Flexible Systems Management

Sushil
Kanika T. Bhal
Surya Prakash Singh *Editors*

Managing Flexibility

People, Process, Technology and Business

Springer

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Sushil • Kanika T. Bhal • Surya Prakash Singh
Editors

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Editors
Sushil
Department of Management Studies
Indian Institute of Technology Delhi
New Delhi
India

Surya Prakash Singh
Department of Management Studies
Indian Institute of Technology Delhi
New Delhi
India

Kanika T. Bhal
Department of Management Studies
Indian Institute of Technology Delhi
New Delhi
India

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Preface

Managing flexibility in modern organizations is emerging as an area of great interest at the levels of people, process, technology, and business. The need for managing flexibility is growing to cope with the developments and challenges in the global business environment. Flexibility is a major dimension of business excellence and deals with a paradoxical view point such as stability and dynamism, continuity and change, centralization and decentralization, and so on. It needs to be managed at the levels of people, process, technology, and various business functions and accordingly, the book is organized into various parts. It is important to create flexibility at the level of people to create and manage flexibility in processes and technologies to support flexible business requirements.

This edited volume is intended to provide a conceptual framework of "Managing Flexibility: People, Process, Technology and Business" supported by researches and case applications in various types of flexibilities in business. This book presents selected, reviewed, and updated papers of GLOGIFT 13 conference on the related theme that was held at Department of Management Studies, IIT Delhi, India. These papers are organized in the form of an edited volume that can serve as a good reference material in this area. The selected papers from a variety of issues concerning the theme are organized into following five parts:

1. Managing flexibility
2. People flexibility
3. Process flexibility
4. Flexibility in technology and innovation management
5. Business flexibility

First, the broader issues of managing flexibility are covered with five chapters in the initial part of the book. The first chapter gives an overview of managing flexibility and developing a flexibility maturity model. The chapter is intended to bring out the key issues of managing flexibility through a review of relevant literature and managerial interviews. It then presents an integrative view of these issues in the form of a framework of flexibility maturity model. The related issue of critical elements that service innovators and providers could leverage in designing new services or improving existing ones is deliberated in the next chapter. Another chapter dwells on the aspect of flexibility intensity; it presents a framework that business managers can use to determine where and how much flexibility is needed. It illustrates the utility of the framework with the case example of IBM. Another chapter, based on the experience of practitioners, deals with a novel framework of Total Flexi-Quality, which integrates flexible systems management practices with total quality management practices through a structured focus on human capital development. The last chapter, in this part, attempts to examine strategy formulation in e-governance projects. It is based on a survey of planners belonging to six national multistate agriculture related projects in India taking flexibility constructs in strategy formulation. The subsequent parts bring out studies on specific aspects of managing flexibility.

People flexibility has been covered in part two, which is composed of five chapters. This part begins with a study on leader-member exchange (LMX) congruence. A leader varies his/her style of interaction and communication in a flexible manner and tends to form different relationships with different subordinates. It presents the testing of a model treating different types of LMX congruence as predictors of job performance and promotability of members. The next chapter presents a qualitative study, using semi-structured interviews, to inquire into diversity and culture-based behaviors in international information and communication technologies (ICT) projects. The study exposed a clear need for a comprehensive, yet flexible and adaptive framework for managing diversity. A holistic model of leadership development is proposed, in the next chapter, which can help organizations to design and implement systematic and customizable interventions to develop effective leaders flexibly. Another empirical study is reported in the next chapter that treats role efficacy dimensions as significant predictors of people flexibility. It also examines moderating functions of demographic factors on relationships between role efficacy and people flexibility. The last chapter, in this part, is aimed at modeling the complex interface between IT professionals and human resource management functions in an IT software services organization using viable systems modeling and variety matching.

Part three on process flexibility is composed of four chapters. It deals with various processes and associated flexibilities of a supply chain. The first chapter provides a broad overview of incentives for information sharing in collaborative supply chains. This chapter discusses two-tier supply chains and determines channel profit and members' profit under different information sharing and inventory locations. Another important area of process flexibility deals with procurement decisions, which is addressed in the next chapter. It deals with flexible procurement problem by integrating supplier selection, lot sizing, and carrier selection by considering dynamic demand, cost fluctuations, and varying capacities of suppliers and carriers. The next chapter presents an interpretive structural model of enablers of supply chain coordination in flexible environment and identifies the enablers with high driving power and low dependence. This part of the book concludes by reporting a study of soft drink industry on flexibility in the transportation strategy keeping the existing retailers, vehicles, and people in place. It uses flowing stream strategy framework in a case situation.

Flexibility in technology and innovation management is the focus of part four, consisting of four chapters. The first chapter, in this part, examines the applicability of real options to the improvement of robustness of research and development (R&D) sustainability of biotech start-ups during the deficit valley or against the systemic risk as the financial crisis. The next chapter deliberates upon the involvement of various stakeholders in every phase of innovation life cycle. It illustrates the applications of stakeholder engagement methodology for successful implementation of competence development framework during innovation diffusion phase in a case organization. The next chapter cites few case studies to discuss about the leveraging effect of strategic flexibility on technological exploitation. The last chapter in this part presents a review of literature to conceptualize a framework for national technological competitiveness. Literature has been reviewed under the topics, such as views of strategic thinking for managing competitiveness, globalization of technology, importance of technology development, innovation, national innovation system and sectoral innovation system, measuring technological competitiveness and strength of national innovation system, policy interventions and strategies to enhance technological competitiveness, and role of industry and business associations.

Part five is the last part of the book, which is composed of four chapters to cover different aspects of business flexibility. The first chapter, in this part, assesses impact of mobile devices on sales with multiple classes of customers for development of marketing flexibility for e-commerce. The purpose of this chapter is to discuss the optimal strategy concerning how to allocate the promotion budget between the PC promotion and the mobile promotion. The second chapter, in this part, aims at exploring the significance of people management in the context of a radical change situation of post-merger integration. The concept of emotional balancing of employees by middle level managers is studied and applied to uncover its effect on projected change outcomes. The next chapter tries to reflect on the aspects of tourism and how different kinds of strategic technology integrations, in terms of banking, insurance, and other service industries are trying to integrate with tourism to provide a better, wholesome, and integrated service convenience to its end users. This is illustrated by a case study using situation-actor-process and learning-action-performance (SAP-LAP) framework. This part concludes with a chapter on managing market demand variability at customer level in the context of a fast-moving consumer goods (FMCG) company. It illustrates a heuristic through a case study with two category groups in food and personal care.

The above briefing of various chapters in the book provides a bird's eye view of the concerns and issues linked with managing flexibility in a variety of situations which makes this volume comprehensive and interesting to read. Sincere thanks are due to all the authors and reviewers, whose valuable contributions have made this volume a reality. The efforts of Rejani Raghu are worth mentioning, who helped at various stages in communicating with authors and reviewers, and also provided support in formatting the manuscript.

We hope that this volume on "Managing Flexibility: People, Process, Technology and Business" will be of interest to the readers and will motivate them to take up research in this area. This will help in further enrichment of the paradigm of flexible systems management.

Sushil
Kanika T. Bhal
Surya Prakash Singh

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About the Editors

Prof. Sushil (Series Editor) is Abdulaziz Alsagar Chair Professor (Professor of strategic, flexible systems and technology management), and Chair, Strategic Management Group at the Department of Management Studies, Indian Institute of Technology Delhi. He has served as a visiting professor and delivered seminars in many leading universities; some representative ones are University of Minnesota, Minneapolis, MN, Stevens Institute of Technology, NJ, University of Lethbridge, Alberta, Université Paris 1 Panthéon-Sorbonne, Paris, among others. He is an active researcher and supervised more than 60 doctoral dissertations. He has 20 books to his credit in the areas of flexibility, strategy, systems thinking, and technology management. He has over 300 papers in various refereed journals and conferences. He has pioneered the area of "flexible systems management" and made original contributions to the field of knowledge in the form of interpretive approaches in management. He is the founder editor-in-chief of Global Journal of Flexible Systems Management and serving on the editorial boards of leading international journals. He is the founder president of the professional body, "Global Institute of Flexible Systems Management." He has acted as consultant to both governmental and industrial organizations. Currently he is serving as an independent director on the boards of RINL and HSCC.

Kanika T. Bhal is Modi Chair Professor and Head at the Department of Management Studies at IIT Delhi. A PhD from IIT Kanpur, and a visiting fellow at Sloan School of Management (Cambridge, USA), she is an expert in behavioural sciences in general and leadership in particular. She has published several articles in national and international journals and conferences and is on the editorial boards of national and international journals. She has authored books on leadership, culture and ethics. She has conducted sponsored research on several nationally and internationally funded (with Fordham University, Bronx, USA and Wharton Business School, Philadelphia, USA) projects. Besides being a consultant to various national organizations like Fifth Central Pay Commission of India, First National Judicial Pay Commission of India, DRDO, UPSC, DGS&D, Ministry of Rural Development NICD, and Ministry of Environment and Forests; she is invited as expert on Government committees and is a member of the Academy of Management, USA;

Society for Industrial Organization and Psychology; and Global Institute of Flexible Systems Management.

Surya Prakash Singh is an associate professor in the area of operations management at the Department of Management Studies, IIT Delhi. He obtained his PhD from IIT Kanpur and Post-Doctoral fellowship in Manufacturing Systems from Singapore-MIT Alliance, National University of Singapore, Singapore. Prior to joining IIT Delhi, he was faculty at Xavier Institute of Management Bhubaneswar and visiting faculty at Management Centre, Ravenshaw University, Cuttack, India. His research interests includes facility layout and locations problems, optimization techniques, optimizing supply chains, materials management, designing heuristics and meta-heuristics, and operations research. He has published his work in various leading international journals such as International Journal of Production Research, Lecture notes in Computer Science, International Journal of Advance Manufacturing Technology, European Journal of Management, Review of Business Research, International Journal of Recent Trends in Engineering, Asia Pacific Management Review and Journal of Academy of Business and Economics. He has also contributed chapters in edited volumes published by Vilnius Gediminas Technical University Publishing House “Technika” Vilinius, Lithuania (*Continuous Optimization And Knowledge-Based Technologies*), and INTECH publisher, Vienna, Austria (*Travelling Salesman Problem: Theory And Applications*). He is a life member of International Association of Engineers (IAENG) Hong Kong; senior member, International Association of Computer science and Information Technology, Singapore; and senior member, The Association of Computer, Electronics and Electrical Engineers (ACEEE), India. He is on the Editorial Board of Journal of Management and Public Policy.

Contributors

Anuradha Alladi Tata Consultancy Services Limited, Hyderabad, India

Christina Böhm Faculty of Computer Science, University of Vienna, Vienna, Austria

Umesh Kumar Bamel Indian Institute of Management Raipur, Raipur, India

Kanika T. Bhal Department of Management Studies, Indian Institute of Technology Delhi, New Delhi, India

Amit Chatterjee ASQ India, New Delhi, India

Sreenivasa Divi Tata Consultancy Services Limited, Hyderabad, India

Takao Fujiwara Toyohashi University of Technology, Toyohashi, Japan

L. Ganapathy National Institute of Industrial Engineering (NITIE), Mumbai, India

Megha Gupta Department of Management Studies, Indian Institute of Technology Delhi, New Delhi, India

Rashmi Jain School of Business, Montclair State University, Montclair, New Jersey, USA

Dhanya Jothimani Department of Management Studies, Indian Institute of Technology Delhi, New Delhi, India

Kamal Karnatak RJ Corp, New Delhi, India

Harpreet Kaur Department of Management Studies, Indian Institute of Technology Delhi, New Delhi, India

Meenakshi Kumari National Institute of Industrial Engineering (NITIE), Mumbai, India

Supriya Kummamuru Tata Consultancy Services, Business Systems & Cybernetics Center, Hyderabad, India

Sudhir Kumar Mittal Department of Management Studies, Indian Institute of Technology Delhi, New Delhi, India

Kirankumar Momaya Shailesh J. Mehta School of Management (SJMSOM), Indian Institute of Technology Bombay, Mumbai, India

P.N. Murthy Tata Consultancy Services, Business Systems & Cybernetics Center, Hyderabad, India

Shyam Narayan National Institute of Technology, Kurukshetra, India

Saboohi Nasim Department of Business Administration, Faculty of Management Studies and Research, Aligarh Muslim University, Aligarh, India

Zeba Naz Department of Business Administration, Faculty of Management Studies and Research, Aligarh Muslim University, Aligarh, India

Nirmal Pal Pennsylvania State University, University Park, USA

Gautam Pant NTPC Ltd., New Delhi, India

R. C. Pathak JSPM's Imperial College of Engineering & Research, Pune, India

Rajesh Pathak PRTM, London, UK

Ravi Shankar Pillutla Tata Consultancy Services Limited, Hyderabad, India

Ashok K. Pundir National Institute of Industrial Engineering (NITIE), Mumbai, India

Santosh Rangnekar Department of Management Studies, Indian Institute of Technology Roorkee, Roorkee, India

Renu Rastogi Department of Humanities and Social Science, Indian Institute of Technology Roorkee, Roorkee, India

Aditya Saharia Information Systems, Gabelli School of Business and Graduate School of Business Administration, Fordham University, New York, NY, USA

P. R. S. Sarma Indian Institute of Management Raipur, Raipur, India

G.V.R Sastry Center for Tourism and Technology Solutions, New Delhi, India

Ravi Shankar Department of Management Studies, Indian Institute of Technology Delhi, New Delhi, India

Qing Shu School of Business, Montclair State University, Montclair, New Jersey, USA

Sumati Sidharth DIAT, Pune, India

Surya Prakash Singh Department of Management Studies, Indian Institute of Technology Delhi, New Delhi, India

Shuchi Sinha Department of Management Studies, Indian Institute of Technology Delhi, New Delhi, India

Ushio Sumita Graduate School of Systems and Information Engineering, University of Tsukuba, Tsukuba, Japan

P. K. Suri Delhi School of Management, Delhi Technological University, Delhi, India

Sushil Department of Management Studies, Indian Institute of Technology Delhi, New Delhi, India

Surendra S. Yadav Department of Management Studies, Indian Institute of Technology Delhi, New Delhi, India

Jun Yoshii Graduate School of Systems and Information Engineering, University of Tsukuba, Tsukuba, Japan

Part I
Managing Flexibility

Chapter 1
Managing Flexibility: Developing a Framework of Flexibility Maturity Model

Sushil

1.1 Introduction

To cope with the developments and challenges in the global business environment, progressive business groups and companies are expected to redefine their strategies and resorting to restructuring. In the changing scenario, the management should redefine their corporate policy to cope with the uncertainties of both the free market economy and economic downturn using the flexible mechanism. It is felt that under the changing scenario the corporate world can take advantage by way of: (i) redefining their corporate strategies; (ii) making use of the flexible mechanism; (iii) redefining the organization culture; and (iv) formulating dynamic and competitive functional strategies. This is desirable both to compete with the best in the world and to survive during the turbulent phase of meltdown as well as partial recovery.

The business organizations usually face uncertainties and turbulence in the environment, and are expected to use innovative approaches to cope with the uncertainty rather than treating the management to be more rigid and bureaucratic in character. There is a growing realization that, in reality, the systems are faced with higher instability and turbulence than stability; it was a manner that was adopted in traditional management. The trends on all the management fronts indicate a movement toward greater flexibility in modern management. According to Upton (1994), "flexibility is the ability to change or react with little penalty in time, effort, cost, or performance." The concern for strategic flexibility has been highlighted by Hayes and Pisano (1994), while discussing the new manufacturing strategy. According to them, "In today's world, where nothing is predictable and unfamiliar competitors emerge from unexpected directions at the worst possible time, a company should

Sushil (✉)
Department of Management Studies, Indian Institute of Technology Delhi, New Delhi, India
e-mail: sushil@dms.iitd.ac.in; profsushil@gmail.com

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think of itself as a collection of products and businesses, which provide the flexibility needed to embark in new directions." Merkhofer (1977) defined the concept of choice and decision flexibility. According to him, "larger the choice set, that is, the more alternatives available for a decision the greater the decision flexibility." Gerber et al. (2014) have also highlighted the significance of dynamic decision management in the context of both operations and business plans by leveraging flexibility.

The term flexibility has been taken by various researchers and practitioners in multiple ways. First, a brief review of past work is provided keeping in view the paradoxical nature of flexibility. This is supplemented by the use of it, in practice, as per the views of professionals based on interviews and workshops. The elements reflected in practice have been clustered into different levels of flexibility maturity.

1.2 Managing Flexibility: A Brief Review

The term flexibility has, many a times, been treated in literature as well as practiced as an antithesis of rigidity. Thus, maximizing flexibility might be reflected as minimizing rigidity. If this logic is extended, then at the extreme, it might turn out to be infinite flexibility. Both the extremes, that is, thesis and antithesis, usually pull the organizations to extreme. Chaos theory has amply illustrated such a pull toward stability as well as instability. The forces of integration, control, certainty, and security invariably pull the organizations toward stability. Whereas, the organizations may also be attracted toward extreme instability by decentralization, innovation, and exploration. In either of the cases of extreme stability or instability, organizations are most likely to fail. In the study on the downfall of excellent organizations, it has been classified by Miller (1990) that they amplify their strategies, policies, attitudes, and events toward either of the extremes, which may give them initial success, but in course of time the extremism brings usually them to failure. It would be dangerous for management to head toward a chaotic organization, which would get destabilized and would go out of control.

According to Pascale (1990), successful organizations are characterized by paradox exhibiting integration or fit on one hand and differentiation or split on the other. Bahrami (1992) has taken Silicon Valley as the context and presented the emergence of a Bi-modal organization that could accommodate opposing tendencies and yet being effective in achieving goals. The study brought out three types of tensions, viz. centralization versus decentralization, stability versus dynamism, and uniformity versus diversity. While discussing reengineering business processes, Hammer and Champy (1994) emphasized hybrid centralized/decentralized operations. An elaborate treatment of paradox in the world of organizations has been highlighted by Handy (1994). According to him, "Paradox does not have to be resolved, only managed." Such a duality in strategy has been pointed out by many researches. The "either/or" proposition needs to be replaced by "both–and" proposition. In diagnosing the paradoxes in organizational strategies, Mckenzie (1996) developed 15 dialectal frames.

Gewirtz (1996) has provided the framework of flexible enterprise to reinvent it in a dynamically changing world. To cope with uncertainty, contrary thoughts need to be encouraged for exploratory learning and strategic opportunism; simultaneous top-down and bottom-up approach to learning (Flectcher and Olwyler 1997). Volberda (1997) considered flexibility as the most valuable strategic option in turbulent environment and proposed a construct of internal and external flexibilities at the operational, structural and strategic levels. Tushman and Anderson (1997) also provide a series of dualities negating "a versus b" options and worked for exploring the challenge of "a and b." Reilly (2001) has also worked upon polarizations of opinion while dealing with workplace flexibility and suggested the balancing of intent of both employee and employer.

The flexibility in the systemic sense cannot be generated by attaching ourselves to a point on the continuum. The flexibility is generated in the system by managing the paradox on the continuum. The success lies in making a dynamic interplay between the thesis and the antithesis. Thus, the systemic flexibility can be defined as (Sushil 1997, 1999, 2000):

> Flexibility is the exercise of free will or freedom of choice on the continuum to synthesize the dynamic interplay of thesis and antithesis in an interactive and innovative manner, capturing the ambiguity in systems and expanding the continuum with minimum time and efforts.

The continuum provides more than one point to operate. If there is only one option, the system would have fixation and is bound to become rigid. To have flexibility, more options need to be generated across the continuum which we can dynamically interplay or synthesize. Such a systemic concept of flexibility dwells on three central issues of "continuum" or "options," "dynamic interplay" or "change," and "freedom of choice" that are highly interrelated. To create flexibility, first we must have a range of "options;" second, we should be prepared to "change" across these options; and third, the change should not be random but governed by the "freedom of choice" (Sushil 2008, 2013a). The evolution of flexibility concepts has been comprehensively reviewed by Sharma et al. (2010). It reviews flexibility from external and internal context as well as active and passive context. The paper also elucidates different types of flexibilities such as organizational flexibility, technical flexibility, operations flexibility, strategic flexibility, marketing flexibility, and financial flexibility.

The duality in organizations has also been described as ambidexterity (Birkinshaw and Gibson 2004). This takes the exploitation strategy on one extreme and exploration strategy on the other. An ambidextrous organization is one that handles and balances the opposing strategies together. The concept of ambidexterity has been used by many authors that treat a balance of continuity in terms of alignment–orientation, rigor, and discipline and change in terms of adaptiveness–orientation, flexibility, and agility. This can be achieved by implementing flowing stream strategy(Sushil 2005, 2007, 2012a, b, 2013a). A *flowing stream* exhibits continuity being a *stream,* and at the same time also characterized by change in terms of continuous *flow* of water. In a similar manner, an enterprise also, usually, evolves like a flowing stream through its course of growth and development.

Bahrami and Evans (2010, 2011) have been working on the management of enterprises in the Silicon Valley and proposed a concept of super flexibility as flexibility practiced on a real-time basis. They have proposed super-flexible ecosystems, strategies, execution, organization, and leadership frameworks. Keeping in view the increasingly dynamic nature of organizational environments, van der Weerdt et al. (2012) developed a framework specifying linkages between types of flexibility and organizations design characteristics. Another notable contribution to cope with the uncertainty is that of adaptability as discussed by McKeown (2012). According to him, success depends upon successful adaptation and failure is a result of failure to adapt. Sushil (2015) has provided a glimpse of diverse shades of flexibility and agility in business and their hierarchical relationships.

1.3 Managing Flexibility—A Practitioners' Perspective

Modern management is moving toward greater flexibility in organization management globally. Under the changed scenario, flexibility might give a lot of room for managers to play, survive, and succeed. To understand the practical relevance of flexibility as the coping mechanism, some structured interviews were conducted in private, government, and public sector organizations. The fluidity of the subject topic being high, semi-structured interviewing method was preferred and conducted in a congenial, interactive yet in an informal environment for idea generation.

Problems in managing organizations traditionally and maximizing organizational effectiveness through enlightenment of employees have been focused. The problems created due to managing organization in a traditional manner have been found as:

- Failure to respond quickly to changes
- Lack of innovation
- Communication and coordination problems
- More compartmentalization and limited vision
- Rigidity in structure and function
- Little scope for creative and revolutionary actions
- Feudal approach of top-level management
- Poor control of work processes
- Narrow work role and stagnant career development opportunities

In today's situation, it can be observed that private sector enterprises are more flexible in management systems; however, large enterprises are, invariably, constrained to be less flexible. Private sector enterprises with their openness to changes have been successful in pioneering flexibility, while public sector organizations could not adopt adequate flexible work practices due to their structural hierarchy and rigid procedures.

With increasing competition, changing customer demands and need for quality, there is a need for speed to meet tight deadlines, technology upgradation, and product innovation; in other words—hyper-competition. The functional areas that various units recommend to introduce flexibility for tangible organizational benefits are:

- After sales servicing
- Marketing and engineering through job rotation
- Effective decision-making
- Customer handling with adequate autonomy
- Innovation and R&D
- Operational areas, customers' interaction and choice of research projects
- Supply chain responsiveness

Currently, several guidelines dictate about how to get and conduct business. Reduction or elimination of such guidelines (wherever feasible) would generate freedom and creativity to the operating managers. Flexibility means having broad guidelines but at the same time being more focused. Therefore, it should not be restricted to some departments but should be practiced company wide. The concern for establishing relations with customers (both external and internal) should be reflected in all functional areas. "Can I help you?" is an effective approach toward achieving this.

The most important aspect is the acceptability of flexible approach at the top-level. Next, the education and the sharing of the concept of flexible approach with larger number of people in the working group, especially the opinion leaders. Next is gradual experimentation and implementation.

The executives of high-tech private companies preferred breaking down traditional outlook and opening new doors of perception. The focus has been on training, commitment, awareness, and attitudinal development. Interactive working environment and cross-functional atmosphere can be created by introducing flexibility practices. Cultural development will enhance flexibility in the long run. Structural networking and empowering through delegation would build flexible functioning of organizations.

Some of the organizations indicated the following initiatives that can be taken to create a flexible work environment:

- Wider participation in decision-making process
- Slow process of induction
- Delegation of authority and responsibility
- Adopting professional approach instead of a feudal approach
- Ability to accept mistakes and learn from them instead of rigid "zero error" approach
- Greater autonomy
- Better scope for career development

- The preferred work place environment is one: in which each member takes pride; cheerful and friendly with basic services available; informal and relaxed work environment; improved quality of life at work for working at peace and harmony; spacious and well-facilitated office facilities to create delight in employees, that is, canteen, rest rooms, games room, etc. during lunch hour; and job rotation with reasonable frequency

Breaking of barriers at the peer level and operating much more informally in terms of style, attitude, treating employees as co-owners of an enterprise and making them feel equally responsible and responsive to the business objectives or corporate goals contribute in creating a healthy work environment. Thus, corporate structure, flexibility, dynamism, and culture should reflect in not only the way an enterprise does business but also in the products and services that the company offers. A company with concerns for customers and its own corporate image will, therefore, think twice before selling the wrong product to the customer and getting a back lash.

The preferred organizational structures were found to be:

- Business-need oriented
- Flat and lean
- Less divisions/compartments
- Process-based rather than product-wise along with effective coordination, optimal span of control, efficient orientation
- Networking for faster access and response time

The reasons of failure to respond quickly to the changing scenario have been structural rigidity, lack of innovation, and communication and coordination problems. This in turn obstructs the organizational vision and financial losses accrued to, that may ultimately result into collapse of the enterprise. Multi-functional task force and job rotation are good examples for job of enrichment. But however, if these skills are recognized, it will lead to organizational enlightenment. Flexibility is a tool for providing time to top management for their thought process to generate a clearer picture. Flexibility is intended to generate organizational benefits, but, if it is not carefully handled, it may degenerate into indiscipline and incompatibility. People have to be mature enough to appreciate that flexibility is not detrimental to organizational growth.

1.4 Practice of Flexibility

The views of the professionals who participated in a series of Flexible Systems Management workshops, conducted in last couple of years, were obtained to generate a field-level understanding of the concept of flexibility. A few of the views expressed by professionals are put together here.

Many of them felt that flexibility is adaptability or openness (not being rigid "as per rules always") to suggestions with continuous changes. It means having freedom of choice according to the desire of the person and adaptation to achieve a set goal.

Integrating self-ideas with other person's ideas has also been understood to be flexibility. It may be defined as understanding of problems in a broad way, yielding to solve problems of organization by interaction of individuals to get satisfactory results or adjustability to the situation. It can be emphasized that work should be smooth, taking into consideration problems of colleagues, even if some relaxation in rules is necessary in some circumstances it should be given for the better result.

To some extent, it means freedom of choice to take decision in a living situation without predicate from higher up and identify within the system. It is also expressed as adaptability to any given situation with continuous interactions within the system and the environment resulting in regular revisions and upgradation to achieve the targets.

Flexibility is also visualized as being malleable to situation and changing the action according to the demand in a set of circumstances and yet not losing sight of the goal. Even when the goal remains fixed, the methods of achieving these goals can vary and one who adopts these varying methods is flexible in the key areas in which he/she organizes work in different sections of the department and allocating work to other members.

Flexibility is also understood as adjusting to a given situation to produce the best possible solution with minimal waste taking into consideration the performance of subordinates. This means finding out the reasons for poor performance and try to rectify them and give sufficient time to achieve changes and treating disciplinary action, invariably, as the last resort. Knowledge of available options in a system and capability to make more appropriate choice for the particular environment and acceptance of the need for availability of choice for varying/changing environment is also considered flexibility.

Organizations as living entities practice flexibility at various levels. Select views of the professionals on the practice of flexibility are synthesized here to gain practical insights about the way flexibility is implemented and the extent to which professionals have flexibility in their work environment.

The continuum needs to have different end points for different levels of functionaries. However, freedom or flexibility gets restricted with red-tapism. There is very little to play around. The rules are such that there is little room for flexibility. There are too many obstacles in the implementation even if someone wants to be flexible or adopt a dynamic interplay in management.

In professional life, there is freedom of decision-making, that is, one can have choices. For employee care, the choices are available but with the system constraints and limited finances. However, for teaching the freedom is much greater. The crucial areas in which flexibility can provide the cutting edge and freedom of choice are management of human resources, job performance, and organization and intent structures.

In the present situation, almost everything is channelized by the guidelines already laid down within the system, which may not be relevant in all cases. One says that yes, I have freedom of choice but not to the desired extent (fully understanding the framework of our rules); I do have freedom of choice to take decision but important decisions should be taken by top management; I do have freedom of choice in the organization but after it seems to become rigid; I do see previous actions help in creating external flexibility but we have to adopt practices to see that there are internal changes in people as well. The crucial areas are learning, values, decision-making, and judgment in which flexibility could provide a cutting edge as in this process these subjects would become more systemic and comprehensible.

In summary, we find a mixed opinion about the practice of flexibility in the real-life setting. This connotes flexibility with a frame of reference. The freedom of choice seems to be only apparent which is usually lost in the jungle of bureaucracy. The need to have flexibility is expressed widely for effective functioning but there are impediments on the way.

1.4.1 Impediments

It is widely accepted that flexibility is comparatively more practiced while less preached. Organizations and individuals both are practicing flexibility in one way or the other, which is a characteristic of any living system. To find out the various impediments, small group exercises were conducted to identify the obstacles or impediments in practicing flexibility. The major points generated are as follows:

Flexibility Misunderstood Thinking on the organization's part that giving too much of flexibility may go against the organization, hence not much flexibility is provided.

Lack of Total Autonomy Total autonomy may never be given in view of coordination problems, but what is generally provided to an individual is inadequate autonomy; inadequate power is disastrous.

Task Structure This is related to autonomy. If enough autonomy is provided, then task structure is not a problem but if it is not so, the flexibility options are reduced. An example quoted here is that in a typical bureaucratic pyramidal structure if a subordinate refuses to work, then the superior may be helpless, as he/she does not have enough powers.

Low Level of Thinking Ability For being more flexible, thinking ability has to be more that helps in taking quick decisions and actions. The ineffective decision-making is directly linked to improper thinking.

Type of Organizational Set Up For example, hierarchical setup provides less flexibility. People are clearly instructed what they have to do rather than giving them a space to contribute creatively.

Type of Functional Area It is also suggested that type of functional area also has a bearing on flexibility, that is, as per one of the groups, flexibility in financial matters should be limited.

Size of the Organization If size of the organization is large flexibility is less, and if size of the organization is small flexibility is more, as in small companies changes can be made comparatively fast.

Type of Management Flexibility is, invariably, influenced by the style of management. Flexibility in professionally managed organizations is comparatively more, while it is less in family managed or traditionally managed organizations. If a company has strong hire and fire policy, flexibility exercised by the individuals would be less, as managers may not be inclined to invite trouble by going against the rut.

External Inhibitors Plurality or diversity is desirable but perhaps difficult and not widely practiced.

External Flexibility In case of insufficient external flexibility the individuals may be restricted to be flexible (Sushil 2013b).

This section has dealt with the various obstacles in practicing flexibility. In this light, the individuals and the organizations have to be conscious to overcome these impediments in the way of flexibility in management. The next section deals with the various ways how to overcome the obstacles.

1.4.2 Overcoming Obstacles in Practicing Flexibility

In the uncertain times, the management has to be fast adaptive. Knowing the obstacles only will not help, hence there have to be proper solutions for overcoming the obstacles or practicing flexibility. Sky is treated as the metaphor for flexibility. Since there are impediments in the way of each one to reach the fuller sky, emergence of flexibility options was carried out by the groups through a creativity exercise. Nominal group technique was conducted (Round Robin way) for the whole group of participants in three rounds. All the options generated were prioritized from one to three and group ranking was obtained. The seed question posed to the participants was "how to overcome obstacles to flexibility?"

After ranking the generated options, the group consensus was clubbed into two categories. The discussion among participants gave pointer toward that not only the individual but the organizational changes have also to be brought in. The selected points may be clearly divided into organization's structural issues and behavioral issues of individuals.

Organization's structural issues are:

- Effective communication and information systems
- Greater functional autonomy for decision-making
- Organizational restructuring, that is, from pyramidal to flat structure
- Introducing professional management
- Inculcate values that add to flexibility
- Rewards and incentive schemes for practicing flexibility

While individual based issues are:

- Inculcate team spirit
- Build consensus on organizational goals and objectives
- Give training to individuals on various dimensions of flexibility

Apart from the creativity exercise, participants expressed their views on "how to create flexibility in management?" interactively as well as through written feedbacks on formatted questionnaires. Some of the views of participants of the workshops are summarized below.

For human resource management, flexi-time, multi-skilling, flexible space, flexible leadership styles, motivational strategies, and training of people to think and act flexibly are some important ways. For job performance, the options suggested are loose (bounded) job descriptions, providing people with continua for different aspects, and distribution of authority/responsibility depending upon task.

In the crucial areas like decision-making, it is essential to generate managerial excellence and broaden the knowledge base of managers. Many previous actions may be rather rigid; however, in order to evolve better decision-making, appropriate actions as discussed earlier must be taken so that the system is flexible and better decision-making is possible.

One group of participants proposed that to provide flexibility in the crucial areas decentralize to create a flatter organization, store databases and information flow, inspire an attitudinal change among all levels of management, simplify the work processes, provide continuous training and development, seeking and advocating flexi-time, sharing information with group and other managers whenever possible, and willingness to change the attitude. It has been suggested that to create flexibility, we have to learn, appreciate, and communicate and at the same time take up the challenges, plan and then implement their analysis, and adopt and reengineer.

Finally, it may be concluded that to overcome the impediments to flexibility drastic organizational changes are required and the organizations should provide more flexibility to individuals to practice flexibility. It is imperative that more external flexibility is required for meeting new challenges of the current decade. It is also felt that total cultural change is not a prerequisite for the structural change, which will lead to greater flexibility in management.

1.5 Flexibility Maturity Model: Levels and Elements

As flexibility is emerging to be a major business excellence dimension; it is imperative that maturity models of enterprises should define flexibility of various types at different maturity levels. This will facilitate organizations to chart out their road map for creating or enhancing flexibility to become more competitive and to effectively manage risk of uncertainty in business environment.

A typical flexibility maturity model (Sushil 2012c, 2014a, b) could have multiple maturity levels of flexibility in organizations. According to situation-actor-process (SAP) framework (Sushil 2001, 2009), it may treat situation as the driving force

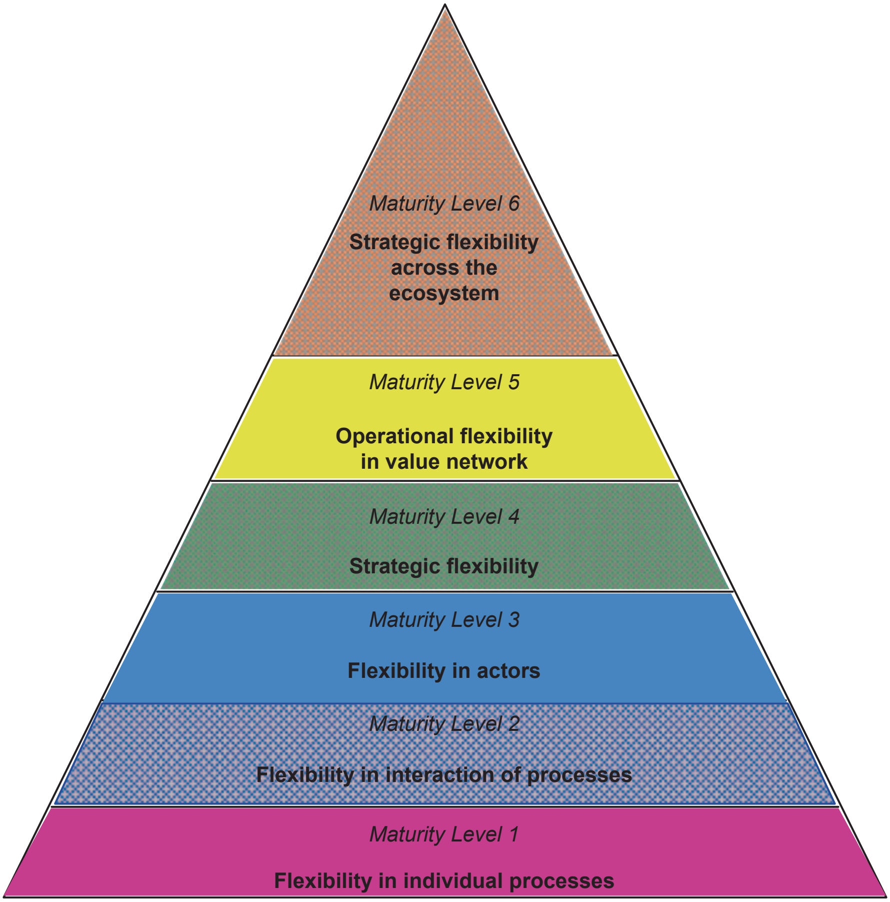

Fig. 1.1 A typical flexibility maturity model

and cope with it by flexibility on the fronts of actors as well as processes. An organization may climb the maturity of flexibility from operational to strategic on one hand, and organization-centric to value network orientation on the other. Various possible maturity levels could range from lower to higher maturity in terms of: flexibility in individual processes at operational level; flexibility in interaction of processes; flexibility in actors; strategic flexibility; and flexibility at operational as well as strategic levels in the whole value network as depicted in Fig. 1.1. As per practitioners' view, various aspects of flexibility in practice have been obtained and reported in previous sections. These elements of flexibility are arranged at different maturity levels in this section.

Level 1: Flexibility in Individual Processes At the lowest level of flexibility maturity, an organization is expected to create options and change mechanisms separately in various operational processes. This would facilitate generation of numerous types of flexibilities such as operations flexibility, manufacturing flexibility (Honda by way of using robots), marketing flexibility (Unilever), financial flexibility (ICICI), human resources flexibility (GE), and so on. This becomes the start point of journey of flexibility maturity for any organization. The flexibility elements at maturity level one are identified as follows:

- Simplifying and reengineering the work processes
- Planning flexible budgets
- Practicing flexi-time, flexi-place, and telecommuting
- Responsiveness to customer complaints
- Implementing flexible manufacturing technology
- Flexible pricing to suit the customer
- Direct marketing/e-marketing—minimizing the channels
- Enhancing labor flexibility
- Designing flexible space
- Outsourcing customer interface processes
- Flexible hierarchy and reporting
- Flexible finance handling
- Innovation in processes
- Responsive after sale service processes
- Execution flexibility

Level 2: Flexibility in Interaction of Processes The next higher level would work toward interaction of flexibilities in various processes by creating flexibility at the interfaces. For example, how flexibility in marketing interfaces with flexibility in manufacturing, how technological flexibility is linked with financial flexibility, how flexibility in human resource management processes would help in creating a flexible supply chain, and many such interactions among business processes would pave the way for a flexible enterprise. Interaction of two or more processes would open up multiple frontiers of enterprise flexibility. The flexibility considerations at the organizational level and in information systems would help in effective integration. Some selected elements at this level of maturity are:

- Effective communication and information systems
- Implementing knowledge-based decision support and management support systems
- Integrating R&D personnel with marketing teams
- Flexible and innovative product designs
- Creating ambidexterity in organization
- Organizational restructuring, that is, from pyramidal to flat structure
- Implementing manufacturing resource planning and enterprise resource planning systems
- Providing an environment for end-user computing
- Introducing e-business architecture
- Implementing knowledge tone applications
- Cross-functional flexible processes
- 360° feedback in the process

- Interdepartmental transfers
- Transparency in information sharing
- Enhancing co-creation
- Implementing informal communication system across the organization

Level 3: Flexibility in Actors At the next higher level of flexibility maturity, the issues related with actors or stakeholders would become pertinent. At this level, it is expected to link processes with actors (stakeholders) and thus intend to address sustainability and vitality of organizations. To effectively implement flexibility in processes and their interactions, flexibility capability is to be nurtured in various actors in terms of openness, questioning world views or mental models, responsive actions, learning orientation, flexible leadership, and many more actor related dimensions. Some elements, as identified in this study, at this level are given below:

- Flexible leadership styles
- Creating innovative culture
- Inculcate team spirit
- Give training to individuals on various dimensions of flexibility
- Greater functional autonomy for decision-making
- Creating empowerment and localness of decision-making
- Developing multi-skilling across the organization
- Acquiring, sharing, and storing the knowledge
- Create an attitudinal change among all levels of management
- Broaden the knowledge base of managers
- Rewards and incentive schemes for practicing flexibility
- Institutionalizing organizational learning
- Inculcate values that add to flexibility
- Integrating self-ideas with other persons ideas
- Cross-cultural management
- Intense advocacy of flexibility should be provided with actors
- Wider acceptance of mistakes and failure
- Communicating core values and core purpose to whole organization

Level 4: Strategic Flexibility The flexibility ladder takes the next step to strategic level. At this level, an organization would exhibit strategic flexibility to manage paradoxes; the most prominent one is that of "confluence of continuity and change" addressed by flowing stream strategy (Sushil 2012a, b, 2013a). Some other strategic paradoxes could be globalization–localization; expansion–diversification; exploitation–exploration; and many more. This is the highest maturity level in the organizational context; beyond which flexibility in the value network is to be defined. This is reflected by many leading corporations such as Apple (exploring new technologies in convergence to existing ones), Microsoft (cannibalization), IBM (from products to solutions), Nokia (creating options), and others. The maturity level four of strategic flexibility of any organization may be exhibited by following initiatives:

- Blue ocean strategy to create new market spaces
- Managing confluence of continuity and change (flowing stream strategy)

- Developing innovative business models
- Building existing core competencies and acquiring new competencies
- Entering into alliances and strategic networks
- Evolving the shared vision
- Strategically changing the scope by mergers and acquisitions
- Redefining bases of customer value
- Changing the action according to the demand and yet not losing sight of the goal
- When the goal remains fixed, the methods of achieving these goals can vary
- Incorporating emergence in the planning
- Retaining existing customers and entering new markets
- Reinventing strategy
- Redefining the enterprise and the industry
- The vision, mission, and goal should be adaptive and changeable to the new environment
- Resource flexibility
- Competence flexibility

Level 5: Operational Flexibility in Value Network Further, the organization should transcend flexibility to operations in the whole value network. This would enable creating processes and systems to enhance flexibility of interactions with partners such as supply chain flexibility. Even if the organizational processes are flexible, but the processes in the rest of the value network are comparatively rigid, the whole response would be constrained. To effectively practice flexibility in business, operations in the entire value network should have flexibility alignment. This can be facilitated, a great deal, through developments in information and communication technologies. For example, direct marketing by Dell through e-route has enhanced logistic, marketing, and organizational flexibilities of all partners in the network. At this maturity level, elements interlinking the value chain are considered; some important ones are:

- Supply chain flexibility
- Open relationships with partners
- Disaggregating and reaggregating the value chain
- Boundaryless organization with outsourcing/alliance partners
- Innovative options in after sales servicing
- Facilitating vendors to practice flexibility in processes
- Market pull supply chain
- Upstream and downstream flexibility
- Openness for forward and backward integration

Level 6: Strategic Flexibility Across the Ecosystem Finally, it should strive to inculcate strategic flexibility across the ecosystem of business encompassing all possible stakeholders (both near and far) in the star model. This would enhance performance not only of the firm but also of all stakeholders in the ecosystem such as society, environment, customers, government, media, interfacing industries, and so on. This has been reflected by Apple, Nokia, Ford, and other technology intensive organizations. Some flexibility elements at the highest level of maturity would be represented by:

- Going green throughout the ecosystem
- Integration of products, services, and applications
- Integrating continuity and change in ecosystem
- Marketing through social networks
- Creating an ecosystem of applications around the products
- Integrating products and services into solutions
- Integrating strategic flexibility across the system
- Government–industrial interface interaction

1.6 Assessing Flexibility Maturity Levels

The flexibility maturity of any organization needs to be assessed. The process of assessing flexibility maturity of any organization would involve following steps:

i. Generate elements about the practice of flexibility through managerial interviews and focus group discussions.
ii. Verify the elements through a questionnaire survey of larger sample of managers.
iii. Develop hierarchical structure of flexibility elements using total interpretive structural modeling (Sushil 2012d).
iv. Treat each element as a variable and carry out a questionnaire survey to empirically assess these flexibility elements.
v. Carry out factor analysis as per the six levels of flexibility maturity. The highest factor loading will indicate the maturity level.

The process of assessment would involve various stakeholders in any organization. The organization concerned may either create an internal group or can take help of an external advisor/assessor for this purpose.

1.7 Conclusion

The business and industry should forge ahead with plans to reformulate survival and growth strategies. In a bid to equip and face the challenges of uncertainty thrown up by the new business environment, it is stressed to incorporate flexibility by managing the confluence of continuity and change in the corporations. The task before the organization is to device strategies that help it to energize the untapped potential by empowering people for inspired contribution, internal streamlining through redeployment of work strength and managerial structured adjustments, mergers and acquisitions, divestments, spin-offs, leveraged buyouts, and financial capital restructuring. The focus should be on strategic execution and creation of strategic flexibility. In a successful restructuring move, 10 % is strategy; rest is in the execution, which means the ability to take uncomfortable decisions and follow-up on it.

