.9 Standardized canonical discriminant function coefficients

	Function
	1
Utility	0.949
Validity	0.237
Reliability	−0.439
Universality	0.204

where
β represents the canonical coefficients and
F represents the independent variable. Applying the values, we this get

$$D = (0.949 \times \text{Utility}) - (0.439 \times \text{Reliability})$$

The discriminant function coefficients indicate the partial contribution of each variable to the discriminate function controlling for all other variables in the equation. They can be used to assess each factor's unique contribution to the discriminate function and therefore provide information on the relative importance of each variable.

It is important to also note that the positive or negative values of the coefficients are arbitrary and do not necessarily indicate that there is a positive or negative correlation between the independent variables and dependent function.

As we can see here, Utility has the maximum effect on the assessment of the scale impact, followed by Reliability on the dependent variable that determines whether a scale is considered high or low impact by practitioners.

Table 23.10 Calculation of the discriminant value for various scales

Scale	*D* value	*D* value interpretation for scale impact	Primary data classification of scale impact
MARKOR	1.091	Low	Low
VALS	−0.368	High	High
Brand personality	0.142	High	Low
SERVQUAL	0.581	High	High
DAGMAR	0.581	High	High
SOCO	1.969	Low	Low

Using the centroid values, we can determine a cut off value, such that all discriminant values above and below that categorize the scales into specific group. The values are thus:

$$\text{Cut-off value} = \text{Average of the centroid values} = (-1.036 + 2.282)/2 = 0.623.$$

All discriminant values below 0.623 would therefore, correspond to the value 1 on the evaluation, which implies a high impact scale, and values above 0.623 would correspond to the value 5, which would mean that the scale is a low impact one (Table 23.10).

The calculated discriminant values, therefore, are in sync with the practitioner's perspectives on these scales, in all but one cases. The distinction in the case of the brand personality scale could be attributed to its high level of utility (although it scores low on all other aspects), that was specified by most respondents, and utility being the most important element of the discriminant determinant.

The discriminant value can be interpreted from a practitioner's perspective as really a derivative of how useful the scale is for his analysis purposes—that is a clear driver for the user of the scale in his estimation and decision making abilities and is therefore, a huge factor in the classification of scales. Some highly cited scales might not have high utility in today's context, or their usefulness quotient in terms of decision making for practical purposes may be low, which explains why they might be classified as low impact scales by expert practitioners.

23.7 Appropriate Scale Selection

Basis the above calculation, the authors propose a decision process to help identify appropriate scale for a given construct, or the creation of a new one for a given measurement situation. This would help both scale developers and users of scale to classify and utilize their scales (Fig. 23.1).

Through this analysis, we have thus attempted to highlight the critical attributes of important scales and how they are perceived to be ranked on each of these attributes by literary experts and researchers, as well as expert practitioners.