The process of assessment of flexibility maturity needs to be tested in real-life situations. This will also help in refining and enriching the flexibility elements at different maturity levels. The flexibility maturity model can be compared with other maturity models to enable managing flexibility in organizations in an effective manner.

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Chapter 2
Critical Design Elements for Service Systems

Rashmi Jain and Qing Shu

2.1 Introduction

Service design is increasingly being recognized as a competitive force in a global economy where technology is now a commodity. At the same time, as customers are becoming more and more sophisticated, the ability to provide outstanding service will allow companies to find a niche in even some of the most high-cost and low-margins industry. While the traditional focus in product design is important in building a successful enterprise, the more subtle service design is equally, if not more, critical in differentiating the excellent from the mediocre. Therefore, identifying the critical elements in service design will be highly valuable in guiding companies in innovating new services or improving the existing ones. In this chapter, we propose a set of such critical design elements, which if taken into consideration, will impact the success of services.

2.2 Service Design: Terms and Definitions

Traditionally, services and products have been compared in terms of how they are produced and consumed (Shostack 1977; Zeithaml et al. 1985; Fisk et al. 1993). Generally, products and services are distinguished in terms of their characteristics such as role of customers in the delivery, nontransferability, intangibility, heterogeneity, inseparability, and perishability. The problems of treating services as an extension of the body of goods-centric knowledge have been noted in terms of

R. Jain (✉) · Q. Shu
School of Business, Montclair State University, Montclair, New Jersey, USA
e-mail: jainra@mail.montclair.edu, rashmijain@verizon.net

Q. Shu
e-mail: shuqingsq@gmail.com

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the distinguishing attributes, namely, inseparability of production and consumption, location of delivery of benefits, and the role of customer in the achievement of excellence in outcomes (Ng et al. 2011). An attempt to provide an integrated value-centric approach has been proposed by these authors by reconciling various streams of research.

Service design is a design specialism that helps to develop and deliver great services. Service design focus improves ease of use, satisfaction, loyalty, and efficiency right across areas such as environments, communications, and products—and not forgetting the people who deliver the service (Stickdorn and Schneider 2012). "When you have 2 coffee shops right next to each other, that each sell the exact same coffee at the exact same price; Service Design is what make you walk into the one and not the other" (Fonteijn 2008). Critical elements are defined as "an input of a process that is essential to the production of the final product at a satisfactory level of quality" in literature (Business Dictionary 2012). We define critical elements in service design as the important characteristics or attributes that a service should possess in order to be successful.

A survey for this research was designed based on literature review on product and service design as well as best practices observed in the service industry. A pilot study was done with three companies. Later professionals from eight service industries were surveyed. They included hospitality, health care, education, tourism, consulting, banking, aviation, and estate management.

2.3 Critical Elements in Current Literature

Our literature review resulted in a set of critical elements in product design which could be applied to service design. Therefore, these are not a comprehensive set of critical elements for product design but only those selected ones that apply to services. These critical elements are discussed below.

Quality and Performance Quality and performance is an important element in product design (Taguchi 1986). There are various definitions for quality and performance. It is defined as "conformance to specifications," which means "how well a product or service meets the targets and tolerances determined by its designers" (Reid and Sanders 2007). It is also defined by Joseph M. Juran as fitness for use in terms of design, conformance, availability, safety, and field use (Battikha 2003).

Ergonomics Ergonomics involves the matching of a product to the target user's capabilities to maximize safety, comfort, and efficiency of use. Ergonomics requirements would affect form such as weight, texture, and shape. Inadequate attention to ergonomics may result in consumer dissatisfaction (Bloch 1995).

Appeal Appeal refers to aesthetics, attractiveness, and beauty. The aesthetic appeal, the pleasure it creates and the satisfaction it brings to the customer may determine the success of a product in the marketplace (Khalid and Helander 2006).

Novelty Novelty is the degree to which a product is seen as different from a typical object. Novelty offers differentiating value to the users, which is part of the emotional value that a product could bring (Noble and Kumar 2010).

Product Personality Product personality is personality perceptions emanating solely from design elements and not from the broader brand. For example, a unique design of a toaster through the shape and color could "exude a sense of bubbly excitement" for a young person. A standard stainless steel toaster is "more sophisticated and classic" which would appeal to an older person. Design with more personality gives higher symbolic or self-expression value which enhances emotional value of the product (Noble and Kumar 2010).

2.3.1 A Proposed Set of Critical Elements in Service Design

In this section, we present the proposed set of relevant critical elements in service design. These were selected to be used in our study for gathering information from the companies. These are based on the set of critical elements in product design and existing literature on service design. Some elements are also synthesized from best practices in the service industry. The critical elements of service design are discussed below in this section.

Service Quality and Performance This element is borrowed from the same critical element in product design, and has been recognized as an important design attribute in literature (Sousa et al. 2008). However, quality in service organizations is defined differently as that in manufacturing. This is because services can only be experienced, rather than seen or touched. Therefore, perceptions of service can be highly subjective (Reid and Sanders 2007). In designing quality and performance into services, it implies having design parameters at the design phase that would ultimately ensure service quality and performance. For example, to ensure that the haircut meets the clients' requirement, it might be useful to have a photo record of the hair styles of repeat customers. In this way, if the repeat customer requests for the same previous hair style, the reference photo would clarify the customer requirement, and hence help to achieve better service quality. Service quality and performance are multidimensional, and encompasses several sub-elements.

Service Staff's Attitude to Consumers It manifests in how courteous, friendly, and helpful the service personnel are. This is an important element in achieving a high service quality and customer satisfaction (Reid and Sanders 2007).

Privacy and Security The ability to protect the safety and confidentiality of customer information (Sousa et al. 2008). This element could be interpreted differently in different service industries. For example, online shopping websites such as *Amazon* would need to protect the customer's credit card information. In health-care industry, it could include the confidentiality of the patient's medical condition and physical privacy which encompass the safekeeping of the medical record and a private clinic room for medical examination.

Comfort in Receiving the Service A sense of physical or psychological ease, often characterized as a lack of hardship. This is the equivalent of "ergonomics" in product design elements (Bloch 1995). For example, *Singapore Airlines'* economy class seats are ergonomically designed to provide comfort to customers. Other design considerations such as "KrisWorld" (an award-winning in-flight entertainment system which provides the latest selection of programs and games), in-seat laptop power supply, onboard amenities including individual toothbrush, toothpaste, knitted sock packs, etc. are also aimed at providing travelers more comfort during the flight (Singapore Airlines).

Timeliness and Promptness The ability to provide services quickly without having to make customers wait for prolonged period of time (Sousa et al. 2008). It includes the ability to respond to standardized or special customer requirements quickly.

Consistency The degree to which the service is the same each time (Sousa et al. 2008). However, it is worthwhile to notice that consistency would not be achieved if the service allows customization. Therefore, consistency should rather be interpreted as a high level of quality in terms of hospitality, security and privacy, comfort, timeliness and promptness, and hence overall customer satisfaction.

Pricing of Service Price is the amount consumer would be paying for the service. When there is uncertainty in the performance of the service, consumers are likely to use price as a cue in forming performance expectations (Dodds et al. 1991). Pricing is an important design element that has direct impact on how satisfied customers are with the service. Therefore, it is important to price the service at the right level, so that the consumers experience minimum price–expectation inconsistency (Voss et al. 1998).

However, it is important to note that pricing of service might not be the basis in forming service standard expectation when the service provider practices demand-oriented pricing which results in widely varying prices for the same service depending on the time that the service is booked and consumed. For example, air ticket is likely to be more expensive if it is booked a few days before the flight, compared to a few months ahead. However, consumers would still demand more from airlines that generally charge more (e.g., Singapore Airlines) compared to the rest which charge less.

Convenience and Usability of Services Convenience and usability of services refer to the ability of consumer to use the service with ease (Osterwalder et al. 2010). This element has been manifested in the design of services across various industries. For example, airlines and hotels design their booking systems in a way that is intuitive to understand, with as few clicks as possible to reach the final confirmation page (Zedlman 2001). Meanwhile, in its recent advisement, *Mercedes-Benz* focused heavily on its convenient services, featuring only after-sales services in the Straits Times (Mercedes-Benz 2012). The highlights are centralized servicing booking system, 60-min express service and star collection, and return service. There are two sub-elements under convenience and usability of services.

Accessibility of Services The degree to which the service is available to as many people as possible. Accessibility can be viewed as the "ability to access" and benefit from some system or entity (Hwang 2011). For example, online shopping websites that offer various payment methods are making their services accessible to a larger group of consumers.

Customization and Flexibility of Services The ability to tailor the service to the specific needs of an individual customer or customer segments (Osterwalder et al. 2010). It is also the ability to cater the service to the customer's preferences (Bhandari and Snowdon 2012). Some examples are the ability to add an extra bed in the hotel room and the flexibility for consumers to choose their seats and meals during a flight.

Availability of Service-Related Information for Consumers Availability of service-related information is an important service design characteristic for two reasons. First, such information is a powerful marketing tool in informing consumers the usefulness, usability, and desirability of the service (Bhandari and Snowdon 2012).

Second, a readily available pool of service-related information also helps consumers in decision-making. For example, *AirAsia* online booking system provides flight prices 3 days before and after the customer's chosen date, so that travelers, who are flexible with travelling dates, could compare the prices and make a best decision on when to travel (AirAsia 2013). A large number of service providers with physical locations inform customers their opening hours and getting-there directions on their websites. Such information on price and accessibility are important in helping customers make decisions and hence, enhancing overall customer satisfaction.

Ambience of Service Environment Ambience is the result of interaction between people (i.e., service providers and customers) and the physical environment (i.e., the servicescape; Heide et al. 2007). This entails ambience design or atmosphere design which affects people through the creation of a psychophysical entirety. In practice, this means emphasizing on experience and phenomenality (Koskinen). For example, *Starbucks Coffee* creates the experience of coffee-drinking through the use of light music, coffee aroma, free wi-fi, and comfortable chairs and sofas.

Prestige Perception by Consumers The perception of high prestige is often associated with wealth, status, and success (Osterwalder et al. 2010). If a service is able to create high prestige perception, it is likely to bring out more consumer satisfaction. Service designers could vary factors such as location, price, branding, exclusivity, and spokesperson to create high prestige perception. For example, *the Peninsula Hotel* in Hong Kong served its guests with Rolls-Royce automobiles since 1970, creating high-end prestige perception among consumers (Nunez 2006).

On the other hand, the perception of ordinariness is associated with affordability and ability to meet the basic needs of consumers. For example, *Best Value Inn* hotel chain in the USA gives consumers a perception of affordability and great value. This is also reflected through its pricing, marketing, and amenities provided (AmericasBestValueInn 2013).

Uniqueness of Services Uniqueness is the degree to which a service is seen as different from a typical service (Noble and Kumar 2010). This is based on “novelty” in the critical element of product design. Uniqueness could be achieved through new service concept or technology innovation. It ensures cost reduction (e.g., budget airline) or meets a new type of demands previously unknown to the consumers (e.g., destination dining offered by high-end resorts).

Two new aspects on uniqueness were added as a result of the interview process. The first is the sentiment in the airline and hospitality industry that uniqueness can be very expensive to achieve. Even if they have created something unique, others may copy it. Therefore, there is a need to constantly innovate to meet the needs of the consumers. A good way to innovate is to focus on the soft skills such as people, rather than the hardware which can be purchased and hence replicated by competitors. For example, Singapore Airlines has successfully used the “Singapore Girl” theme to make itself stand out among all airlines.

The second aspect is that the service providers would need to know if consumers actually care about the unique features they are providing. In other words, it is important to understand the needs of consumers very well. For example, Emirates provided shower services in their first class A380 suites which received great feedback because business traveler going to work right after a flight would appreciate a refreshed look (Fischer 2011). If the unique service features do not make a difference to the consumers, it would be a waste in innovation and marketing expenses.

2.4 Conclusion

This research is an initial step toward proposing a set of critical elements in service design and leverages on product design and industrial best practices. Eight service design elements are proposed based on literature review, industry best practices, and interviews with service professionals. The elements are: service quality and performance, pricing of service, convenience and usability of services, availability of service-related information for consumers, ambience of service environment, branding and reputation perception by consumers, uniqueness of services, and consideration of constraints in designing the services. The set of critical elements identified and validated through this research could be used as reference list or toolkit to help beginner service designers propose and justify design ideas. As a primary research in the area of critical element in service design, it lays the foundation for future research in identifying critical elements that would have an impact on the success of services during the design stage.

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Chapter 3
Flexibility Intensity—How Market Forces Drive Variability

Nirmal Pal

3.1 Introduction

Other chapters in this book address the compelling reasons for flexibility management. Therefore, I will not elaborate on those. Rather, I will attempt to present a framework that business managers can use to determine where and how much flexibility is needed. Implementation of flexibility is cost, time and resource intensive, and I hope this simple framework will help you in analyzing and then implementing flexibility in your various business segments and in their appropriate dimensions that I discuss later in this chapter.

3.2 Definition of Flexibility Management

My simple definition of flexibility management is demonstrated by the chart given in Fig. 3.1. It is the ability to apply a change that results in significant business gains or in sustaining business gains. If there is no change to the bottom line or top line as a direct consequence of implementing a change, then I would urge you to question the change itself. Sometimes, we may have to consider a societal or regulatory change, but the results must contribute to, at least, sustaining gains.

I use three basic areas of your enterprise where flexibility can be implemented. And by intensity, I mean the extent to which the area of your business needs to be flexible. For want of quantity rigour, I define the intensity to be low, medium or high as qualitative dimensions (Fig. 3.2).

By business model, I mean the core value proposition of your business of how you design, develop and deliver value to your customers, and the underlying financial model and profit formula.

N. Pal (✉)
Pennsylvania State University, University Park, USA
e-mail: nip1@psu.edu

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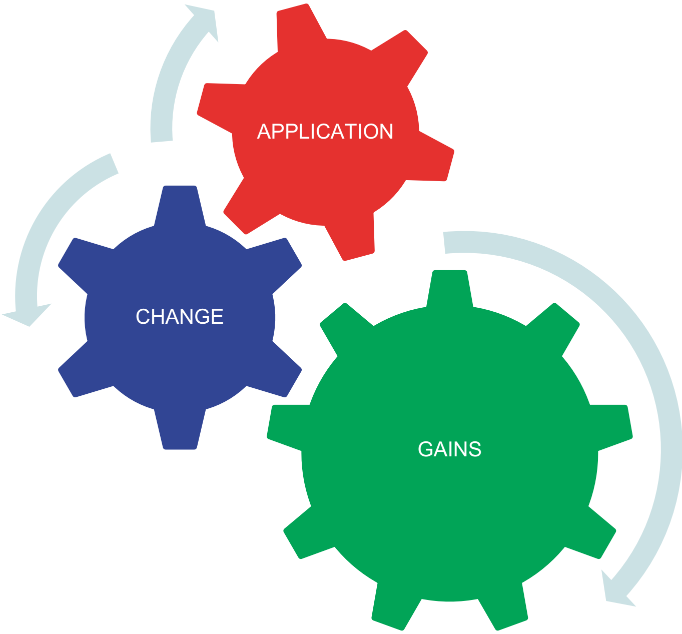

Fig. 3.1 Definition of flexibility management

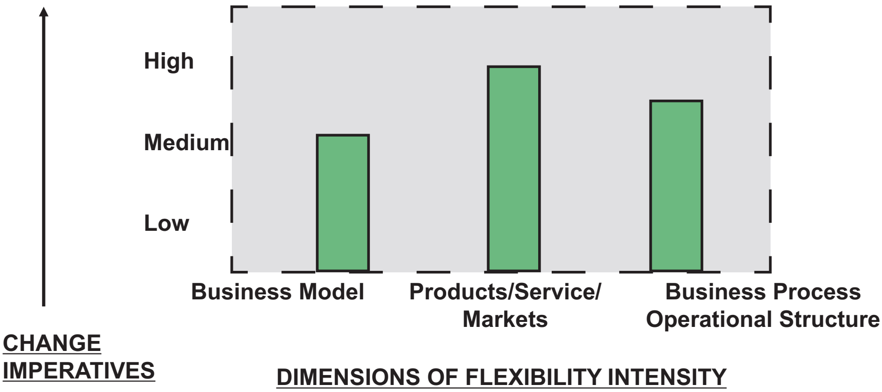

Fig. 3.2 Dimensions of flexibility intensity

By products/services, I mean those that constitute your value proposition in terms of meeting the needs and wants of your customers. And by markets, I mean the segment of the population and the geography where your customers are located.

By business processes and operational structure, I mean your core resources, including key business processes, technology infrastructure and human capital, to correspond to the business model and products/services/markets of your business.

3.3 A New Framework for Flexibility Management

I first introduced this framework in my book, “The Agile Enterprise” Springer, 2006 Pal and Pantaleo (2006) (presented here in Fig. 3.3). I am happy to say that the framework has stood the test of time, and you can judge its effectiveness as you apply it to your own business enterprise.

As you can see, it has two dimensions: market demand and market dynamics. The horizontal scale of market demand relates to your products and services, and varies from left to right, from fully standardized to fully differentiated or customized. So, on the extreme left, you make no changes to your products/services irrespective of whom you serve or where you serve. But on the extreme right, your products and services are fully customized to the specific needs of each and every customer.

The vertical scale of market dynamics relates to the market and your competitive environment. On the top, you have no or little competition, and the market is consolidated within a few players. At the bottom, the market is fully fragmented, and you have a lot of competition.

Then I introduce the concept of quadrants from 1 to 4, and I profess that the required flexibility varies by quadrants, and the intensity varies by how far away your business is from the centre point (Fig. 3.4).

In quadrant 1, you are lucky to be in a stable environment with only a few competitors if any at all. These are mainly public sector undertakings, utility providers and the like. Oil companies can fall in this quadrant too. In the sixties and seventies, IBM used to be in quadrant 1. These are, or used to be, vertically integrated companies with hierarchical organizational structure, and have a very low need for change.

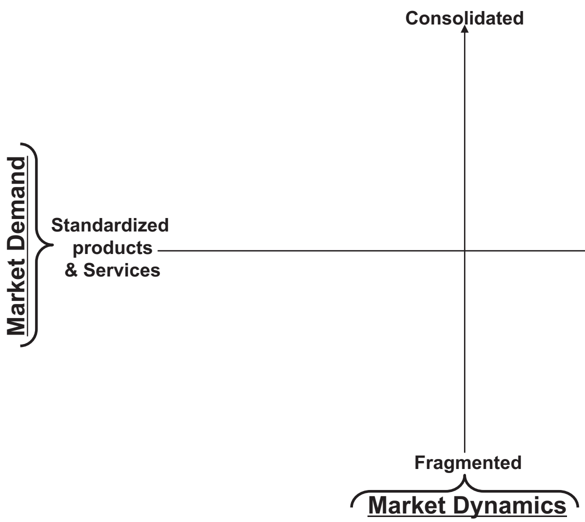

Fig. 3.3 Market demand and market dynamics—a new framework for flexibility management

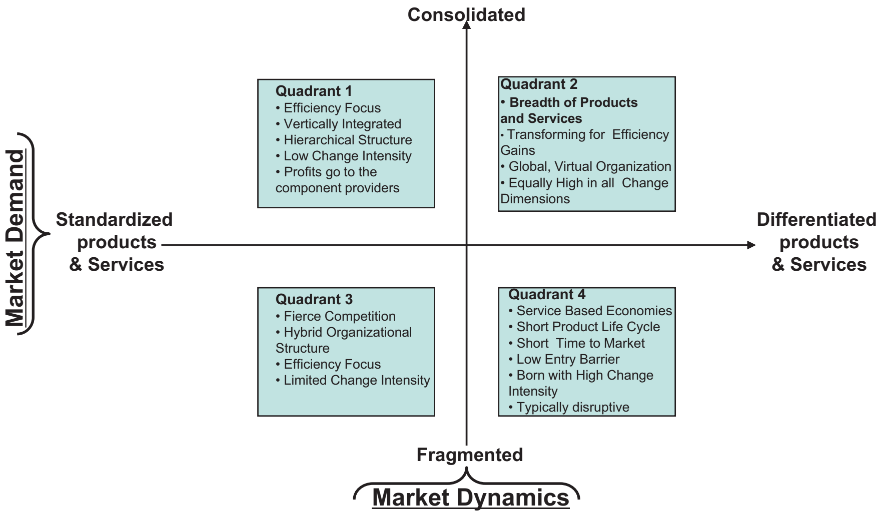

Fig. 3.4 Flexibility intensity vary by quadrants

Diagonally opposite to quadrant 1 is quadrant 4, where the environment is extremely volatile with many players and discriminating customers demanding unique products and services. These are dotcom and/or service-based companies with short-life-cycle products. Generally, there is a low entry barrier, and time to market is short. These companies are born with high change intensity.

Quadrant 3 with standardized products and services in a fragmented market perhaps only exists in theory. There is fierce competition and soon the survivor moves into quadrant 1.

Quadrant 2 is very important. Most of these companies were born in quadrant 4 and have moved to this quadrant after a series of mergers and acquisitions, as seen in the mobile telephone business for both handset manufacturers as well as service providers.

I have now introduced the flexibility intensity charts in each of the four quadrants for the three dimensions mentioned earlier (Fig. 3.5).

For quadrant 1, as you will agree from my earlier explanation, there is low change intensity. They feel no need to change their business models or their products and services. There is societal and/or government pressure to keep price increases to the minimum, so these enterprises will periodically look at their key business processes and the underlying technology infrastructure to improve their efficiencies of design, development and delivery.

Quadrant 4, on the other hand and as I said before, is born with high change intensity, and for all three dimensions of flexibility they work hard to stay ahead of the competition. Many, who do not, soon die or get swallowed by a larger predator.

As I mentioned earlier, in quadrant 2, many companies enter this phase as a result of mergers and acquisitions from quadrant 4. But in this market, customers

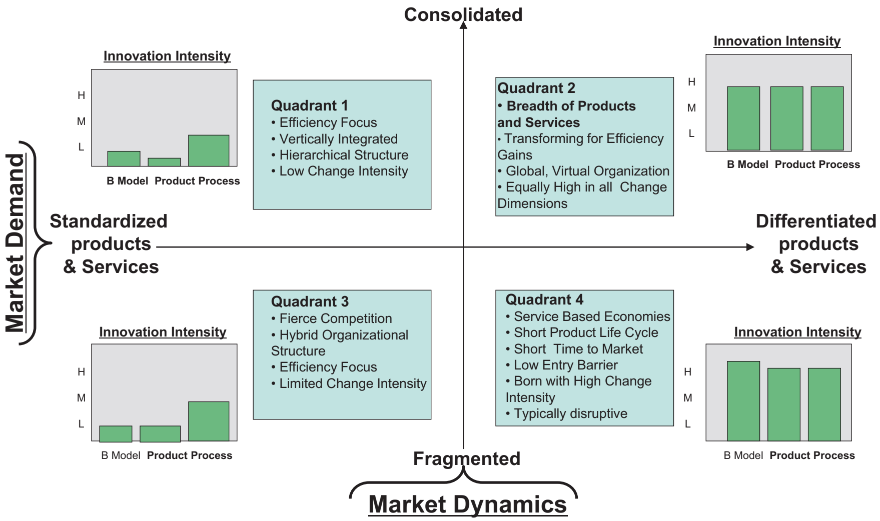

Fig. 3.5 Flexibility intensity

continue to demand highly customized products and services, so there is a high demand to maintain flexibility in all three dimensions.

There are many examples in many industries that can be used to demonstrate the usefulness and applicability of the flexibility intensity framework discussed in this chapter.

I have chosen to use IBM as a case study. In the 1960s and 1970s, IBM was surely in quadrant 1. They had very little competition with over 70 % of the market share. There was a famous article in *Time* magazine entitled "IBM and the seven dwarfs". The dwarfs were HP, Univac, Burroughs, CDC and a few others. There was then a saying in the industry that no customer manager was ever fired for buying IBM.

IBM introduced the personal computer (PC) in 1984, where all the components were manufactured by IBM suppliers. It was a revolutionary product and was directly responsible in creating Microsoft. But that is another story.

Many others found PCs relatively easy to manufacture, and the market was soon flooded by many competitors, and IBM's PC segment, unknown to IBM management, moved into quadrant 4. Many of them soon moved to PC storage devices first and server storage devices later. Others moved into portable printers and copiers. Thus, many of IBM's business segments moved into quadrant 4. But IBM's business models, products/services, go-to-market strategies and the underlying business processes and technology infrastructure remained unchanged, and in quadrant 1.

The year 1992 was a watershed year for IBM. A company, who until then was the darling of Wall Street, suddenly lost $ 9 billion that year. At that time, it was the largest yearly loss of an American corporation. For the first time in IBM history, the CEO was fired and IBM's stock plunged to the 40-dollar mark.

Table 3.1 A case study—IBM

Year	1992	1999
Revenue	50 B$	100 B$
Head count	400,000	200,000
Profit	(9 B$)	9 B$
Stock price	40'S	500

To make a long story short, it took IBM 6 long years to transform into the flexible enterprise of today. IBM re-engineered every key business process, and made them flexible and global. It relinquished many non-profitable businesses like the printer division, storage systems division and later, the PC division. It re-aligned the technology infrastructure and the human capital, and moved into the profitable services business. The results of 1999 as shown in Table 3.1 speak for themselves, and I feel additional explanation is not needed. I have rounded off some of the numbers, but basically they reflect the status of 1999. IBM stock price never reached 500, but on the last day of 1999, the stock price was 125. And because IBM stock prices were split twice between 1992 and 1999, effectively the 125-dollar value is equivalent to 500 as shown in the chart.

3.4 Another Framework for Flexibility Management

I offer another framework for flexibility management based on your product life cycle and development time (Fig. 3.6).

The above chart is self-explanatory. I have populated the chart with product examples in Fig. 3.7. Perhaps you can name other products and your own and populate the chart.

I have now added the flexibility intensity boxes, that you are by now very familiar with, into the quadrants (Fig. 3.8).

You will not be surprised that the quadrant that demands most flexible intensity is that with a short life cycle and short development time like customer service, whereas products with a long life cycle, irrespective of the development time, do not require high flexible intensity. Thus, a Cola brand takes a relatively shorter time to develop, but has a long product life and requires lesser flexible intensity. On the other hand, a Boeing 747 takes many years to develop, but also has a very long life cycle, and thus requires lesser flexibility intensity.

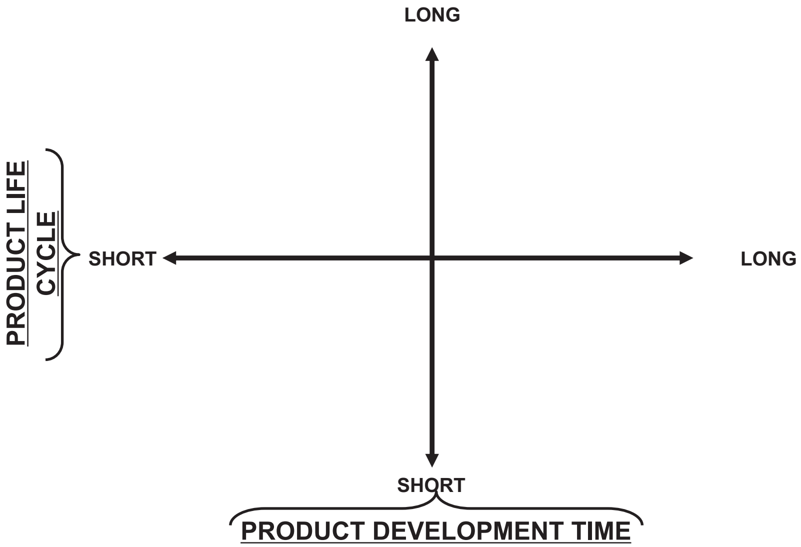

Fig. 3.6 : Product life cycle and product development time—another framework for flexibility management

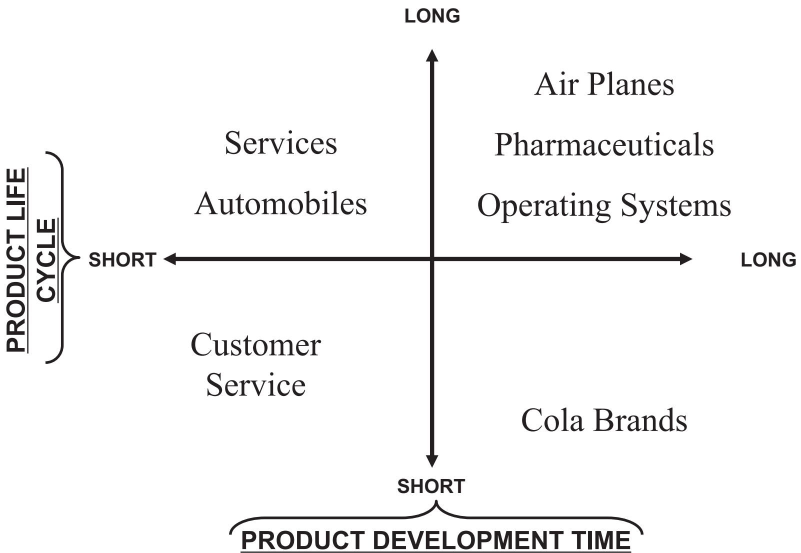

Fig. 3.7 Product life cycle and product development time—another framework for flexibility management

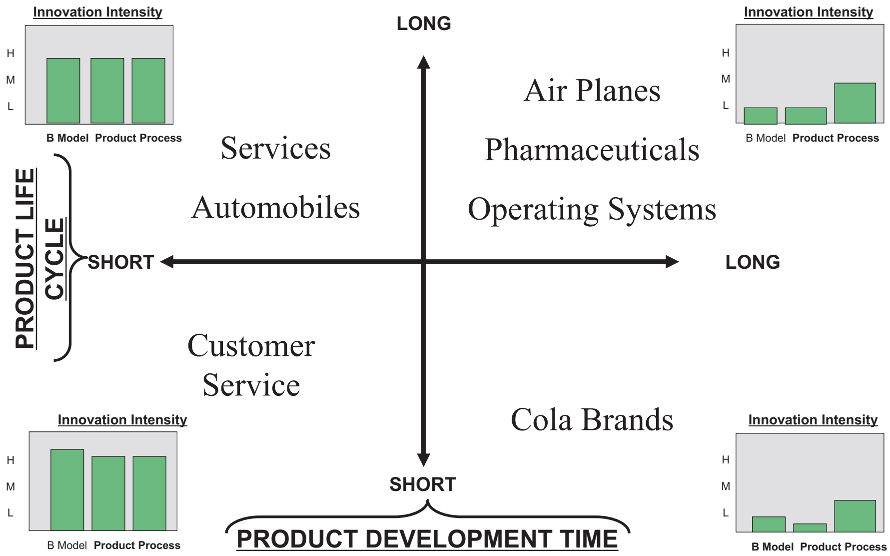

Fig. 3.8 Product life cycle and product development time—another framework for flexibility management

3.5 Conclusion

"The future and fortunes of many of the best known companies of today will rise or fall depending on how good they are in anticipating, sensing and responding to what is shaping out to be a period of perpetual, rapid and pervasive change."—Pantaleo and Pal (2008) "From Strategy to Execution".

You have to anticipate what is coming at you around the corner, and be flexible enough to change before it hits you. There is little science to clairvoyance, and I hope the frameworks presented in this chapter will be helpful to predict, prepare and respond.

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Chapter 4
Organizational Excellence Through Total Flexi-Quality: People Dimension

Amit Chatterjee

4.1 Introduction

The mass production needs of arms and ammunition of the allied forces during the Second World War drove tremendous progress in various scientific techniques drawn together from multiple disciplines, such as manufacturing, statistical methods, economics, and behavioral sciences, were consolidated together under quality-based system sciences leading to vastly improved production methods in the USA and Europe. This gave manufacturing sector a vanguard position among all other sectors in major economies of the world. Post Second World War, the world saw resurgence of Japan and it emerged as a major global economic force, branding its products with highest quality, with delivery capability at lowest cost and offering value-based differentiation. Companies such as Toyota and Sony led the pack, with first signals of flexible manufacturing. Japan stormed the US market in automotive and electronics.

Total quality management (TQM) practices were refined and Toyota's quality-centric management principles became the management focus globally based on workforce discipline, defined systems, and scientific methods for continual improvement culture. However, copying Toyota culture was difficult and most of the management culture that emerged in manufacturing and related sectors was that of command and control, with very limited flexibility. Large and established global corporations such as IBM, Motorola, etc., in the USA could not respond to the environment dynamics, which was rapidly changing the context of business (Fig. 4.1).

A. Chatterjee (✉)
ASQ India, 325, 3rd Floor, DLF Tower-B, Jasola District Center, New Delhi 110025, India
e-mail: AChatterjee@asq.org

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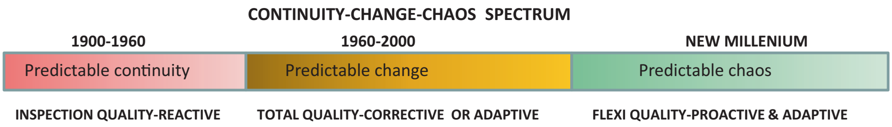


Fig. 4.1 Genesis—quality to flexi-quality

4.2 Flexi Quality—Process Capabilities and Innovation

Innovation creates new opportunity but quality creates demand, makes an enterprise sustainable, and a balance between continuity and change. This was and continues to be a challenge, a flexi-quality culture with systems focus that combined modern process-based quality with creativity evolved into an enterprise scale integration (ESI) model leveraging Lean-Six Sigma- Theory of Constraints (TOC)- Theory of Inventive Problem Solving (Russian translation) (TRIZ) tools architecture resident on Baldrige-based diagnostics platform for strategic alignment of improvement initiatives. This ESI approach started generating greater synergies across multi-business enterprises with capacity to create and deliver differentiated customer and business value in a fast-changing competitive environment. The US companies like GE, Apple, Microsoft, CISCO, and recently Korean organizations such as Samsung and Hyundai have emerged and rallied back strongly at Japanese companies building market share at global scales. The integrated ESI model adopted by the leading Fortune companies, including some of the Indian multinationals, following suit is shown in Figs. 4.2, 4.3, and 4.4.

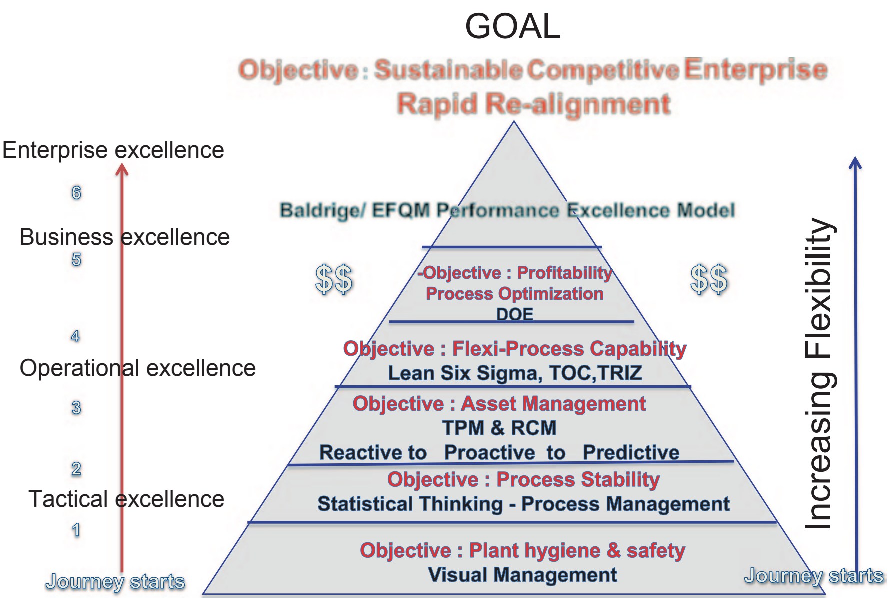


Fig. 4.2 Flexi-quality: rapid re-alignment model

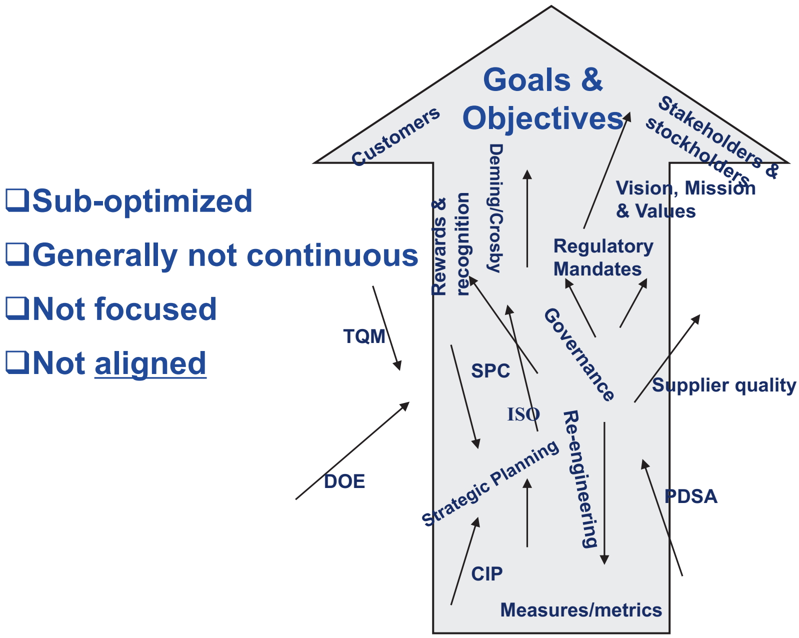
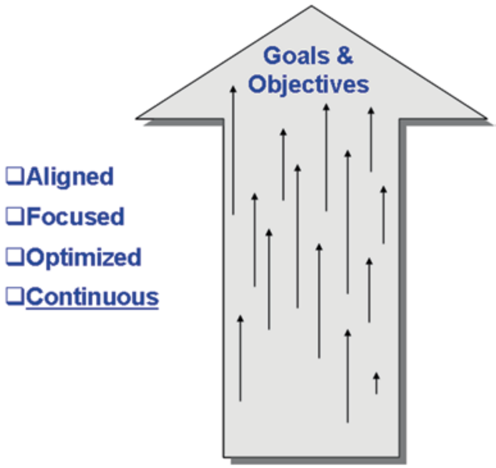


Fig. 4.3 Random acts of improvement—no management system

Fig. 4.4 Aligned acts of improvement baldrige as the management system



4.3 A Successful Model-Flexi People driven "Total Flexi Quality (TFQ)"

With the IT-led internet revolution starting in the 1980s and explosion of Internet in the new millennium, physical geographies and boundaries that constrained workgroups started dissolving leading to the emergence of global knowledge supply chains. Outsourcing of manufacturing processes started shifting to emerging economies like China, Vietnam, Thailand, etc., which offered relatively lower cost of labor and associated infrastructure while services outsourcing was adopted as a business strategy to remain competitive by most of the Fortune companies by leveraging human capital from countries like India that could offer knowledge workforce and IT-based skills. There emerged a distinct geographic segregation of workforce in multinational organizations, while the leadership was concentrated in majority of strategic positions in western countries. The distributed talent structure had benefits of lower cost structures; however, it posed challenges in organizational alignment and constrained flexibility associated with capability of human capital.

The model shown in Fig. 4.5 is an integrated model that embraces all components discussed for TFQ and injects the implicit foundation of people capability (shown in green). The career path management (CPM) model integrates organizational objectives with skill development of workforce creating an alignment capability that is flexible. The flexibility dimension depends on engagement of workforce, their aptitude for knowledge, and behavioral attitude toward change.

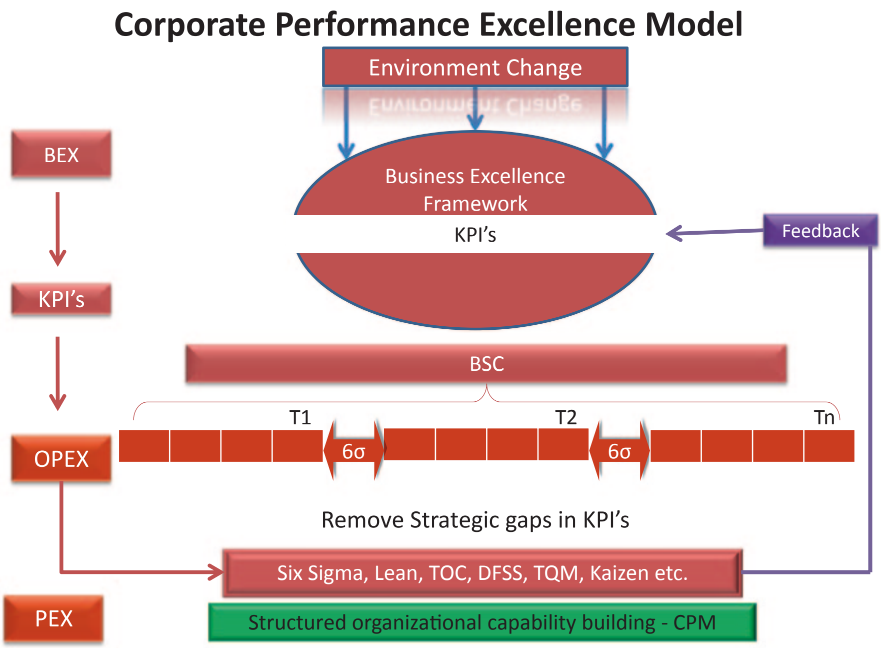


Fig. 4.5 ESI based rapid re-alignment model

4.4 Case Study of "Company A"

One of India's leading multinational conglomerate having a diverse business presence across services and manufacturing sectors has over the past two decades successfully launched a globalization strategy through organic growth as well as acquisitions of international brands. The managerial success of the globalization driven change process is based on a large pool of strong leadership talent and bandwidth of organizational capability, behavior, and practices that is broad and flexible enough to adapt quickly to diverse business and cultural needs across geographies and demographics. A flexibility-based capability model for adoption of global best practices in quality utilized by "Company A" is shown in Figs. 4.6 and 4.7 that builds a knowledge and skills-based culture with mutual respect and team work as ingredients to engage every level of the organization from top leadership, CEO's/CXO's to the shop floor operator/front line service staff using a framework-based approach founded on ASQ's Body of Knowledge (QBoK) and the Baldrige System for performance excellence to drive alignment.

The rapid realignment alignment process using the Baldrige framework brought to focus the business needs, its strategic priorities and challenges, and the capability structure with specific people skills, attitudes, and practices needed at all levels to

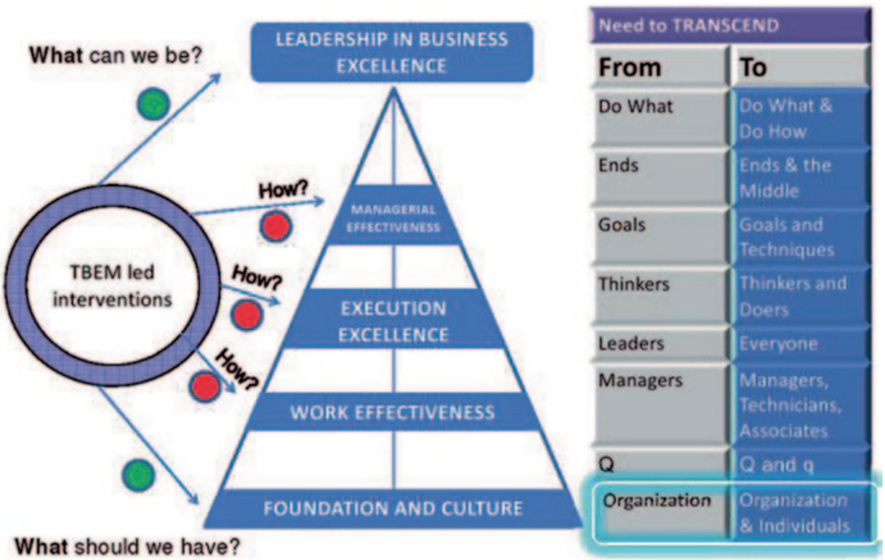


Fig. 4.6 Flexible capability pyramid

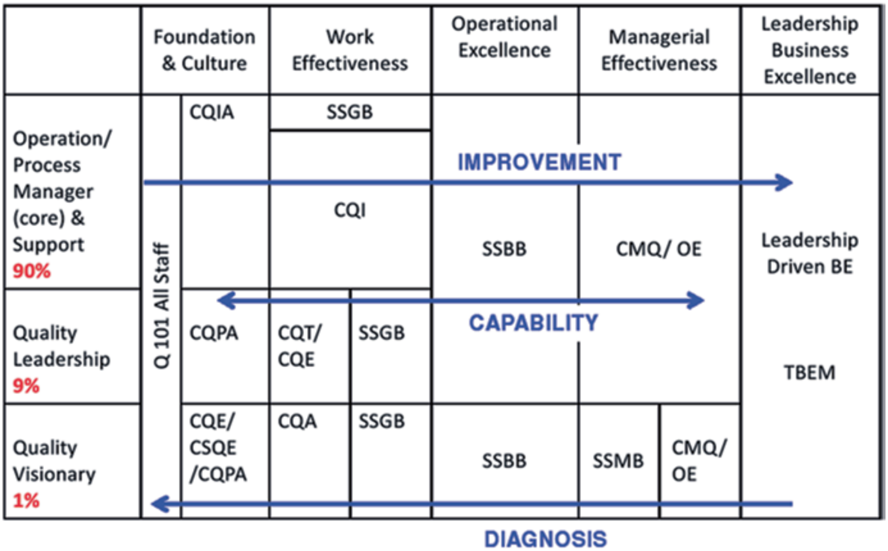


Fig. 4.7 Career path flexibility management

address these priority areas to deliver success. Figure 4.7 mapped the knowledge and skill areas required to create the capability structure to support the alignment and response. The process is evolutionary as at the core it dealt with organizational behavior and culture change to become more adaptable and flexible in a dynamic environment.

4.5 Conclusion

Usually, most organizations have a tendency to focus and invest on technology and process capabilities overlooking the significance of people dimension that limits the overall system flexibility to respond proactively to change. ASQ offers a structured CPM model that develops, engages, aligns, and integrates knowledge and skills of the organizational workforce to the existing operational and business excellence platforms, which has resulted in improved performance and organizational success in many of the Fortune companies who have adopted the TFQ model.

Chapter 5
Towards Linkage between Strategy Formulation and E-governance Performance

P. K. Suri

5.1 Introduction

Government organizations across the globe are trying to adopt information and communication technology (ICT) to streamline their internal functioning and strengthen interfaces with citizens. The phenomenon is termed as e-government or e-governance as per the country context. For example, the word “e-government” is more popular in the developed countries from where most of the journals on the subject are being published. However, in India, the popular term is e-governance and accordingly the corresponding national plan is titled as “National e-Governance Plan (NeGP)”. In this chapter, the words “e-government” and “e-governance” are used interchangeably as it is based on learning issues from the literature as well as a few Indian e-governance projects. The inspiration for this study has come from the pursuit for effective e-governance by many countries on one hand and the dismal performance of several e-governance projects on the other as discussed by many authors.

In India, e-governance is being perceived as a solution for effective service delivery to the citizens. The seriousness of the government is reflected in the formulation of NeGP, which was launched in May, 2006 with an initial budgetary outlay of INR 230,000 million. The NeGP presently comprises 31 Mission Mode Projects (MMPs). These projects are broadly categorized under 11 central MMPs, 13 state MMPs and 7 integrated MMPs. NeGP was jointly formulated by Department of Electronics and Information Technology and Department of Administrative Reforms and Public Grievances. The MMPs, which form the core of the NeGP, are expected to be executed through respective central level line ministries or the state

P. K. Suri (✉)
Delhi School of Management, Delhi Technological University, Shahbad Daultpur, Bawana Road, Delhi, 110042, India
e-mail: pksuri@dce.ac.in; pks.suri@gmail.com

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governments as per the subject matter of the project (mit.gov.in). Each of the MMP has to deal with a number of complexities due to the inherent dependence of the NeGP on a large number of actors in government and non government domains, and the associated country-specific peculiarities in terms of a large population, low literacy rates, poor infrastructure—particularly at the grassroots, multiple languages, diverse local expectations, etc. It, therefore, appears logical that NeGP was predicted as an ambitious but highly risky initiative (Harris 2007).

The risks are more when an MMP conceptualized by central government is to be implemented through state governments. For example, India has adopted a federal system of government where agriculture is a state subject. At the central level, the union government is responsible for formulating plans and policies for overall development of agriculture in the country by involving the state governments. The central government is also responsible for ensuring adequate supply of quality inputs like seeds, fertilizers, pesticide, etc., with the help of state governments by enforcing specific central legal acts. The large span of stakeholders of this sector include farmers, domestic traders, exporting firms, fertilizer and pesticides manufacturing companies, employees, state agriculture departments, etc.

E-governance in agriculture has been identified as a project to be executed in mission mode by the National e-Governance Plan (NeGP) keeping into view its significance in the Indian economy. The complexities involved, however, pose a big hurdle for Agriculture MMP to sail through smoothly. Even though the technological challenges involved may be of lesser significance (ARC 2008, p. 81; Rose and Grant 2010), resolving of non technological issues is likely to emerge as a bigger challenge.

It is observed that even before launching of Agriculture MMP, concerted efforts were already being made, particularly by the central government, to improve service delivery at the grassroots through large-scale e-governance projects. It is, therefore, of utmost importance that lessons are drawn from such projects and empirical measures are brought out, which can serve as guiding tools for the practitioners. Such measures can be helpful in taking corrective steps for effective implementation of Agriculture MMP in particular and other MMPs in general.

The conventional framework generally being followed for the planning and implementation of a majority of e-governance projects in India is characterized by several strategic gaps due to which the expected benefits are not reaching the grassroots (Bhaya 1997, pp. 91, 114–115, Planning Commission 2012, pp. 286–287, 291, Suri and Sushil 2012). This chapter attempts to analyze comprehensiveness of strategy formulation and performance of e-governance from the perspective of government officials involved in the planning of agriculture-related e-governance projects. The chapter is based on the main study (Suri 2009), which involved cross-case analysis of planning and implementation aspects in select agriculture-related e-governance projects in India. The main study brought out a strategic framework for improving the performance of e-governance projects using situation-actor-process-learning-action-performance (SAP-LAP) framework (Sushil 2001). The objectives of this chapter, having a limited scope in the study context, are as follows:

- To propose validated constructs for measuring comprehensiveness of strategy formulation and performance of e-governance.
- To analyze comprehensiveness of strategy formulation and performance of e-governance.

The chapter is organized into eight sections comprising the introductory remarks, a brief review of the relevant literature, the methodology adopted, conceptualization of research variables, a summary of the opinion survey conducted for empirical support, a discussion on results of the analysis, research contribution, implications and limitations of the study followed by concluding remarks.

5.2 Literature Review

There is a need to understand the strategy formulation-related variables at play for studying their influence on project performance in e-governance context. The area of information systems/information technology (IS/IT) strategic planning and implementation has been extensively researched from the perspective of organizational mechanisms in the context of organizations belonging to corporate sector. In view of the limited availability of the relevant direct literature on e-governance, an attempt has been made here to develop insights about these aspects based on a review of strategic management, IS/IT management and e-governance literature as summarized below under subsections significance of environmental analysis, strategic importance of stakeholders, need for refining organizational structure and processes, significance of feedback system, and e-governance assessment.

5.2.1 Significance of Environmental Analysis in E-Governance

The existing strategic planning framework needs to address the evolving character of e-governance projects (Suri and Sushil 2006). A reflective, participatory and emergent process of planning and strategy formulation is expected to be better than the traditional analytic, directive and planned process (Mintzberg 1994; Upton and Staats 2008; Planning Commission 2012, pp. 270−71). Strategy formulation is a learning process for the management (Lee and Bai 2003). It begins with situation analysis, which involves study of internal and external environment. The analysis throws light on an organization's ability to take advantage of opportunities while avoiding threats (Wheelen and Hunger 2004, p. 109). For a strategic information system planning process to be comprehensive, it is necessary to have sufficient information input from within the organization as well as from external environment. Environmental changes have, therefore, to be quickly sensed and responded by promptly shifting the strategy rather than sticking to an outdated plan (Pietersen 2002, pp. 46−47).

The relevance and applicability of e-government plans fade rapidly with time due to changes in environment (Heeks 2006, p. 62). A number of projects in India have failed to achieve their stated original goals (Weerakkody et al. 2011). It is important that e-governance plans achieve a balance between internal needs and external requirements to keep pace with changing expectations of the beneficiaries (Heeks 2006, p. 64). Even if initial needs of stakeholders are met, it is required to remain alert and responsive to their continuing demands to avoid eroding of early advantages by the environmental changes (Malhotra et al. 2008, pp. 216–226). Regular and structured deliberations with a diverse set of stakeholders including internal cross-functional teams encourage learning from divergent views and thus facilitate assimilation of new trends (Pietersen 2002, pp. 48–50, 61; Lee and Bai 2003). Such an approach can facilitate rational and periodic assessment of current and future requirements of beneficiaries, which in turn may help in minimizing design–reality gaps.

5.2.2 Strategic Importance of Stakeholders in E-Governance

Stakeholders should be an integral part of any e-government project for its long-term success (Rowley 2011). Axelsson et al. (2013) have argued in favour of a stakeholder-centered analysis of expectations and opinions concerning the e-service for its success. In e-governance projects, a public agency is required to deal with a wide spectrum of stakeholders. The operational level staff as well as other stakeholders need to be adequately involved during information systems/information technology strategic planning (Lee and Bai 2003). The e-government service offerings should create added value and measurable benefits to their stakeholders (Gouscos et al. 2007). Pardo et al. (2000) have emphasized on incorporating stakeholders' requirements in the development as well as maintenance of e-governance initiatives. A participatory approach needs to be adopted for ensuring commitment of stakeholders. Kumar et al. (2004, pp. 256–264) have identified 'stakeholders participation' as one of the eight factors of effectiveness of e-governance programmes. Past empirical studies based on organizational information systems in the context of corporate entities also throw light on importance of adopting a participatory approach in system development (Palanisamy 2000). A project is expected to have measurable goals in terms of the benefits that would be delivered to specific stakeholders depending on the application context (Bhatnagar 2004, pp. 61–62).

The low success rates of e-governance programmes could well be due to the assumption of default involvement of internal and external actors with such programmes. There are examples in the literature that illustrate achievement of better results through methodical management of stakeholders' concerns (Scott et al. 2011; Tan et al. 2005). A review of evaluation reports of some of the popular Indian e-governance projects has also revealed that due importance was given to involve key stakeholders while designing the BHOOMI, CARD, e-Procurement Exchange and Lokvani projects by the project authorities (DIT 2003, 2004, 2005).

5.2.3 Need for Refining Structure and Processes

Government system comprises several independent organizations with specific mandates and stakeholders to deal with. The traditional organizational structures and work processes in government need to be redesigned to facilitate many-to-many interactions and better exploitation of ICT (ARC 2008, pp. 71–79; Weerakkody et al. 2011; Cordella and Bonina 2012; www.knowledgecommission.gov.in). Efforts to infuse ICT in government functioning are primarily directed at existing procedures and processes. The organizational structure continues to remain hierarchical and command/control based due to which decision-making is largely a top-down, reactive and crisis-driven process. For government organizations to be client oriented and employee centered, the basis of decision-making is supposed to be bottom-up and supported by a culture that encourages employee learning and creativity (Heimler 1996). With growing infusion of e-governance at every level, the multilayered government structure requires redefining of roles and responsibilities (Farooq et al. 2006). Changes in organizational structures are forced as e-governance progresses to higher levels. According to Kawalek and Wastell (2005), the complexity and institutional inertia associated with public sector organizations need to be methodically handled through incremental process changes over time even though information technology can facilitate business process redesign (Davenport and Short 1990).

In the corporate sector, there are ample examples which demonstrate that smart business entities have been able to use IT effectively by redesigning core business process before applying IT (Suri 2009, pp. 40–41, 2015). Adoption of similar practices by the project authorities is clearly visible in the popular Indian e-governance projects. IT-induced changes in roles and responsibilities have been one of the features of most of these projects. In a few projects (BHOOMI, CARD, e-Procurement exchange, e-Seva and KAVERI), government authorities have taken special efforts for process re-engineering before applying ICT for accruing better value from the systems (Suri and Sushil 2012).

5.2.4 Significance of Feedback System

Learning based on feedback is essential for improving a system. For ensuring that intended benefits are reaching the deserved, it is required to strengthen the government planning process through real time data from grassroots (Bhaya 1997, pp. 114–115; Planning Commission 2012, p. 291). ICT systems are effective only when they deliver relevant and meaningful information to the end users (UNDP 2001). Relying solely on internal consistency checks does not serve the purpose of maintaining data quality. The quality of data content maintained by an information system can be improved through its constant use. Information systems are therefore expected to have a feedback control system in place (Orr 1998). Customer feedback should form the basis for re-engineering public service delivery (Chadwick 2003).

Inclusive mode of governance demands equal access to opportunities by citizens. Continuous improvement of a system is possible only through committed involvement of users. This is expected to happen only when users feel that their inputs matter. It is required to have a sound feedback system to achieve this (UN 2008, p. 66; Upton and Staats 2008; Planning Commission 2012, p. 291). An effective feedback system helps in creating a cohesive culture in an organization, which contributes in achieving higher performance (Feld and Stoddard 2004). For change and adaptation to happen constantly as part of execution process, organizations are expected to get timely and regular feedback from all levels (Hrebiniak 2005, pp. 53–54). Projects like BHOOMI, GYANDOOT, e-Procurement Exchange, e-Seva and Nagrpalika are characterized by effective feedback-based learning systems. Field units were encouraged to point out shortcomings for further improvement. Some of the project authorities have given thrust on learning from pilots before rolling out (DIT 2003, 2004).

5.2.5 E-Governance Assessment

The traditional financial measures are unsuitable for analyzing performance of e-governance; therefore, researchers have been trying to address this gap. A few examples are: IT value in public administration in terms of timeliness, accuracy and convenience to citizens; strengthening of interfaces with stakeholders, etc.(Bannister 2002); e-government impact in terms of capabilities, interactions, orientations and value distributions (Andersen et al. 2010); a framework based on hard, soft and a hierarchy of measures applicable for mature e-governance projects (Gupta and Jana 2003); application of balanced scorecard (Lawson-Body et al. 2008); application of information system success model proposed by DeLone and McLean (2003) for assessing success of e-tax service (Wang and Liao 2008); conceptual frameworks such as a framework based on investment decisions, evaluation methods, culture, structure and post-hoc evaluation (Irani et al. 2005); and a framework based on maturity levels, stakeholders and assessment levels (Esteves and Joseph 2008). Most of such frameworks are, however, conceptual or based on single case studies and limited segment of citizens or are yet to be tested in real-life situations (Karunasena and Deng 2012).

A few recent studies in Indian context have emphasized on taking into account governance aspects in the performance measures (Mitra and Gupta 2008); predefining effectiveness parameters of e-governance programmes and cautiously managing factors of change for giving real benefits to stakeholders (Kumar 2009); controlling gaps in planning and implementation for better performance (Suri 2009), simultaneously dealing with continuity and change forces for better outcomes of e-governance initiatives (Nasim and Sushil 2010). It is observed that empirical studies which analyze performance from governance reforms perspective are lacking. Published evaluation reports (DIT 2003, 2004; Bhatnagar 2004) of a few well-executed e-governance projects (AKSHYA, BHOOMI, CARD, e-Procurement Exchange, e-Seva, FRIENDS, GYANDOOT, KAVERI, Lokvani, Nagarpalika) in different states of India reflect governance reforms-related benefits accruing from these projects.

Performance of these projects has been adjudged better in terms of ensuring easier access to service, offering comprehensive and reliable service, time and cost savings, improved transparency in government functioning, improved interactions with government, faster processing of requests, improved monitoring and control, improved decision-making, etc. (Suri and Sushil 2011). However, such studies could not be traced in the literature, which have analyzed strategy formulation and performance of e-governance based on governance reforms-related outcomes from the viewpoint of government officials.

5.3 Methodology

A focused review of the literature was undertaken to develop an understanding about the strategy formulation and performance aspects in the context of large-scale agriculture-related e-governance projects in India. For this, relevant project documents and published evaluation reports of successfully implemented popular e-governance projects were studied besides reviewing scholarly articles on the subject. While selecting projects for the study, care was taken to ensure that only such large ongoing projects are chosen where the intended services are operational for at least 1 year. A summary of six shortlisted projects, which qualified the criteria when the main study was initiated in the year 2005, is presented in Table 5.1. The

Table 5.1 Shortlisted agriculture-related projects. (Source: Suri and Sushil 2011)

Project and owner organization	URL and value proposition
AGMARKNET Directorate of Marketing and Inspection (DMI)	www.agmarknet.nic.in Collection and dissemination of daily all India commodity prices and arrivals information for the use of farming community
Kisan Call Centre Directorate of Extension (DoE)	http://agricoop.nic.in/PolicyIncentives/kisanCallfirst.htm Agricultural extension support for the farming community
DACNET IT Division, Department of Agriculture and Co-operation (DAC)	www.dacnet.nic.in Intranet for messaging, collaboration and implementing e-governance applications
GrapeNet Agricultural and Processed Food Products Export Development Authority (APEDA)	www.apeda.com Integrating various stakeholders involved in the export of grapes
Computerized Registration of Pesticides (CROP) Central Insecticides Board and Registration Committee (CIB and RC)	www.cibrc.nic.in Streamlining of procedures involved in registration of pesticides as per Insecticides Act, 1968
Integrated Fertilizers Management Information System (IFMIS) Department of Fertilizers (DoF)	www.fert.nic.in Ensuring adequate supply of good quality fertilizers to farmers at affordable price

knowledge developed about strategy formulation and governance reforms-related expected outcomes of the identified projects provided the necessary ground for conceptualizing the research variables. To reduce design and Implementation related complexities in the study, only such performance aspects were considered which had relevance across the six projects.

A questionnaire was developed to capture strategy formulation and performance-related feedback. Key senior level project officials, who were responsible for planning and strategy formulation, were identified with the help of respective project nodal officers. It was observed that generally in each project, there are five to eight senior level officials who are involved in the planning and strategy formulation. These officials could be surveyed with census approach as their number was found to be small in each project. The observed mean values of the data collected have been used for analyzing comprehensiveness of strategy formulation and performance in the study context.

5.4 Research Variables

The variables for the study are based on a review of the literature presented above, a pilot study of an ongoing e-governance project (Suri 2005) and practical experience of executing projects. These are defined in terms of macro and micro variables in the following sections.

5.4.1 Macro and Micro Variables

The macro research variables for the study, viz. 'Performance of e-governance' and 'Comprehensiveness of strategy formulation' and the respective constituting micro variables are defined as follows.

Performance of e-governance This performance macro variable is conceived as fulfillment of the project objectives in terms of realization of expected benefits of e-governance. The common benefits that are applicable across the e-governance projects under study are identified as achieving efficiency in government operations, bringing transparency, facilitating interactivity among internal and external actors and aiding the decision support process. The constituting micro variables are defined as follows. For understanding the linkage of these variables with the literature, readers are referred to a mapping done by Suri and Sushil (2011). The same is not reproduced here due to space constraints.

Efficiency Measures service improvement in terms of fast execution of the core process, simplification of government procedures, reduced paper work and decreased communication cost while transacting with government.

Transparency Measures service improvement in terms of reliability, whether the service is reliable, comprehensive, easily accessible and fairly delivered.

Interactivity Measures service improvement in terms of enhanced internal and external interactions enabled by the e-governance service.

Decision support Measures improved decision support in terms of better planning, decision-making, and monitoring and control enabled by the e-governance service.

Comprehensiveness of strategy formulation This variable is conceived as taking care of internal and external environment and coverage of other strategic elements that are considered necessary for realizing an e-governance project plan. The constituting micro variables include process re-engineering, redefining of roles and responsibilities, involvement of stakeholders in strategy making, and making provision for obtaining feedback on services which are defined as follows:

Environment scanning This micro variable reflects the level of environment scanning undertaken while formulating the project strategy. The related questions are: extent to which SWOT like analysis is conducted before finalizing the project strategy and extent to which expected changes in user needs are projected over time.

Involvement of stakeholders in strategy formulation This micro variable reflects the importance given to stakeholders while formulating strategy before taking up project implementation. A project-specific list of stakeholders is provided in the questionnaire for the respondents to indicate the respective extent to which each stakeholder is involved in strategy formulation.

Provision for stakeholders' concerns Involving stakeholders at planning and strategy formulation stages is not sufficient to keep their interest alive in the project cycle. This micro variable captures the extent to which stakeholders' concerns are taken care in a project. The related questions are: extent to which there is clarity in the project plan about benefits accruing to different stakeholders and extent to which measures for assessing these benefits are reflected in project objectives.

Process re-engineering This micro variable reflects extent to which existing processes are re-engineered before taking-up computerization.

Redefining of roles and responsibilities This micro variable captures extent to which roles and responsibilities have been redefined for better execution of the project.

Provision for obtaining feedback This micro variable captures the extent to which provision has been made for obtaining feedback through regular interaction with internal and external actors.

5.5 Survey of Planners

5.5.1 Questionnaires Development

All the six projects identified for the study were studied to develop basic knowledge about the project objectives and expected benefits. Strategy formulation and performance related standardized questions were developed keeping in view the relevance and observed commonalities of corresponding conceptualized variables across the identified projects. Questions were standardized to ensure their applicability across the projects. For better understanding and interpretation, the standard performance-related questions were qualified with project-specific contexts. The questionnaires were subjected to face criteria related and content validity tests (Kerlinger 1983, p. 458) for fine-tuning before launching the survey. The validation of questionnaires was followed by pre-testing of questionnaires. Ambiguity in questions was removed and wording of questions improved based on learning from the field visits. For the purpose of statistical analysis, the observed sample data, collected using five-point Likert scale, was transferred into five contiguous equal-sized classes in the interval [0, 1] with classes labelled as Nil, Small, Medium, Large and Very Large, respectively. Most of the prospective respondents were approached in person. This was feasible as the planners in each project were generally centrally located and their number in each project was also small. In all, 36 valid filled-in questionnaires were received with number of respondents ranging from five to eight in case of each of the six projects.

5.5.2 Reliability and Validity Analysis

The Cronbach's Alpha values, measuring internal consistency (Kerlinger 1983, pp. 451–452) of the 'Comprehensiveness of strategy formulation' and 'Performance of e-governance' constructs are found to be 0.89 and 0.94, respectively. These values are above the threshold level of 0.6 that is recommended as acceptable for empirical research of this nature (Hair et al. 2006, p. 118). The macro and micro variables are subjected to factor analysis for validating the constructs (Kerlinger 1983, pp. 659–678; Hair et al. 2006, pp. 90–114). The construct acceptability criteria are based on the values of cumulative extracted squared loading. Hair et al. (2006) have recommended that factor loadings greater than 50 % may be considered practically significant. At the macro level, the factor loadings in respect of macro variables 'Comprehensiveness of strategy formulation' and 'Performance of e-governance' are found to be 60.9 and 80.9 %, respectively, which are above the threshold value. At the micro level, the factor loadings in respect of the constituting variables of 'Comprehensiveness of strategy formulation', viz. 'environment scanning', 'involvement of stakeholders in strategy formulation', 'provision for stakeholders' concerns', 'provision for obtaining feedback' and 'presence of feedback loop', are found to be 56.9, 58.6, 76.6, 75.4, and 57.6 %, respectively, which are above the threshold value. It was not required to do such analysis for the micro variables 'process re-engineering' and 'redefining of roles and responsibilities' as these micro variables have only one constituting item. The factor loadings in respect of the constituting variables of 'Performance of e-governance', viz. 'efficiency', 'transparency', 'interactivity' and 'decision support', are found to be 73.0, 65.2, 82.3, and 68.7 %, respectively, which are above the threshold value. Further, it was found that all the items constituting the 'Comprehensiveness of strategy formulation' and 'Performance of e-governance' are loading on the respective constructs.

Based on factor analysis and reliability analysis conducted above, the constructs are treated as validated and used for further analysis.

5.6 Univariate Analysis and Discussion

The survey data is used to conduct univariate analysis with respect to the macro variables 'Comprehensiveness of strategy formulation' and 'Performance of e-governance' and the corresponding micro variables. The statistically computed mean, coefficient of variation, range, and quartile percentiles are shown in Table 5.2. The observed values of statistics pertaining to macro and micro variables are discussed below.

5.6.1 Comprehensiveness of Strategy Formulation

All the six micro variables have consistent mean values and are contributing to a medium extent only to the comprehensiveness of strategy formulation (COMPSF) with respect to these projects. This clearly reflects that the conceived strategic aspects, viz. 'environment scanning', 'involvement of stakeholders in strategy formulation', 'provision for stakeholders concerns', 'process re-engineering', 'redefining of roles and responsibilities' and 'provision for obtaining feedback', are not adequately addressed in the projects. Among the six micro variables, the contribution of 'involvement of stakeholders in strategy formulation' and 'processes re-engineering' is still lesser and towards small extent level. The high values of coefficient of variation and the range values of all the micro variables is due to the extreme variation in importance given to these aspects by different organizations while formulating the project strategy. For example, in the CROP project, processes have been re-engineered before computerization whereas in the IFMIS project, processes were computerized as they are. Further, unlike IFMIS project, due importance was given to stakeholders while formulating strategy in the case of CROP project.

E-governance projects require a sound interactive mechanism with users for obtaining feedback to address the gaps in understanding their requirements and constantly improving the service levels. The response of planners to related questions reflects that the projects do have provision for regular interaction with internal actors (field offices/operational staff) to a large extent. However, similar emphasis

Table 5.2 Univariate statistical analysis for micro variables (Base Survey: Planners)

Planners											
Variable	*N* Valid	Mean	SE (Mean)	SD	CV (%)	Range	Min	Max	Percentiles		
									25	50	75
Comprehensiveness of strategy formulation (COMPSF)	36	0.47	0.03	0.19	40.42	0.67	0.18	0.85	0.32	0.44	0.64
Environment scanning (ESC)	36	0.46	0.03	0.18	40.19	0.75	0.13	0.88	0.28	0.50	0.50
Involvement of stakeholders in strategy formulation (INSTSF)	36	0.41	0.03	0.19	45.35	0.69	0.12	0.81	0.26	0.39	0.54
Provision for stakeholders' concerns (STC)	36	0.54	0.03	0.20	37.82	0.75	0.25	1.00	0.38	0.50	0.75
Process re-engineering (PRE)	36	0.42	0.06	0.35	82.04	1.00	0.00	1.00	0.00	0.50	0.75
Redefining of roles and responsibilities (ROL)	36	0.51	0.05	0.29	56.91	1.00	0.00	1.00	0.25	0.50	0.75
Provision for obtaining feedback (FDPROV)	36	0.50	0.04	0.24	47.57	0.92	0.08	1.00	0.33	0.50	0.67
Performance of e-governance (PERF)	*36*	*0.70*	*0.03*	*0.17*	*24.28*	*0.69*	*0.31*	*1.00*	*0.59*	*0.70*	*0.82*
Efficiency (EFFI)	36	0.73	0.03	0.19	26.16	0.69	0.31	1.00	0.63	0.75	0.86
Transparency (TRANSP)	36	0.73	0.03	0.16	22.41	0.69	0.31	1.00	0.69	0.75	0.81
Interactivity (INTER)	36	0.61	0.04	0.22	35.41	0.92	0.08	1.00	0.50	0.63	0.75
Decision support (DECSP)	36	0.63	0.04	0.22	34.08	0.75	0.25	1.00	0.50	0.63	0.75

is not given on making provision for interacting with intended beneficiaries and other related external actors. The observed values of the constituents of COMPSF construct reveal weaknesses in strategy formulation for e-governance projects in the study context.

5.6.2 Performance of E-Governance

As per the observed values, overall performance of e-governance, as perceived by the planners, is in the large extent range even though the comprehensiveness of strategy being formulated at their level is observed to be just above the small extent category. It may be noted that it is the planners who are responsible for conceptualizing the e-governance projects and arranging for the required resources for project execution. It is, therefore, possible that the planners might have opined in favour of higher project performance in order to justify the investments made or they may be actually drawing more benefits from the e-governance initiatives when compared with officials operating at lower levels and the intended beneficiaries. Further, the planners generally operate from headquarters level and are thus relatively better equipped for using the ICT infrastructure developed under the projects as compared to operational level officials in the field and beneficiaries. At the micro level, their perception levels about performance in terms of 'efficiency', 'transparency', 'interactivity', and 'decision support' are found to be in the large extent range with the observed values of 'interactivity' and 'decision support' marginally qualifying for the large extent range. In other words, planners perceive that e-governance has contributed more to improve efficiency and transparency when compared with interactivity and decision support.

5.7 Contributions, Implications and Limitations of the Study

5.7.1 Study Contributions and Implications

This study may be viewed as an initial attempt for arriving at validated constructs to measure 'Comprehensiveness of strategy formulation' and 'Performance of e-governance' based on cross-case analysis of six agriculture-related projects in India. An opinion survey of select government officials belonging to the six ongoing projects was conducted to populate the constructs and perform univariate analysis. The analysis reflects that there is a need for planners to view performance in terms of governance reforms-linked value created by e-governance projects. For this, performance assessment measures need to be defined in advance and embedded within the project plans. As has emerged from this study, specific measures to assess intended project outcomes such as improvement in transparency, efficiency, interactivity and decision support should be pre-defined and included in project plans. Post implementation, the progress of e-governance projects may be reviewed based on such predefined measures. Similarly, the construct for measuring 'Comprehensiveness of strategy formulation' is expected to sensitize the planners for giving due consideration to environment scanning, involvement of stakeholders and identifying their concerns, redefining roles and responsibilities of involved actors, re-engineering of conventional processes and keeping provision for obtaining feedback while formulating strategy for an e-governance project.

From the viewpoint of researchers, the validated constructs can be further used to explore the relationship between the two by taking 'Comprehensiveness of strategy formulation' as independent variable and 'Performance of e-governance' as dependent variable. Based on the conceived variables, following macro and micro level hypotheses of association are formulated. These may be statistically tested for examining the relationship between the conceptualized strategy formulation macro/micro variables with the performance macro/micro variables in the context of the study.

The macro level alternate hypothesis, conceptualized on the basis of this study, is:

HAP1: 'Comprehensiveness of strategy formulation' (COMPSF) is a predictor of 'Performance of e-governance' (PERF).

The corresponding null hypothesis for HAP1 is:

HAP0: COMPSF is not a predictor of PERF.

The generalized alternate hypotheses of association, in terms of micro level variables, are of the form:

HAPij: *i*th micro variable is a predictor of *j*th performance micro variable; i Є {ESC, INSTSF, STC, PRE, ROL, FDPROV}; j Є {EFFI, TRANSP, INTER, DECSP}.

The predictive relationships which get revealed from such an analysis may be interpreted in the context of each of the case studies using Interpretive Matrix Tool (Sushil 2005) to arrive at the interpretation of influencing links between 'COMPSF' and 'PERF'.

5.7.2 Limitations

This study is constrained by lack of similar past studies. As such, there is ample scope for improving the proposed constructs by studying more e-governance projects pertaining to different areas.

5.8 Conclusion

Many studies have revealed that several of the e-governance projects have not delivered as per expectations. The dismal performance could well be due to gaps in the strategy formulated for these projects. In this chapter, two constructs have been proposed to measure comprehensiveness of strategy formulation and performance in the context of the study, which are based on six agriculture-related projects. The constructs have been statistically validated. An opinion survey of government officials involved in planning of these projects has been conducted to populate the constructs for further analysis. The results reflect upon the gaps related to strategy formulation in the e-governance projects in the study context. There is much scope for improving performance as well in the context of the study. The analysis has brought out implications for both researchers and practitioners. The corrective measures by the practitioners, in terms of addressing the identified strategic gaps with due diligence, are expected to play a catalytic role in the realization of the intended outcomes of the Agriculture MMP for the benefit of the farming community. The study findings also serve as a base for proposing hypotheses of association for testing predictive relationship between the two variables conceptualized for measuring 'comprehensiveness of strategy formulation' and 'performance of e-governance'.

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Part II
People Flexibility

Chapter 6
Significance of LMX Congruence and Its Flexibility on Subordinate Performance and Promotability

Megha Gupta and Kanika T. Bhal

6.1 Introduction

The Leader-Member Exchange (LMX) theory, unlike previous theories, contended that there is a unique and definite relationship between a leader and his/her member (Dansereau et al. 1973). Following this contention, various researchers have studied LMX and its consequences in organizations. This theory is interesting as it explores both the leader and member perspective and is dyadic in nature. But only limited number of studies (e.g., Liden and Graen 1980; Rosse and Kraut 1983; Wayne and Green 1993; Scandura and Schriesheim 1994; Deluga and Perry 1994; Deluga 1998; Colella and Varma 2001; Yrle et al. 2002; Greguras and Ford 2006; Harris et al. 2006; Liden et al. 2008) have tried to study and examine both the leaders' and members' perspective while establishing the relationship between LMX and subordinate outcomes. There is no study, as per our knowledge, that has tried to correlate and determine the relationship between LMX and leader assessment. Nonetheless, numerous amount of empirical data has been collected and reviewed with respect to LMX quality, and its impact on in-role and attitudinal outcomes of the members and leaders (Gerstner and Day 1997).

In their pursuit of analyzing LMX quality, many researchers discovered the fact that congruence between the leaders' and members' perception is important to determine task and behavior related outcomes of employees (Coglister et al. 1999). LMX congruence is a concept that highlights how similar is the leader and his/her respective member in perceiving the nature of their relationship. Hence, it will predict consistency in how both the parties of the dyad view and approach their

M. Gupta (✉) · K. T. Bhal
Department of Management Studies, Indian Institute of Technology Delhi, Hauz Khas, New Delhi 110016, India
e-mail: mga1988@gmail.com

K. T. Bhal
e-mail: kanika@dms.iitd.ac.in; kanikabhal@gmail.com

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relationship, which will further determine the quality of LMX relationship and its relation to leader assessment. The congruence level may vary from high, low, overestimation, to underestimation (Coglister et al. 2009).

The objective of this chapter is to apply this conceptual framework of congruence provided by, Coglister et al. (2009), and explore the flexible relationship between LMX match and leaders' assessment of the subordinates, in terms of job performance and promotability. The uniqueness of this work is, that it looks at the relationship between LMX congruence and leaders' assessment of how he/she perceives the subordinate in terms of job performance and promotability.

Social exchange theory has been used to infer LMX (Dienesch and Liden 1986; Liden and Maslyn 1998), according to which, the leader–member exchange relationship is rooted in social exchanges. Blau (1964) emphasized that unlike economic changes, social transactions result in feelings of higher level of obligation, appreciation, and trust. Therefore, the nature and extent of social exchanges reflect the quality of relationship in a leader–member dyad (Liden and Maslyn 1998).

Exchange is classified as low quality and high quality. *Low quality exchange* encompasses interactions between leaders and members, which are strictly contractual and are characterized by formal roles. Here the leader takes up supervisory role wherein the interaction between him/her and the member, is fundamentally task focused. The term given to such subordinates who experience low quality exchange is out-group (Dansereau et al. 1975). Whereas, *high quality exchange* comprises interactions between the leaders and their subordinates that are over and above the employment contract in the organization. It implies that the boss is expected to use various methods and techniques to impact constructively the behavior of the subordinate, resulting in his/her overall development and that of the organization as well. The foundation of such high quality among the dyad is trust, respect, and obligation. The leader is flexible in terms of forming different varying relationships based on such qualities with different subordinates. The members who experience high quality exchange form the in-group wherein the leader and member share high levels of trust, loyalty, and communication (Graen and Cashman 1975). Reciprocity is an important component to ensure high quality exchange. Uhl-Bien and Maslyn (2003), highlight the significance of reciprocal behavior, which is the extent to which quality of exchange, is equal. In this sense, it is not enough to assess the quality of exchange from one member of the dyad, it has to be assessed from both the perspectives, to first establish the extent of match and then the impact of this match on outcomes and assessments.

6.2 Conceptualizing Leader Member Congruence

Over the years, research has been concentrated on effect of LMX quality on individual and organizational consequences. But some theorists, such as Scandura (1999), assert that the extent of coherence between the leader and member regarding the quality of LMX, is an important indicator of quality of LMX. Limited empirical work on LMX congruence, makes it a viable area to explore further.

Relationships take time to develop and so do those between leaders and subordinates as they go through different stages and phases (Sin et al. 2009). The first stage is the *role-taking phase,* in which the leader's role is to make the subordinate aware of his/her expectations with respect to tasks and assignments. The member acknowledges this and responds, which, in turn, is evaluated by the leader. The next phase is the *role making,* followed by *role-routinization* wherein a pattern of interaction is observed and sustained, despite LMX quality developed between the leader and the member. Therefore, over a period of time through interactions, both are aware of and proficient enough to determine the kind of relationship they share. Hence, it would be reasonable to foresee that the congruence between the leader and member, about the relationship, would be clear in terms of the present scenario as well as how it will develop in future course of time. Hence, both the members of the dyad are expected to assess their relationship quality similarly, leading to higher LMX congruence (Sin et al. 2009).

However, in real life things are not as perfect between leaders and their subordinates, nor as clear as they seem to be. People have varying perceptions about the same reality even if they look at it from a common perspective about each other, which may or may not match with each other. The difference in perception is much more likely to be present when viewed from different positions of authority, e.g., between a boss and a subordinate.

Various researchers, such as Gerstner and Day (1997), have revealed that member perceived LMX correlated only modestly with leader perceived LMX, challenging the basic foundation of LMX theory. This absence of perfect match shows that there is disagreement between the perspective of LMX relationship with the dyad. Lack of convergence in the dyad's perspective of their LMX quality is likely due to different perceptions of LMX dimensionality (Zhou et al. 2009).

Previous research highlights the fact that LMX quality assessment is incomplete if taken only from one perspective.

6.2.1 Assessing Leader–Member Congruence

LMX congruence can stimulate and ensure high quality exchange. According to Schyns and Day (2010), LMX agreement is not just a high correlation between the ratings of leaders and members, but, it is the match and congruence between them, which may be positive or negative. Scandura (1999) has emphasized on the relevance of examining all dimensions in determining the implications of LMX match. According to her, dyadic data, wherein data from both the leader and member is collected, is a suitable method of understanding the match. Since equivalence between leader and member impressions of LMX has been fairly low, it looks like these impressions are mostly not shared impressions.

6.2.2 LMX Congruence

Coglister et al. (2009) have given a way of classifying LMX congruence that examines its impact on subordinate outcomes. They used a model inspired and taken from Atwater and Yammarino's (1997) model of self-other agreement which constitutes of LMX as four varied dimensions with balance as a concept. These are balanced high, balanced low, member overestimation, and underestimation. Humans tend to show flexibility and variance in their perceptions and behaviors. As a result there can be four varying scenarios due to differences in leader and member perceptions. *Balanced high LMX* congruence is the optimal state in which the leader and member perceive relationship as high quality that indicates the relationship is balanced in terms of perception and high match. *Balanced low LMX* is described as a stage wherein both parties of the dyad perceive the relationship in a similar manner, but the quality is low wherein they are aware that the relationship is strictly transactional and none of them will go over and above, their formal roles to develop the relationship.

Follower/member overestimation occurs when the member perceives the interaction to be of high quality in nature but the leader perceives otherwise. This situation is said to be unbalanced as the opinions of both the parties of the dyad are not similar and there is a mismatch. This can be due to the error in judgment of cues by the leader or a case of miscommunication. *Follower/member underestimation* wherein the relationship is again unbalanced as in this scenario, the leader views the relationship highly, but the subordinate does not see it in a positive manner.

LMX research on dyad congruence is parallel to the performance appraisal research in the early 1980s, when Wexley and Pulakos (1983) studied the relationship of perceptual congruence and performance appraisals in leader–subordinate dyads and showed concern over the lack of studies that simultaneously examined the perceptions of both the leader and member. It was seen that there were differences between the leader and member ratings, and there were cues that agreement affected outcomes**.**

In fact, Wexley et al. in 1980 realized that majority of studies done so far were centered on actual similarity, rather than interpersonal perceptions about each other. In their study, they revealed that more similarly a leader perceived his/her subordinates' attitude, the more positively the subordinate was evaluated. Likewise, the more similarly the subordinate perceived the leaders attitude, the more contented he/she was with his/her supervision. Mutual agreement can actually be seen as a form of apt communication, which subsequently leads to interpersonal satisfaction.

According to Graen and Uhl-Bien (1995), low match would imply low quality of LMX. But Sin et al. (2009) expressed that low LMX match does not inevitably indicate low quality LMX relationship. We posit that high agreement (even if both perceive LMX to be low) would actually predict a healthy leader member exchange, as both perceive each other in a similar pattern and hence there is congruence between them. A balanced perception (high or low) is psychologically more stable and a viable option than an imbalance one.

Conforming to balance theory given by Hieder in 1958, human beings have a propensity to organize their likes and dislikes in a balanced proportional manner. When people are complementary in some facet and feel positive about each other, it is a balanced state of being emotionally pleasant. However, there are situations when people may not be similar, yet are fond of each other. This unbalance leads to emotional unpleasantness, which they try to resolve through change in ones' attitude and behavior to compensate for the same. Hence, being in a balanced state of agreement is not only desirable but ensures stability.

The issue of agreement in LMX ratings may have been explored, but the consequences of diverse ratings: high congruence, low congruence, or none at all, have not been examined. Prior studies have used the leader and member ratings in isolation due to which the possible effects of mismatch or divergent LMX perceptions were not credible, nor were they explored.

The need for studying the impact of LMX match/mismatch on subordinate outcomes, hence, is well established. We proceed with the four types of match/mismatch proposed by Coglister et al. (2009) and their likely impact of subordinate outcomes.

6.3 Outcomes of LMX Congruence

6.3.1 LMX Balance and Member Performance

Job performance is one of the most important indicators for explaining organization performance. It is not only determined objectively in terms of financial figures, but also in terms of behavior and task related issues. According to Gerstner and Day (1997), job performance is a significant and prominent outcomes of high LMX quality. There are many other studies that support this (e.g., Liden and Graen 1980; Vecchio and Norris 1996; Varma and Stroh 2001; Schyns and Wolfram 2008). It is clear that better the LMX quality, better are the opportunities the members get to perform, which, in turn, increases the performance rating by the leader. Similarly, better the congruence of ratings amongst the leader and member, better are the possibilities of favorable outcomes with respect to performance. Hence, it is expected that this will be further validated in this research along with the proposition that high LMX congruence will also lead to high job performance as appraised by both the leader and the member (Coglister et al. 2009). According to the congruence framework provided by Coglister et al. (2009) we posit that job performance ratings will be at its peak when both the leader and member have a high balanced match in perceptions, followed by underestimation, overestimation, and low balance.

Hypothesis 1 Members in high balanced relationships will obtain the highest ratings of job performance among the four relationship types, followed by underestimation, overestimation, and low balance.

6.3.2 LMX Balance and Member Promotability

Another important consequence of LMX quality is promotability. Subordinates with high valued relationships with their leaders, are expected to have positive effect on their promotability assessments. They are expected to be given more exposure, roles, and challenging tasks for career growth. It would be expected that these subordinates would be given more opportunities to grow, which then, would lead to higher levels of promotability than those who have a low quality LMX (Harris el al. 2006). Studies done in the past support this (e.g., Scandura and Schriesheim 1994; Liden and Maslyn 1998). Similarly, higher the congruence between the leader and member, better is the chance of communicating and understanding the expectations from one another. Hence, we posit that the highest congruence in promotability will be achieved when both the leader and member have a high balance in their perceptions, followed by underestimation, overestimation, and low balance.

Hypothesis 2 Members in high balanced relationships will receive the highest ratings of promotability among the four relationship types, followed by underestimation, overestimation, and low balance.

6.4 Methods

6.4.1 Sample

Survey questionnaire was administered to a total of 208 working executives, out of which a total of 103 dyads were identified and studied. The leaders and members were asked questions about job performance and promotability of the member. The executives were from a part-time MBA program at IIT Delhi and a government construction based organization wherein they were given questionnaires to fill personally and the responses collected as well. A total of 259 responses were received, out of which 103 dyads were identified and analyzed.

6.4.2 Variables and Measures

6.4.2.1 Leader-Member Exchange (LMX)

LMX lays emphasis on the two-way relationship between supervisors and subordinates. It was measured with the help of 12 items on a 7-point Likert-type scale taken from Liden and Maslyn (1998). The Cronbach's alpha of the items was 0.865.

6.4.2.2 LMX Balance

To facilitate the checking of the hypotheses proposed, LMX balance variable was defined and then we performed a median split on the leader and member LMX data. Dyads, wherein both the leader and member have rated their LMX at or above the median, were assigned to be high balanced dyads. Relationship where the leader and subordinate have rated LMX below the median were defined as low balanced dyads. Relationship where the leader has rated LMX at or above median, but the subordinate has rated LMX below the median, is described as subordinate underestimation. Finally, relationship where the leader has rated LMX below the median but the subordinate has rated LMX at or above the median, is described as subordinate overestimation (Coglister et. al 2009).

The outcome according to the agreement levels defined above among the 60 dyads is as follows: (i) high balanced = 21 matched responses (20.4 %); (ii) low balanced = 37 matched responses (35.9 %); (iii) subordinate underestimation = 13 matched responses (12.6 %), and (iv) subordinate overestimation = 32 matched responses (31.1 %).

6.4.2.3 Subordinate Performance

Job performance of the subordinate as rated by the leader, was measured with the help of 7 items on a 7-point Likert-type scale. The Cronbach's alpha of the items was 0.824.

6.4.2.4 Subordinate Promotability

Promotability of the subordinate as rated by the leader, was measured with the help of 7 items on a 7-point Likert-type scale developed by Harris et al. (2006). The Cronbach's alpha of the items was 0.755.

6.5 Results

Table 6.1 displays that the dependent variables are significantly different for the four types of LMX match/mismatch. In the table, mean, standard deviation, and F ratio values are displayed.

The MANCOVA model was significant ($F = 8.052$, Willis $y = 0.644$ and accounted for 34 % variance $(1 - y)$ indicating overall differences among the means for the set of dependent variables across the four LMX relationship types.