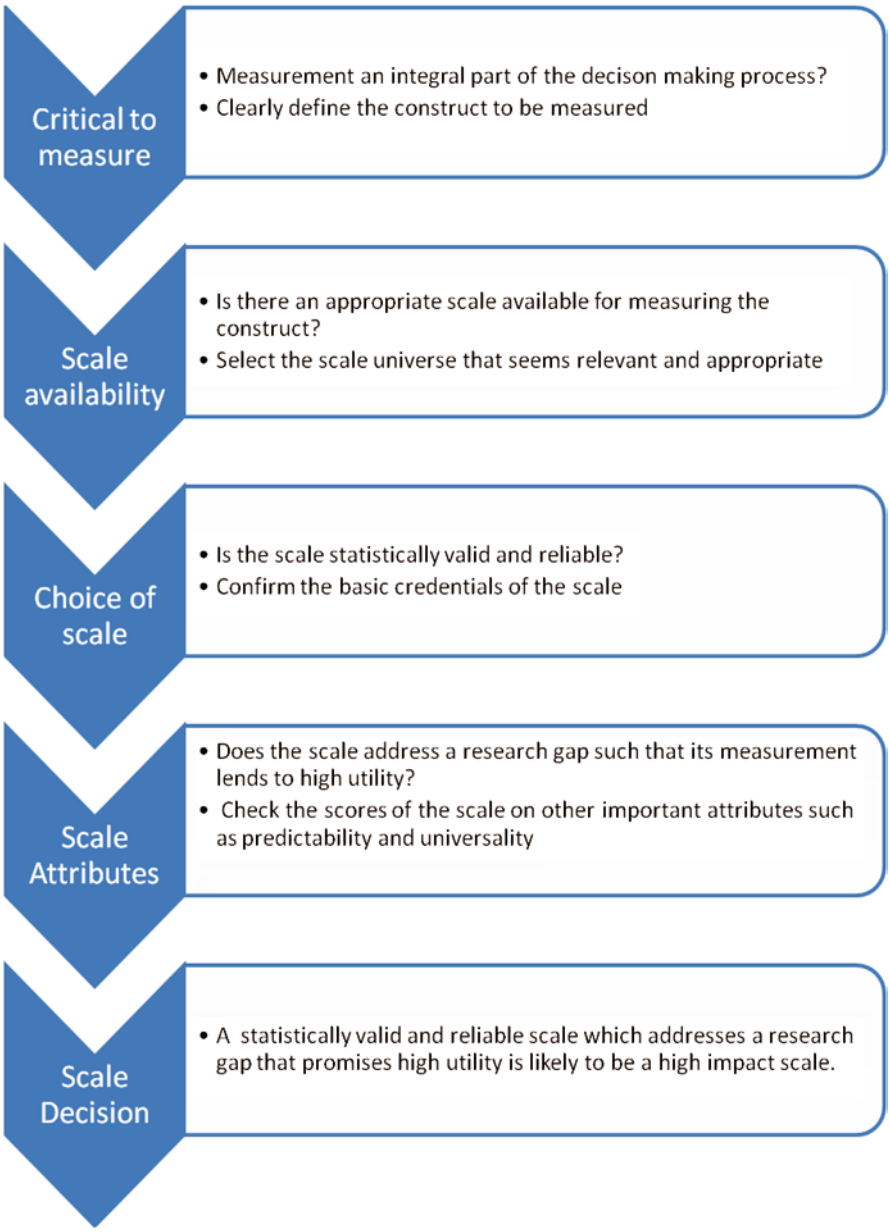

Fig. 23.1 Decision process for identifying appropriate scales

It is clear that the Utility of a scale is seen as the most critical parameter that determines its impact in the practitioner's world. However, literature suggests that Utility is not the prime driver of developing a scale—in fact Validity and Reliability are much more critical components while designing and verifying the importance of scales in marketing.

23.8 Conclusion

Having studied literature on scale creation pertaining to high impact and most widely popular scales in terms of their practical application, this study has been an attempt to highlight issues in scale development and application. The key findings have been outlined below.

In many instances, a scale is created with multiple interpretations of the construct, inadequate understanding of the scale creation approach and its fit in the given context, improper filtering to narrow down the sample, unnatural setting to get responses from the sample and use of statistics to prove an assumption, irrespective of whether the choice of statistical tools is correct or adequate. The biggest limitation, however, is the fact that a scale is created in a context, and applied in a very different setting. The dynamic nature of the factors that impact marketing decision making, render the application of the same scales to different situations a rather redundant exercise.

Scale interpretation, and application, then, is probably the only way of proving that a scale is truly representative of a construct. True validation is derived from actual proof of usage, and predictability, more than anything else. For instance, approaches such as those suggested by SERVQUAL have shown real application, and real results on the ground, and therefore have real validity in a variety of marketing situations, though universal applicability is still not promised. However, the same high level of standardized applicability is not true of many other scales, models and approaches presented in marketing literature.

What the scales do, instead, is provide a guidance, direction or approach to how a specific phenomenon can be understood in a given situational context. Taken in that sense, a scale offers a structured and organized method to evaluate a process, construct or behavioural parameter, thus enabling a common understanding across multiple potential. If scale application is limited to its usage as outlined here, scales can really serve their actual intent.