Table 6.1 Analysis results

Subordinate outcomes		High balanced N=21	Low balanced N=37	Underestimation N=13	Overestimation N=32	F ratio
Job performance	*Mean*	6.40	5.4	6.5	5.6	16.786***
	Std. D	0.58	0.76	0.40	0.55	
Promotability	*Mean*	6.32	5.1	6.09	5.4	10.592***
	Std. D	0.59	1.09	0.75	0.81	

*$p<0.05$, **$p<0.01$, ***$p<0.001$

6.6 Discussion

6.6.1 Subordinate Performance

As we see the mean values, underestimation (mean = 6.5) resulted in highest subordinate performance as perceived by the leader. This is followed by high balanced relationship (mean = 6.4), overestimation (mean = 5.6), and low balanced relationship (mean = 5.4) respectively. The mean of performance rating by the leader for subordinate, for underestimation, is more than high balanced relationships and are significantly higher than overestimation and low balanced relationships. However, it is not significantly different from high balanced relationships. Contrary to what we had predicted in terms of order, member underestimation has had the highest mean for subordinate performance as rated by the leader. Hence, hypothesis 1 was partially supported.

6.6.2 Subordinate Promotability

In case of subordinate promotability, the high balance relationship, as predicted, displays the highest mean value (mean = 6.32). This is followed by underestimation relationship (mean = 6.09), overestimation (mean = 5.4), and low balance relationship (mean = 5.1) respectively. The mean of promotability rating for high balanced relationships, is more than underestimation and are significantly higher than overestimation and low balanced relationships. However, it is not significantly different from high balanced relationships. Contrary to our conjecture of the four relationship types examined, follower underestimation had the highest mean. Hence, hypothesis 2 was partially supported.

6.7 Conclusion

The objective of this chapter is to understand the concept of LMX congruence, and to provide further empirical evidence and establish the relevance of flexibility within a dyad to have a match/mismatch of perceptions between a leader and his/her subordinate. This study supports the existing work of Coglister et al. (2009) and reestablishes the fact that, the four types of LMX congruence, have different impact on subordinate outcomes. This study being dyadic in nature, views performance outcomes, that is, job performance and promotability of the subordinate from the leaders' perspective. To our knowledge, there is scarcity of work done in this fiend specifically Indian context. The results are similar to the study done by Coglister et al. (2009) in the USA. Our study has certain limitations like sample size and limited number of outcomes being tested. There needs to be more work done to establish the impact of different types of LMX congruence on performance and attitudinal outcomes of subordinates. LMX congruence is an emerging area of interest and has the potential to further explore the flexible dynamic leader member relationships and determine its unique outcomes.

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Chapter 7
Practical Insights on Managing Diversity in International ICT Projects

Christina Böhm

7.1 Introduction

It is well proven from literature and empirical studies that diversity has a major impact on the success of international information and communication technology (ICT) projects. Conflicts arising from diversity differences can lead to lower effectiveness, decreasing efficiency, and productivity (Böhm 2013). Project managers as well as team members are required to deal with diversity aspects in their international environments. Being aware of differences and commonalities, creating an understanding for diversity as well as supporting respectful cooperation reduces the risks for conflicts and can make projects more efficient (Böhm 2013). Although the effects of diversity in projects were revealed in several studies, neither project management standards nor cultural studies developed a comprehensive concept for dealing with diversity in dynamic, flexible environments such as ICT projects. Thus, the practical solutions are very individual and highly dependent on the project manager's attitude, approach, as well as his or her personal experience. Practitioners in the international ICT project field often have to rely on personal experience and learning "on-the-job."

In this chapter, a qualitative study illustrates the practical application of diversity methods in international ICT project. The study is based on a literature study on managing diversity in ICT projects (Böhm 2013). Existing research on diversity in global management situations (i.a., Hofstede 2001; Hofstede et al. 2010; Trompenaars and Hampden-Turner 2010) provides high-level concepts and country-based cultural studies, but partly contradict with modern, humanistic management approaches (i.a., Highsmith 2004; Cockburn and Highsmith 2008). There is a clear gap between recommendation from literature and actual business practices in international environments that demand a high degree of flexible application. Therefore,

C. Böhm (✉)
Faculty of Computer Science, University of Vienna, Vienna, Austria
e-mail: christina.boehm01@gmail.com; e-mail: christina.boehm@univie.ac.at

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this chapter presents a study that reveals the relevant challenges and success factors from experienced practitioners' perspectives. Further, this chapter shows which diversity aspects actually impact ICT projects in practice, and provides an overview of necessary attitudes, skills, and possible measures.

The study consists of semistructured interviews with experts from various cultural backgrounds as well as with professional experience all over the world. The dispersion of the study participants around the globe allows a comprehensive insight into current issues and solution strategies in practice regardless of cultural affiliation. The study's results emphasize the importance of intercultural and diversity aspects in practice, and specifies success factors and diversity impacts in international ICT projects from a practitioners' perspective. Further, the study reveals the variety of approaches and techniques used by project managers for managing diversity in their projects.

Before presenting the study, this chapter will examine the current state of the art in international project and diversity management with a special focus on success factors and managing techniques. Further, the research design of the conducted study will be presented with explicit information on the participants' background and experience. Through the qualitative study, this chapter also provides a practical perspective on the topic. To conclude, the consequences for international project management—in research and practice—will be elaborated.

7.2 Diversity in International Projects

In the globalized world, people from different cultures have to work together in international projects, but often their diverse values and habits cause problems and conflicts. Several studies indicate the importance of diversity on the effectiveness of ICT projects (Dunavant and Heiss 2005; Harris and Davison 2002; Ives and Jarpenpaa 1991; Markus and Soh 2003; Narayanaswamy and Henry 2005). Also, the risk of project failure is highly linked to effective diversity management in international projects (Harris and Davis 2002). Unawareness of diversity aspects—on an interpersonal but also methodical and technical level—can increase misinterpreting and misunderstandings, which may negatively affect personal relationships, economic opportunities, and successful project implementations (Chroust 2008; Hofstede et al. 2010). Creating an understanding and acceptance for differences in culture or behavior, misunderstandings and disputes in business situations can be avoided or reduced.

7.2.1 Research on Diversity in Business

Among the published approaches—examining cultural diversity in business situations—the studies by Hofstede and Trompenaars are referred the most. While Hofstede (2001) described cultures as "mental programs"—which are influenced by personal experiences—and researched on dimensions of national culture, Trompenaars and Hampden-Turner (2010) elaborated the high impact on international companies' success in surveys with 30 different international companies. Further, whereas Hofstede's five dimensions (Hofstede et al. 2010)—power distance index, individualism, masculinity, uncertainty avoidance, and long-term orientation—focused on differences, conflict potential, and structural aspects, Trompenaars and Hampden-Turner examined how people solve problems and find solutions in business situations based on their cultural background and relationships (Böhm 2013). Although these two concepts are widely researched, various researchers revealed bias in Hofstede's studies (i.A., Huo and Randell 1991; Markus and Soh 2003). Further, the concept of national culture in both approaches seems inappropriate in a globalized world as a person's origin may not match the actual cultural values one holds (Böhm 2013). Moreover, the tendency to generalize and cluster people according to their nationality contradicts with modern, humanistic management principles.

Further, research on diversity management and intercultural interactions mainly focus on demographic aspects; whereas, diversity facets regarding organizational aspects such as affiliations or functional positions are rarely examined (Böhm 2013; Cummings 2004). Also, diversity management emphasizes cultural differences rather than using diversity as a source to form new knowledge within organizations, and to resolve issues in international projects and collaborations (Holden 2002).

7.2.2 Diversity Techniques and Trainings

In order to avoid failures and enhance success in projects, being able to manage cultural differences and professional responsibilities is vital. Managing cultural differences does not only mean understanding other cultural behaviors but also being able to apply frameworks to understand cross-cultural interactions and gaining intercultural communication skills (Bennett et al. 2000). On the other hand, understanding how business is handled in other countries and how people normally work is equally important. Various approaches provide guidelines for trainings or specific techniques. Fowler (2006) differentiates between intercultural trainings—aiming at preparing people, especially those who move to another culture, for interactions with other cultures—and diversity trainings, which aim at improving social problems, intergroup relations, and workplace settings. As behavior "is affected not only by culture but also by factors such as organizational norms, education, age, social class" (Fowler 2006, p. 404), it seems necessary to have both aspects included in effective diversity trainings.

Diversity trainings would typically combine cognitive processes with experiential learning that enables practice-oriented, cross-cultural experiences (Landis et al. 2004). Comprehensive trainings need to cover four major components: culture, behavior, perception, and communication (Fowler 2006). Whereas understanding and respecting cultural differences, its behavioral manifestation, and the individual perception is important, "communication is the heart of intercultural trainings" (Fowler

2006, p. 409). Communication is essential as it is the key to demonstrate respect and build trust with people of diverse backgrounds. “Without trust, it is very difficult to motivate, supervise, negotiate” (Bennett et al. 2000), and sustain successful cooperation. According to Bennett et al. (2000), not only communication but also team work and collaboration serve as the basis for building trustful relationships.

Numerous techniques to analyze or manage cultural aspects exist. For instance, Köster (2010) provides two techniques particularly tailored to international projects. The author suggests a cultural gap analysis that gives the opportunity to assign relevant project management activities to a two-dimensional cultural pole system. It does not aim at precisely measuring, but on raising awareness for cultural differences that might impact the project manager. Further, Köster (2010) suggests a diversity–complexity assessment. In the assessment certain factors—i.e., the number of national, organizational, or functional cultures; the number of languages; the degree of physical distance; the degree of heterogeneity of stakeholder interests—are analyzed and their importance is evaluated by categorizing their impact (e.g., from “low” to “high”). “The stronger the cultural diversity, the higher the complexity, the more efforts have to be made in terms of managing the international project” (Köster 2010, p. 91). This method can be understood as a basic source for communication strategies and risk management.

Although countless techniques seem to exist, no researcher has yet integrated these separate techniques into a comprehensive diversity management framework for project management. The following study will confirm the high impact of diversity as a success factor in ICT projects, and reveals the large variety of techniques used and specific measures in practice that may demonstrate the need for a standardized approach.

7.3 Description of the Study and Research Design

This section gives information on motivation of the study, background of the study participants as well as the research design and procedure used.

The basis of the study is a series of semistructured expert interviews conducted between December 2011 and December 2012 in various countries. The interviewees were practical experts in the field of project management and global management. The interviews were primarily performed via face-to-face interactions with an average duration of 1 hour. In total, ten experts were interviewed for this study.

7.3.1 Sampling

As the research focuses on diversity in a global field, it seemed important that the study participants also represent various regions and cultural background. Figure 7.1 illustrates the diverse cultural mix of the interviewees from four different continents.

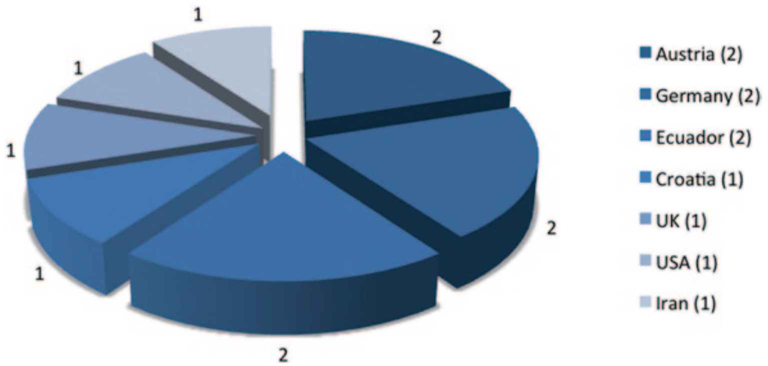

Fig. 7.1 Cultural background of interviewees

Further, the study participants' experience was vital for the relevance of the findings as well as profound and comprehensive results. All participants had more than 5 years of work experience, six interviewees were working in the field for more than 9 years, and two participants had more than 19 years of experience in project environments. In order to provide a comprehensive and generic picture, independent of cultural bias, it was important for the study that the participants had a wide range of experience in diverse cultural and geographic regions. Figure 7.2 illustrates the global experience of the participants divided into continental regions and the associated countries. All participants worked in at least five different countries located in two different continents.

The field of experience ranged from international project management—which was a precondition for participating in the study—to intercultural team management, program and portfolio management, process management, and management education. The interviewees' project experience derived primarily from ICT projects such as software development projects or network system projects. Some participants had additional experiences in organizational development projects, outsourcing projects, core banking projects, construction projects, international development and governmental projects, or marketing projects. Although all participants work in international environments, none of them ever received a formal, cross-cultural, or diversity training before their first international assignments.

7.3.2 Research Method

In addition to the participants' background regarding their global work experience, the study aimed at finding out:

- In which aspects international ICT projects differ from local ICT projects.
- Which aspects are particularly challenging in international ICT projects.
- Which aspects are perceived as success factors for international ICT projects.

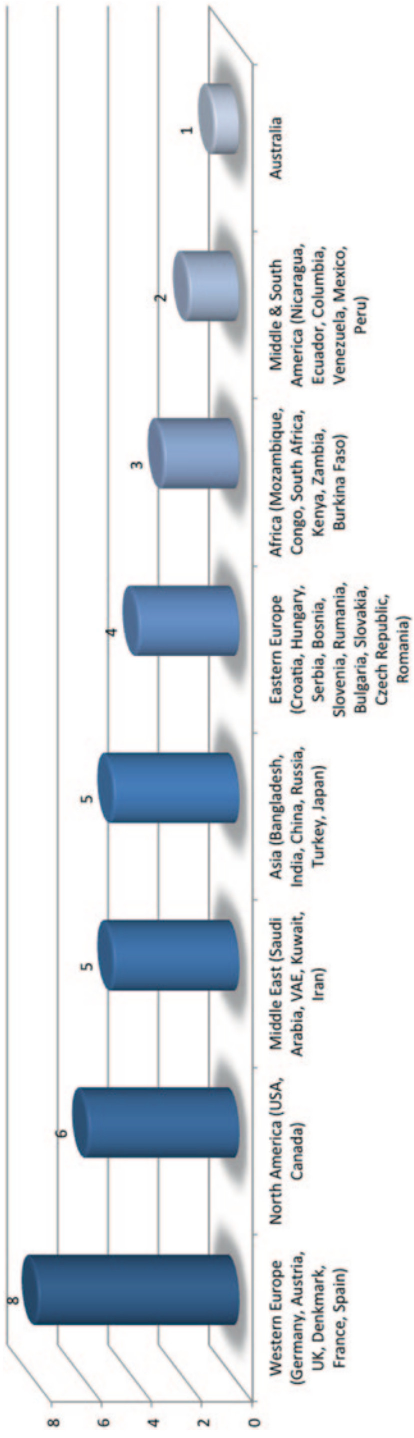

Fig. 7.2 Interviewees' global experience (multiple answers possible)

- Which diversity aspects directly influence ICT projects in an intercultural setting.
- Which steps and measures were used by the experts in practice to deal with diverse teams and intercultural environments.

The semistructured interviews were recorded, transcribed, and analyzed by applying a structured content analysis according to Mayring (2008). This research procedure demanded defining categories upfront. During the data analysis, significant parts of the transcripts were allocated to those predefined categories according to certain coding rules. These categories were derived from the interview guideline. The following categories revealed significant information: background information, challenges in international ICT projects, success factors in international ICT projects, diversity aspects relevant in ICT projects, and steps toward dealing with diversity in projects. After categorizing the interview content, the data was simplified, partly quantified, and summarized to reduce complexity for the presentation of the findings.

7.4 Study Findings

The results of the study are presented in four categories: challenges in international ICT projects, success factors in international ICT projects, diversity aspects relevant in ICT projects, and steps toward dealing with diversity in projects.

7.4.1 Challenges in International ICT Projects

This category shows which aspects the interviewees perceived as challenging in international ICT-related project environments. Figure 7.3 illustrates that 28 % of the identified factors (13 out of a total of 46 identified factors) concerned diversity.

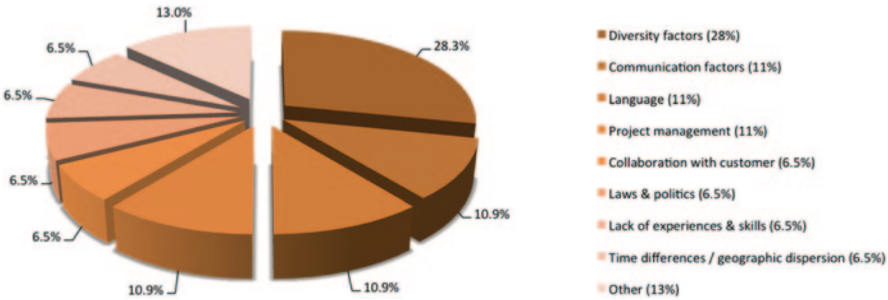

Fig. 7.3 Challenges in ICT international projects (multiple answers possible)

Such diversity factors were for instance "low cultural awareness," "prejudices," "religion," "different education," and "different ways of doing business." Communication (i.a., "virtual communication" or "lack of face-to-face communication"), language and project management factors (such as planning, scope or responsibilities) were mentioned five times (equals 11 %) by the study participants. Further, collaboration with customers, regional laws and politics, time differences and geographic dispersion, and a lack of skilled staff were stated as challenges.

7.4.2 Success Factors in International ICT Projects

The study participants were asked what—in their opinion—is needed to ensure project success in diverse environments. Figure 7.4 provides an overview of all factors (in total 119) that were perceived as needed for effective project management in an international context. The largest category with 19 statements (equals 16 %) regarded communication, while soft aspects (e.g., "be open-minded," "transparency," "flexibility," or "meeting people on eye-level") were mentioned 16 times (equals 13 %). Diversity aspects (e.g., "get rid of prejudges," "know people's background," or "cultural awareness") were mentioned ten times. Further, frequently mentioned success factors were experiences and skills (8 %), good project management (meaning the effective application of project management techniques), the role of the project manager, and the type of collaboration within the team (i.a., "sharing ideas together" or "build consensus within the team") .

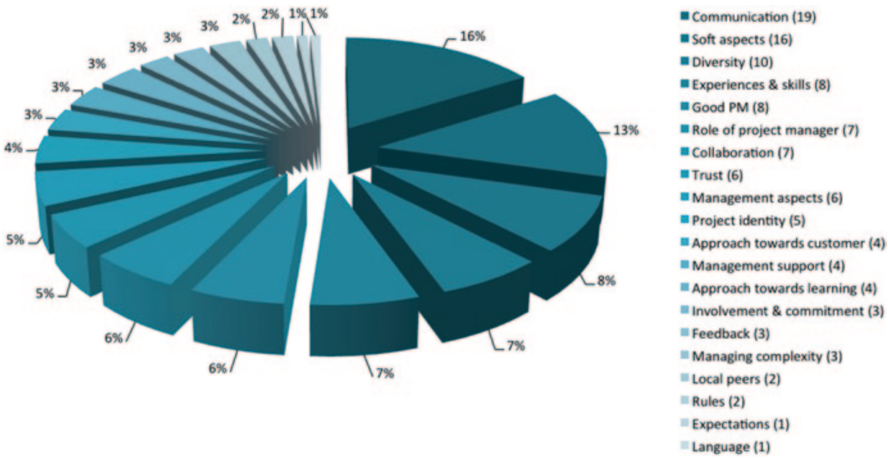

Fig. 7.4 Success factors in international ICT projects (multiple answers possible)

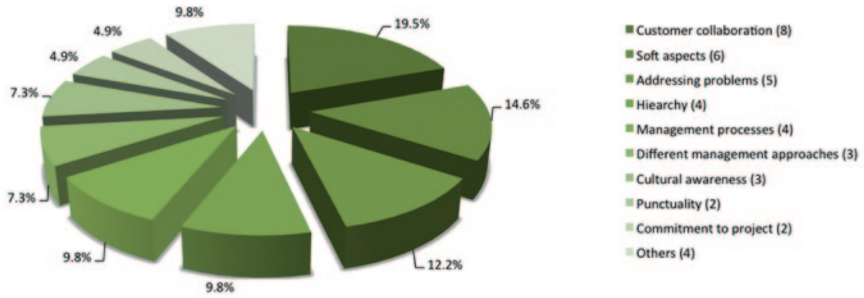

Fig. 7.5 Diversity aspects directly influencing project success (multiple answers possible)

7.4.3 Diversity Aspects in ICT Projects

In the interviews, the experts also described how diversity aspects affect the success of ICT projects. Many interviewees perceived customer collaboration (8 statements out of 41 statements), managing soft aspects (6 statements), the way how problems are addressed (5 statements), hierarchical structures (4 statements), and project management processes as most affected. Further, ICT projects are exposed to different management approaches and the level of cultural awareness of people (Fig. 7.5).

7.4.4 Steps Toward Dealing with Diversity

When participants were asked about how they deal with diversity in their business practices, they revealed over 50 steps necessary for managing diversity. Those steps can be categorized in two groups: necessary skills and attitudes (22 out of 57) and specific measures (35 out of 57).

The major part (16 out of 22 statements) concerned cultural skills and attitudes. The required skills and attitudes are listed in Table 7.1.

The interviewees identified 35 particular measures to manage diversity in their project practices. Table 7.2 gives an overview of measure categories.

Raising cultural awareness (e.g., by addressing communication and cultural issues directly), collocating the entire team for a certain period of time, applying good project management practices and techniques were perceived as an effective way to deal with a diverse team. Also, cultural assessments (e.g., "steering new team members on intercultural aspects," "using profiling assessments," "using cultural translators," and "developing a guideline with best practices"), translating relevant documents or laws, and building trust were perceived as effective measures. Other measures that were shared by the participants were frequent and fearless communication at eye level, building personal relationships and a project culture regardless of team members' nationalities, and choosing particularly open-minded partners for collaboration.

Table 7.1 Cultural skills and attitudes required in practice

Attitudes	Number of statements
Respect	3
Tolerance	3
Show understanding	2
Do not differentiate where people are from (also not gender)	2
Focus on individual personalities rather than on nationalities	1
Patience	1
Reduce prejudice	1
Same rules for all people and countries	1
Adjust to other cultures	1
Do not praise your own nationality	1

Table 7.2 Specific measures toward managing diversity in ICT projects

Measures	Number of statements
Raise awareness	5
Collocation for certain time	5
Effective project management	5
Cultural assessments	4
Translations	4
Build trust	4
Communication	3
Build personal relationships	2
Build project culture	2
Collaborate with open-minded partners	1

7.5 Conclusion

The results of the study illustrate the complexity of international ICT project environments from a practitioners' perspective. The variety of challenges and success factors identified demonstrate that there is no standard method or technique for managing diversity. One participant confirmed this interpretation: "There is no general recipe for a country or a cultural region." Also, depending on the project manager's cultural background, his or her personal attitude, and the individual approach, specific measures toward diversity management varied and there was not a clear consensus that all interviewees used a specific technique.

Further, the majority of the interviewed experts never attended a formal diversity or intercultural training or referred to the techniques provided in literature. This may be due to several reasons: lack of dissemination of existing diversity assessment techniques or lack of guidelines on how to use existing techniques. In each case, this fact shows that there is a clear gap between research and practice, and that there is need for a new way of approaching diversity. Further, the results may also indicate that rigid cultural management approaches are not applicable in today's (international) business environment as these concepts primarily help to reveal cultural differences, but do not support practitioners in applying that information into practice.

This implies that project management standards—which are frameworks and guidelines for practitioners—may need to focus more on the practical application of diversity management and adjust to the complex situation in international projects. As it seems that managing diversity cannot be solved as easily and generically—compared to measurable aspects of project management such as scheduling or structuring a project—there is a demand for a comprehensive approach that allows flexible application of techniques depending on the environment. Further research needs to be conducted to provide an adequate and adaptive framework in combination with a set of practice-proven techniques and tools to deal with diversity in international ICT environments effectively.

Finally, the interviews reveal clear tendencies on the importance of so-called "soft facts." 50 percent of the challenges regarding diversity and communication aspects (including language), and at least 53 % of all success factors can be summarized in the cluster "soft facts": communication, soft aspects, diversity, experiences and skills, trust, involvement, and commitment. Further, the identified intercultural attitudes and skills also show the importance of those topics in practice. As one participant stated: "I have never seen that a project failed due to technical or content differences—never! It were always those interpersonal aspects on a socio-cultural level."

The presented study should be understood as a starting point for further research. As the study was conducted with ten experts in the field with an explorative, qualitative research design, the study results cannot be generalized on a larger scale. Still, the study reveals tendencies that provide impulses for deeper examination and future research.

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Chapter 8
Developing Flexible Leaders Flexibly

Gautam Pant and Shuchi Sinha

8.1 Introduction

Current business scenario is characterized by a frantic pace of change requiring organizations to be flexible and proactive, while reflecting constantly on their strategic choices (Sushil 2000). Global connectivity, radical innovations and enhanced availability of information are opening vistas that were never explored earlier (Frank 2010). The boundaries between collaborators and competitors are diminishing, with competition emerging not only from disruptive innovations, but in the form of new players who find innovative means to counter the entry barriers (Boussebaa et al. 2014). The situation is further complicated with increased government involvement in managing businesses, partly due to past management irregularities, stringent corporate governance and environmental norms, rise in importance of NGOs, changing consumer demographics and trends, urbanization, pressure on natural resources and *exnovation* (innovation happening in association with external agencies) (Ghadar and Peterson 2008; Pant and Rathore 2012).The scenario is true not just for one type of business, but cuts across the business landscape and even permeates political governance, wherein the performance of a government and its delivery standards are compared across geographical boundaries.

Leaders acknowledge that operating in such a complex and dynamic environment requires them to be responsive, reflective, and adaptable (Barton et al. 2012). Strategies need to be realigned quickly to keep up with dynamic business scenario, which could vary with geographies. Leaders require equipping themselves with a

G. Pant (✉)
NTPC Ltd., New Delhi, India
e-mail: gautam_150874@yahoo.co.in; e-mail: gpant.ntpc@gmail.com

S. Sinha
Department of Management Studies, Indian Institute of Technology Delhi, New Delhi, India
e-mail: shuchisinha02@gmail.com

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host of diverse competencies, which can be utilized to address the changing demands. Leadership development, therefore, requires being flexible and customizable in order to develop flexible leaders, able to adapt to their environment and provide effective leadership. Organizations on their part, are responding to these leadership challenges by spending considerable time and effort in developing leaders. Development Dimensions International (DDI) projects that organizations with high leader quality are six times more likely to be among the top 20 financial performers of all organizations (Sinar et al. 2014). Leadership development is one of the top strategies of organizations for addressing the human capital challenge. DDI reports that development assignments, formal workshops, training courses, seminars and coaching are considered to be among the most effective methods of development as per the leaders surveyed. However, as per DDIs Global Forecast 2014–2015, not more than 50 % of the leaders surveyed indicated that they were 'very prepared' to address future challenges; indicating that a lot more needs to be done in the field of leadership development (ibid). 'There is clearly a need for a more systematic approach to the study of leadership development activities' (Yukl 2011, p. 451). There is limited research on the relative advantage of the different leadership development methods and initiatives adopted by organizations. Little is known about the ways to combine different methods (e.g. training, development and self-help activities) effectively to maximize their benefits.

In this chapter, we propose a model for leadership development which would facilitate a more comprehensive, systematic and customizable approach to leadership development. This model includes selection of right candidates, use of appropriate techniques for leadership development, evaluation of the process and outcome to ensure the development of an individual as a leader and alignment of her/his leadership capabilities to respective business and individual needs such that there is a high probability of development of leaders who are capable and flexible to adapt and lead in the tumultuous business environment today.

To facilitate our argument, we begin by discussing the question often asked about leadership—'does it matter?' Following this, we discuss the prominent parameters used to evaluate the effectiveness of leadership and leadership development; highlighting the challenges and concerns accompanying these measures. In the next few sections, we discuss the aspects that need to be considered carefully in order to enhance the effectiveness of leadership development initiatives. We begin by considering the design related issues where focus is directed towards the objective of such programs. Following this, we consider issues pertaining to participant selection and commitment. Various leadership development approaches are then outlined. The chapter culminates with a proposed model and approach which incorporates the parameters that need to be considered in order to design a comprehensive, systematic and flexible leadership development initiative.

8.2 Does Leadership Matter?

The debate on the impact of a leader borders on whether the significance of leader in the success of an organization is a part of attribution error (Nohria and Khurana 2010) that is error in ascertaining whether success of organizations is because of the leaders or any other factor. Lieberson and O'Connor (1972) concluded after their study of 167 organizations that the effect of the external environment (on organizations) is far greater than that of an individual leader. The constraints and forces in an organizational context are considerably uncontrollable by an individual; therefore, leadership hardly has a scope of having an effect (Hannan and Freeman 1989; Carol and Hannan 2000). Contrastingly, the Global Leadership Forecast 2014–2015 (DDI report) highlights that organizations having high quality engaged leaders are nine times more likely to financially outperform their peers. Wasserman, Nohria and Anand (2001) contribute to this argument by discussing the situations when CEOs can make a difference. Leader sets directions, aligns the workforce, motivates and inspires the workforce to achieve the desired results (Kotter 2001). The effect of leadership, though varies from organization to organization, cannot be ignored (Nohria and Khurana 2010). The US companies have increased leadership development spending by on an average 14 % amounting to $ 15 billion in 2013 (Bersin by Deloitte 2014).

In view of the importance of leadership impact discussed above, focus on leadership development makes the question around effectiveness of these initiatives a pertinent one. We address this question in the next section by highlighting the prominent indicators used to assess the effectiveness of leadership and leadership development and discussing the concerns surrounding these indicators.

8.3 Effective Leadership—Indicators and Challenges

Research on leadership has come a long way from proposing a static and deterministic view of leadership to a more dynamic and developmental view of it. The trait approach to leadership pioneered the idea of leaders being born. It proposed a list of traits which could predict effective leadership. In doing so, it consolidated the make-up of effective leaders and simplified their identification. Despite its contribution, the trait approach offered a rather simplistic and universalistic view of leadership; ruling out the possibility of developing leaders, capable of adapting to the changing business landscape.

The later theorization, particularly the contingency theories (Fiedler 1964,1967; Evans 1970; House 1971; Vroom and Yetton 1973; Potter and Fiedler 1981; House 1996; Robbins and Judge 2007) examine the concept of optimal leadership type suited to different situations bound by factors related to the ability and willingness of followers, nature of the tasks at hand, leader–follower relationship, etc. Technical skills (job related), cognitive skills, interpersonal skills, emotional intelligence (Goleman 1998), systems thinking (Senge and Sterman 1992) and ability to learn are related with leadership effectiveness (Yukl 2011). These coupled with the capability to utilize requisite skills best suited to a situation, and ability to learn would enable a leader to be effective in different situations and in managing change (for a detailed discussion, see Yukl 2011). These ideas offer the basis of development of various business relevant competencies (knowledge, skills and attitudes) to be the focus of the outcome of various leadership development initiatives. Leadership effectiveness can also be evaluated along the following criteria proposed by Yukl (2011):

- Consequence of influence—commitment, compliance or rejection.
- Company outcomes (profit margins)/Goals achieved (sales targets, market share, etc.).
- Perceptions of the followers.
- Leader's contribution in building the quality of the group processes as perceived by the followers and outsiders.
- Career profile of the leader—how soon a leader has risen along the ranks.

The above criteria offer a multifocal framework for evaluating leadership effectiveness; however, it may not be easy to establish a direct linkage between each of these and leadership effectiveness. For instance, company outcomes are effected by a range of internal and external factors and attributing them to leadership effectiveness alone would be misleading. Similarly, the career profile of a leader is not only facilitated by his/her effectiveness within a context, but shaped by a variety of factors such as the overall structure of an organization, prevailing economic environment, among others. It is important to highlight here that leadership effectiveness should not be seen as synonymous with goal accomplishment, as leadership happens even when leaders and collaborators/followers intend to achieve something, but fail (Rost 1993). Leadership effectiveness is linked to initiating change—altering the established patterns of work and behaviour (adaptive change) (Heifetz and Laurie 1997). Successful leadership (and change) is linked to eliciting people's commitment, not simply compliance. Unsurprisingly, analysis of the prominent definitions of leadership highlights that leadership is 'the process of influencing the activities of an organized group towards goal achievement' (Rauch and Behling, as cited in Yukl 2011). Rost (1993) too emphasizes that leadership is about influencing relationships, between leaders and collaborators. Uhl-Bien (2006) also describes leadership as a relational process. Effective leadership, therefore, is achieved through persuasion, not domination (Rost 1993; Hogan et al. 1994). Development of ability to influence may thus be concluded as the desirable outcome of a leadership development exercise. With this view, organizations require to rethink and redesign their leadership development initiatives, in order to develop leaders capable of exercising influence, resulting in employees' commitment for adaptive change.

8.4 Leadership Development Initiatives—Objectives and Design

Leadership development includes the life impact of a person on his/her leadership qualities (i.e. before he/she even joins the organization) (Brungardt 1997); however, for the purpose of this chapter, we focus on leadership development interventions conducted within the lifecycle of an employee in an organization. Organizational leadership development initiatives often focus on developing leaders to carry out the role demands of the next level to which they will be promoted to, instead of equipping them to perform the fundamental roles of leadership such as direction, organization, selection, motivation and implementation (Nohria and Khurana 2010). Leadership is not only associated with formal roles, but needs to be developed at all levels (Day 2001)—an aspect that leadership development initiatives should consider.

It is also important to distinguish between leader development and leadership development—the former focuses on an individual, while the latter on relational aspects (ibid.). Leader's capability and effective leadership are complementary and one cannot be successful without the other (Day 2001). From this stand point, organizations may have two parts to the development programs—one which focuses on the leader, whose content may vary depending on the different types of competencies required based on role changes and individual learning needs, and the other on leadership, which is more fundamental and consistent. The purpose and design of the developmental program should be aligned with the organizational culture and dominant beliefs and assumptions around leadership.

Knowing, doing and being are the three aspects on which leadership development program should focus (Nohria and Khurana 2010). The following may be included in each of these aspects for developing leaders and leadership:

- *Knowing*—understanding the strategy, processes and practices adopted by organizations, understanding the business context, opportunities and challenges facing the organization and businesses in general, knowledge of tools for environment scanning and decision-making, understanding the fundamentals of interpersonal behaviour and dynamics underpinning team work. Since leadership is about influence, knowledge of relational aspects and influencing tactics is crucial. Knowledge related to development of competencies (technical and behavioural) relevant for business may also be included.
- *Doing*—may include on the job and off the job exercises (simulations) which could enhance skills for problem solving, conflict resolution and effective communication. The other aspect to be included in the doing part is visioning and strategy formulation, change management planning, organizing and motivating others. Effective usage of the tools pertaining to management of people, situations and self and communication modes (including social media) may also be included. Besides these, Day (2001) specifies development of skills for building team orientation. Practicing influencing skills would also be important.

- *Being*—identifying and developing the concept and style of leadership which embodies an individual's beliefs and principles. Self-awareness in terms of personal motivators, emotional quotient (Goleman 1998) and areas of self-development are required.

8.5 Enlisting Participant Commitment

Any kind of developmental interventions would not have the desired impact, unless the need for change or development is felt by the person concerned. The approach of leadership development followed by Coverdale UK ensures that participants of any leadership development program first make a transition from the stage of unconscious incompetence to conscious incompetence. This is done by engaging the participants in a group exercise, which challenges them and highlights their areas of improvement. Participants are given feedback from other participants of the exercise, with the aim to generate a desire for self-improvement, which is crucial for a person to improve. The aforementioned approach is reproduced in pictorial form in Fig. 8.1.

The participant is then taken through a development program interspersed with reflection, feedback and coaching to take the concerned person to a stage of conscious competence, where he/she practices the skills learnt in a protected yet challenging environment and then through repeated practice, critical reflection and challenging his/her basic assumptions, the participant finally reaches the stage of unconscious competence.

This focus on participant's intent is a key aspect of the trans theoretical model (TTM) used by Bernal (2009) to develop the leadership development program. The TTM model also includes creation of intent for change by raising participant awareness, which is followed by preparing a plan to change, its implementation, maintenance and ends with commitment to change.

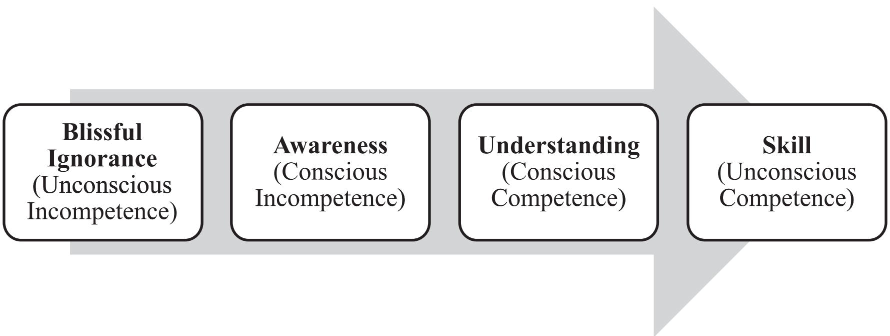

Fig. 8.1 Skill building stages

Similar emphasis on self-awareness, reflection and commitment to change is visible in the gradation of the leadership development levels proposed in the following approach in Fig. 8.2 for developing authentic leaders (Eigel and Kuhnert 2005):

Feedback and its acceptance is the bedrock of any development process and therefore, mental complexity/maturity of LDL-3 would be a prerequisite for a person to take charge of one's own development. SchÖn (1983) emphasizes the need for professionals to be researchers—analytical and reflective—deploying an action, reviewing it and changing the course if required (a trait of LDL-5 leader).

8.6 Participant Selection—Consideration and Challenges

Leadership development programs need to select people having requisite traits and maturity to drive their development, while also creating conditions to create the need for change in an individual and facilitating its actualization. Traits refer to the relatively stable dispositions to behave in a particular way (Yukl 2011, p. 43).

Several traits have been identified to predict effective leadership (Kirkpatrick and Locke 1991; Hogan et al. 1994; Lowe et al. 1996; Goleman 1998; Kelly 1998; Atwater et al. 1999; Robbins and Judge 2007; Yukl 2011). Prominent literature highlights that the following traits underpin successful leadership behaviours, which help the leader to elicit commitment, satisfaction and productivity from the followers:

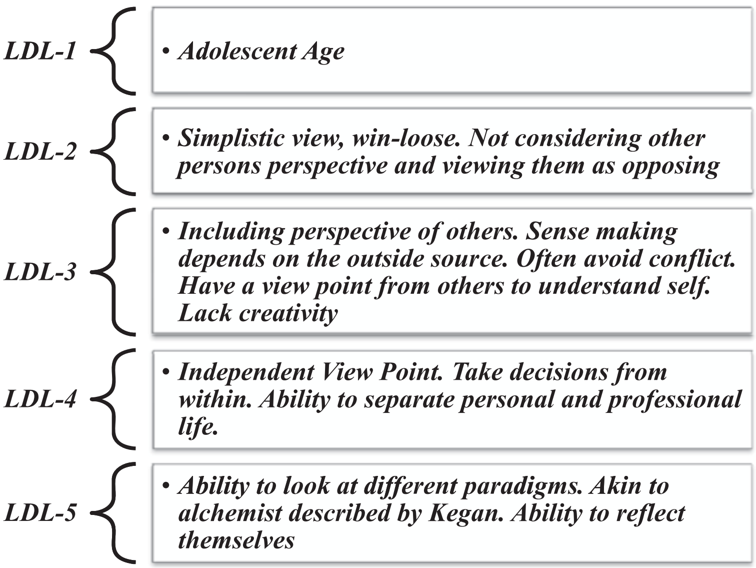

Fig. 8.2 Approach for developing authentic leaders focusing on leadership development levels

i). Socialized power motivation—which would include affiliation needs, for socialized power motivation could not be achieved without affiliation. It would further include desire to use powers for the greater good and is found to be associated more with emotional stability, openness, desire to develop others, empowerment, among others', representing a capacity for wielding sustainable influence.
ii). Drive—achievement motivation, ambition, energy, tenacity and initiative.
iii). Emotional stability—maturity and stress tolerance
iv). Honesty and integrity
v). Internal locus of control orientation
vi). Self confidence
vii). Dependability

These traits (typically drive and internal locus of control) also effect the motivation of a potential leader to learn and take ownership of self-development. It is argued that substantial improvement in knowledge and skills can be obtained by giving the right development to the right leaders (Collins and Holton 2004). Ensuring the presence of traits, highlighted above, in the participants of leadership development program, would strengthen the probability of achieving the desired output.

In the subsequent section, we review the prominent tools and frameworks adopted for understanding and designing leadership development initiatives.

8.7 Approaches to Leadership Development

The following framework given by Cacioppe (1998a) in Fig. 8.3, highlights the need for an integrated leadership development program which should be guided by strategic imperatives and aligned with the human resource systems of an organization.

Amagoh (2009) discussed the following approaches to leadership development:

- *Integrated-solution approach*—contains the following steps:
  - Develop a comprehensive strategy for leadership development
  - Connect leadership development to organization's environmental challenges
  - Set the context for development using leadership story
  - Balance global needs with individual needs
  - Employ emergent design and implementation
  - Ensure that the development options fit the organizational culture
  - Focus on critical moments of the leadership lifecycle and
  - Apply a blended methodology

For instance, the development program at Infosys, based on company values, may fit this category (Barney 2010). The dimensions of leadership development at Infosys include—strategic leadership, transition leadership, operational leadership, talent leadership, relationship and networking leadership, content leadership and

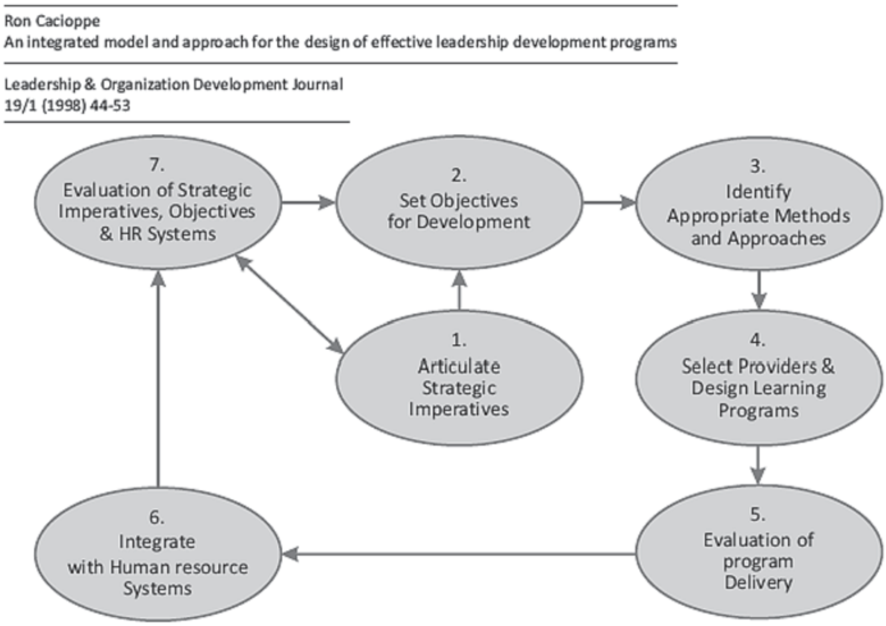

Fig. 8.3 An integrated approach to planning leadership development

entrepreneurial leadership. Infosys uses the Rasch Family of psychometric tests to test their leaders on dimensions of personality traits and values that predict leader performance and succession. Influence tactics of Robert Cialdini (Cialdini 1993; Cialdini and Cliffe 2012) have also been incorporated in their leadership program.

- *Experience-based approach*—combines job experience, life experience and specific skill development. This approach links the leadership development tool with leader's experiential insight to develop them. PepsiCo's leadership development program (Cacioppe 1998b), which uses 360° feedback to assess leadership effectiveness could be included in this approach along with the approach detailed by Tichy and Cohen (2002) which focuses on the development of competencies found to be effective for leadership roles. Los Angeles Times also uses similar approach coupled with one-on-one coaching and 360° feedback (Cacioppe 1998b).
- *Formal mentoring*—a popular technique to ensure career and psychological support and role modeling. There is evidence that involvement of senior leadership in programs is very effective (Cacioppe 1998b.). Similar approach is adopted by GE, FedEx and Pepsico (Day and Halpin 1999).
- *Leadership life cycle*—contains six steps(Block and Manning 2007)
  - Identification of leadership needs
  - Education content to address the skill gaps
  - Action learning

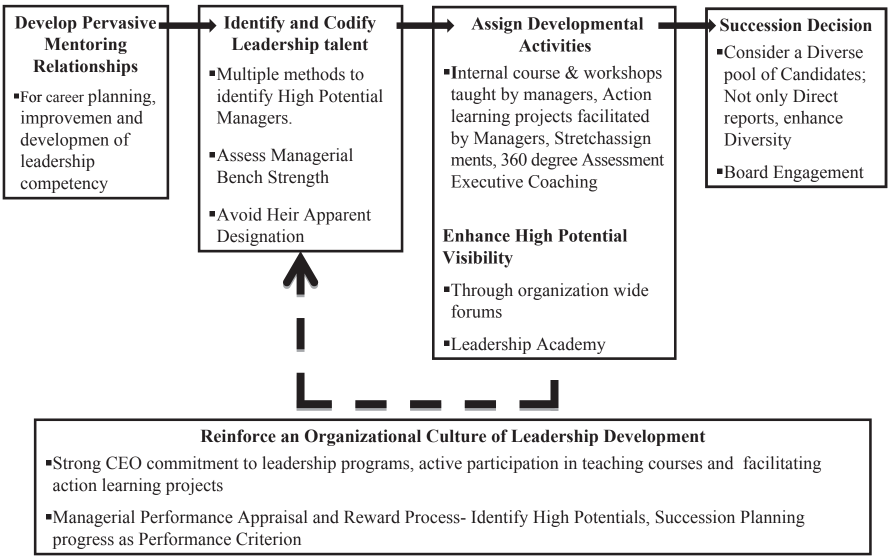

Fig. 8.4 Model proposed by Groves (2007)

– Workplace supports like mentoring to get ongoing guidance, feedback and support
– Recognition of leader's commitment and contribution
– Renewal Process to align development with organization's strategic goals.

Groves (2007), on the basis of the study of companies in the US health care sector gave the following model given in Fig. 8.4.

Leadership development has also been identified with the competencies that a leader needs to develop (Livingston 1971), which has now become a popular approach, used by two thirds of 100 Fortune 500 companies (Day and Halpin 1999). Charan et al. (2011) talk about developing competencies associated with change in responsibility and enhancement of span of control of a leader, before the actual event. Kelley (1998) identifies skills required for a worker to be considered as a star worker.

The tools and techniques used during various leadership development program include job assignment/job rotation, action learning (Revans 1982), training, mentoring, coaching, assessments and feedback, critical reflection and networking (Day and Halpin 1999; Day 2001). Training is one of the most commonly used tools in various approaches, however, its effectiveness is contingent on trainer, trainee, composition of the training group, follow-up reinforcement and feedback. Training not aligned to respective organizational cultures may not facilitate its application. Despite these factors, training and development is found to be usually effective, provided the ability, learning styles and preferences of trainee managers is taken care of (Collins and Holton 2004).

8.8 Analysis and Recommendations

The approach of many organizations is event-based (Broome and Hughes 2013), that is developing requisite capability to take up responsibility associated with next level of leadership. The Global Leadership Forecast 2011, DDI report states that leaders are found to be ineffective on the future critical competencies of managing innovation, creativity, coaching, etc., which are crucial to lead in the times of change. In the current scenario, the efficacy of the outcomes of leadership development initiatives may not just be profit in the short run, but development of reflective, flexible and adaptable leaders, equipped to respond to the current and emerging challenges and manage change (Petrie 2011). To address some of the concerns and challenges underpinning leadership development initiatives, we propose the following model and approach to facilitate the design and delivery of systematic and customized leadership development programs for companies.

8.8.1 Step1—Diagnostic State

Prior to designing and implementing a leadership development initiative, the following needs to be assessed/ascertained:

- The leadership belief held by top management and reflected in organizational culture (personal interviews, focus group discussions and surveys could be used). The difference in perceptions could also be effectively mapped using pictorial representation of beliefs of leaders and followers (Schyns et al. 2012).

Sustainable influence does not happen unless there is trust and mutual respect—the bedrocks of building the social capital as discussed by Day (2001). This would result in commitment of the followers/collaborators. Trust and mutual respect are not just fostered by individual behaviours, but are nurtured by the organizational culture. It is, therefore, important that the current culture is assessed and examined before launching a leadership development initiative.

- Key leadership positions (defined by those having maximum impact on business and culture), and the skills and competencies associated with them in order to use the same for leadership development.
- Existing bench strength of leaders to focus on the requirement of leaders. This exercise would also help in identifying job assignments/positions which could be used for development by mapping their Development Challenge Profile (to indicate the degree of difficulty) based on obstacles, task characteristics and unfamiliar responsibilities, with respect to an individual (Day 2001).
- Extent of leadership development needs by analysing the company wide data on competencies (if available). The development needs should be identified both, from the point of view of skills to be developed for leaders and behaviours to be developed for effective leadership. In case a company needs to start from scratch,

questionnaires may be administered to the reporting officers asking them to assess their reportees and vice versa.
- Existing workforce practices, to see whether they are aligned to foster the development of social capital based on networks, mutual trust and respect.
- Coordination between all the departments engaged in leadership development, so a holistic view can be adopted.
- Quality and willingness of people to be enlisted as mentors. Preferably, the mentors should be chosen across the organization enlisting existing and emerging leaders. Willingness of the mentors is the key.

In case the organizational culture does not foster the development of effective leadership, cultural interventions along with leadership development need to be started simultaneously. In case the organization is hierarchical and the top leadership does not have the right leadership ethos, they may be sensitized and leadership development and cultural interventions be rolled out only when management commitment in spirit is evident.

8.8.2 Step 2—Design of the Leadership Development Programs

- The first step of the program is to diagnose and assess the motivation level of the participant and entry level assessment of skills and competencies related to being a leader. Past assessment center results and 360° feedback of the participants may be used. The tools used by Infosys that is Rasch Family of psychometric tests seems to be well tested and may also be used to assess the participants. Motivation level of participant could be gauged either by using Behavioral Event Interviews, questionnaires or by gauging the progress on any task assigned to be completed before the entry into the program.
- Segregate leader and leadership development. Table 8.1, suggests some indicative contents to be included for the development of leader and leadership, which could be customized as per the needs of the organization. The aspect of knowing, doing and being are included in both, leader and leadership development; however, the aspects/contents included are distinct.

The aspects of knowing dimension may be customized based on specific competency requirements related to a sector or business and in view of the dynamic global business scenario. Further, suitable training/delivery agents with requisite experience of delivering the above programs need to be developed internally or taken from outside. Tools (action learning etc.) suggested may be modified to include different combinations suiting company's culture, feasibility and ease of operability.

It is suggested that leadership development programs be started early in the career span of an individual. Pant and Rathore (2012) point out that 5 years after the beginning of career is a good time for enrollment of desired participants in such programs. Training on knowing and doing dimensions should preferably be

Table 8.1 Indicative framework for design of leader and leadership development programs

Development of leaders	Development of leadership
Knowing (knowledge)—prior to and during the development/training program	
Knowledge of business and environment, challenges faced by the business, company strategy scenario planning, knowledge about cross functional department, legal provisions relevant for the business, knowledge about customers and competitors, management tools for effective decision-making and analysis	Concept of leadership, understanding effective leadership behaviours and how they could be deployed, nature and importance of influence, influence techniques and tactics, emotional intelligence, implications of dysfunctional behaviours, best practices related to leadership, importance of networks and ways of creating them, nature and relevance of change and approaches to managing it, communication process and medium available, team dynamics, knowledge of self and self-management
Doing (developing skill sets)—during development/training programs	
Create shared vision, formulate strategy and identify goals for the unit and team	Behavioural role modeling coupled with feedback
	Outbound training programs to build relationships, teams and leadership capability
	Formulating goals and strategy for alignment of the group/unit for a cultural improvement intervention to be rolled out by the participant
Suggested training and development tools	
Classroom training	
Case studies, business games and simulations	
Action learning projects, coupled with a top level sponsor acting as coach and having element of feedback from fellow participants and critical reflection could be used	
A network of participants and their mentors—may be created using internal web portals wherever they exist or using the web 2.0 tools. Knowledge management portal, if it exists, could create a community comprising of the mentors and leaders	
Being (practicing the acquired skills in order to imbibe)	
Special job assignments/rotations aligned with the development plan	
Practicing leadership and leader skills learnt at the work place to be reviewed by 360° feedback at the end of each year	
Participants may be encouraged to identify people from peer groups and subordinates to give periodic feedback. The duration of this type of semi-structured quick feedback could be shorter	
Assign a mentor. Participants may be encouraged to develop a creative profile highlighting their personality and interests. Profiles of mentors should also be developed. These could be maintained on sites like Facebook and Linkedin and matching could take place based on mutual likability and potential for reverse mentoring. Some companies use FIRO-B results to match the mentors and mentees	
Continue with critical reflection using journal to record experiences and reflections	

combined to allow participants to practice what they have learnt. However, they could be split and scheduled as per the participant's convenience, taking care to ensure retention of concepts learnt in the knowing phase. Knowing could be carried out at work place using e-learning modules or through evening sessions at work. The development needs to be planned as per the planned career path for the individual, to create requisite capability before it is required to be used by a leader with increase in span of influence. The framework for leadership development needs to be based on development of social capital, with increase in complexity and depth of deliberation in the content, associated with elevation in job positions. The design of the leader development program shall be changed based on the skill set required specific to each transition level/job position. Individual needs based on aspiration for specific leadership positions may be catered to by giving specific training/development.

Attempt should be made to classify the leader types based on their leadership style and development needs (Griffin 2003). Networks of such leaders across the company may be created to ensure that they support each other in their developmental challenges.

8.8.3 Step-3—Select the Right Leaders—to be Included in the Leadership Development Program

- Selection of the leader should be based on assessment of the presence of traits as highlighted in Sect. 8.6 above.
- The following assessment tools/techniques could be used for selection.
  - 360° feedback
  - Rasch Family of psychometric tests
  - Big five personality tests—http://psychcentral.com/personality-test/start.php
  - FIRO-B coupled with MBTI
  - Behavioural Event Interviews
- Candidates may be chosen by inviting applications and through nominations for being a part of the leadership pool, to ensure willing participants.
- The candidates should at least be at leadership development level (LDL) level-3, that is they must be able to accept the other view points and not be rigid about their own world view.
- Work performance may not be the criteria to enter the pool of potential leaders selected for development, because a star performer could be a victim of biased assessment or could be unaware of his/her capabilities, but should be a criterion to be considered for continued membership of the pool.

8.8.4 Step 4—Evaluation of the Leadership Development Program

- Following criteria may be used to assess an individual's development:

  - Improvements in 360° feedback

– Progression from LDL-3 to higher levels. This suggestion is made to ensure that the respective leader is able to acquire a mental level required for reflection, taking self-ownership for requisite development of competencies and leadership abilities.
– Surveys highlighting leadership quality

8.8.5 Step-5—Review and Improve

Review the skills and competencies specified for development of leader to ensure alignment with current organizational needs and strategy. Review the content, process and techniques deployed to see that they are well received and are fitting the existing culture. Review should also be based on participant's feedback.

The diagrammatic representation of the model described above is placed as Fig. 8.5.

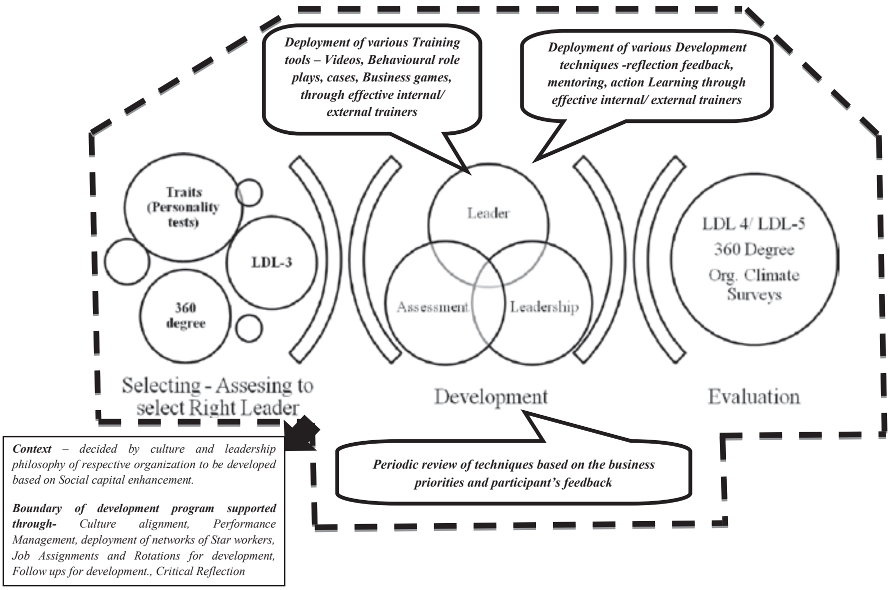

Fig. 8.5 Suggested model of leadership development

8.9 Conclusion

Business leaders today are facing a host of unique challenges; requiring them to respond quickly and flexibly. Despite spending considerable amount of time, effort and money towards developing leaders to lead effectively in a dynamic business environment, organizations are not able to optimize the benefits from these efforts. In this chapter, we propose a model and approach for leadership development which would facilitate a more comprehensive and systematic approach to leadership development. This model includes selection of the right candidates, use of appropriate techniques for leadership development, evaluation of the process and outcome to ensure the development of an individual as a leader and alignment of her/his leadership capabilities to respective business and individual needs, such that there is a high probability of development of leaders who are capable and flexible to adapt and lead in the tumultuous business environment today.

This model recognizes the rising need for effective leadership (not just leaders). The attempt of the suggested leadership model is to develop LDL-5 leader to address this future requirement. Focus is directed towards ensuring development of requisite leadership capability in an organization, by not only focusing on an individual as leader but also incorporating other people in the process of leadership development to make it more inclusive, resilient and flexible to respond to the current and emerging business challenges.

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Chapter 9
Role Efficacy and People Flexibility: Examining Moderating Functions of Demographic Factors

Umesh Kumar Bamel, Renu Rastogi, Santosh Rangnekar and Shyam Narayan

9.1 Introduction

In recent years, there have been extensive academic endeavors to understand the concept of flexibility and its interplay with organizational outcomes. Flexibility has been a recurring theme in contemporary scholarly writings (*strategy* in Sushil 2005, 2010; *product development* in Sanchez and Perez 2003; *marketing* in Singh 2011; *operations* in Dalpati et al. 2010; *people/people flexibility* in Bamel et al. 2011, 2013; Piansoongnern 2013; creativity and *innovation* in Prasad and Prasad 2013). Publication of a journal *(Global Journal of Flexible Systems Management)* and organization of an annual international academic conference *(GLOGIFT)* on flexibility and related concepts have substantially held the meaningfulness of the construct. As evident in literature it is a diverse, multidimensional, and multilevel construct.

> …..the term flexibility is used at various levels. It is used at the level of products, processes, people, management, organizations, strategy, systems, structure, nation culture and frame of mind.
> Sushil 2010

In the present chapter flexibility has been studied from people's perspective, i.e., people flexibility and it may be referred to as an extension of the author(s) previous

U. K. Bamel (✉)
Indian Institute of Management Raipur, 492001 Raipur, India
e-mail: umeshbamel@gmail.com

R. Rastogi
Department of Humanities and Social Science, Indian Institute of Technology Roorkee, Roorkee, India

S. Rangnekar
Department of Management Studies, Indian Institute of Technology Roorkee, Roorkee, India

S. Narayan
National Institute of Technology, Kurukshetra, India

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efforts. In a similar study conducted previously, we (*see in* Bamel et al. 2013) addressed the three main questions, i.e., what is people flexibility? What is its significance? And how to improve/impart people flexibility? We have defined people flexibility by considering the generic assumption of flexibility (Sushil 2001) and by synchronizing it with the views about flexibility given by different scholars (Mott 1971; Drazin and van de Ven 1985; Volberda 1996). According to the definition "…people flexibility simply may be viewed as the ability to take advantage of the pragmatic and opportunistic changes by freely selecting the best suitable options" (Bamel et al. 2013). To answer the second question we have drawn evidence from the available literature and correlated flexibility with people effectiveness. While addressing the concern about how to impart (predictors of) flexibility, organizational processes have been examined as its predictors. In continuation, the present study is an attempt to widen the inventory of people flexibility predictors. At this juncture, a possible question might arise, i.e., what is the rationale for doing so? If we propose and conceptualize people flexibility theoretically and urge about its importance, subsequently, we must be able to answer the practical question: how to improve people flexibility? And then only the presence of this construct would become more valuable. We aim to explore the possible ways of improving people flexibility, and therefore, in the present case role-efficacy perception of managers and its dimensions have been proposed and tested as predictors of their flexibility. In the next section theoretical framework is presented. Theoretical framework is followed by methodology, analysis, and discussion. Conclusion and suggestions for implication are also given.

9.1.1 Role Efficacy and People Flexibility

Research on role efficacy has reported its beneficial consequences on many workplace constructs (individual as well as organizational), e.g., the internal locus of control (Sayeed 1989), coping with stress, job satisfaction, motivation, managerial effectiveness (Bamel et al. 2013; Sayeed and Jain 2001), and so on. The term first appeared in the early writings of Pareek (1980, 1987, 1993) who proposed role efficacy as the potential effectiveness of the role occupant. Subsequently, the association of role efficacy with other variables has been explored. According to Pareek, it has two attributes, i.e., role perception and role expectation. Role efficacy is found to be directly proportional to the degree of alignment between these two said attributes. Another assumption about role efficacy is that it is considered as a cognitive element and is believed to affect the role occupant's belief in his/her knowledge, skills, and abilities. In other words it may be understood as the perception of the role occupant about "*…the extent to which she believes that role has the potential to be effective depends upon whether they feel themselves capable of executing the role effectively*" (Pethe and Choudhary 2000). It is the role occupant's perceived confidence in his/her abilities to perform. Our presumption that role efficacy would predict people flexibility is founded on the scholarly claim that it is a cognitive element and it augments the role occupant's confidence in the given role.

Ever-changing workplace environment continually changes managerial roles. A manager who adjusts, adapts, and responds to the dynamic factors is more likely to enhance organizational value (Tsui 2004). A manager's ability to be responsive to changes is nothing but people flexibility. It is an employee's ability to make alignment of his actions with continuous changes. The role occupant's perception of his/her abilities leads to the formation of self-schema or self-concept (Marsh et al. 1991; Skaalvik 1997) and it is through this that role efficacy is believed to boost people flexibility. On the basis of this presumption, we propose that role efficacy would predict people flexibility positively and significantly. To be more specific, following hypotheses were framed on the basis of this presumption.

Hypothesis 1: Role-making perception of Indian managers would predict their flexibility.

Hypothesis 2: Role-centering perception would lead to people flexibility of Indian managers.

Hypothesis 3: Role-linkage perception would lead to people flexibility of Indian managers.

9.1.2 Moderating Effect of Demographic Variables

Since the proposition of Cohen (1978), the role of demographic variables (such as age, gender, ethnic belongingness, education, expertise, social class, geographical locations, etc.) have been studied by organizational researches. These variables are assumed to influence the relationship between predictor and criterion variables in terms of strength (weak and strong) and direction (positive and negative) (Barron and Kenny 1986; Frazier et al. 2004; Wu and Zumbo 2008). Studies have reported the existence of moderation effect due to gender, hierarchy, and type of organization (Booysen and Nkomo 2010; Gbolahan and Catharine 2012; Riquelme and Rios 2010; Kaiser and Craig 2011; Rastogi et al. 2012). Following this, we also intend to test the moderating effect of gender, hierarchy, and type of organization on the role efficacy–people flexibility relationship. Hypothesis 4 of the study has been developed to examine the said effect.

Hypothesis 4: Demographic characteristics (gender, hierarchy, and type of organization) of managers would moderate the relationship between role-efficacy perception and people flexibility.

9.2 Methodology

9.2.1 Participants and Procedure

The present study is a cross-sectional survey that has used structured questionnaires to obtain data from a sample of 348 managers in India. Questionnaires were administered directly to respondents. The instrument used was a structured questionnaire

Table 9.1 Demographic characteristics of participants

Variables		Private sector		Public sector	
Age (years)	(Number, %)	Number	% of total	Number	% of total
	>30 (155, 44.5)	108	31	47	13.5
	30–40 (102, 29.3)	73	21	29	8.3
	40<(91, 26.1)	29	8.3	62	17.8
Gender					
	Male (308, 88.5)	188	54	120	34.5
	Female (40, 11.5)	22	6.3	18	5.2
Education					
	Diploma (28, 8)	22	6.3	6	1.7
	Graduate (145, 41.7)	71	20.4	74	21.3
	Postgraduate (155, 44.5)	101	29	54	15.5
	Doctorate (20, 5.8)	16	4.6	4	1.1
Managerial level					
	Junior (154, 44.3)	108	31	46	13.2
	Middle (95, 27.3)	67	19.3	28	8
	Senior (99, 28.4)	35	10.1	64	18.4
Total	(*N* 348, 100)	210	60.3	138	39.7

Note: source primary data

with closed-response options. Table 9.1 reports the demographic characteristics of respondents.

9.2.2 Measures

The scale used to measure role-efficacy perception was taken from the work of Pareek (1987). This scale contains 20 questions and intends to assess the participants' perception of role making (8 questions); role centering (6 questions), and role linkage (6 questions). In order to ascertain the reliability of the scale and of its factors, Cronbach's alpha (reliability coefficient) was calculated and the obtained values were found to be satisfactory (i.e., 0.76 for the role-efficacy scale, and 0.62, 0.60, 0.59 for role making, role centering, and role linkage, respectively).

The measure of people flexibility is composed of five items and originally is a part of Mott (1971) work. The single-factor scale has been validated in the Indian context (Bamel et al. 2013, 2014). A five-point likert scale was used to record the responses. These items cover behavioral aspects such as making adjustment to changes, responding to emergencies, and so on. The Cronbach's alpha value of people-flexibility scale was 0.67.

9.3 Analysis and Results

Data analysis has been done in three steps. Appropriateness of the data (Table 9.2) (normality, multicollenearity and reliability) and descriptive statistics (Table 9.3) were calculated in the first step. The values for skewness, kurtosis, and VIF held the appropriateness of the data for quantitative analysis.

Results for descriptive statistics, i.e., mean score, standard deviation, and correlation coefficient are listed in the Table 9.3. The correlation matrix reveals an existence of significant relationships between role-efficacy dimensions and people flexibility. These results correspond to what we proposed in H1, H2, and H3. Though, in order to test the predictory function, hierarchical regression was employed subsequently.

In the second step, hierarchical multiple regression was employed using SPSS 17 to test the research hypotheses. Gender, managerial level, and type of organization were treated as control variables. The predictor variables were entered as follows: step one control variables (gender, managerial level, and type of organization); step two: step one + role making; step three: step two + role centering; and step four: step three + role linkage. Table 9.4 presented the results of hierarchical multiple regression analysis.

Table 9.2 Normality, reliability, multicolinearity statistics

N 348	Skewness		Kurtosis		Croanbach's alpha	VIF
Scale	Statistic	SE	Statistic	SE		
RE	0.197	0.131	0.524	0.261	0.76	1.041
RM	−0.125	0.131	−0.617	0.261	0.62	1.530
RC	−0.361	0.131	−0.018	0.261	0.60	1.472
RL	−0.502	0.131	−0.172	0.261	0.59	1.377
PF	−0.113	0.131	0.277	0.261	0.67	

Source: primary data, *N* total no. of participants, significance level < 0.05; *RE* role efficacy, *RM* role making, *RC* role centering, *RL* role linkage, *PF* people flexibility, *SE* standard error, *VIF* variance inflation factor

Table 9.3 Descriptive statistics

	Man.	Org	RE	RM	RC	RL	PF
Gen.	0.10	−0.03	0.02	0.01	0.029	0.01	0.10
Man.		0.28**	0.10	0.09	0.11*	0.05	0.12*
Org			−0.06	−0.11*	−0.08	0.01	−0.08
RE				0.83**	0.76**	0.76**	0.33**
RM					0.51**	0.46**	0.28**
RC						0.44**	0.27**
RL							0.27**
Mean			2.26	2.29	2.13	2.34	3.33
SD			0.37	0.39	0.36	0.38	0.63

Note: source primary data, significant at *$p<0.05$, **$p<0.01$, *Gen.* gender, *Man.* managerial level, *Org* type of organization, *RE* role efficacy, *RM* role making, *RC* role centering, *RL* role linkage, *RE* role efficacy, *PF* people flexibility

Demographic variables such as gender, managerial level, and type of organization explains only 2.7 % (R2.027; F (1, 346) 4.726, $p>.05$) variance in the dependent variable. In the second model, role making was added and this increased the variance significantly by 6.3 % (R2.09; F (2, 345) 11.344, $p>.000$). The third model adds role centering, and it significantly increased the R2 by 1.8 % (R2.109; F (3, 344) 10.438, $p>.000$). In the fourth model role linkage has been inserted and it improves the R2 by 1.7 % (R2.126; F (4, 343) 9.826, $p>.000$). The retained model

Table 9.4 Hierarchical regression analysis results (PV role-efficacy factors, DV people flexibility)

	Predictors	Step 1b	Step 2b	Step 3b	Step 4b
1	Constants	16.484	11.774	10.258	9.059
	Gender	0.052	0.059	0.062	0.055
	Managerial level	0.148**	0.113*	0.102*	0.107*
	Type of organization	−0.121*	−0.084	−0.076	−0.087
2	1 + role making		0.256***	0.176**	0.124*
3	2 + role centering			0.159**	0.177*
4	3 + role linkage				0.153**
	F change Sig. F	4.793 0.05*	23.952 0.01**	7.115 01**	6.686 01**
	R^2	0.027	0.09	0.109	0.126
	Adj. R^2	0.021	0.082	0.10	0.113
	R^2	0.014	0.063	0.018	0.017

Note: *$p<0.05$, **$p<0.01$, ***$p<0.001$; *PV* predictor variable, dependent variable, $N=348$, *b* standardized beta score (fourth model) has significantly explained approximately 12.6 % variance in people flexibility (R2 12.6 %, adjusted R2 11.3 %). Further, regression results also withheld role making (standardized beta value .124, t (1.98) $p < 0.05$), role centering (standardized beta value .177, t (1.94) $p < 0.05$), and role linkage (standardized beta value .153, t (2.568), $p < 0.01$) as significant predictors of people flexibility.

Thereafter, bootstrapping was employed by using the structural equation modeling to ascertain the moderating effect of demographic variables. The moderation effect means that the value of a moderator variable affects the strength or direction of the relationship (Barron and Kenny 1986). To achieve this objective, three sub-hypotheses were developed: hypothesis 4a for moderation effect of gender, hypothesis 4b for moderation effect of managerial level, and hypothesis 4c for moderation effect of the type of organization and critical ratios (CR) were calculated.

Hypothesis 4a postulates that the role efficacy–people flexibility relationship would differ for male and female groups. The results show that the total effect for male and female managers are .17 and .13 respectively (Fig. 9.1). However, the critical ratio difference between these two groups is not found significant (a1/a2 −.346 lies within the range of z score (± 1.96) at 95 % significant level). Hence, the assumption that gender would cause a difference in the relationship of role efficacy and people flexibility stands rejected.

Similarly, the moderated function of managerial level was tested. The results show that the total effects for junior, middle, and senior managers are .12 (SE .047, significant at .001), .14 (SE .043, significant at .01), and .24 (SE .043, significant at .001), respectively (Fig. 9.2). The critical ratio difference between junior managers and middle managers was found insignificant (critical ratio difference score a1/a2 −.446 and was within the range of z score (± 1.96) at 95 % significant level). A significant moderation effect was found between the pairs of junior and senior

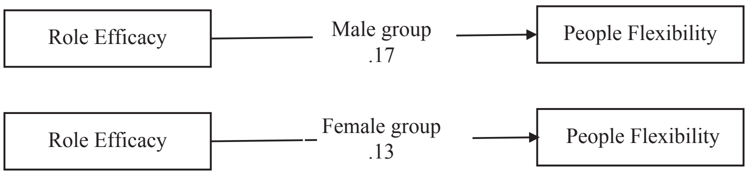

Fig. 9.1 Moderated path for male and female managers

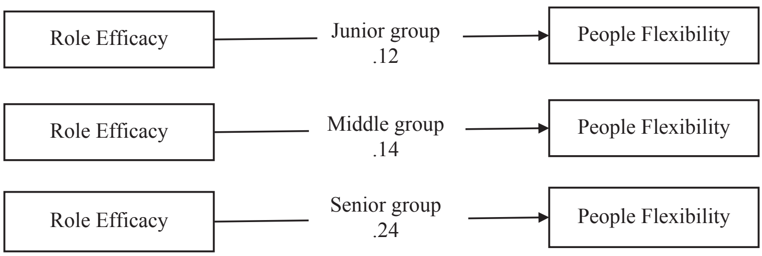

Fig. 9.2 Moderated paths for junior, middle, and senior managers

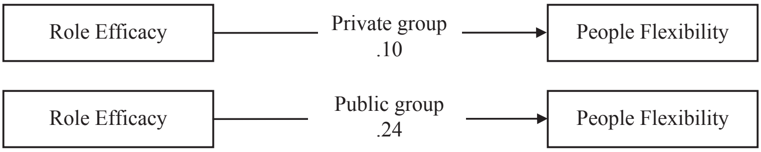

Fig. 9.3 Moderated path for private and public managers

managers (critical ration difference (1.98) was found beyond the range of z score at 95 % significant level), and the middle and senior managers (critical ratio difference (2.007) was found beyond the range of z score at 95 % significant level). The critical ratio differences between these three groups confirmed the partial moderation effect of managerial level.

Likewise, the critical ratio difference was calculated for public and private managers (type of organization). The results show that the total effects for private and public managers are .10 (SE .033, significant at .001), .24 (SE .038, significant at .001), (Fig. 9.3). The critical ratio difference (a1/a2 2.987 and was beyond the range of z score (±1.96) at 95 % significant level) between junior managers and middle managers was found significant and thus proved the moderation function of the type of organization on role efficacy and people flexibility relationship.

9.4 Discussion

The purpose of the present study was to measure role-efficacy perception as predictor of people flexibility. In addition, efforts were made to examine the moderating effect of demographic variables. Role-efficacy perception and its factors (role making, role centering, and role linkage) were proposed and subsequently tested as predictors of people flexibility. The findings of the study supported our hypotheses. Bandura (1977, 1999, 2007) also apprehended the notion and purported that efficacy belief of role occupant leads to desired behavioral outcomes. In the present study, we also addressed people flexibility as a behavioral aspect. Therefore, Bandura's argument augments the findings of the present study. Role-efficacy perception fosters the process of introspection in terms of judging internal strengths and capabilities, and this internal assessment improves the concept of the self in relation to surroundings. In addition, understanding of the self in terms of possessed resources (knowledge, skills, and abilities) accelerates the probabilities of individual responsiveness towards changes. In other words, the awareness of the self in occupied role develops people flexibility. For example, if there is a change in technology, the manager who lies within the scope of this change has to acquire a specific skill set to imbibe this technical change. Here, the self-awareness would tell the manager about the availability of the requisite skill set. And, in case if it is not available, it prompts the manager to obtain it. Acquiring a new skill set to manage the change may be termed as a manager's responsiveness towards change.

Moving ahead, the moderating function of demographic variables was ascertained. The results revealed that gender does not interact with the said causal path. In other words, no significant change exists for male and female managers. Both categories of managers seem to recognize the importance of self-belief and self-awareness in managing changes around them. Next, exploration was done to see the moderation effect of managerial level. And the results seemingly support the assumption of Pareek (2008) that role-efficacy perception increases gradually with experience. The strength of the relationship between role efficacy and people flexibility increases from junior to senior level, and a significant difference was observed among junior and senior, and middle and senior categories. However, the difference between junior- and middle-level mangers was not significant. A huge and significant difference was observed among private and public category managers. Public category managers outperformed private managers. A possible explanation for this outcome lies within the data set itself; in the private category, the majority of respondents (30 %, in Table 9.1) are from the junior-level position whereas in the public category, senior-level managers constitute the largest portion of the data set (17.8 %, in Table 9.1). Therefore, in a way this finding too generalizes the effect of the managerial level; however, the moderating effect of the organization type is still inconclusive. This may be taken as a potential limitation of the present study.

9.5 Conclusion

The present study examined the functions of role efficacy and its dimensions (role making, role centering and role linkage) as predictors of people flexibility. In addition, the moderating functions of demographic variables were studied on the said causal path. Following are the conclusions from the study:

- Role making is a significant and positive predictor of people flexibility.
- Role centering is a significant and positive predictor of people flexibility.
- Role linkage predicts people flexibility positively and significantly.
- No moderating effect of gender was observed on the said causal path.
- Managerial-level wise, the quantum of relationship index increases from junior to senior level.
- Moderating role of type of organization is not apparent because of the nature of the data set because variable "managerial level" seemed to appear as confounding variable.

Despite the audacious claims which the present study has made about predictors of people flexibility, it is not free from some inherited limitations. The nature of the data itself has appeared to be as a noteworthy limitation. Second, for achieving research objectives, a positivistic approach by using a cross-section methodology was used. Generalization of the results could not be made as triangulation of methodologies was not used. Another limitation is related to belief of what is people flexibility; the concept is still in its nebulous stage and needs more scholarly endeavors to mature. However, the presence of these limitations does not paralyze the potential contribution of the present study:—in terms of its application and contribution in the existing knowledge base of people flexibility. Implication wise, the knowledge of how role-efficacy factor contributes towards people flexibility could be used to shape people flexibility. Some role-related interventions such as involvement of the role holder in role development and expanding the interaction among different roles in organization may be developed "more particularly" for shaping people flexibility.

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Chapter 10
Exploring the Complex Interface between IT Professional and HR: Building Flexibility Applying Cybernetic Concepts

Supriya Kummamuru and P. N. Murthy

10.1 Introduction

The Indian information technology (IT) industry is still in its early stages of development compared to other industries. But the phenomenal growth of this industry has caught the attention of the world as a major powerhouse for software development (Chakraborty and Dutta 2002).

"IT services export is the fastest growing segment, growing by 19 % in financial year (FY) 2012, to account for exports of $ 40 billion" (www.nasscom.in 2012). The Indian IT services offerings have transitioned from application development and maintenance services (ADMS), to providing a wide spectrum of services including testing, infrastructure, consulting and system integration."

There has been a paradigm shift in the approach to building customer needs from a single model to several models from the same factory (www.nasscom). This has led to a growing army of Indian software engineers constituting a new global technical workforce that has been produced in response to the demands of the global economy. The workforce also has the exposure of working with Fortune 500 companies and building strong professional capabilities on par with IT professionals across the world. This growth of the IT industry in India, which is due to the availability of highly competent and cost competitive IT professionals, is being challenged. The work demand bridging several time zones, shorter learning cycles, technology challenges and frequent travels have taken a toll on the human resources of this industry.

India is home to large IT organizations that are knowledge-centric, wherein knowledge resides in people. However, we have not adequately addressed the needs

S. Kummamuru (✉) · P. N. Murthy
Business Systems & Cybernetics Center, Tata Consultancy Services, Hyderabad, India
e-mail: Supriya.Kummamuru@tcs.com

P. N. Murthy
e-mail: prof.pnmurthy@gmail.com

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of this key resource yet. This, combined with a shortage of competent professionals from a large pool of engineering graduates, has made the task of attracting and retaining IT professionals in India very complex and demanding. As per an article about the top 10 challenges faced by the IT industry, the need was to design ways to reduce stress amongst employees and align company requirements to the needs of the employees. All these issues faced by professionals fall into the lap of HR. The need, therefore, is to view the problem from two lenses, one from the needs of the IT professional, and the other from the perspective of the organization of HR (www.techrepublic.com 2011). The issues have been normally studied as problems relating to recruitment, training, appraisal etc. as silos. They have been viewed as mutually exclusive events and the cybernetic nature of such a system has been ignored; hence, the chapter proposes to model these relations using cybernetic models to identify systemic challenges in such a scenario.

The chapter has been organized as follows: Sect. 10.2 describes the Indian IT professional space, characteristics and challenges of a typical IT services organization. Section 10.3 gives an overview of the HR function and its interface with software professionals. Section 10.4 broadly outlines the viable system model (VSM), the variety concept to measure complexity and Ashby's variety matching concept. Section 10.5 interprets the challenges of the IT services organization at a broad level into a functional VSM model and captures an instance variety matching. Section 10.6 concludes this chapter.

10.1.1 Uniqueness of IT Services Organizations

The software IT services industry is a workforce-intensive industry. Skilled artisan-based factories belong to the early years of the industrial revolution. The IT services industry is an engineering industry because software is a man-made artifact requiring large-scale effort, but still has a long way to go in comparison to other mature engineering industries. It is unlike other engineering industries because it produces non-material products. It is unlike artisan-based factories because it employs a skilled intellectual workforce (who work with and produce ideas) rather than a skilled manual workforce (who work with materials, and produce material goods). It is unlike other intellectual workforce-intensive industries, such as the newspaper business or the entertainment industry because the ideas it produces actually control machines, that is to say that these ideas are formal, precise and unambiguous and not open to interpretation (Kummamuru 2012). In this section, we attempt to characterize the software IT services industry. The comparison between the IT services and conventional service organizations is captured in Table 10.1.

In an engineering/manufacturing organization, there is a human-machine interface which works together to produce a product. The success of a product in the manufacturing organization depends on both, the machine and the human, with the machine dominating the way the product is developed. Whereas in an IT services organization, the variety of machines used is dominated by technology needs. Thus,

Table 10.1 Comparison between IT and conventional service organizations

IT services organizations	Conventional organizations (Includes manufacturing and non-IT service)
Are *human intensive* organizations	Not necessarily human intensive; the size and scale of operations determine it
The service is customized with respect to a request. In Application Development & Maintenance Services (ADMS), it is a *co creations activity* with the consumer and producer in a state of constant dialogue. In case of product-based software, such as ERP, customizations are done on the base platform	Predominantly, the product is mass produced and production and consumption are separated in time. Customization is done at the basic level
The key ingredient for developing a software artifact is a *knowledge, skill* and process ability, which is predominantly *intangible*	Many critical aspects are tangible. E.g. raw materials and output quality
Inventory for IT services are the Knowledge Management (KM) Repository and the knowledge and competence of the people who build the services. The technologies can become obsolete after which they can be *upgraded*	Inventory is in the form of products or raw materials. There is a shelf-life associated with them
It is difficult to maintain *consistency* in building software services	A manufacturing concern builds products with consistent qualities. This is possible because of the detailed product specifications and measurable quality control systems
The *variety* generated in a service context is vast	The variety in products have specific combinations
People-oriented functioning	*Process-oriented* functioning
First, the customer requests for a service and then services are delivered in an ADMS environment	Products are produced based on market assessment and then marketed
Skilled workforce can work from any location. *Virtual locations* are a reality	*Physical location* is of strategic importance depending upon availability of raw materials, transportation and regulatory constraints
Policies to control should be *people oriented*	Policies to control should be more *process oriented*
Recruitment in large numbers, cyclically	Recruitment as per needs
Attrition a strategic concern	Attrition not a major concern
People cost is high	People cost not significant

humans need to handle the variety of rapidly-evolving technologies. In order to meet this goal; humans should have a corresponding capability or variety. Learning is continuous and applied to problems in real time. The other pressing challenge faced by the IT professional is professional demands invading the social space. In the IT services industry, individuals work for long hours and have high levels of stress which leads to encroachment of social space by professional space. What separates the IT professional from the conventional service industry is captured in Table 10.1 (Kummamuru 2012) above.

10.2 Challenges for IT—HR[1]

The HR role in IT service organizations has been a challenge, as unlike other business systems, the role is required to align itself with the strategic perspective of the organization. Conventional HR is not known to partner itself strategically with the organization (Lawler 1995; Brockbank 1999).Ulrich, in his early writing, defined HR to be largely an administrative function, focused on controlling cost and implementing administrative activities. Lawler, in his study of large corporations, also found that the focus of most HR functions is on cost control and administrative activities. Contemporary organizational challenges faced by HR are focused on training, upskilling capability and creating positive environments during mergers and acquisitions etc. IT services organizations are relatively young and differ from other services organizations. IT professionals have to cope with new areas of knowledge as they have short cycles of evolution, which range from at least three to five times in one's professional career. Therefore, they have to be nurtured through career planning and continuous training so as to prepare them for life-long learning.

According to Ed Nair, "Attracting and retaining the talent in the IT organization requires more than usual support from HR. They are largely responsible for creating conditions that help attract and retain talent in IT" (Harvey et al. 2006). Recruitment challenges include getting the best talent, huge costs for campaigning and poor offer to joining ratios. All this reduces the effectiveness of the hiring process.

The other challenge is the ability to retain manpower in times of boom and healthy business environment and avoiding lay off in times of crisis. These two challenges have been addressed through several interventions like recruitment drives, rewards initiatives, policies etc. So far people have seen different issues pertaining to people management in IT, such as recruitment, training, engagement, performance management and retention etc. These issues have been viewed as mutually exclusive concerns. These concerns predominantly fall into the HR domain, but responses to several of them often appear to be reactive, sporadic and short term. The IT software professionals and HR thus seem to be always in disagreement on the quality of support they get from each other.

[1] HR is used in this entire chapter to refer to the function, domain and its role.

People who are critical of the performance and success of the IT organization have to be nurtured at each HR touch point. These pertain to hiring people, training leaders, designing creative compensations, doing HR analytics, managing the increasing personnel demands of the HR jobs, time allocations and staying upbeat in the face of overwhelming demand. HR has to deal with different sets of stakeholders and challenges at each of the touch points in the HR value chain. The points below briefly outline these.

- The recruitment environment: This has challenges where they have to deal with competition from other industries for the cream of the resources, the academia, and the challenge of having to motivate people to join, prior to understanding the company's demands based on the vision, mission, and goals.
- The training environment: This has multiple challenges which include keeping up with the fast changing technologies, good faculty, updated technical competencies in associates, motivating employees, time from faculty, associates, non-technical training like motivation, leadership etc. which is an inherent need of the industry.
- The engagement environment: Project related concerns, client challenges, career progressions, mobility, long working hours because of the 24 h cycle etc.
- Performance management environment: Work measurement is a challenge for this industry and disgruntlements set in during the appraisal process, goal setting, feedback management, designing career paths etc.

The entire environment along with the interface between and amongst them poses challenges for HR. They have to be viewed as a total system and not as mutually exclusive subsystems. Given the context of the IT software services environment, in order for the industry to be viable, HR has to enable and sustain this viability. The section below introduces the models to be applied for this context.

10.3 Cybernetic Concepts and Models

This section briefly outlines the conceptual cybernetic model namely the VSM, variety as a conceptual measure of complexity and Ashby's variety matching concept which were used for modelling HR as a function in an IT services organization. It begins with an understanding of how the VSM was conceived by Stafford Beer in a scientific manner through a homomorphic modelling process. It further gives a description of VSM, followed by the derivation of Ashby's concept of variety as a measure of complexity and concludes with the variety matching concept which is fundamental to maintaining the viability of a system. This chapter discusses briefly the theoretical foundation for further application and analysis.

a. ***Scientific Evolution of Beers Model***

Stafford Beer belonged to Great Britain and was a professor at the Manchester Business School. He contributed immensely to the field of management cybernetics

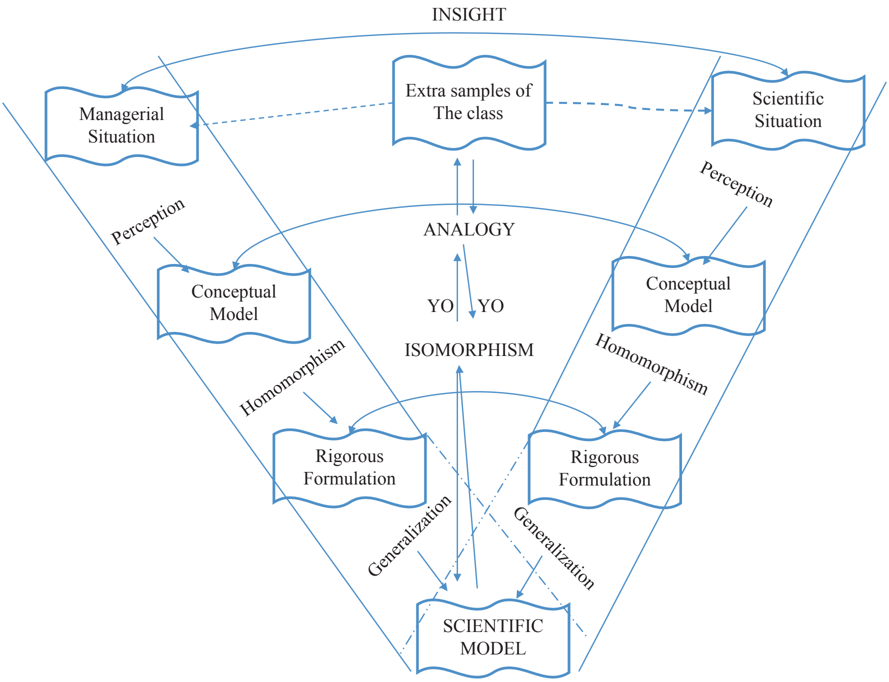

Fig. 10.1 Beer's account of scientific modeling

and operations research. He was the architect of the VSM, which has been extensively used in the diagnosing and design of business organizations. Beer evolved this model by observing similar properties across different systems; for example between the brain and the firm, heart and the firm etc.; between the living and the business system.