In summation:

1. Scales offer a critical direction and guideline to every construct
2. Scale development, however, has inherent problems, that get transferred to the actual measure created and therefore its practical applications
3. Critical attributes of scales pertain to its robustness, statistical validity and universal usability and applicability
4. Many practitioners use the scales as guidelines but change the actual scale items to suit their specific context. This is true even for the most popular and highly academically cited scales.

The authors have tried to present the critical attributes of important scales and score the scale on each one of them—thus providing a baseline reference for understanding, appreciating and applying each of these scales in a future research or organizational analysis situation.

We have also presented a simple equation that relates the important attributes of scales and explains on the basis of these attributes if the scale would be a high impact or a low impact one.

23.9 Limitations and Future Research

This study aims to bring out salient elements of a few highly cited scales in marketing. The intention is to highlight various aspects of the scale applicability and relevance in the dynamic context of ever changing marketing ethos. One clear limitation, however, is the limited universe of scales that has been studied. The selection of these scales has been primarily on the basis of various aspects of the field of marketing—with an attempt to cover different marketing principles. At the same time, the effort was to find measures which have been most popular and most prominently cited by academic and practical applications. The choice of scales, if altered, could have lent a larger perspective to this study.

Based on actual data of scale application and accuracy for the subject it intends to measure, one can possibly draw up a Scale Quadrant which can categorize scales with regard to their strength, usage and other parameters. Such a representation can add substantially to the understanding of a scale and its interpretation, as well as applicability for specific measurement situations.

All parameters that characterize a scale application in a context are critical for its evaluation and for understanding its real value to the knowledge of the subject. For instance, Utility and Universality are the two attributes most apt in capturing how useful a scale or model is in actual practical scenarios. On the other hand, Reliability and Validity underpin the core strengths of the scale in providing a measure for what it intends to be studying.

The proposed Scale Quadrant can plot a scale's perceived levels on these attributes to help understand which scales are credible benchmarks in marketing literature. Any new scale development effort then would aim to emulate these benchmarks with respect to scale definition and creation.

A representation of this type would provide a context to the usage quotient of a scale—it would make it easier to understand the degree to which a scale meets critical requirements, including but not limited to statistical measures of validity. A greater appreciation of the same can possibly be drawn if one could present a multidimensional representation which captures various factors along each axis and uses a spatial representation to enable assessment of the scale in question.

Development of such a Scale Quadrant across various dimensions could be an interesting future research subject for students of the science of measurements in marketing.

Some of the scales we are applying in today's studies have been the ones developed 25–30 years ago. While their fundamental logic and construct validity holds, especially for some of the high impact universal scales, these scales fail to capture the evolution and dynamic changes that have happened in business, marketing and even the way the customer or the brand is perceived today. What this really means is that though the measure is valid and applicable, it does not do justice to various new aspects of the marketing function that have come into being in the years after the scale was established. In a few cases some scales have seen random efforts of modification or embedding the new ideas such as those presented by the integrated marketing communication philosophy. Some new scales have also emerged to capture the constructs of newer disciplines such as those of digital marketing or the social media phenomena. However, the elements covered in the new scales do not get mention or adequate attention in some of the older measures which might not have seen a comprehensive revisiting or a complete redevelopment in keeping with the emerging new trends.

In this regard, one can possibly draw a parallel with some established chronological trend patterns and define a concept of a Scale Cycle. The Scale Cycle would represent its valid lifetime after which it needs a revisit to ensure that dynamic environmental or evolution of the function gets adequate mention in the scale items and measures. A 5 or 7-year business duration may in many ways seem the most logical and appropriate. A scale being used say 7 years after it was first introduced should necessarily be revalidated with adequate and appropriate interventions of any new measures or phenomena that might have an impact on the fundamental construct in the new context.

However, what would be the true validity time period for a given scale or what kind of changes would trigger a revisit of a developed and popular scale are subjective topics in themselves. Drawing these specifically would need greater thought and definite research of a scale usage versus a time period study.

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