Beer used the YoYo methodology to construct this model. This model as given in Fig. 10.1 has also been validated in several situations. This model was used, given its earlier applications, in the business context and was applicable from a viability context.

b. ***About the VSM***

The model has been articulated in three different books written by Stafford Beer, including *Brain of the Firm*, *Heart of the Enterprise* and *Diagnosing the System*. The design of the human nervous system was the platform on which the organization model is designed (Ashby 1956; Heylighen and Joslyn 2001; Espejo 1976). It establishes a control and communication structure via a chain of homeostats (feedback loops). Six major systems ensure 'viability' of the system (Umpleby 2005). Stafford Beers VSM, as evident, is a prototype representing a viable organization. It is a Neuro Cybernetic Model comprising five key functions which can be associated with different parts of the body and brain. The ability of an organization to exist as a separate entity or viability is assumed for designing effectiveness of

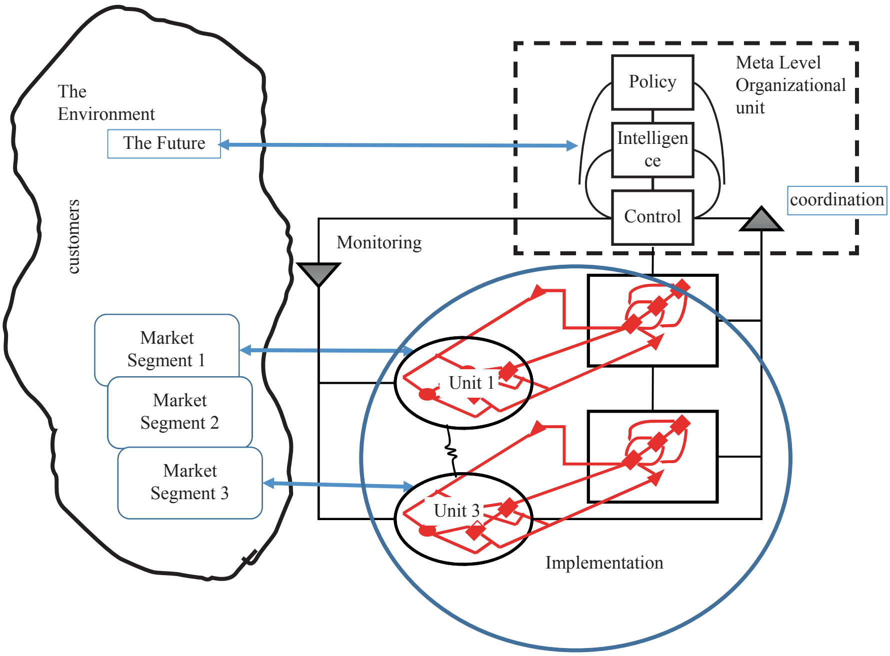

Fig. 10.2 Viable system model

the organization. Economic or financial numbers are assumed to be measures for business wellbeing. In the context of a rapidly changing environment these may not be true indicators of viability, hence we need to look at the structural requirement in terms of these five basic functions. VSM comprises five subsystems and a sixth audit channel for system viability (Fig. 10.2). The five subsystems perform certain activities/functions. The model implements a control and communication design through a hierarchy of homeostats (feedback loops). These connect to form the total viable system. This provides a design which can help extensible, recursive, model-based architecture, delegating power to subsystems. The subsystems are structured together using the principle of variety matching (or principles of organization). The model identifies six management actions in an adaptive system. System 1 comprises units that do the basic work of the organization, for example building products or creating services.

System 2 handles the task of coordination and scheduling amongst the system 1's. They also allocate space and equipment and enforce rules and procedures. System 3 is the middle management function, which ensures a 'resource bargain' amongst the system 1's. That is, system 3 ensures that the resources are available in exchange for an assurance by the system 1's to meet certain goals that are agreed upon. System 3 star does the job of auditing the system. System 4 is a strategic function and needs to plan ahead and project requirements for the future. System 3 is in charge of activities 'inside and now', system 4 is responsible for activities 'outside and then'. System 5 takes care of the interaction between system 3 and system 4 and reflects the corporate ethos. Hence, system 5 decides the identity of the firm and its governing principles and norms. This includes decisions about the kinds of businesses to be developed by system 4 and to be put into operation by systems 3, 2 and 1.

An important property of VSM is the organization and movement of variety throughout the system. The people in organization need information to perform their jobs effectively, but too much information can be a disturbance. What is required is both variety attenuation and variety amplification.

c. ***Variety: A Cybernetic Measure of Complexity***

Complexity is a key challenge in the management of a viable system. It poses a threat and tends to overwhelm the regulators of the systems. This can be easily observed in biological systems, where there are no designated 'managers'; complexity in social systems also tend to overwhelm managers whose actions are directed towards short term goals. Variety has been defined as a precise measure of systemic complexity, implying the sum of distinct states or elements in a system (Ashby 1956). The cybernetic measure of complexity is defined as variety. It is not the absolute measure of variety that matters, because even in simple systems, its value will be high enough as to be non-operational. Ashby's law of 'Requisite Variety' gives meaning to this measure.

d. ***Law of Requisite Variety***

Ashby developed a schematic treatment of variety engineering based on Sommerhoff's account of directive correlation as presented in Fig. 10.3. To define variety engineering Ashby defined a parameter to define disturbance, i.e. D, an outcome represented by E and the transformation function represented by a table T, which D will undergo to create E which is compared to the environmental context of Sommerhoff. According to Ashby, R directly influences T towards changing E.

Ashby's makes use of the simple equation depicted in Fig. 10.3 to articulate his famous *Law of Requisite Variety* (Beer 1984). The role of R determines the application of the law; if R were always to have the same influence on T, irrespective of D's state, than the variety of E and D will be equal. But if we intend to have some required outcomes we need to revise R's variety. Control devises designed by us are most often simple, they do not anticipate scenarios in the environment which are likely to affect it and often collapse. Therefore it is inherent that we need to ensure that the adequate variety in the control system can only deal successfully with variety in the system controlled.

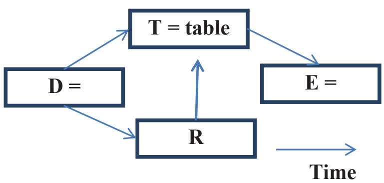

Fig. 10.3 Ashby's account of 'Requisite Variety'

This law simply says that 'only variety can absorb variety', or in Beer's words, "the variety of a given situation can be managed effectively only by control systems having at least as great a capacity to generate variety themselves" (www.nasscom). The law of requisite variety means that either by filtration or amplification, two interactive systems should balance their varieties if the interaction is going to remain over time. The characteristics of these filters and amplifiers are the very substance of the assessment of how complexity organizes itself (Chakraborty and Dutta 2002).

10.4 Interpreting the Context Using Cybernetic Models and Concepts

Contemporary human resource development (HRD) has evolved and its key foundations have been from the field of systems thinking and organization development (OD). Despite this, thinking in this domain remains simplistic and not equipped to deal with the complex environments it faces (In Lee, M. (ed.), 2003, HRD in A Complex World, Studies in Human Resource Development, Routledge, pp. 25–41). The chapter is a continuing series in exploring the application of cybernetic models to the context of IT and HR interface. The author has dealt with it to a certain extent, in the earlier paper written by her (Kummamuru 2012). In this chapter, the context of HR in an IT services organization has been articulated in the form of a VSM. The IT services organizations need to view their organizations using this meta language of cybernetics to sustain the challenges of the environment and remain viable.

A. ***Application of VSM to the Context***

The model has been used to diagnose the human resource (HR) function gaps applying the VSM to the system at organization level. The approach is to elaborate the context from the basics and then elaborate on the required functions pertaining to HR. Given that IT organizations are human intensive, most of the critical activities within the five subsystems will pertain to the HR function. HR has been viewed as a value chain from recruitment to the exit phase in an associate's life including the training, engagement and performance management dimensions. It has been observed increasingly that HR does not connect adequately to the goals of the organization and is insensitive to the needs of the skilled IT professional (Thornton 2006). This may be a result of a systemic failure rather than the personnel attributes of the HR associate. Application of the model may help diagnose such concerns conceptually.

A basic representation of a business context can be done using four key components. The environment (E) in which business operates is depicted in the form of an amoeboid; the operations (O), which are the doers or builders of products or services of the business, is represented by a circle; the management of these and the external environment is represented by a square; and the systems used by this management is in the form of a triangle (William Christopher 2007).

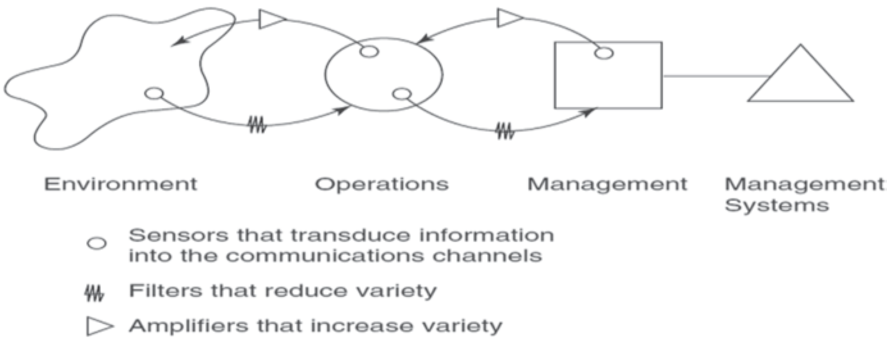

Fig. 10.4 A business system representation

The analysis starts with assuming IT organization as a viable system. It is then viewed by slicing it into these four fundamental blocks: environment, operations, management and the management systems as articulated by Beer (Fig. 10.4). To these four blocks, the organization principles are applied for identifying requisite channels for communication and sliced further into the five basic subsystems with the sixth audit channel. The functions or aspects relating to the fundamental building blocks of an IT services organization were identified and then aspects specific to the HR function were delineated and identified appropriately with the other subsystems of the organizations.

This helped in coming up with the gaps and the appropriate feedback and homeostats which should fundamentally belong in an organization from HR perspective for viability. The sections below elaborate on the environment of the IT industry, the operations in the context of an IT services organization and the management required thereof.

i. *Environment of the IT Industry*

The environment here is the software industry in a developing country which must evolve to survive and thrive in context of its growth. Different developing environments pose different constraints and challenges. The evolutionary growth path of an industry marks various stages of its maturity in its growth. One may imagine a space within which different evolutionary paths could be traced by the same software industry in different developing country contexts. The lack of prior history for the industry in a developing country context and the availability of hindsight of what has happened elsewhere, are both good reasons for leap-frogging over the pitfalls that others have gone through, and charting one's own path.

There is a simplistic presumption that the software industry is all about deploying technical skills with respect to software technologies to build software. Even at this level, the presumption is fallacious because software artifacts are the result of an engineering practice, the core of which is engineering design based on analysis; software is a non-material artifact that is formal, abstract and mathematical in its essence; software development is an engineering industry practice. All this is internal to the technicalities concerning software. The main purpose of the software industry

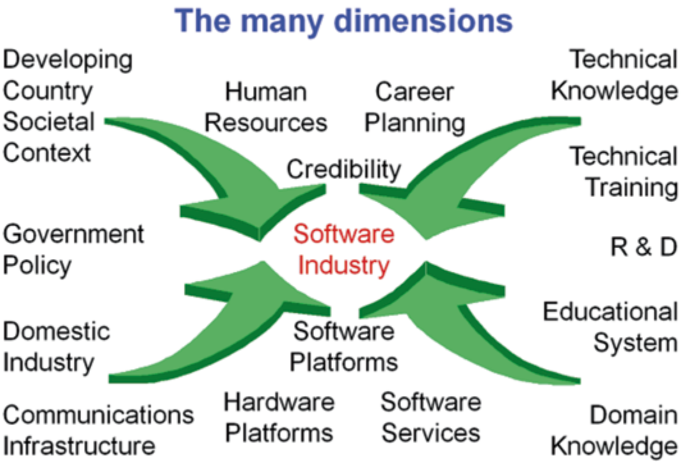

Fig. 10.5 The business environment

is to build applications. This cannot be done without clear, precise and detailed knowledge of the application domains, which are then reflected in software. The many dimensions of software industry are captured in Fig. 10.5. These include elements internal and external to the organization.

In order to understand the context we are studying, we look at where the *services offering* fall as part of the software industry. The software industry typically has four offerings, which are characterized below with respect to how it relates to the case we are referring to.

- Platforms: requires greater maturity, is already established elsewhere, hard to get in
- Middleware: evolving, smaller wide-spread market, challenging
- Products: requires great maturity, local market—custom needs, enormous potential
- Services: human resource spread and depth and has a huge market

From the above we now concentrate on the service offerings context. In order to remain viable in this, the following aspects are considered for decision making.

- Industry verticals it will address
- Geographies it will enter
- Technologies it will invest in
- Services it will offer
- Investment for training
- Investment for infrastructure
- Available resources with varying competencies and experience
- Developing country societal context
- Government policy towards this industry
- Domestic and international industry
- Engineering educational system

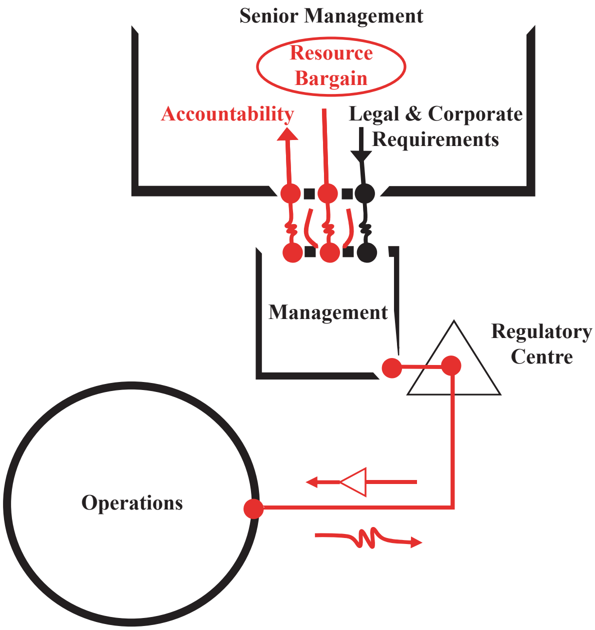

Fig. 10.6 Basic organization of the subsystems

All these aspects of the environment lead to the relation established between and amongst the operations and management. The conceptual model of this relationship is depicted in Fig. 10.6.

Senior management in a corporation designs the work of the operational management. In the case of IT services, the operations can exist at three levels of recursion. The lowest level is the project level which is contained in the higher viable entity which can either be a program or account belonging to a vertical business unit. The design from senior management is translated down to local management. The design is to strike a resource bargain with them. This implies that the management of each operation or delivery unit has to agree to meet certain business goals or targets in exchange for a share of the resources of capital, manpower and facilities which are available to the total system. Given the challenges of skilled manpower in this industry, the bargain could be on different counts like using low-cost resources, i.e. trainees or technology to reduce effort etc. There is enormous variety in a typical software development environment; this needs to be managed by attenuating it. There are two ways of doing it, by striking a bargain with respect to resources; and by ensuring accountability is established, the metrics reported are in terms of the manpower effort spent, amount of work completed, amount spent on H/W and S/W etc. This reduces the actual variety which may not be open to interpretation by senior management. Besides this attenuation, senior management establishes norms to ensure that the operational management meets corporate and legal requirements.

The representation is simplified and includes a regulatory centre which acts as a channel of communication between them. It is important for the operations to be controlled through regulation rather than ad hoc intervention. In order to reduce the ad hocism between the different delivery systems, the management develops a set of processes and procedures pertaining to software development, quality control etc. This attenuates the operational variety.

ii. *Operations in a Software Service Organization*

The service of the organization for which it comes into existence is built here. Therefore, all the operations which justify the existence of the system, i.e. the value chain for developing the software services from requirements to development to testing, function here. It includes the management of these operations like team lead, project manager, program manager, group lead etc. It does not include senior management like the unit head, COO, CEO etc. System 1 is the primary unit because of which the organization exists. The diagram depicts only one system 1; however, in a typical IT services organization there could be more than one based on vertical service offerings (e.g. banking, retail etc.) or a technological offering like SAP, Oracle etc. or ERP-based division. The role of the project managers here is to manage at a lower level of recursion. The overall system can have an operations manager doing the system 3 function of overseeing the system 1's to ensure optimization of resources. This includes the manpower allocation, given the challenge of having adequate competent staff on how best to meet the organization obligation by having a big picture view of all the operations. This is a challenge of the software service industry and this is a key responsibility of HR. There seems to be a gap in terms of this, as there are no formal and robust systems to capture the entire competency requirement against the priority for the organization. "Organizations have started recognizing the need to have competent HR professionals to deal efficiently with the employees in the IT sector who are characterized by their high knowledge and higher costs for acquiring them, in order to safeguard their investments" (Maria Schafer 2005).

iii. *Management and Regulatory Systems*

In the above description of the environment and the operations, there will be a level of indecision unless there are boundaries set for the interactions. These would be in the form of policies, strategies, procedures, standards and scope which is set by a management system. These relate to decisions at three levels and need to be designed by the organization. These look at the following dimensions.

- Those which are day to day decisions, dealing with the detail at the operational level (system 3)
- Those which pertain to the future concerns or the environmental challenges (system 4)
- Those which need a policy or boundary to be set (System 5)

These are the three management subsystems depicted in Fig. 10.7 for further devolution. In the context of IT services, the following aspects have to be addressed to maintain stability between the environment and operations:

- Deciding which customer segments to be addressed
- Chalking out the geographies to be addressed

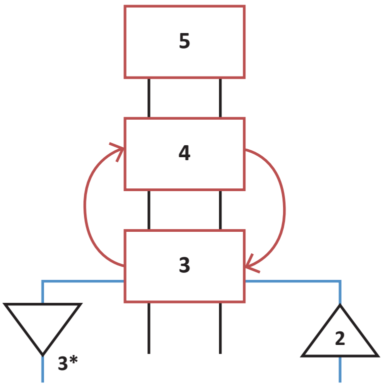

Fig. 10.7 Devolution of the managements into 3, 3*, 4 & 5

- Offering to be developed
- Scope for technology
- This leads to decisions on competency building, amount to be invested for building and retaining the associates
- The future technology trends
- The audit function to ensure reduction of 5 variety
- The salary structure etc.

The responsibility for translating this to specifics falls on the management function. Unless these translations are not designed appropriately, there will be a disturbance in the system and viability can be affected. These are translated into appropriate policies, standard procedures and processes which are implemented by the management function. System 3 is in constant dialogue with the operational managers for fulfilling their needs. In this case, critical to business need is the knowledge worker with the right skills and competence. The fundamental needs of this knowledge worker can be further sliced to respective subsystems in the management system. The decision making belongs to each one of them which are then converted to procedures in system 2 to be followed, which predominantly belong to the HR value chain.

- Recruitment
- Selection and staffing
- Training and development
- Engagement and employee relations
- Performance management
- Work measurement systems
- Job and work design
- Compensation and rewards
- Safety, health and wellness
- Workforce diversity
- For each of these aspects there will be specific slices which will be dealt with by each of the subsystems in management and operations. For recruitment, the strategy defined by the senior management will define the competencies required

and the numbers to be recruited, while the actual translation of this is by the HR systems. The challenge here often is not adequate amplification of variety and tends to have challenges. Environment will define the technology and competency training requirements and competition will define the strategy for building resources. This requires internal competencies of the HR function to convert these at the level of execution.

From the above analysis, the specific set of practices, policies and procedures which belong to each of the subsystems are defined by Ulrich and Wayne. They have clustered these into four categories: people, performance, information and work. The people-related practices fall into system 1 and system 2 of the model, which include recruitment, staffing, training, retention and outsourcing related to movement of people. The performance function in an organization deals with measuring the performance of an employee using the appraisal system, designing compensation and reward structures. These aspects relate to system 1, system 2, system 5 and the System 3 star audit channel.

The information category relates to the channel of communication between the different subsystems. Ulrich refers to it as the external public relations and internal employee communications. Besides this, the model throws up the other channels for viability between the relevant subsystems. Work dimensions relate to the approach to design administrative policies, to define terms and conditions for labor relations and the facilitation for work processes, redesign of physical facilities and aligning the structure with company strategy.

The responsibility for managing system 1 functions on a daily basis is done by system 3. The internal and immediate control of the organization is also the responsibility of system 3.

The operations in the organization are a collection of projects or programs and they are usually managed by the middle management or one who manages the day to day operations of these sets of projects. They perform the function of system 3 by controlling the operations in setting guidelines, translating policies into system 2 etc. The devolution of a software services organization into several 1s has a manager, i.e. a project lead or manager. They supervise the coordination and activities of system 2. System 3, is the local management function which is headed by the vertical functional head or a horizontal technology function head which exercises power primarily using the vertical command channels shown in the diagram, i.e. by way of reporting structures etc. However, exercising power through these channels may not have the required variety to be really effective. System 3 will have to directly oversee the operations of system 1 to ensure that system 1 is managed in a professional manner and not accidentally. Software services ensure this by carrying out technical audits, management audits etc. This method is productive for maintaining system 3's requisite variety.

iv. *HR in the Context of VSM*

The context of a IT services organization from a VSM perspective is detailed above. It is obvious from above that the elements belonging to the HR value chain form the core of the analysis. Critical HR activities pertaining to each of the subsystems

Table 10.2 Interpreting HR into VSM subsystems of VSM

Subsystem	Predominant role	HR Role
5—Policy	Policy, ultimate authority, identity	Policies, the vision, mission vision which will set the constraints on the operations in terms of compensation, recruitment policies in terms of numbers, nature of business deciding competencies, associate profile etc
4—Intelligence	Adaptation, forward planning, strategy	Identifies business opportunities and threats which will determine competencies required for the future business environment, which HR needs to build
3—Control	Internal regulation, optimization, synergy	Role of project lead, program manager, their needs, predominantly the people engagement role of mentoring, motivating, resolving disputes etc. The role for allocating the scarce resources in this context goes to people with required competencies, compensation and reward strategies
2—Co-ordinations	Conflict resolution, stability	HR systems uniform across all system 1's, in terms of policies, procedures relating to promotion policies, training requirements etc
1—Operation	Primary activities	Design IT training, performance measurement, mentoring, recruitment, leadership programs

has been captured in Table 10.2. Further analyses along these dimensions will throw up gaps, if any, in a typical IT services organization from an HR perspective. The analysis shows that parameters critical to business belong to the HR function in an IT concern. While HR by itself is not a viable entity, it is critical to the viability of the organization.

B. ***Variety Matching Concept***

The above analysis has broadly interpreted the HR context to the subsystems of the VSM. In order for the system to be viable, three fundamental units follow four principles of organization (Beer 1985).This includes the variety matching between the environment, operations and management. In a naturally viable system or designed systems, it is done by amplification or attenuation of variety. Below is an illustration of this concept wherein the variety mismatch in engineering education for software professionals is amplified by the organization by introducing it into its own system.

Operational Context: (Requires Variety Amplification)

Needs and development of human resources: Software services are a manpower intensive industry. Qualified and experienced professionals are its most valuable resource. The pace of change in this field is rapid, and it is imperative to inculcate an *attitude of lifelong learning* through a professional career. It is, therefore, not enough that the educational infrastructure of the country provides the base on which the industry is built, for this *base has to be rebuilt* several times over during professional careers. *Training institutions* outside the educational establishment and in-house facilitation of training are an absolute necessity. Furthermore, besides training, *tutoring, mentoring and coaching on the job* by excellent peers is essential to bootstrap the technical capability and maturity of the workforce. Therefore, the scope of education and training required by this industry is dictated by the skill requirement in the industry.

Considering the worldwide shortage of workforce in this industry, it is clear that only those who are educated and trained in computer science and engineering cannot fill this need. Therefore, it is imperative that introduction to uses of computers become a standard part of all curricula. Wherever meaningful, the programming of computers to address applications in the principal domain of study further increases the value of this technology as a tool for constructive learning (Kesav 1999).

Environment Context: (does not have the requisite variety)

Shortfalls in an engineering education for software professionals: Engineering education in a variety of engineering disciplines is not sufficient background for being software professionals. Software as an engineering discipline is still finding its feet worldwide. Software is man-made, and hence ought to be the subject matter of an engineering discipline. In contrast with other engineering disciplines, software does not deal with the material world and build upon the properties of materials for its technology. Software is an expression of well-designed constructive ideas that, when deployed, construct the idea of the solution. The software engineering discipline educates and trains to cast abstract constructive models of the world around them into the computer such that these models have integrity with respect to the outside world they depict and synchronously maintain it through its operation. Though software is a model, an idea, it becomes tangibly manifest because of the box that houses it, the general-purpose computer and its attendant software technology platforms. The engineering characteristics of software are manifested through the properties of the hardware box, and the properties of the software technology platforms that provide the environment that breathe life into it.

Whilst software engineers need to appreciate the meaning and value of engineering, engineers from other disciplines need to appreciate the (mathematical) foundations of software to know why constructions yields desired results, and need to be technically trained in contemporary software technologies so as to possess the skills needed by software professionals. Clearly, the onus of education (in foundations of computing) and training (in contemporary software technologies) lies outside the scope of a traditional academic establishment. Organizations need to amplify this variety into the environment by establishing their own training establishment to manage this task. The technical training market is large in India, and there are several established players in it. However, they do miss out on the need for foundation of software, and as a result, do not create the capability to learn new software technologies by uncovering that which underlies them (Kesav 1999).

10.5 Conclusion

This chapter has dealt with the application of the Beers VSM Model and Ashby's variety matching to the complex HR–IT interface. It is part of the research work being pursued by the author. This application has thrown up some challenges or systemic inadequacies in the design of HR organizations. This chapter limits the analysis at a macro level using theoretical concepts from cybernetics and experiential knowledge of the industry. The objective further is to apply the models with more rigour and validate the findings of the conceptual analysis by conducting a primary survey for the stakeholders using a structured questionnaire. This will result in interpreting the conceptual analysis of the context into managerial language and suggest a distinctive design for HR. Further research has implications to formulate a new paradigm for the design of IT services organizations from an HR perspective. This would be a model based on cybernetic practices which will create a viable and sustainable model for HR. This may result in measures to creative positive environments for IT professionals in the organization. The IT services industry is one of the fastest growing industries in India. Along with the benefits it gives, it is replete with several societal challenges due to the nature of work, bridging several time zones etc. Research in this direction may, to some extent, absorb the excess variety load on the IT professional and influence society positively.

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Part III
Process Flexibility

Chapter 11
Incentives for Information Sharing in Collaborative Supply Chains

Aditya Saharia

11.1 Introduction

With technology-enabled collaboration among supply-chain members, the basis of competition has shifted from the firm level to the supply-chain level. In this new environment, firms can reduce procurement times, increase velocity of material flow and provide process-to-process integration. Firms are increasingly collaborating with their partners to reduce inefficiencies in the procurement processes and extend the supplier base (and for downstream activities, extend the distribution channels) globally. As technology enables deeper process-to-process integrations, firms are moving from a low level of integration, which involves the simple exchange of procurement and payment data to synchronized supply, where integrated planning and collaboration are put into place. This eventually leads to the co-creation of value through joint innovation in products and processes.

Replenishment cycles are becoming shorter and shorter through the automation of many inter-organizational processes. Because the flow of demand information is more accurate, inventory levels at different points in the supply chain have dropped (and in many cases, inventory buffers have been eliminated). In procurement processes, simple reorder point policies and later point-of-sale-based systems like QR and ECR have been replaced by Collaborative, Planning, Forecasting and Replenishment (CPFR) systems where supply-chain members at different echelons keep each other informed of the inventory levels, forecasts and planned productions.

These IT-led collaborations have resulted in reduced replenishment cycles, and more efficient use of production and warehousing facilities. In many industries, we saw the emergence of industry-owned neutral collaborative marketplaces (e.g. GHX in the healthcare supply industry) that makes supply processes much more transparent and cost effective by bringing buyers and suppliers together (Applegate

A. Saharia (✉)
Information Systems, Gabelli School of Business, Fordham University,
113 W. 60th Street, New York, NY 10023, USA
e-mail: saharia@fordham.edu

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and Ladge 2003). In the merchandising industry, there has been an emergence of sourcing agents like Li and Fung that allow retail chains such as Bed, Bath and Beyond to reach out to global suppliers and, if necessary, use connectivity and tools provided by Li and Fung to design products collaboratively with their suppliers (McFarlan et al. 2012).

Collaborative supply chains eliminate the "bullwhip effect"—wild fluctuations in inventory levels—by eliminating unnecessary noise as the demand for information propagates upstream (Chen et al. 2000). Collaborative supply chains also increase systems-wide flexibility. They allow participants in large global supply chains to "embrace complexity while better serving the customer" (*McKinsey Quarterly* 2011). In other cases, the information-sharing mechanism may allow a firm to splinter its supply chain by keeping a conventional production and supply network for low-variability, high-volume products and implementing a specialized production system for high-variability and low-volume products that may demand a high degree of customization, giving the firm a further differentiation (*McKinsey Quarterly* 2011). A smart supply chain can increase transparency in the buyer–supplier relationships, allow supply-chain members to reduce cost, manage risks, facilitate customer collaboration and innovation and build a global network of supply-chain and distribution partners (IBM 2009).

Despite significant investments in implementing real-time supply chains, in many cases the desired visibility and risk management efforts have not been achieved. According to a recent study by McKinsey, as many as 68 % of executives expect the supply-chain risk to increase in the future. The IBM study on the future of the supply chain found that only 20 % of managers that have adopted real-time supply chains in the auto industry have achieved a desired level of visibility, and many feel that the supply chain does not provide the desired level of flexibility. Similarly, the Grocery Manufacturers Association (GMA) found that "67 % of GMA member companies are engaged in some form of collaborative planning, forecasting and replenishment activity, with only 19 % moving beyond pilot studies (GMA 2002)." Even in synchronized supply chains that are dispersed over long distances, lead-time uncertainty sets in, or products may show short-term fluctuations, creating "wriggles" in information flow, potentially mitigating the benefits of synchronization. Similarly for perishable goods, the opportunity to collaborate on inventory level is limited, as inventories are kept and managed in short cycle times (Holweg et al. 2005; Sherman 2007).

While an information-sharing system may lead to a better outcome for the entire supply chain, individual members can potentially achieve higher performance, especially on a short-term basis, by making myopic decisions or by not participating in any collaboration. Collaborative supply chains that integrate processes across firm boundaries provide much larger benefits than simple B2B commerce (Riggins and Mukhopadhyay 1994; Rai et al. 2006). However, all participants do not achieve the benefits evenly; as pointed out by Zhang et al., an information receiver always gains from information-sharing systems, but the information provider may not gain in all situations (Zhang et al. 2006). Different supply-chain members have different incentives; a retailer who incurs inventory costs would focus on order quantity, while a supplier who incurs production and scheduling costs would focus more on shipment schedules. An information-sharing system that reduces lead-time uncertainty or variability in shipment quantity benefits downstream members, but may not necessarily benefit the supplier, and thus creates uneven incentives to adopt such systems (Iyer and Bergen 1997). Even when information systems are in place, one or more members may be willing to hold back on critical information. A manufacturer who becomes aware of an adverse forecast may delay sharing it with retailers in an effort to prevent retailers from reducing order sizes (Guo and Iyer 2010). Similarly, in cases where the information gathering is sequential, an information collector may not resolve all of the uncertainty if its profits will not increase with further information. Thus, along with the information-system implementation, the governance of the relationship and profit sharing between supply-chain members emerges as a critical issue. In cases when the manufacturer has the option of sharing information systems with some but not all retailers, there may be diminishing returns in rolling out information systems to additional retailers (Gal-Or et al. 2008).

In this chapter, we analyze a two-tier supply chain with a single supplier and multiple retailers and examine the social and individual profitability under different collaboration mechanisms for developing forecasts and inventory locations. In particular, we consider uncertainties that arise due to global factors that affect overall reception of the product in the marketplace and each retailer individually. We consider a number of different information-sharing scenarios and their implications for price and inventory decisions. In many of these cases, we will use the context of a one-time event like a product introduction or a product promotion. These cases are interesting as the information asymmetry between the different supply-chain members can be high and therefore the value of collaboration across supply chains can be high. Where the demand is relatively stable, the supply-chain performance can be improved through synchronization, but the value of collaborative forecasting can be low (Iyer and Bergen 1997; Gal-Or et al. 2008; Kurtulus et al. 2012). The information systems for reducing uncertainty can possibly include forecasting tools implemented separately by the supplier, and retailers who can then choose to share information (collaborative forecasting) or not share information. A manufacturer may choose to build a global forecast using its own resources or build a global forecast based on demand reported by individual retailers. It can then choose to share the information with all or some retailers. The actual sharing will be specified by the contract between the supplier and individual retailers.

We begin with the discussion of a simple scenario of identical retailers (i.e. the demand is an independent, identically-distributed random variable for each of them), and the supplier is constrained to offer the same information-sharing contract to every retailer. We examine the social and individual profitability under different collaboration mechanisms for developing forecasts and inventory locations. We then discuss the cases when the supplier has the option to selectively reveal information to select retailers. Finally, we consider the case when the supplier can deliberately choose to improve on forecast, lest the improved forecast makes retailers choose lower order quantity.

11.2 Identical Retailers—Uniform Contracts

In the simplest case, all of the retailers operate in independent markets (so that a sale is lost if a retailer faces stock-out condition in its market) and the manufacturing cost (marginal), transfer price and retail prices are set. Each player solves its own Newsboy Problem based on the information available. We further assume that even though the retailers do not compete, they do not share any information with each other either. In other words, any reduction in a retailer's uncertainty about the demand can only be the result of the supplier's information sharing.

Case 1: No Information Exchange If there is no information-sharing system in place, each retailer uses a common prior distribution function for the demand to set the service level (i.e. set the order level) in its own market. The supplier then acquires just enough quantity to meet the retailer's orders. The supplier bears no cost of shortage or holding excess inventory; any cost of shortage or excess inventory is borne only by the retailers.

Case 2: Supplier Determines Global Demand and Retailers Manage Inventory The supplier can use information-collection processes and forecasting methods on its own to determine the global demand (or rather, revise parameters of the distribution function for the demand). Alternatively, the supplier can ask each retailer to determine a preliminary forecast for its own market. These forecasts are then used as realizations of the global demand and help determine the posterior distribution of the global distribution function. The supplier then informs the retailers of its posterior global demand function. Retailers combine the supplier's posterior with their priors to set the service level and place the appropriate order. Similar to Case 1, the supplier acquires just the right amount to meet the retailer's order. The supplier bears no cost of shortage or holding excess inventory; any cost of shortage or excess inventory is borne only by the retailers.

Case 3: Supplier Determines Global Demand and Manages Inventory The supplier can use information-collection processes and forecasting methods on its own to determine the global demand (or rather, revise parameters of the distribution function for the demand). Alternatively, the supplier can ask each retailer to determine a preliminary forecast for its own market. However, rather than sharing information with individual retailers, the supplier manages all inventory at all retail stores. We further assume that the supplier has the flexibility of shifting unsold items from one store to another in a costless manner. This case then is equivalent to a centralized environment with the retailer acting as a pass-through agent and receiving a fixed per-item fee for facilitating sales. The supplier bears all cost of shortage or holding excess inventory, whereas retailers do not bear any inventory-related cost.

Using the generalization of the Newsboy Problem, we can easily determine order quantities and profits for retailers and suppliers (Chandra and Saharia 2013). The insights that follow from the model are that the pooled demand with centralized decision making, Case 3, leads to the highest service level and highest channel profit. In other words, retailers enjoy the benefits of a high service level without having to undertake inventory risk. Thus, retailers would like to support an information-sharing system and a supplier-based inventory-management system. On the other hand, the quantity ordered is highest when there is no information sharing, Case 1, and retailers bear all the inventory risk. This allows for the highest profit for the supplier. Thus, the supplier benefits from higher-demand uncertainty and has no incentive to adopt an information-sharing system. If it must, it would like to pass on the pooled demand to retailers and then follow a make-to-order approach. Further, in the two cases where retailers bear the inventory risks, the supplier's profit increases as the global as well as local uncertainty increases. Thus, the supplier has incentives to mislead retailers into thinking that the demand is more uncertain than it actually is. Thus, the supplier has to be rewarded for sharing, an amount equal to the profit it would forgo if information systems were in place. Even when information systems are in place, retailers have to ensure that the supplier does not inject an unwarranted uncertainty to induce retailers to place higher orders. These issues are addressed in the next section.

11.3 Generalizations

There are a number of generalizations of the simple model that have been proposed to examine incentives of the members of a supply chain. Gal-Or et al. consider heterogeneous retailers who are allowed to compete with each other. The transfer price charged to the retailer is not set ex ante but is set when the supplier has developed it according to the global forecast. A retailer can then use the transfer price to infer the demand as seen by the supplier (Gal-Or et al. 2008). The magnitude of this inference effect depends on a number of factors including the precision of the forecast determined by the individual retailer and the degree of competition. A retailer with a precise forecast will not benefit much for such an inference as it already has enough information about the demand. On the other hand, a retailer with poor information will gain much more from such an inference and is more likely to use it. Gal-Or et al. further show that such an inference on the part of the retailer forces the supplier to distort the price downwards so as to imply that the demand is higher than it actually is. Based on the assumptions that these authors make, they arrive at two key hypotheses: (i) In a more competitive retail environment, there are fewer incentives for information-sharing between suppliers and retailers; and (ii) In channels where retailers have invested heavily in information systems (which allow them to determine local demand more carefully), there are fewer information-sharing alliances between suppliers and retailers.

One of the key assumptions in the work by Gal-Or et al. is that the supplier has to agree to the information sharing ex ante. The only strategic flexibility that the supplier has is that it can inject uncertainty about the actual global demand via the transfer price. Guo and Iyer consider an alternate scenario, for a single supplier and a single retailer, in which the supplier can decide ex post whether to share information with the retailer (Guo and Iyer 2010). They consider two different dimensions:

information gathering and information sharing. For information collection, they consider a possible situation where the supplier can gather information sequentially so that each step of its posterior distribution improves further. In an extreme case, the supplier may undertake an infinite number of steps to resolve the demand uncertainty. In this case, an inflexible contract can potentially commit the supplier to a specific level for precision. However, if the contract does not commit the supplier to a specific level of precision, the supplier will continue to collect further information only if it is economically beneficial. On one hand, it would stop collecting any more information if it perceives that additional precision will not change the retailer's ordering decision because the posterior distribution the retailer will build is good enough. On the other hand, it would stop collecting additional information if it perceives that the additional precision will adversely affect it because the retailer will order less because of the improved forecast. In other words, the supplier can gain by introducing strategic uncertainty. This is similar to the ambiguity introduced in Gal-Or et al. through intermediate price. In the extreme case, the supplier may choose not to undertake any forecasting and let the retailers base their order quantities on the local forecast only. This is similar to Case 1 discussed in the previous section.

For information sharing, they consider a possible situation where the supplier can enter an ex–ante contract and reveal all the information it has collected or it chooses not to enter any contract and reveal information it has collected. On the sharing dimension, the supplier can either enter a contract in which it is obligated to share demand information with the retailers (irrespective of the degree of precision) or it can choose not to share any information and once it has arrived at its posterior distribution, choose to share information with retailers. Guo and Iyer show that when a supplier has committed to a fixed contract, the manufacturer has incentive to collect more information. Also when the prior belief on consumer preference is low, the supplier is more likely to enter a fixed contract that commits it to information sharing. Thus, in situations where the product fit can be potentially low, committing to a mandatory information-sharing mechanism may induce the retailer to order a higher quantity.

11.4 Multi-Period Systems

Supply-chain coordination for an established product takes significantly different form. For such products, retailers and suppliers typically set up procurement policies based on the historic sales data, and account for short-term fluctuations by adjusting order quantities and/or ordering time. With advances in technology, underlying ordering, fulfillment and settlement processes are increasingly supported by inter-organizational IT systems (Riggins and Mukhopadhyay 1994; Cachon 2003; IBM 2009). In addition to technology supporting the underlying physical flows, members of the supply chain may share their inventory positions with each other or undertake collaborative forecasting.

A number of authors have examined the effect of information sharing and collaborative forecasting on supply-chain performance. Cachon and Fisher examine a two-tier supply chain with a single supplier and multiple identical and non-collaborating retailers. In an information-sharing environment, the supplier has access to retailers' inventory positions and can adjust its supply allocation based on this information. They find that such increased transparency can potentially improve the supply-chain efficiency, but the overall effect is small. By comparison, the improvements that can be achieved by reducing lot sizes or reducing cycle time can be an order of magnitude larger (Cachon and Fisher 2000).

Aviv examined a two-tier supply chain with a single retailer and a single supplier, both facing significant lead times. In the absence of any forecasting systems, the replenishment decisions are based on long-term demand characteristics. However, the supply-chain performance can be improved by augmenting the long-term demand by the forecast for individual period(s). The variation of the individual-period demand from the long-term demand is the result of local conditions such as weather forecasts, competitors' announcements, etc. In a localized forecasting environment, each player builds its own forecasts for future periods and bases its replenishment decisions on these forecasts. In a collaborative environment, the retailer and supplier share their individual forecasts and develop a joint forecast and then make replenishment decisions. Through a series of simulations that allow for demand variability, Aviv finds that both local and collaborative forecasts allow both players to fine-tune their order quantities, thereby improving supply-chain efficiencies. The collaborative forecast is much more cost-effective than the local forecast. However, the benefits of the collaborative forecasting are meaningful only if the collaborating parties bring something unique to the table. In other words, if both parties use the same environmental condition to develop a new forecast, the collaboration does not lead to any improvement over individual forecasts (Aviv 2001). Thus, it is not only important to collaborate, but also to look for different factors that cause variances from established demand patterns. Further, the benefits of collaborative forecasts are greater when lead times are shorter.

11.5 Competition among Supply Chain Members

In the works described above, the main factor has been demand uncertainty. In supply-chain relations, there are many other factors that create inefficiencies, like lead-time uncertainties, competition at different levels of the supply chain and costs associated with investments in forecasting technology by individual members. Shin and Tunca incorporate the competitive behaviour of retailers who operate in a common market. They show that if the market allows for private investments in technology, retailers can potentially invest more than optimally to improve their private forecast, which in turn would have a significant negative impact on the overall supply-chain surplus. If competing members can observe one another's investments, they tend to invest even more, thereby increasing inefficiencies even more. The effect increases as demand uncertainty increases and as the number of retailers increases (Shin and Tunca 2010). (Such a competition among retailers leads to a situation where a fixed-transfer price fails to achieve market coordination. In such a case, Shin and Tunca propose a uniform price auction that makes retailers reveal their price–quantity equilibrium and then the supplier chooses an aggregate quantity that clears the market.)

11.6 Lead-Time and Shipment Quantity Uncertainties

Yet another factor that is responsible for supply-chain inefficiency is uncertainty in lead time that may arise because of uncertainty in transportation systems and variability in administrative processes. In cases where orders can be partially filled by the supplier, because of stock-out conditions, retailers also face uncertainty as to the actual amount of the goods that would be delivered to the retailer. In collaborative supply chains, implementing a shipment information system can reduce this uncertainty. In case no information systems are in place, the retailer gets to know the actual shortfall in the future at the end of lead time (that may include a number of ordering cycles). Zhang et al. consider the situation where the retailer is informed immediately in each period of the shipment sent by the supplier, so that the retailer can adjust the order in the next ordering cycle. They show that if the demand uncertainty is high, a shipment information system can reduce the supply-chain inefficiencies. If the supplier commits to fulfilling the backlogged demand within a fixed period, the improvements are not significant. They further show that while the information receiver, in this case the retailer, always benefits from having a collaborative information system in place, the provider, in this case the supplier, may not always benefit from such a system (Zhang et al. 2006).

11.7 Conclusion

Many of the works described here provide useful insights on the role of information systems in supply-chain coordination. In particular, several have examined collaborative forecasting as a means of reducing inefficiencies. However, most of these works have significant limitations. Suppliers do not face any competition (only one supplier is considered); only a few cases have considered completion at the retail level. In real life, it would be unusual for a supply-chain member to depend on a single supplier. The price charged to the retailer by the supplier is considered fixed; only Gal-Or et al. allow for the price to be determined after the demand uncertainty has been (partially) resolved. (But even there, the supplier has incentive to introduce price ambiguity.) Only Aviv allows for price to be determined through a common price auction so that the retailers reveal their price-demand continuum truthfully. We look forward to upcoming research works that address many of these issues.

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Chapter 12
Modeling Flexible Procurement Problem

Harpreet Kaur and Surya Prakash Singh

12.1 Introduction

It has been found that the purchased items constitute about 60 % of the total revenue of an organization (Boer et al. 2001). Hence, it is utmost important for every firm to choose its suppliers and allocate optimal lot-sizes to establish a competitive and effective purchasing function, thus making an efficient procurement decision. Selecting the right supplier(s) provides a significant advantage and plays a vital role in reducing costs and increasing the profit margins for a firm. This is popularly known as procurement problem. To optimize the cost associated with procurement, work on modeling suitable procurement is still diverging. As far as optimizing order allocation is concerned, the main issue is to determine an optimal ordering policy for given set of suppliers over a specified planning horizon (Mafakheri et al. 2011). Moreover, now-a-days business environment has become much more competitive due the uncertain market behavior, change of customer orientation and shorter lead times. The firms not only have to provide standard products at low cost but also have to be more flexible to sustain (Stevenson and Spring 2007). Hence, flexibility of business operations has become one of the major concerns of all the firms. Flexibility is basically the ability to respond more quickly to market uncertainties (Gerwin 1993). This chapter aims to incorporate the flexibility aspect into a procurement problem. Procurement problem is an important business operation and directly influences the economic efficiency of a firm. The chapter proposes a mixed integer linear program (MILP), which integrates the lot-sizing issues of procurement with supplier and carrier selection. The proposed model optimizes the

H. Kaur (✉) · S. P. Singh
Department of Management Studies, Indian Institute of Technology Delhi, New Delhi, India
e-mail: harpreetk.iitd@gmail.com

S. P. Singh
e-mail: surya.singh@gmail.com

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lot-sizes to be procured from different suppliers using different carriers and also provides an inbuilt response to the cost and supplier's capacity. Hence, making the procurement model a flexible one. The structure of the chapter is as follows. Section 12.2 provides detailed literature review on flexibility in supply chain. The proposed flexible procurement model is developed and discussed in Sect. 12.3. Section 12.4 demonstrates three illustrative examples with results followed by conclusions in Sect. 12.5.

12.2 Literature Review

Growing market competition and globalization has forced the firms across the globe to reconsider their various business strategies including procurement decisions, supplier selection, etc. Also, there is a growing need to make the procurement decisions more flexible. The procurement process is a procedure followed to obtain or buy certain goods or services. Procurement process begins with defining the business need followed by developing a procurement strategy. Once procurement strategy is defined the suppliers must be selected and evaluated, contract negotiations takes place, and in the end the whole process is reviewed (Aissaoui et al. 2007). For addressing and modeling procurement problem, it can be decomposed into three subproblems of supplier selection, carrier selection, and procurement lot-sizing. There is a need for a better strategy in decision-making process which includes identifying suitable suppliers who can supply quality goods at low cost without delays and allocating appropriate lot-sizes to them. The supplier selection process takes care of aforesaid requirements. Suitable selection of suppliers affects the operations of a firm ranging from procurement of raw materials to the timely delivery of end products. Hence, supplier selection problem has been widely addressed in literature, for example, Bhutta and Huq (2002), Chan (2003), Carter and Jennings (2004), Chan and Chan (2004), Onesime et al. (2004), Pearn et al. (2004), Basnet and Leung (2005), Lin et al. (2005), Valluri and Croson (2005), and Ware et al. (2012). But in multiple sourcing, not only suitable selection of suppliers is required but optimal allocation of orders is also very important. Gaballa (1974) was one of the first researchers to use integrated supplier selection and lot sizing by making use of MILP for a real case of Australian post office. Ghodsypour and O'Brien (2001) proposed an integrated supplier selection and lot-sizing model which minimizes the total ordering and holding costs including logistic cost. The procurement lot-size is determined by using economic ordering quantity (EOQ) model. Many researchers which integrate supplier selection with procurement lot-sizing does not built upon classical EOQ by Harris (1913). Rather mathematical programming is used to model multi-period problem. Ware et al. (2014) recently developed a dynamic supplier selection model integrated with order allocation. The model also incorporates the transportation cost and delivery delay.

The present literature about lot-sizing and supplier selection does not consider transportation cost as it is usually assumed that transportation cost is incurred by suppliers. But due to change in regulatory policies and developments of inbound freight movements, incorporation of transportation modes and costs in procurement decisions has become essential (Gentry and Farris 1992). The joint inbound transportation and the lot-size procurement can be seen from Russell and Krajewski (1991), Carter and Ferrin (1996), Swenseth and Godfrey (2002). Supply chain flexibility is multidimensional in nature. It is seen differently by different researchers, Gosling et al. (2010) suggested categorizing the suppliers into different categories as agreement, preferred, and approved. According to authors, maintaining suppliers in each category provides flexibility in supply chain.

Based on literature review, it can be said that very little work is done where all the three aspects of a procurement problem, that is, supplier selection, lot-sizing, and carrier selection are addressed together. Songhori et al. (2011) developed a framework which integrates both qualitative and quantitative criteria for supplier selection, order allocation, and logistics all together. They demonstrated the applicability of framework with a case study by decomposing the problem into supplier selection and order allocation. But the crisp evaluation of the framework is required. Choudhary and Shankar (2013) suggested a model for joint decision-making of lot-size, supplier and carrier selection where a lot-sizing problem of a single product can be procured from various suppliers offering different quantity discounts and carriers. The study showed that considering lot-sizing decisions along with supplier and carrier selection can really cut down the cost and increase the efficiency of this system. This chapter is a novel attempt to address a flexible procurement problem by combining supplier selection, lot-sizing, and carrier selection and incorporating flexibility by considering dynamic demand, cost fluctuations, and varying capacities of suppliers and carriers. In Sect. 12.3, the development of flexible procurement model is discussed and presented in detail.

12.3 Flexible Procurement Problem Formulation

The proposed MILP deals with a lot-sizing problem of multiproduct, multi-period procurement having multiple suppliers and carriers. The proposed MILP optimizes the lot-size of all products specifying the selected suppliers and carriers. The proposed model is flexible as it takes care of capacity constraints of suppliers and capacity and availability of carriers. It also takes care of cost fluctuations occurring over a planning horizon and gives a procurement lot-size strategy accordingly. The total quantity of each product for the selected suppliers must satisfy the demand after eliminating defectives. In the proposed MILP, shortages are not allowed and excessive quantity for a product in any period is carried forward to next period. The objective function including purchasing, ordering, transportation, and inventory holding costs has to be minimized. Following are the assumptions considered to model the flexible procurement problem.

- Demand for each item for each period is constant and known with certainty.
- Shortages and late deliveries are not allowed.
- Supplier capacity for each item is known and constant.
- Storage capacity of buyer is known and constant.
- Ordering cost is known for each item procured from each supplier.
- Transportation cost depends on carrier size.
- Inventory holding cost is applicable if an item is carried forward to next period in the planning horizon.

Following are the notations used to model the problem:

x_{ijmt}	Lot-size of *i*th product procured from *j*th supplier in period *t* using *m*th carrier
u_{ijmt}	1 if *i*th product procured from *j*th supplier using *m*th carrier in period else 0
D_{it}	Demand for *i*th product in period t
p_{ijt}	Cost of procuring *i*th product from *j*th supplier in period t
t_{ijmt}	Cost of transporting *i*th product from *j*th supplier using *m*th carrier in period *t*
o_{ijt}	Cost of ordering *i*th product from *j*th supplier in period t
I_{it}	Inventory for *i*th product carried from period *t* to t+1
h_{it}	Cost of holding inventory for *i*th product in time period t
C_{ijt}	Capacity of *j*th supplier for *i*th product in period t
Ω_{jm}	Available truck load capacity of *m*th carrier with supplier j
V_{jmt}	Total number of *m*th carriers available with *j*th supplier in period t
W_t	Storage capacity of the buyer in period t

12.3.1 MILP Formulation

From the above decision variables and parameters, the problem can be formulated mathematically as follows:

$$Minimize\ Z = Z1 + Z2 + Z3 + Z4 \tag{12.1}$$

$$Z_1 = \sum_i \sum_j \sum_m \sum_t p_{ijt} x_{ijmt} \tag{12.1a}$$

$$Z_2 = \sum_i \sum_j \sum_m o_{ijt} U_{ijmt} + \sum_t \sum_j \sum_m \sum_t t_{ijmt} u_{ijmt} \tag{12.1b}$$

$$Z_3 = \sum_i \sum_t h_{it} I_{it} \tag{12.1c}$$

Subjected to

$$I_{it-1} + \sum_j \sum_m x_{ijmt} = D_{it} + I_{it}\ \forall i,t \tag{12.2}$$

$$\sum_{j}\sum_{m} x_{ijmt} \leq \sum_{j}\sum_{m} C_{ijt} \ \forall i,t \tag{12.3}$$

$$x_{ijmt} \leq \Omega_{jm} u_{ijmt} \ \forall i,j,m,t \tag{12.4}$$

$$\sum\nolimits_{i} x_{ijmt} \leq \Omega_{jm} u_{ijmt} \qquad \forall j,m,t \ \text{(Redundant constraint)} \tag{12.4a}$$

$$\sum_{i}\sum_{j} u_{ijmt} = V_{mt} \ \forall m, \forall t \tag{12.5}$$

$$\sum_{i} x_{ijmt} \leq W_t \ \forall j,m,t \tag{12.6}$$

$$I_{it} \geq 0 \, and \ integer \tag{12.7}$$

$$x_{ijmt} \geq 0 \ and \ integer \tag{12.8}$$

$$u_{ijmt} \in \{0,1\} \tag{12.9}$$

Equation (12.1) of the proposed MILP minimizes the total costs bared by buyer over entire planning horizon. The objective function consists of three cost functions: purchasing cost, ordering and transportation cost, and inventory holding cost. Equation (12.1a) represents the total cost of purchasing an item (or product) from the supplier in each time period. In Eq. (12.1b) there are two parts, the former represents the total cost of ordering the products from different suppliers while the latter represents the total cost of transportation of various products from the supplier using different carriers over a planning horizon of T time periods. Equation (12.2) is basically the inventory balance equation. It balances out the excess inventory carried forward from period t − 1 added to current lot-size procured to the demand and inventory in period t. In Eq. (12.3), the lot-size ordered in any period must not exceed the capacity available with suppliers in that period. Constraints (12.4) and (12.4a) ensure that the amount of quantity ordered from supplier should not exceed the total truck load capacity available with supplier both overall and each item. Equation (12.5) describes that the number of carriers chosen by the suppliers for supplying each product must not be more than the total number of available carriers. Equation (12.6) restricts the quantity ordered for all products in any period according to the storage space limitation. Equations (12.7) and (12.8) represent non-negativity and integer values. The binary nature of the decision variable to decide whether a supplier with a particular carrier is selected for a product in a time period *t* or not is shown in Eq. (12.9).

12.4 Numerical Illustrations

The flexible procurement model developed in preceding section is illustrated using three different examples in this section. Data for all of the three examples have been generated randomly. The examples discussed are for the firms producing various products and for producing these products there are further certain parts which need to be procured from suppliers. The suppliers use different types of carriers to deliver the parts. Each supplier offers different cost for each product that may or may not change over entire planning horizon. Similarly, the transportation costs may or may also change for each part from each supplier over planning horizon. In addition to this, supplier capacity can also change in each time period depending upon availability of parts with the suppliers. Ordering cost is also bound to change for each part over a given planning horizon.

Example 1 In first example, the case of three products for three time periods have been considered that needs to be procured from five suppliers and each of supplier can make use of three different carriers. Hence, it is a three-period, three-product, five-supplier, and three-carrier problem (3T-3P-5S-3M). The data are randomly generated for per unit purchasing cost offered by each supplier, ordering cost incurred capacity of each supplier for each product, transportation costs. The randomly generated data are tabulated in Table 12.6 (refer Appendix). Apart from the tabulated data, the number of each carrier and capacity of each carrier with each supplier is also kept same over the entire planning horizon for simplicity of the problem. The inventory holding cost is considered 2 currency units per item per period.

The proposed MILP is programmed and solved using LINGO 10. The results obtained are shown in Tables 12.1 and 12.2. Table 12.1 shows the supplier and carrier distribution for products P_1, P_2, and P_3 for all periods. Similar distribution of suppliers and carriers for all the products over entire planning horizon is shown in Fig. 12.1. Table 12.2 provides lot-sizing schema for products P_1, P_2, and P_3 for entire planning horizon.

Table 12.1 Supplier and carrier selection for entire planning horizon for 3T-3P-5S-3M problem

		S_1			S_2			S_3			S_4			S_5		
		M_1	M_2	M_3	M_1	M_2	M_3	M_1	M_2	M_3	M_1	M_2	M_3	M_1	M_2	M_3
T_1	P_1	0	0	0	0	0	0	120	0	0	0	0	0	0	0	0
	P_2	95	0	0	0	0	0	0	0	0	0	0	60	0	0	0
	P_3	60	0	0	100	0	0	0	40	0	0	0	0	0	0	0
T_2	P_1	0	0	100	80	0	0	0	0	0	0	0	0	60	0	0
	P_2	0	0	0	100	0	0	0	0	0	30	0	0	0	0	0
	P_3	0	0	0	0	0	0	0	0	0	0	50	0	0	0	175
T_3	P_1	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0
	P_2	0	0	0	0	0	0	0	0	0	0	0	0	110	0	0
	P_3	160	0	0	0	0	0	0	0	0	0	20	0	0	0	0

Table 12.2 Lot-size schema for 3T-3P-5S-3M problem

		T_1	T_2	T_3
P_1	Demand	120	140	150
	Order	120	240	50
P_2	Demand	150	135	110
	Order	155	130	110
P_3	Demand	200	225	180
	Order	200	225	180

Example 2 In Example 2, a slightly bigger problem is considered to validate the proposed MILP for flexible procurement problem. The procurement problem for seven periods, four products, five suppliers, and three carriers (7T-4P-5S-3M) has been considered. Data have been again generated randomly and are provided in Table 12.8 (refer Appendix). Data include demand, purchasing cost, ordering cost, transportation cost incurred, and supplier capacity. Each product is having different purchasing cost, even each supplier offers different purchasing cost for each product in each time period. Ordering cost incurred by the firm also varies for each product in each time period. Supplier capacity for each product also varies in each time period. The transportation cost varies according to the carrier used for each product but remains same over each period. The number of each type of carriers and capacity of each carrier with each supplier also remains same over the entire planning horizon.

The problem is solved using LINGO 10 optimization solver and results are summarized in following tables. Table 12.3 shows the selection of suppliers and carriers for all the four products over entire planning horizon of seven time periods. Table 12.4 gives the procurement lot-sizing schema for the products P_1, P_2, P_3, and P_4 over entire planning horizon. Figure 12.2 shows the supplier and carrier distribution for products P_1, P_2, P_3, and P_4 for all the seven periods.

Example 3 In third example, a much bigger problem is considered to test the flexibility and robustness of the proposed MILP. The procurement problem for 12 periods, 5 products, 5 suppliers, and 3 carriers (12T-5P-5S-3M) has been considered and data for demand, purchasing cost, procurement cost, and supplier capacity have been generated randomly and are provided in Table 12.9 (see Appendix). Purchasing cost for each product varies with each supplier in each time period. Procurement cost and supplier capacity also varies for each product in each time period. The transportation cost varies according to the carrier used for each product by each supplier but remains same over each period. The number of each type of carriers and capacity of each carrier with each supplier also remains same over the entire planning horizon. Holding cost of 2 currency units is incurred with each unit of a product which is carried from one period to another. The problem is solved using LINGO optimization solver and results are summarized in Tables 12.5 and 12.6.

Table 12.5 provides the supplier and carrier selection plan for each product to be ordered over entire planning horizon, while Table 12.6 provides an overall lot-size ordering schema of each product over entire planning horizon. The supplier and carrier distribution for all 5 products over entire planning horizon of 12 time periods is shown in Fig. 12.3.

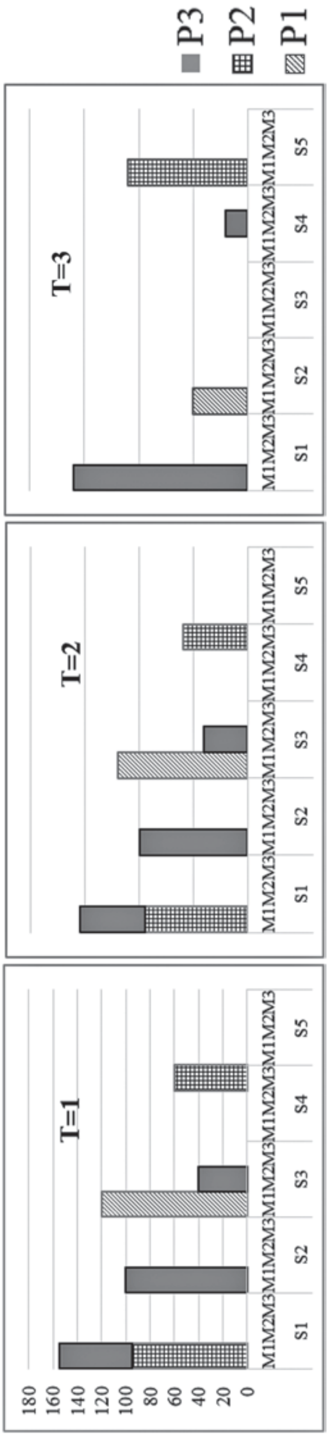

Fig. 12.1 Supplier and carrier selection distribution for entire planning horizon for 3T-3P-5S-3M problem

Table 12.3 Supplier distribution and carrier selection in the given planning horizon for 7T-4P-5S-3M problem

		S1			S2			S3			S4			S5		
		M_1	M_2	M_3	M_1	M_2	M_3	M_1	M_2	M_3	M_1	M_2	M_3	M_1	M_2	M_3
T_1	P_1	0	0	0	0	0	0	0	0	0	0	0	0	120	0	0
	P_2	0	75	60	0	0	0	0	0	0	150	0	0	0	0	0
	P_3	165	0	0	0	0	0	0	0	0	0	0	0	35	0	0
	P_4	100	0	0	50	0	0	0	60	100	0	0	40	0	0	0
T_2	P_1	0	0	0	250	50	0	0	0	0	0	0	0	0	0	0
	P_2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	P_3	0	0	0	250	100	50	0	0	0	5	0	0	0	0	0
	P_4	150	0	0	0	0	0	0	30	0	10	0	90	0	0	20
T_3	P_1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	P_2	0	0	0	0	0	0	0	0	0	0	0	0	175	0	25
	P_3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	P_4	0	0	15	200	0	0	0	0	0	100	0	0	85	0	0
T_4	P_1	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	P_2	0	0	0	0	0	0	0	0	0	0	0	0	55	0	0
	P_3	0	0	0	0	0	0	0	60	0	0	190	0	0	0	0
	P_4	0	0	50	40	0	0	0	0	0	200	0	0	0	0	0
T_5	P_1	0	0	0	0	0	0	0	0	0	0	190	0	0	0	0
	P_2	150	0	0	0	0	0	0	0	0	0	0	0	120	0	80
	P_3	0	0	0	150	0	0	0	0	0	0	0	0	0	0	0
	P_4	50	150	0	0	0	0	0	0	0	200	0	90	0	0	0
T_6	P_1	0	0	50	0	80	0	0	0	0	0	0	0	0	0	0
	P_2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	P_3	160	40	60	0	0	0	0	0	0	0	0	0	0	0	0
	P_4	0	0	0	0	0	0	0	0	0	0	0	0	75	0	0
T_7	P_1	0	0	0	0	0	0	0	0	0	0	0	0	140	0	0
	P_2	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0
	P_3	0	0	15	0	0	0	0	0	0	0	0	0	175	0	0
	P_4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50

Table 12.4 Lot-size schema for a 7T-4P-5S-3M problem

		T_1	T_2	T_3	T_4	T_5	T_6	T_7
P_1	Demand	120	140	150	150	180	200	140
	Order	120	300	0	200	190	130	140
P_2	Demand	150	135	110	160	200	100	150
	Order	285	0	215	55	350	0	100
P_3	Demand	200	225	180	250	150	150	300
	Order	200	405	0	250	150	260	190
P_4	Demand	300	350	400	290	315	140	160
	Order	350	300	400	290	490	75	50

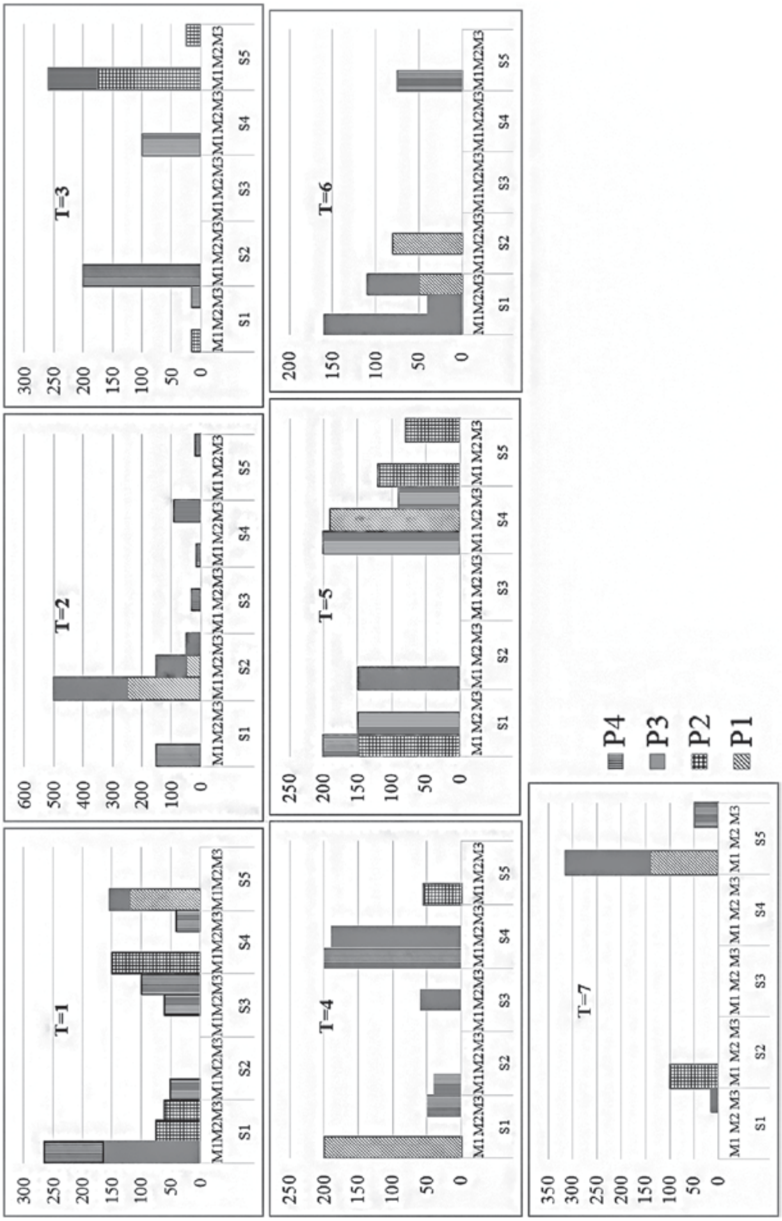

Fig. 12.2 Supplier and carrier selection distribution over entire planning horizon for 7T-4P-5S-3M problem

Table 12.5 Supplier distribution and lot-size for entire planning horizon for 12T-5P-5S-3M problem

		S_1			S_2			S_3			S_4			S_5		
		M_1	M_2	M_3	M_1	M_2	M_3	M_1	M_2	M_3	M_1	M_2	M_3	M_1	M_2	M_3
T_1	P_1	0	0	0	0	0	0	0	0	0	0	0	0	120	0	0
	P_2	0	0	0	150	0	0	0	0	0	0	0	0	0	0	0
	P_3	0	0	0	0	0	200	0	0	0	0	0	0	0	0	0
	P_4	200	150	60	0	0	0	0	0	0	200	190	0	0	0	0
	P_5	0	0	0	250	100	0	0	50	0	0	0	0	0	0	0
T_2	P_1	0	0	0	0	0	0	0	0	0	0	0	0	140	0	0
	P_2	0	0	0	0	0	0	0	245	0	0	0	0	0	0	0
	P_3	0	0	0	0	0	0	0	0	0	200	25	0	0	0	0
	P_4	0	0	0	0	0	0	0	0	0	0	0	75	0	0	0
	P_5	0	0	0	15	0	0	0	200	100	110	190	0	0	0	0
T_3	P_1	0	0	0	0	0	0	0	0	0	150	0	0	0	0	0
	P_2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	P_3	80	0	0	0	0	0	0	0	0	100	0	0	0	0	0
	P_4	0	0	0	0	0	0	0	0	0	0	0	0	175	0	0
	P_5	0	0	10	0	0	0	0	0	0	0	0	0	175	0	0
T_4	P_1	0	0	0	0	0	0	0	0	0	0	0	0	150	0	0
	P_2	0	0	0	0	0	0	0	220	0	0	0	0	0	0	0
	P_3	180	150	0	0	0	0	0	0	0	0	0	0	0	0	0
	P_4	0	0	0	0	0	0	300	0	0	0	0	0	0	0	0
	P_5			0	0	0	0	0	120	0	200	190	60	0	0	80

Table 12.5 (continued)

		S_1			S_2			S_3			S_4			S_5		
		M_1	M_2	M_3	M_1	M_2	M_3	M_1	M_2	M_3	M_1	M_2	M_3	M_1	M_2	M_3
T_5	P_1	200	30	0	0	0	0	0	0	0	0	0	0	0	0	0
	P_2	0	0	0	0	0	0	0	250	0	0	0	0	0	0	0
	P_3	0	0	0	70	0	0	0	0	0	0	0	0	0	0	0
	P_4	0	0	16	230	0	0	0	0	0	0	0	0	59	0	0
	P_5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T_6	P_1	0	0	0	230	0	0	0	0	0	0	0	0	0	0	0
	P_2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	P_3	0	0	0	0	0	0	0	0	0	150	0	0	0	0	0
	P_4	0	0	60	0	0	0	0	5	0	0	0	0	175	0	0
	P_5	200	0	25	0	35	0	0	0	69	21	0	0	0	0	50
T_7	P_1	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0
	P_2	0	0	0	0	0	0	0	250	0	0	0	0	0	0	0
	P_3	66	0	0	234	0	0	0	0	0	0	0	0	0	0	0
	P_4	0	0	0	0	0	0	0	0	0	0	0	0	60	0	0
	P_5	0	0	0	30	0	0	0	0	20	0	0	0	0	0	0
T_8	P_1	200	0	42	0	0	0	0	0	0	0	0	0	0	0	0
	P_2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	P_3	180	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	P_4	0	0	0	0	0	0	0	45	0	0	0	0	175	100	80
	P_5	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 12.5 (continued)

		S_1			S_2			S_3			S_4			S_5		
		M_1	M_2	M_3	M_1	M_2	M_3	M_1	M_2	M_3	M_1	M_2	M_3	M_1	M_2	M_3
T_9	P_1	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0
	P_2	0	0	0	210	0	0	0	0	0	0	0	0	0	0	0
	P_3	0	0	0	190	0	0	0	0	0	0	0	0	60	0	0
	P_4	66	0	0	0	0	0	0	56	0	0	0	0	168	0	0
	P_5	0	0	60	0	63	0	0	48	0	0	67	0	175	0	80
T_{10}	P_1	0	0	0	0	0	0	0	250	100	0	0	0	0	0	0
	P_2	0	0	0	250	0	0	0	0	0	0	0	0	0	0	0
	P_3	0	0	0	0	0	0	0	0	0	150	0	0	0	0	0
	P_4	0	0	60	0	0	0	0	0	0	0	0	0	175	0	80
	P_5	66	0	0	0	0	0	0	0	0	200	20	90	131	0	0
T_{11}	P_1	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0
	P_2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	P_3	56	0	0	42	0	0	0	0	0	0	0	0	0	0	52
	P_4	0	0	0	0	0	0	0	0	0	0	190	0	110	0	0
	P_5	0	0	0	30	0	0	0	0	180	190	0	0	0	0	0
T_{12}	P_1	0	0	60	0	0	0	0	48	0	0	0	0	0	0	0
	P_2	0	0	0	0	0	0	0	0	0	0	0	0	150	0	0
	P_3	0	0	0	0	0	0	300	0	0	0	0	0	0	0	0
	P_4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	P_5	0	0	0	42	0	0	0	0	0	0	0	0	0	0	8

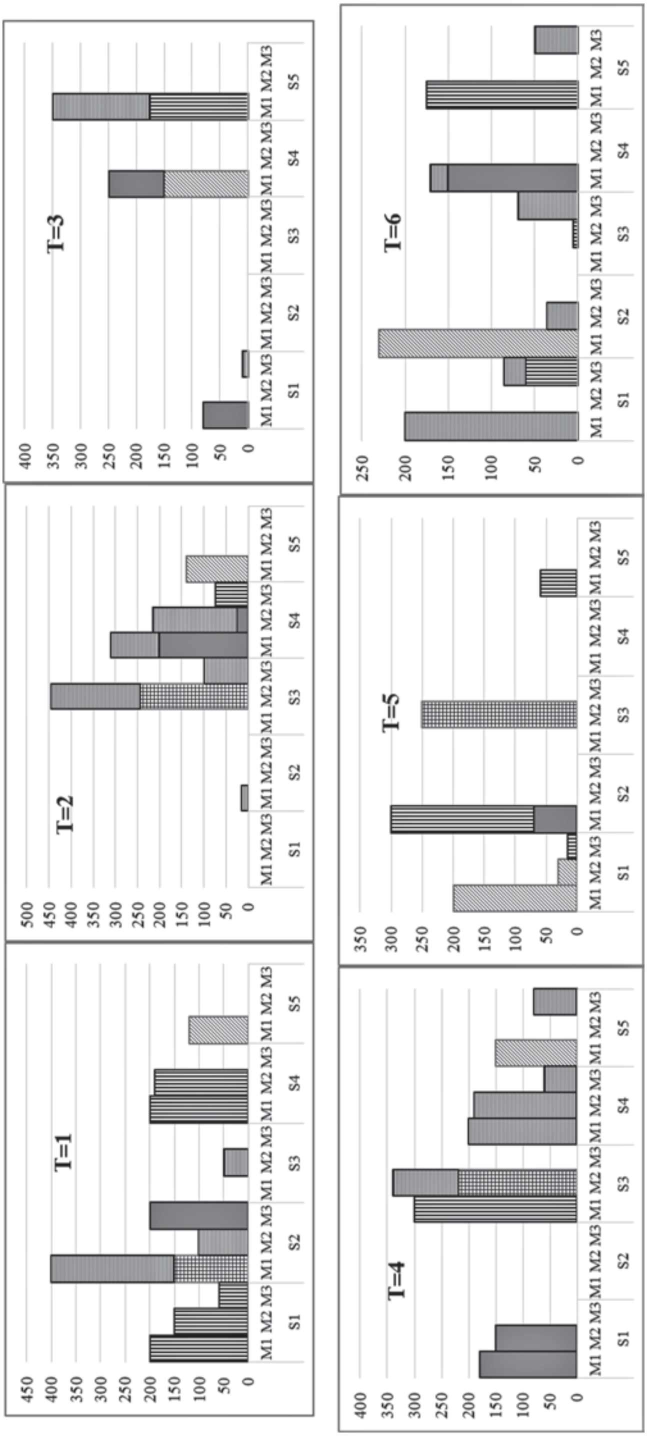

Fig. 12.3 Supplier and carrier selection distribution over entire planning horizon for 12T-5P-5S-3M problem

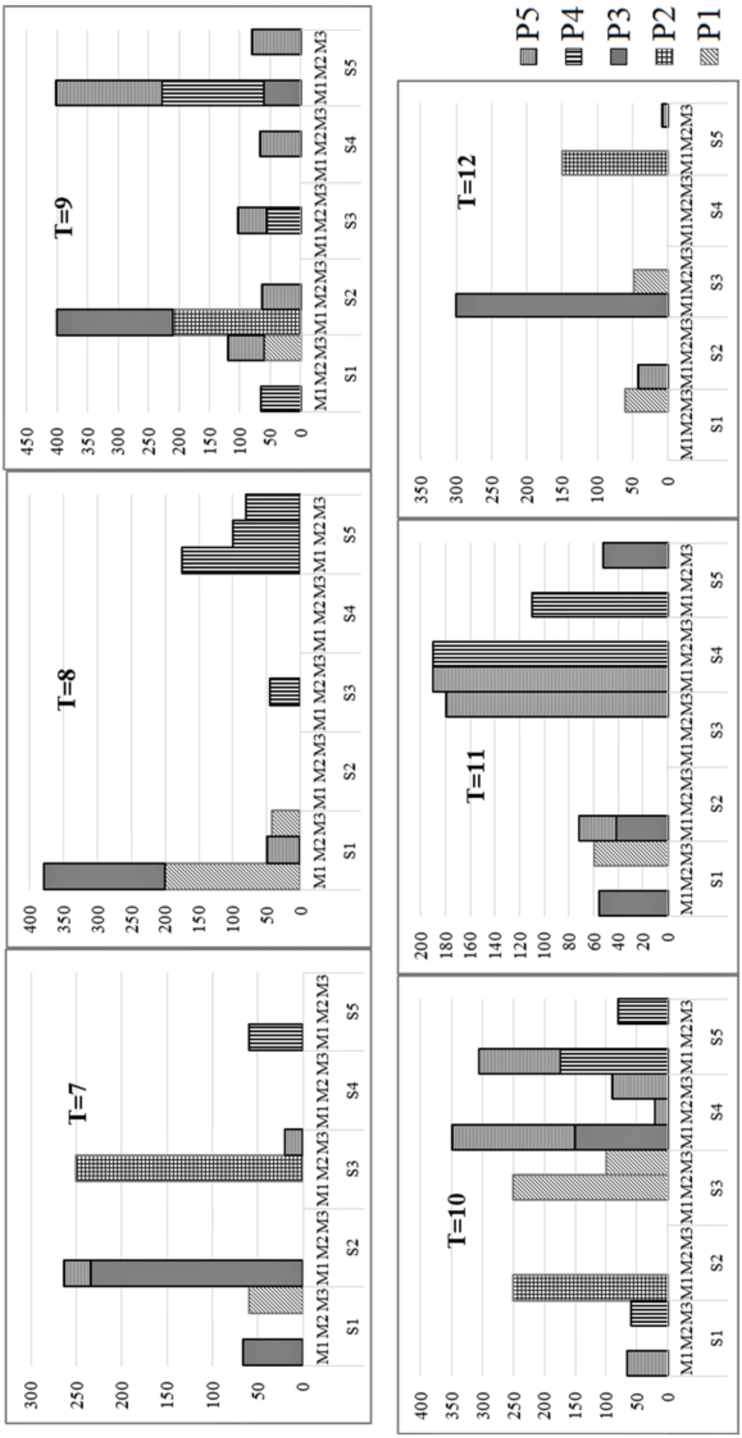

Fig. 12.3 (continued)

Table 12.6 Lot-size schema for a 12T-5P-5S-3M problem

		T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
P1	*Demand*	120	140	150	150	180	200	140	150	150	180	200	140
	Order	120	140	150	150	230	230	60	242	60	350	60	108
P2	*Demand*	150	135	110	160	200	100	150	110	160	200	100	150
	Order	150	245	0	220	250	0	250	0	210	250	0	150
P3	*Demand*	200	225	180	250	150	150	300	180	250	150	150	300
	Order	200	225	180	330	70	150	300	180	250	150	150	300
P4	*Demand*	300	350	400	290	315	140	160	400	290	315	140	160
	Order	800	75	175	300	305	240	60	400	290	315	300	0
P5	*Demand*	400	450	350	300	350	400	50	50	300	700	400	50
	Order	400	615	185	650	0	400	50	50	493	507	400	50

12.5 Conclusion

This chapter presents an MILP where the flexibility is incorporated in a procurement problem by integrating lot-sizing problem with supplier and carrier selection. The flexibility is being taken care by incorporating sudden fluctuations like change in prices offered by various suppliers, supplier's capacity, the availability of various carriers, and transportation cost incurred accordingly. The proposed MILP provides the lot size of given product to be procured from the given supplier in a given planning horizon. Also, the carrier being used by the supplier to supply the order can be provided by MILP. This model for flexible procurement problem is able to handle day-to-day fluctuations in the price levels and capacity levels of suppliers; thus making it much more relevant and practical. This model is a deterministic model and is proposed to extend the model for stochastic demand in future. In this model, the availability of carriers and the cost of transportation have been considered fixed; however, they can also be varied and their effect can be analyzed. Moreover, lead time for procuring items from suppliers can also be one of the extensions to the proposed model.

Appendix

Table 12.7 Randomly generated data for (3T-3P-5S-3M) problem

		Demand	Purchasing cost	Ordering cost	Supplier capacity	Transportation cost		
						M_1	M_2	M_3
T_1	P_1	120	80,70,75,85,80[a]	5000	100,50,600,30,60[a]	15,20,11,10,17	10,12,13,12,15	13,13,12,10,15[a]
	P_2	150	100,110,115,100,105	2000	200,100,50,60,0	20,20,21,20,27	20,22,23,22,25	23,23,22,20,25
	P_3	200	30,35,40,40,30	2500	60,100,60,0,0	5,6,7,4,7	10,12,10,12,15	7,8,7,10,6
T_2	P_1	140	70,70,80,80,75	1000	100,80,60,30,100	15,20,11,10,17	10,12,13,12,15	13,13,12,10,15
	P_2	135	105,100,110,100,110	1200	30,100,100,30,20	20,20,21,20,27	20,22,23,22,25	23,23,22,20,25
	P_3	225	40,30,40,30,40	2500	45,15,20,50,200	5,6,7,4,7	10,12,10,12,15	7,8,7,10,6
T_3	P_1	150	75,75,80,90,80	1200	30,50,60,80,70	15,20,11,10,17	10,12,13,12,15	13,13,12,10,15
	P_2	110	100,110,110,105,100	1000	200,580,70,120,170	20,20,21,20,27	20,22,23,22,25	23,23,22,20,25
	P_3	180	35,40,45,34,40	2500 2000,1500,1000,1500	300,40,0,20,100	5,6,7,4,7	10,12,10,12,15	7,8,7,10,6

[a] (S_1,S_2,S_3,S_4,S_5)

Table 12.8 Randomly generated data for (7T-4P-5S-3M) problem

		Demand	Purchasing cost	Ordering cost	Supplier capacity	Transportation cost		
						M_1	M_2	M_3
T_1	P_1	120	80,70,75,85,80[a]	5000	500,5,60,40,300[a]	15,20,11,10,17	10,12,13,12,15	13,13,12,10,15[a]
	P_2	150	100,110,115,100,105	2000	200,200,25,150,150	20,20,21,20,27	20,22,23,22,25	23,23,22,20,25
	P_3	200	30,35,40,40,30	2500	400,300,300,0,35	5,6,7,4,7	10,12,10,12,15	7,8,7,10,6
	P_4	300	50,55,59,51,60	2000	100,50,600,40,300	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
T_2	P_1	140	70,70,80,80,75	9000	40,300,120,30,60	15,20,11,10,17	10,12,13,12,15	13,13,12,10,15
	P_2	135	105,100,110,100,110	2500	150,200,30,100,200	20,20,21,20,27	20,22,23,22,25	23,23,22,20,25
	P_3	225	40,30,40,30,40	2500	50,400,30,300,45	5,6,7,4,7	10,12,10,12,15	7,8,7,10,6
	P_4	350	45,55,61,55,50	2000	150,90,30,100,20	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
T_3	P_1	150	75,75,80,90,80	4500	200,30,70,300,50	15,20,11,10,17	10,12,13,12,15	13,13,12,10,15
	P_2	110	100,110,110,105,100	2000	15,200,30,10,200	20,20,21,20,27	20,22,23,22,25	23,23,22,20,25
	P_3	180	35,40,45,34, 40	2500	50,0,300,300,450	5,6,7,4,7	10,12,10,12,15	7,8,7,10,6
	P_4	400	50,45,60,55,60	2500	15,200,0,100,200	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
T_4	P_1	150	60,70,85,75,90	5000	300,80,70,30,150	15,20,11,10,17	10,12,13,12,15	13,13,12,10,15
	P_2	160	120,115,115,110,105	1500	150,200,300,100,200	20,20,21,20,27	20,22,23,22,25	23,23,22,20,25
	P_3	250	40,40,30,30,35	2000	300,400,300,300,45	5,6,7,4,7	10,12,10,12,15	7,8,7,10,6
	P_4	290	50,55,59,51,60	2500	50,40,300,300,450	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
T_5	P_1	180	75,80,70,80,85	5000	400,300,40,300,500	15,20,11,10,17	10,12,13,12,15	13,13,12,10,15
	P_2	200	100,110,110,105,100	2000	150,200,300,200,200	20,20,21,20,27	20,22,23,22,25	23,23,22,20,25
	P_3	150	35,30,38,40,40	2500	300,200,100,300,450	5,6,7,4,7	10,12,10,12,15	7,8,7,10,6
	P_4	315	51,59,60,50,55	2000	200,40,350,300,250	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12

Table 12.8 (continued)

		Demand	Purchasing cost	Ordering cost	Supplier capacity	Transportation cost		
						M_1	M_2	M_3
T_6	P_1	200	85,75,72,85, 80	4000	300,80,70,30,150	15,20,11,10,17	10,12,13,12,15	13,13,12,10,15
	P_2	100	105,110,120,115,105	2500	50,40,300,300,450	20,20,21,20,27	20,22,23,22,25	23,23,22,20,25
	P_3	150	30,35,41,38,35	2000	300,400,300,300,45	5,6,7,4,7	10,12,10,12,15	7,8,7,10,6
	P_4	140	50,62,57,60,55	4500	150,200,300,100,200	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
T_7	P_1	140	75,85,80,70,80	5000	85,200,30,10,200	15,20,11,10,17	10,12,13,12,15	13,13,12,10,15
	P_2	150	115,100,105,115,110	3000	50,100,300,300,450	20,20,21,20,27	20,22,23,22,25	23,23,22,20,25
	P_3	300	30,35,40,40,30	2500	15,200,50,100,200	5,6,7,4,7	10,12,10,12,15	7,8,7,10,6
	P_4	160	59,51,60,50,55	2000	200,30,70,300,50	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12

[a] (S_1,S_2,S_3,S_4,S_5)

Table 12.9 Randomly generated data for (12T-5P-5S-3M) problem

		Demand	Purchasing cost	Ordering cost	Supplier capacity	Transportation cost	Demand	Purchasing cost
						M_1	M_2	M_3
T_1	P_1	120	17,15,12,18,11[a]	500	500,500,600,400,300[a]	15,20,11,10,17	10,12,13,12,15	13,13,12,10,15[a]
	P_2	150	22,20,25,21,22	800	200,200,250,150,150	20,20,21,20,27	20,22,23,22,25	23,23,22,20,25
	P_3	200	32,34,30,32,30	100	400,300,300,400,350	5,6,7,4,7	10,12,10,12,15	7,8,7,10,6
	P_4	300	50,55,59,51,60	300	500,500,600,400,300	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
	P_5	400	20,14,16,21,18	200	300,350,400,450,600	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
T_2	P_1	140	15,14,16,15,13	200	400,300,700,300, 500	15,20,11,10,17	10,12,13,12,15	13,13,12,10,15
	P_2	135	20,21,20,22,22	750	150,200,300,100,200	20,20,21,20,27	20,22,23,22,25	23,23,22,20,25
	P_3	225	34,34,31,30,32	150	280,430,400,300,200	5,6,7,4,7	10,12,10,12,15	7,8,7,10,6
	P_4	350	60,55,56,54,55	350	150,200,300,100,200	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
	P_5	450	20,18,15,16,18	200	500,400,300,300,450	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
T_3	P_1	150	16,16,15,14,15	250	500,400,300,300,450	15,20,11,10,17	10,12,13,12,15	13,13,12,10,15
	P_2	110	23,23,25,24,22	600	400,300,700,300,500	20,20,21,20,27	20,22,23,22,25	23,23,22,20,25
	P_3	180	32,34,32,30,32	200	150,200,300,100,200	5,6,7,4,7	10,12,10,12,15	7,8,7,10,6
	P_4	400	58,60,60,59,50	500	150,200,300,100,200	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
	P_5	350	20,22,21,21,19	300	280,430,400,300,200	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
T_4	P_1	150	15,17,17,16,14	400	500,500,600,400,300	15,20,11,10,17	10,12,13,12,15	13,13,12,10,15
	P_2	160	22,20,20,22,22	700	200,200,250,150, 150	20,20,21,20,27	20,22,23,22,25	23,23,22,20,25
	P_3	250	30,30,32,31,33	150	400,300,300,400,350	5,6,7,4,7	10,12,10,12,15	7,8,7,10,6
	P_4	290	59,56,56,58,57	550	500,500,600,400,300	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
	P_5	300	22,21,18,17,18	200	300,350,400,450 600	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12

Table 12.9 (continued)

		Demand	Purchasing cost	Ordering cost	Supplier capacity	Transportation cost	Demand	Purchasing cost
						M_1	M_2	M_3
T_5	P_1	180	14,15,16,14,17	200	410,390,660,240,460	15,20,11,10,17	10,12,13,12,15	13,13,12,10,15
	P_2	200	23,25,22,24,25	750	280,220,350,510,31	20,20,21,20,27	20,22,23,22,25	23,23,22,20,25
	P_3	150	34,33,36,36,35	200	52,520,53,60,460	5,6,7,4,7	10,12,10,12,15	7,8,7,10,6
	P_4	315	60,59,61,60,51	350	58,230,290,65,59	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
	P_5	350	24,22,20,23,22	400	340,48,52,260,370	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
T_6	P_1	200	12,12,13,14,12	550	420,230,25,28,210	15,20,11,10,17	10,12,13,12,15	13,13,12,10,15
	P_2	100	25,24,24,22,23	700	62,570,210,54,270	20,20,21,20,27	20,22,23,22,25	23,23,22,20,25
	P_3	150	33,33,35,32,34	150	480,55,510,670,620	5,6,7,4,7	10,12,10,12,15	7,8,7,10,6
	P_4	140	56,57,57,58,56	400	440,580,42,52,210	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
	P_5	400	20,18,19,19,18	200	370,35,69,21,50	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
T_7	P_1	140	13,13,14,15,15	500	60,330,400,69,50	15,20,11,10,17	10,12,13,12,15	13,13,12,10,15
	P_2	150	22,21,20,22,22	700	64,63,370,60,60	20,20,21,20,27	20,22,23,22,25	23,23,22,20,25
	P_3	300	30,30,31,32,31	200	66,340,67,260,310	5,6,7,4,7	10,12,10,12,15	7,8,7,10,6
	P_4	160	58,59,59,57,57	550	540,290,56,42,60	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
	P_5	50	22,20,21,19,20	150	220,210,56,20,48	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
T_8	P_1	150	11,13,14,12,11	350	460,240,350,510,31	15,20,11,10,17	10,12,13,12,15	13,13,12,10,15
	P_2	110	22,23,22,24,22	850	280,220,410,390,660	20,20,21,20,27	20,22,23,22,25	23,23,22,20,25
	P_3	180	31,32,32,31,32	200	230,290,53,60,460	5,6,7,4,7	10,12,10,12,15	7,8,7,10,6
	P_4	400	56,57,55,56,54	550	58,59,65,52,520	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
	P_5	50	22,24,23,22,23	200	370,340,48,52,260	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12

Table 12.9 (continued)

		Demand	Purchasing cost	Ordering cost	Supplier capacity	Transportation cost	Demand	Purchasing cost
						M_1	M_2	M_3
T_9	P_1	150	13,15,15,14,15	400	540,290,56,42,60	15,20,11,10,17	10,12,13,12,15	13,13,12,10,15
	P_2	160	24,23,24,24,22	900	60,330,400,69,50	20,20,21,20,27	20,22,23,22,25	23,23,22,20,25
	P_3	250	33,32,33,34,31	100	220,210,370,60,60	5,6,7,4,7	10,12,10,12,15	7,8,7,10,6
	P_4	290	55,56,55,54,56	450	66,340,56,20,310	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
	P_5	300	20,18,15,16,18	400	64,63,48,67,260	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
T_{10}	P_1	180	14,15,12,14,13	400	220,210,370,60,60	15,20,11,10,17	10,12,13,12,15	13,13,12,10,15
	P_2	200	22,23,24,24,23	600	60,330,400,69,50	20,20,21,20,27	20,22,23,22,25	23,23,22,20,25
	P_3	150	34,34,31,30,32	150	56,42,60,540,290	5,6,7,4,7	10,12,10,12,15	7,8,7,10,6
	P_4	315	56,57,55,56,54	500	64,63,48,67,260	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
	P_5	700	22,24,23,22,23	350	66,56,20,310,340	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
T_{11}	P_1	200	13,15,15,14,15	500	64,63,48,67,60	15,20,11,10,17	10,12,13,12,15	13,13,12,10,15
	P_2	100	24,23,24,24,22	600	60,330,400,69,50	20,20,21,20,27	20,22,23,22,25	23,23,22,20,25
	P_3	150	30,30,31,32,31	225	56,42,60,540,290	5,6,7,4,7	10,12,10,12,15	7,8,7,10,6
	P_4	140	58,59,59,57,57	350	66,56,20,310,340	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
	P_5	400	22,20,21,19,20	250	260,220,210,370,60	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
T_{12}	P_1	140	11,13,15,14,16	400	64,63,48,67,260	15,20,11,10,17	10,12,13,12,15	13,13,12,10,15
	P_2	150	22,21,23,25,22	700	66,56,20,310,340	20,20,21,20,27	20,22,23,22,25	23,23,22,20,25
	P_3	300	33,32,30,34,30	150	220,210,370,60,60	5,6,7,4,7	10,12,10,12,15	7,8,7,10,6
	P_4	160	56,58,60,58,58	550	60,330,400,69,50	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12
	P_5	50	22,18,20,18,18	200	56,42,60,540,290	10,11,11,13,10	10,13,10,12,13	11,12,12,11,12

[a] (S_1,S_2,S_3,S_4,S_5)

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Chapter 13
Modeling Hierarchical Relationships Among Enablers of Supply Chain Coordination in Flexible Environment

Dhanya Jothimani, Ravi Shankar and Surendra S. Yadav

13.1 Introduction

Recently, the number of supply chain (SC) partners has risen, thus, increasing the complexity of the SC. Growing competition is one of the contributing factors for increased complexity of the SC. With increasing competition, these SC members try to maximize their individual profits which ultimately increases the overall SC costs. Presently, it is not the individual firms that are competing with each other but their SCs are certainly doing so. SC coordination is the process of tackling the interdependencies among the SC members which improves the overall SC performance (Arshinder et al. 2008). Hence, the firms should coordinate with each other to increase the overall profitability and reduce the overall cost of the SC.

The ability of the organization to meet the demands arising within and outside the organization is known as flexibility. The role, SC coordination plays in SC flexibility, is important (Kumar et al. 2013). Like product and process flexibilities, coordination flexibility is one of the dimensions of SC flexibility (Singh and Acharya 2013). Hence, it is necessary for the firms to understand the importance of coordination.

There are various mechanisms that aid coordination among the SC members. Few of them include SC contracts, information sharing, and collaborative efforts. These mechanisms are known as enablers of SC coordination. Henceforth, from this point onwards, the terms mechanism and enablers of SC coordination are used interchangeably. There are studies that deal with the implementation of

D. Jothimani (✉) · R. Shankar · S. S. Yadav
Department of Management Studies, Indian Institute of Technology Delhi, New Delhi, India
e-mail: dhanya.jothimani@dms.iitd.ac.in; dhanyajothimani@gmail.com

R. Shankar
e-mail: ravi1@dms.iitd.ac.in

S. S. Yadav
e-mail: ssyadav@dms.iitd.ac.in

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these mechanisms individually (Stank et al. 1999; Hahn et al. 2000). The overall SC performance can be improved by focusing and executing various combinations of these mechanisms. To achieve this, the interrelationship among the enablers of SC coordination should be understood. This understanding would enable the top management to focus on specific enablers to move towards coordination. Hence, this chapter aims to determine the enablers of SC coordination and to understand the relationship among them.

The next section discusses various enablers of SC coordination. Sections 13.3 and 13.4 deal with interpretive structural modeling (ISM) and MICMAC analysis, respectively. Managerial implications are presented in Sect. 13.5. Limitations of the study and the scope for future work are presented in Sect. 13.6.

13.2 Enablers for SC Coordination

13.2.1 Channel Coordination

Channel coordination is an important factor that would lead to better SC coordination. Information sharing leads to channel coordination, which further increases the operational efficiency of the SC (Lee et al. 1997a).

13.2.2 Collaborative Planning Forecasting and Replenishment

A number of promotional activities can be planned as a joint measure between two or more members in a SC. This initiative is called collaborative planning, forecasting, and replenishment (CPFR). SC members try to synchronize their forecasts which help them to determine the production and replenishment processes. Few benefits that are achieved through CPFR are lower product inventories, increased service levels, lower capacity requirements, shorter response time, improvement in forecast accuracy, reduced system requirements, and lesser number of stocking points (Larsen 2000).

13.2.3 Implementation of Information Systems

SC performance can be improved through implementation of information systems (ISs) since it enables easy and faster information sharing among the SC members (Stank et al. 1999). Implementation of IS aids to reduce the information mismatch among them and it eliminates the consequences of the demand forecasts in bullwhip effect.

13.2.4 Information Sharing

Supply coordination can be successful with effective and proper communication among the SC members (Hahn et al. 2000). Hence, it is considered to be an important enabler. Information sharing is needed to increase trust among the SC members (Henriott 1999). Information sharing helps the organizations in the SC to reduce the distortion in the demand information, thus, reducing the bullwhip effect (Lee et al. 1997a, b; Lee and Whang 2000).

13.2.5 Incentive Alignment Policies

Various SC contracts can help promote incentive policies among the members. This reduces the cost and increases the profit in the SC. This further increases the SC efficiency (Tsay and Lovejoy 1999).

13.2.6 Joint Decision-Making

Joint working and joint promotions encourage the SC members to make their decision together. Joint decision-making influences the members to share information and increases trust among them (Hill and Omar 2006). This would minimize the operating cost of all the members.

13.2.7 Joint Promotion

Joint promotional activities among the SC members motivate them to share benefits as well as the risks (Hill and Omar 2006).

13.2.8 Joint Working

Joint working is one of the mechanisms to improve the coordination among the SC members and hence improving the overall SC performance (Hill and Omar 2006). The joint working influences both joint promotion and joint decision-making.

13.2.9 Performance Monitoring

The SC members should measure their performance to understand the overall view of their position. This will encourage them to improve their performance and realize the importance of coordination among them. Various performance models like supply chain operations reference (SCOR) model and balanced scorecard (BSC) can be used to measure performance of the SC members (Huan et al. 2004).

13.2.10 Resource Sharing

Resource sharing is nothing but collaboration among the independent but related members of SC to share resources to fulfill the requirements of customers on time (Narus and Anderson 1996). SC performance can be improved with resource sharing among the SC members. This also influences the information sharing among the members.

13.2.11 Risk Sharing

Like resource sharing, both reward and risk sharing among different SC members are necessary. Focus of a company should be not only on its risk but also at other points in the SC. The direct risks and their potential causes at each point should be identified (Souter 2000; Mentzer et al. 2001; Christopher et al. 2002).

13.2.12 SC Contracts

The risk-related issues and conflicts among the members can be resolved using SC contracts. There are various types of contracts which include revenue sharing contracts, buy back contract, wholesale price contract, and quantity flexibility contract. The aim of SC contracts is to reduce the underage and overage costs and to increase the SC profit (Arshinder et al. 2008). The problem of double marginalization can be reduced.

13.3 Interpretive Structural Modeling

A system consists of various elements and these elements interact with each other. The terms elements, factors, and variables are used interchangeably. The direction and order of the relationships among the system elements can be established using interpretive structural modeling (ISM). It handles a large number of relationships among the system elements and establishes a hierarchical arrangement (Warfield 1974). The system can be well explained with the help of indirect and direct relationships among the variables than the individual elements. ISM is comprehendible

Table 13.1 Contributions of researchers in ISM in various fields

S. no.	Field of study	Researchers
1	Information security management	Chander et al. (2013)
2	Supply chain collaboration	Ramesh et al. (2010)
3	Cold SC	Joshi et al. (2009)
4	SC performance measurement system	Charan et al. (2008)
5	Flexible manufacturing systems	Raj et al. (2008)
6	Technology transfer for rural housing	Singh and Kant (2007)
7	IT-enabled SC	Jharkharia and Shankar (2005)
8	Reverse logistics	Ravi and Shankar (2005)
9	Knowledge management	Singh and Agarwal (2003)
10	Vendor selection	Mandal and Deshmukh (1994)

since the relationships can be presented in the form of graph. A group of experts are consulted to decide whether and how the elements are related; hence, it is classified under group decision-making technique. A systemic model is constructed on the basis of these relationships. In this chapter, the relationships among the enablers influencing the SC coordination are corroborated using ISM methodology. ISM has been adopted by various researchers for various fields of study (Table 13.1).

The ISM methodology consists of following steps:

i. The system under consideration is defined first. Elements affecting the system are identified through survey or group decision-making process. The elements can be individuals, actions, or outcomes.
ii. Each element is examined with respect to other elements for establishing a contextual relationship among them.
iii. Based on the established relationships, structural self-interaction matrix (SSIM), which is a upper triangular matrix, is conceptualized for the identified elements.
iv. SSIM is transformed into initial reachability matrix. Final reachability matrix is derived from the same on the basis of transitivity. Transitivity states that if an element P influences Q and Q influences R, then P necessarily influences R.
v. Using the concepts of set theory, the final reachability matrix, obtained in the previous step, is partitioned into different levels.
vi. A digraph (which refers to a directed graph) is drawn with the final reachability matrix and the levels obtained, as inputs. At this stage, the transitive links are discarded.
vii. The element nodes in the digraph are replaced with statements to obtain the final model of ISM.
viii. The final model is checked for conceptual consistency. Requisite changes are made in case of inconsistency.

13.3.1 Structural Self-Interaction Matrix

Consensus methodologies, such as nominal group technique and brainstorming, can be used to obtain the contextual relationship among the elements. In this chapter, enablers were identified and shortlisted with the help of domain experts and from existing literature. The contextual relationships among the enablers of SC coordination were obtained with the help of four SC experts, having experience of 8–15 years.

On the basis of the contextual relationship for each element, following four symbols indicate the direction of the relation between any two elements (x and y):

V Enabler x will alleviate enabler y;
A Enabler y will alleviate enabler x;
X Enablers x and y are related to each other;
O Enablers x and y are not related to each other.

The context of the above mentioned symbols in SSIM is explained using following examples:

i. Enabler 5 helps alleviate enabler 9. Information sharing (enabler 5) leads to increase in performance of SC (enabler 9). Thus, “V” denotes the relationship between enablers 5 and 9 in the SSIM.
ii. Enabler 12 helps alleviate enabler 1. SC contracts help in achieving channel coordination. Thus, “A” represents the relationship between enablers 12 and 1 in the SSIM.
iii. Enablers 6 and 7 help alleviate each other. The enabler 6, viz, joint decision-making and enabler 7, viz, joint promotions help alleviate each other. Thus, “X” denotes the relationship between enablers 6 and 7 in the SSIM.
iv. There is no relation between enabler 6 (joint decision-making) and enabler 9 (performance monitoring). Thus, “O” represents the relationship between these enablers in the SSIM.

The SSIM developed for all 12 enablers identified for implementation of SC coordination is presented in Table 13.2.

Table 13.2 Structural self-interaction matrix

	Enablers	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**
1	Channel Coordination	A	A	A	A	O	O	O	A	A	A	A
2	CRPF	X	O	V	O	A	O	O	V	X	X	
3	Implementation of IS	O	O	O	V	O	O	A	V	O		
4	Incentive Alignment	X	O	V	O	A	A	A	O			
5	Information Sharing	A	X	X	V	O	O	O				
6	Joint Decision-making	V	O	O	O	X	X					
7	Joint Promotions	V	O	O	O	X						
8	Joint Working	O	O	O	O							
9	Perf. Monitoring	A	O	O								
10	Resource Sharing	A	O									
11	Risk Sharing	A										
12	SC Contracts											

13.3.2 Reachability Matrix

Symbols in SSIM, viz, A, V, O, and X are substituted by 1 and 0 based on a set of rules (as shown in Table 13.3) to form a binary matrix called the initial reachability matrix.

Initial reachability matrix, derived in accordance to the rules, for SC coordination enablers is shown in Table 13.4.

Final reachability matrix is obtained after checking the initial reachability matrix for a property of set theory called transitivity (Table 13.5). The dependence power (DP) and the driving power (Dr.P) of each enabler are shown in Table 13.5. The dependence of an element P is the sum of all those elements that may help in achieving it. This includes the element itself. The driving power of an element P is defined as the sum of all those enablers (including itself) that may be achieved with the help of element P. Their role in MICMAC analysis is explained in Sect. 13.4.

Table 13.3 Rules for transformation of SSIM

Entry in SSIM	Entry in reachability matrix	
(*x*, *y*)	(*x*, *y*)	(*y*, *x*)
V	1	0
A	0	1
X	1	1
O	0	0

Table 13.4 Initial reachability matrix

	1	2	3	4	5	6	7	8	9	10	11	12
1	1	0	0	0	0	0	0	0	0	0	0	0
2	1	1	1	1	1	0	0	0	0	1	0	1
3	1	1	1	0	1	0	0	0	1	0	0	0
4	1	1	0	1	0	0	0	0	0	1	0	1
5	1	0	0	0	1	0	0	0	1	1	1	0
6	0	0	1	1	0	1	1	1	0	0	0	1
7	0	0	0	1	0	1	1	1	0	0	0	1
8	0	1	0	1	0	1	1	1	0	0	0	0
9	1	0	0	0	0	0	0	0	1	0	0	0
10	1	0	0	0	1	0	0	0	0	1	1	0
11	1	0	0	0	1	0	0	0	1	1	1	0
12	1	1	0	1	1	0	0	0	1	1	1	1

Table 13.5 Final reachability matrix

	1	2	3	4	5	6	7	8	9	10	11	12	Dr.P
1	1	0	0	0	0	0	0	0	0	0	0	0	*1*
2	1	1	1	1	1	0	0	0	1	1	1	1	*9*
3	1	1	1	1	1	0	0	0	1	1	1	1	*9*
4	1	1	1	1	1	0	0	0	1	1	1	1	*9*
5	1	0	0	0	1	0	0	0	1	1	1	0	*5*
6	1	1	1	1	1	1	1	1	1	1	1	1	*12*
7	1	1	1	1	1	1	1	1	1	1	1	1	*12*
8	1	1	1	1	1	1	1	1	1	1	1	1	*12*
9	1	0	0	0	0	0	0	0	1	0	0	0	*2*
10	1	0	0	0	1	0	0	0	1	1	1	0	*5*
11	1	0	0	0	1	0	0	0	1	1	1	0	*5*
12	1	1	1	1	1	0	0	0	1	1	1	1	*9*
DP	*12*	*7*	*7*	*7*	*10*	*3*	*3*	*3*	*11*	*10*	*10*	*7*	

13.3.3 Level Partitioning

From the final reachability matrix, two sets, viz, the antecedent and reachability set (Warfield 1974) for each enabler are deduced. Reachability set for an element constitutes of an element itself and other elements that may be reached with its help. It is obtained by examining the rows of the final reachability matrix. The antecedent set constitutes of those elements that help in reaching this element. It is obtained by analyzing the columns in the final reachability matrix. Finally, the intersection set consists of the elements that are common in both antecedent and reachability sets. In the ISM hierarchy, level 1 would consist of those element(s) with same intersection and reachability sets. These elements do not affect any other elements above their own level. These elements are discarded from further iteration process. Enabler 1 occupies level 1, as shown in Table 13.10. Hence, the top level of the ISM model consists of enabler 1. It can be seen that enabler 1 is removed for second iteration process (Table 13.11). This iteration process is carried out till the level of each element is found out. Tables 13.10, 13.11, 13.12, 13.13, 13.14 show the iteration processes (refer Appendix). The digraph and final ISM are constructed based on the identified elements along with their levels.

13.3.4 Conical Matrix

The elements in the same level are clubbed across the columns and the rows to develop conical matrix. The resultant matrix is shown in Table 13.6.

Table 13.6 Conical form

	1	9	5	10	11	2	3	4	12	6	7	8
1	1	0	0	0	0	0	0	0	0	0	0	0
9	1	1	0	0	0	0	0	0	0	0	0	0
5	1	1	1	1	1	0	0	0	0	0	0	0
10	1	1	1	1	1	0	0	0	0	0	0	0
11	1	1	1	1	1	0	0	0	0	0	0	0
2	1	1	1	1	1	1	1	1	1	0	0	0
3	1	1	1	1	1	1	1	1	1	0	0	0
4	1	1	1	1	1	1	1	1	1	0	0	0
12	1	1	1	1	1	1	1	1	1	0	0	0
6	1	1	1	1	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1	1	1	1

13.3.5 Construction of ISM-Based Model

A digraph is obtained from the conical model and final reachability matrix. An arrow pointing from y to x is drawn to show the relationship between the enablers y and x. The transitive links are removed at this stage and the model is checked for conceptual consistency. From digraph, the nodes are substituted with the statements to obtain a systemic and structural model. The ISM model for the enablers of implementation of SC coordination is shown in Fig. 13.1.

The factors, namely, joint promotion (enabler 7), joint decision-making (enabler 6), and joint working (enabler 8) play a major role in SC coordination, as shown in Fig. 13.1. These variables form the base of the ISM hierarchy. Channel coordination (enabler 1) is the dependent variable which helps SC coordination. This enabler has occupied the top most position in the hierarchical structure.

13.4 MICMAC Analysis

There are two ways to analyze the system elements: direct relationship analysis and indirect relationship analysis using MICMAC. In direct relationship analysis, the direct relationships among the variables in the final model of ISM are examined to obtain a direct relationship matrix M (Table 13.7). In this matrix, the diagonal elements are considered to be zero. The transitive relationships are ignored. The driving power is calculated by sum of the interactions along the row. In the similar way, the dependence power is calculated by adding the interactions along the column. Ranks of the driving power and the dependence power are estimated. The direct relationship matrix signifies the maximum direct impact, but it is unable to

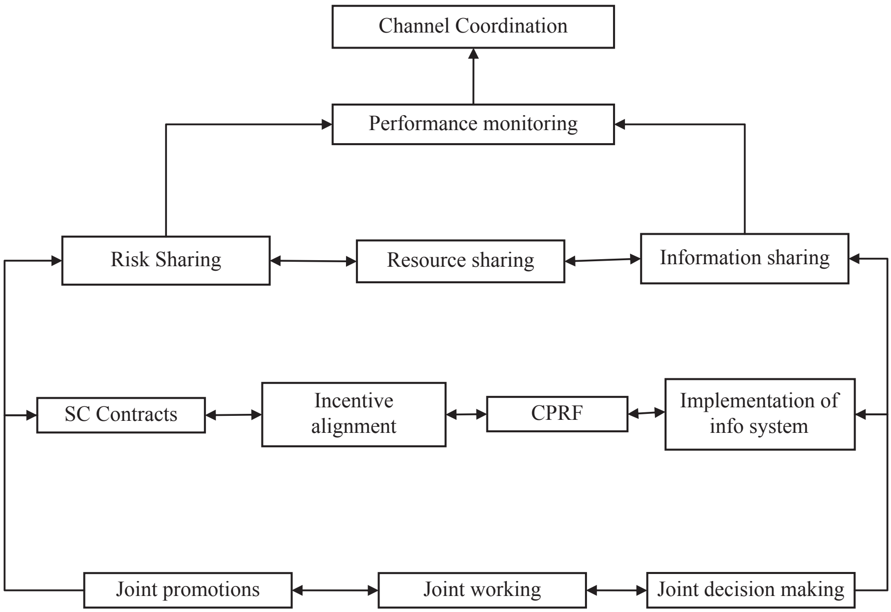

Fig. 13.1 ISM model for enablers of SC coordination

Table 13.7 Direct relationship matrix (M)

	1	2	3	4	5	6	7	8	9	10	11	12	Dr.P	Rank
1	0	0	0	0	0	0	0	0	0	0	0	0	0	3
2	0	0	1	1	0	0	0	0	0	0	0	0	2	1
3	0	1	0	0	1	0	0	0	0	0	0	0	2	1
4	0	1	0	0	0	0	0	0	0	0	0	1	2	1
5	0	0	0	0	0	0	0	0	1	1	0	0	2	1
6	0	0	1	0	0	0	0	1	0	0	0	0	2	1
7	0	0	0	0	0	0	0	1	0	0	0	1	2	1
8	0	0	0	0	0	1	1	0	0	0	0	0	2	1
9	1	0	0	0	0	0	0	0	0	0	0	0	1	2
10	0	0	0	0	1	0	0	0	0	0	1	0	2	1
11	0	0	0	0	0	0	0	0	1	1	0	0	2	1
12	0	0	0	1	0	0	0	0	0	0	1	0	2	1
DP	1	2	2	2	2	1	1	2	2	2	2	2		
Rank	2	1	1	1	1	2	2	1	1	1	1	1		

Table 13.8 Matrix stabilization using MICMAC

Factors	M^2		M^4		M^6		M^8	
	Dr.P.R[a]	DPR[a]	Dr.P.R	DPR	Dr.P.R	DPR	Dr.P.R	DPR
1	3	3	6	4	7	4	7	4
2	1	1	2	2	3	3	3	3
3	1	2	3	3	4	5	4	5
4	1	1	2	2	3	3	3	3
5	2	1	5	1	6	2	6	2
6	1	3	2	5	2	6	2	6
7	1	3	2	5	2	6	2	6
8	1	3	1	5	1	6	1	6
9	3	1	6	1	7	1	7	1
10	1	1	4	1	5	1	5	1
11	2	1	5	1	6	2	6	2
12	1	2	3	3	4	5	4	5

[a] *Dr.P.R* driving power rank, *DPR* dependence power rank

identify the hidden impact of the elements. Hence, the importance of the variables is analyzed by its indirect relationship using MICMAC. The dependence power and the driving power of the system elements can be analyzed using MICMAC analysis (Mandal and Deshmukh 1994).

MICMAC analysis works on the principle of matrix multiplication. If an element *x* affects an element *y* and element *y* affects third element *z*, then any change in element *x* would influence element *z*. Now, elements *x* and *z* are known to have indirect connections. Direct relationship approach provides no information related to numerous indirect relations that exist in the system. When the matrix is squared, then the second order relationship is obtained. In the similar manner, the matrix is multiplied *n* times to obtain the interconnecting elements. The process is continued till the hierarchy of driving power and dependence reaches a stable stage. This completes the process of MICMAC analysis.

Direct matrix, M is taken as the input for MICMAC analysis. Multiply the matrix *n* times till the ranks of dependence and driving power stabilized. The power by which the matrices is raised indicates the length of the circuit (Saxena et al. 2006). It is seen in Table 13.8 that the hierarchy of both the dependence and the driving power is stabilized at both M^6 and M^8. But the matrix gets stabilized at M^6 and the sequence of the ranks gets repeated at M^8. Thus, in this case, 6 represents the length of the circuit. In Table 13.9, the e_{21} (third row and second column) represents a path length of 4 influencing the enablers 2 and 1. Similar to the direct relationship matrix, the dependence power and the driving power are calculated by taking the sum of entries along the columns and rows, respectively. The elements are categorized based on MICMAC analysis (Fig. 13.2) into four different categories: dependent, independent, autonomous, and linkage variables.

Table 13.9 Indirect relationship matrix (M^6)

	1	2	3	4	5	6	7	8	9	10	11	12	Dr.P	Rank
1	0	0	0	0	0	0	0	0	0	0	0	0	0	7
2	4	13	0	0	9	0	0	0	5	5	4	8	48	3
3	1	0	5	8	1	0	0	0	8	8	4	0	35	4
4	4	0	8	13	4	0	0	0	5	5	9	0	48	3
5	4	0	0	0	4	0	0	0	0	0	4	0	12	6
6	5	9	1	4	10	4	4	0	1	1	8	4	51	2
7	5	4	4	9	8	4	4	0	1	1	10	1	51	2
8	0	5	8	5	1	0	0	8	10	10	1	8	56	1
9	0	0	0	0	0	0	0	0	0	0	0	0	0	7
10	0	0	0	0	0	0	0	0	8	8	0	0	16	5
11	4	0	0	0	4	0	0	0	0	0	4	0	12	6
12	1	8	0	0	4	0	0	0	8	8	1	5	35	4
DP	28	39	26	39	45	8	8	8	46	46	45	26		
Rank	4	3	5	3	2	6	6	6	1	1	2	5		

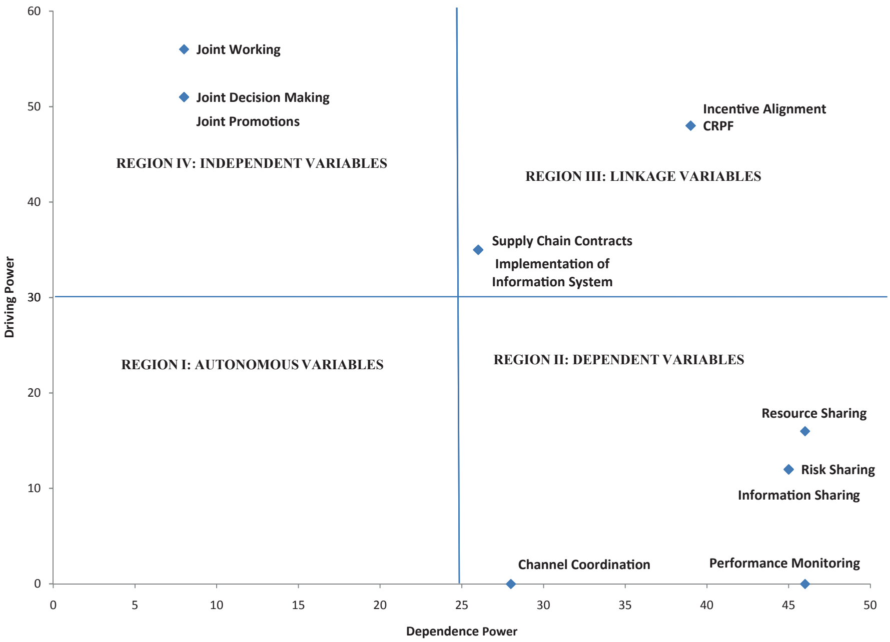

Fig. 13.2 MICMAC analysis of the SC coordination enablers

13.5 Managerial Implications

In this chapter, a hierarchy of elements which would lead to better SC coordination is developed using ISM. Analyzing these variables is important because it is the SC that is competing and not the individual organizations competing anymore; hence, coordination among these members is important. SC can be well coordinated if all the SC members work and make decisions together and also encourage joint promotions. This would improve SC performance since it would encourage all SC members to share their information.

Various enablers of SC coordination are classified with the help of MICMAC analysis. The autonomous cluster (Region I in Fig. 13.2) does not contain any variables, which indicates that all the variables are well connected in the whole system and the management has to focus on all the enablers influencing the SC coordination.

Next cluster (Region IV in Fig. 13.2) consists of independent variables like joint promotion, joint working, and joint decision-making, which have low dependence and high driving power. These enablers play an important role to coordinate all the SC members. Joint decision-making encourages them to share information and which further reduces the need for forecasting at different levels and finally help mitigate the consequences of the bullwhip effect. Joint making, joint promotions, and joint working are all dependent on each other. These variables help in dealing with the operational issues in the SC. These factors should be considered by the management for immediate action, which would influence the factors above their own level.

The next cluster (Region III in Fig. 13.2) consists of linkage variables, which include factors like implementation of ISs, CPFR, incentive alignment, and SC contract. Lower level variables affect linkage variables, which in turn, affect other elements in the system. Any disturbances in this cluster would affect the whole SC since it acts as a connecting link between other variables in the system.

Implementation of the IS is possible if the SC members work jointly and take decisions together. This implementation encourages SC members to have incentive mechanisms amongst themselves, which in turn, helps the organizations to improve the forecast accuracy in the SC. Joint working promotes the usage of supply contracts among various members in the SC. These factors can be also of tactical focus to the management.

The last cluster (Region II in Fig. 13.2) includes variables like information sharing, resource sharing, risk sharing, performance monitoring, and channel coordination. Channel coordination forms the top variable in the hierarchy. This element in the top represents that it is resultant of other actions of SC coordination. Resource sharing, risk sharing, information sharing, and performance monitoring have high dependence and these variables also tend to drive the topmost variable. The strong dependence of the elements indicates that all other enablers should be taken care to enable better coordination. The elements at the top level are also important since they are finally needed by the SC to coordinate its members to increase the profitability of the SC. These factors can be considered as the strategic issues. They are not of immediate concern to the management since any action at the lower level variable would influence these variables.

13.6 Conclusion

Only 12 variables have been considered for understanding the relationship among the enablers of SC coordination. Few more variables can be considered. Since the relationships among the variables are obtained using expert opinion, they may be subject to bias. As a part of future work, structural equation modeling (SEM) can be used to validate the proposed model.

Appendix

Table 13.10 Iteration 1

Barrier	Reachability set	Antecedent set	Intersection set	Level
1	{1}	{1,2,3,4,5,6,7,8,9,10,11,12}	{1}	I
2	{1,2,3,4,5,9,10,11,12}	{2,3,4,6,7,8,12}	{2,3,4,12}	
3	{1,2,3,4,5,9,10,11,12}	{2,3,4,6,7,8,12}	{2,3,4,12}	
4	{1,2,3,4,5,9,10,11,12}	{2,3,4,6,7,8,12}	{2,3,4,12}	
5	{1,5,9,10,11}	{2,3,4,5,6,7,8,10,11,12}	{5,10,11}	
6	{1,2,3,4,5,6,7,8,9,10,11,12}	{6,7,8}	{6,7,8}	
7	{1,2,3,4,5,6,7,8,9,10,11,12}	{6,7,8}	{6,7,8}	
8	{1,2,3,4,5,6,7,8,9,10,11,12}	{6,7,8}	{6,7,8}	
9	{1,9}	{2,3,4,5,6,7,8,9,10,11,12}	{9}	
10	{1,5,9,10,11}	{2,3,4,5,6,7,8,10,11,12}	{5,10,11}	
11	{1,5,9,10,11}	{2,3,4,5,6,7,8,10,11,12}	{5,10,11}	
12	{1,2,3,4,5,9,10,11,12}	{2,3,4,6,7,8,12}	{2,3,4,12}	

Table 13.11 Iteration 2

Barrier	Reachability set	Antecedent set	Intersection set	Level
2	{2,3,4,5,9,10,11,12}	{2,3,4,6,7,8,12}	{2,3,4,12}	
3	{2,3,4,5,9,10,11,12}	{2,3,4,6,7,8,12}	{2,3,4,12}	
4	{2,3,4,5,9,10,11,12}	{2,3,4,6,7,8,12}	{2,3,4,12}	
5	{5,9,10,11}	{2,3,4,5,6,7,8,10,11,12}	{5,10,11}	
6	{2,3,4,5,6,7,8,9,10,11,12}	{6,7,8}	{6,7,8}	
7	{2,3,4,5,6,7,8,9,10,11,12}	{6,7,8}	{6,7,8}	
8	{2,3,4,5,6,7,8,9,10,11,12}	{6,7,8}	{6,7,8}	
9	{9}	{2,3,4,5,6,7,8,9,10,11,12}	{9}	II
10	{5,9,10,11}	{2,3,4,5,6,7,8,10,11,12}	{5,10,11}	
11	{5,9,10,11}	{2,3,4,5,6,7,8,10,11,12}	{5,10,11}	
12	{2,3,4,5,9,10,11,12}	{2,3,4,6,7,8,12}	{2,3,4,12}	

Table 13.12 Iteration 3

Barrier	Reachability set	Antecedent set	Intersection set	Level
2	{2,3,4,5,10,11,12}	{2,3,4,6,7,8,12}	{2,3,4,12}	
3	{2,3,4,5,10,11,12}	{2,3,4,6,7,8,12}	{2,3,4,12}	
4	{2,3,4,5,10,11,12}	{2,3,4,6,7,8,12}	{2,3,4,12}	
5	{5,10,11}	{2,3,4,5,6,7,8,10,11,12}	{5,10,11}	III
6	{2,3,4,5,6,7,8,10,11,12}	{6,7,8}	{6,7,8}	
7	{2,3,4,5,6,7,8,10,11,12}	{6,7,8}	{6,7,8}	
8	{2,3,4,5,6,7,8,10,11,12}	{6,7,8}	{6,7,8}	
10	{5,10,11}	{2,3,4,5,6,7,8,10,11,12}	{5,10,11}	III
11	{5,10,11}	{2,3,4,5,6,7,8,10,11,12}	{5,10,11}	III
12	{2,3,4,5,10,11,12}	{2,3,4,6,7,8,12}	{2,3,4,12}	

Table 13.13 Iteration 4

Barrier	Reachability set	Antecedent set	Intersection set	Level
2	{2,3,4,12}	{2,3,4,6,7,8,12}	{2,3,4,12}	IV
3	{2,3,4,12}	{2,3,4,6,7,8,12}	{2,3,4,12}	IV
4	{2,3,4,12}	{2,3,4,6,7,8,12}	{2,3,4,12}	IV
6	{2,3,4,6,7,8,12}	{6,7,8}	{6,7,8}	
7	{2,3,4,6,7,8,12}	{6,7,8}	{6,7,8}	
8	{2,3,4,6,7,8,12}	{6,7,8}	{6,7,8}	
12	{2,3,4,12}	{2,3,4,6,7,8,12}	{2,3,4,12}	IV

Table 13.14 Iteration 5

Barrier	Reachability set	Antecedent set	Intersection set	Level
6	{6,7,8}	{6,7,8}	{6,7,8}	V
7	{6,7,8}	{6,7,8}	{6,7,8}	V
8	{6,7,8}	{6,7,8}	{6,7,8}	V

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Chapter 14
Flexibility in Transportation Management Strategy for Improved Efficiency: An Indian Soft Drink Industry Perspective

Kamal Karnatak and P. R. S. Sarma

14.1 Introduction

Logistic management, in any organization, helps in achieving desired level of service efficiency and quality at minimum cost. It requires planning and coordination of lot of activities. Logistic is not limited to one function but its scope spans the whole organization. Logistic helps in linking supply base to market place (Martin 2011).

Logistics plays a very important role in today's cost sensitive organizations. If we take the case of soft drink industry, especially in India, transportation of goods across various distributors plays a very important role. The logistic strategy formulation requires proper planning of logistic, its implementation, and controlling of the same. In the overall logistic planning the key area is transportation as it needs to be highly efficient with minimal cost. To make transportation efficient, optimized route determination plays a major role and with the help of technology it can facilitate better decision-making (Fang et al. 2011). The main challenge of soft drink industry is to find the optimized route for the vehicles to deliver the material to retailers. Technology can help in optimizing the routes but it requires change in the transportation strategy keeping the existing retailers, vehicles, and people in place.

With an average growth rate of 9.8% in 2007–2008, and 6.9% during 2011–2012: the years of the worst global financial crisis, India has been one of the best performers in the world economy. The growth that the country has experienced demonstrates the strength of the economy and India's growing importance in the

K. Karnatak (✉)
RJ Corp, New Delhi, India
e-mail: kkarnatak@gmail.com

P. R. S. Sarma
Indian Institute of Management Raipur, Raipur, India
e-mail: dr.pappu.sarma@gmail.com

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world economy. But declining growth rate has created pressure on margins for the companies. Companies are taking projects of reducing cost to improve margins.

14.2 Review of Literature

14.2.1 Flexible Management Systems and Flowing Stream Strategy (FSS)

Flexibility has many meanings depending upon the situation. Sushil (2000) mentions adaptiveness to the changes in the environment, adjustment to situation, amiability in relationships, etc. In an organization there are multiple types of flexibilities like organizational flexibility, strategic flexibility, supply chain flexibility, operational flexibility, information system flexibility, manufacturing flexibility, etc. Sushil further elaborates that "flexibility is the exercise of free will or freedom of choice on the continuum to synthesize the dynamic interplay of thesis and antithesis in an interactive manner, capturing the ambiguity in systems and expanding the continuum with minimum time and efforts." If flexibility is seen from systematic point of view then it has major attributes viz., spectrum, integration, interaction, innovation, and fuzziness (Saxena et al. 2006).

Flexibility is one of the most talked subjects in today's world in the context of an organization. In this section we would review the flexibility concept and would lead to FSS as suggested by Sushil (Sushil 2012a, b). Flexibility is also defined as "the ability to change or react with little penalty in time, effort, cost, and performance" Upton (1994). Bahrami (1992) defines flexibility as "a multidimensional concept demanding agility and versatility, associated with change, innovation, and novelty, coupled with robustness and resilience, implying stability, sustainable advantage, and capabilities that may evolve over time."

All these definitions suggest that flexibility is something which is desired in positive context. Sushil (2000) mentions that flexibility is multidimensional in nature and he uses concept of paradoxes to elaborate his point. He mentions that organization deals with the dilemma of thesis and antithesis in various contexts like continuity–change, centralization–decentralization, and stability–dynamism and so on. If organization moves from one polar opposite to other it does not bring in flexibility, on the contrary system may lose its identity. So in an organization both opposites exist at the same time and they change their degree over time as per the requirement.

In July 2011, a survey was conducted by PRTM (PRTM is a management consulting subsidiary of PwC.) and results suggest that those organizations who have implemented five supply chain flexibility levers could reduce its supply chain costs by 8–10 % and achieved a 12–15 % revenue increase (Reinhard et al. 2011).

Change in any organization is a necessity but it could be channelized only if there is a continuity. Sushil (2005) has used a metaphor of flowing stream to define the continuity and changes simultaneously. A flowing stream has continuity because it is a stream but at the same time it keeps on changing its flow depending upon the changes in the routes. Similarly, managing continuity and change forces simultaneously is the concept of FSS.

14.2.2 Soft and Aerated Drinks Industry in India (Ministry of Food Processing Industry 2012)

Indian soft drink market in carbonated category is worth Rs 60 billion and growing now at 5% annually. The two main companies who have more than 95% of this market are Pepsi and Coke. The aerated beverages sector is an important sector in India as many allied industries like sugar, refrigeration, glass, paper, and transport are getting benefited because of this. This segment is catering to all age-brackets and income groups. This industry exports goods worth more than Rs. 2 billon and contributes over Rs. 12 billion through tax and other contributions.

In India, because of very low per capita consumption of soft drinks, there are huge possibilities of growth. In China this sector is growing by 16% annually and Russian market is growing by 24% and similar numbers are estimated by industry in India.

The industry estimates that the beverage market should grow at twice the rate of GDP growth. The Indian market should have, therefore, grown by at least 12%. However, it has been growing at a rate of about 6%. In contrast, the Chinese market grew by 16% a year, while the Russian market expanded at almost four times the growth rate of the Indian market.

In India two main companies PepsiCo and Coca-Cola are of US origin. Coca-Cola operates through 35 plants and 16 franchisees throughout the country, while PepsiCo has 20 plants and many franchisees and currently PepsiCo is consolidating its franchisees. M/s Varun Beverages Limited (VBL), a group company of RJ Corp, is the biggest franchisee of PepsiCo in India serving nearly 50% of territories through its own manufacturing plants and distribution network. PepsiCo entered India in 1989 and has grown to become one of the country's leading food and beverage companies.

14.3 Supply Chains in Food and Beverages Industry

Beverage industry is quite unpredictable in nature as there is huge supply variation due to various factors like weather conditions, agricultural production, customer demands, and other seasonal factors like festive seasons which result in fluctuating demand and unpredictability. In order to meet this challenge vertical alliances are often preferred (Iijima et al. 1996).

Food and beverages market has always faced a challenge of price reduction; however, with the entry of multinationals, who have more purchasing power, the market condition has improved (Vlachos 2002). Indian scenario is similar to this where multinational manufacturers and corporate retailers focus on streamlining the supply chain and thereby help to reduce delays, leakages, and wastage in the supply chain. These benefits are sometime passed on to the farmers in terms of higher prices for their produce/products and to consumers in terms of lower prices that they pay.

14.4 Methodology and Problem Formulation

Logistics problems are often complex real-world problems and are not very structured. To understand those problems and provide a realistic solution, a multidisciplinary and cross-function approach is often used. Since problems are complex, real-life case studies are often used to find solution (Näslund 2002). Seuring (2008) also highlights, in his research study, the importance of case study-based research for supply chain researchers.

14.5 Case Study

VBL is a franchise of Pepsico for the past 20 years. It handles approximately 55 % volume of Pepsico in India, Africa, Nepal, and Sri Lanka. The company handles over 400 stock keeping units (SKUs) spread over 15 different brands and 19 different pack sizes. Being a bottling plant, it is subjected to uncertainties of demand forecasting caused by brand promotion activities, limited time offers, product launches, location-wise material requirements planning (MRP) variance, etc. The distribution chain starts at their bottling plants; it covers depots/warehouses, distributors, and ends with customers which are the shops or outlets from where consumers pick up the products for their consumption. They have two different types of fleet that handle this distribution—primary vehicles (around 200 in number) which distribute from the bottling plants to the depots and secondary vehicles (around 1000 in number) which distribute from the depots to the distributors/customers.

The supply chain function of the company was created in 2009, prior to which it was handled by the commercial department. While SAP (An ERP Software) had been introduced in the organization in 2008, it was around 2010 that the system was fully integrated and the supply chain management (SCM) function started to provide full benefits of the IT investment.

VBL has a large secondary fleet which incurs a huge operation cost that affects the company's margins. In addition, secondary transportation is handled by the sales team. While the route allocation is done by them, the cost of distribution gets allocated to the SCM function (cost details are available in Appendix A).

VBL was looking for sound transportation strategy so that they can reduce the cost of operations and do a strategic transport planning. They were facing multiple challenges in terms of existing infrastructure and technology.

Globalization has brought in enough complexity in today's business. Now world class technologies are available to all the organizations. As a result, the supply chain has become a crucial area for the cost reduction and margin improvement. It is imperative that the net margin of the product also depends on the transport cost but at the same time customers demand better service delivery and improved performance in terms of SKU availability. The complexity and chaos has led to emergence of unavoidable paradoxes that a business house needs to balance. The successful companies in today's world strive to excel by balancing the paradoxes by implementing flexible systems.

In order to create a sound transport strategy that helps in designing dynamic routing for optimization of secondary transportation, we thought of using *FSS tools and methods*. This is an attempt to implement a strategic change in transport department of a company keeping continuity of various resources. We intend to use FSS for implementing the strategic change (Sushil 2013; Khare 2015).

Following steps of FSS are used in this project.

I. Identification of continuity forces.
II. Identification of change forces.
III. Analysis of continuity forces in terms of their vitality, desirability, and burden.
IV. Analysis of change forces in terms of their impact.
V. Strategic direction diagram for the current scenario.
VI. Strategy formulation matrix of the current scenario.
VII. Identification of correct strategy.
VIII. Analyzing the results and future plans.

14.5.1 Creating Transport Strategy

I. Identification of Continuity Forces

VBL has a large secondary vehicle fleet. Current transport operation is a huge cost and is affecting VBL's margins. Secondary transport is currently controlled by sales team. Secondary vehicles load allocation and routing is planned by sales. Territory allocation is not based on any scientific data. Invisibility of asset utilization is also a problem. Route allocation is also not based on any infrastructure data.

After discussion with supply chain managers, the following continuity forces are identified:

- Infrastructure (existing trucks, lorries, Tata Ace, tempo, etc.)
- Technology (software for tracking, monitoring)
- Manpower (existing manpower specially drivers)
- Distribution network
- Customer base (retailers)
- Performance (delivery time, delivery schedule, SKU availability)
- Current packaging (cartons, shrink wraps, shells)
- Current product mix (pet, glass bottle)

II. Identification of Change Forces

- Competition (less price, better delivery time, better SKU availability)
- Customer needs (better price/retailer margin, better schemes, better service)
- Productivity (improve productivity)
- New technology (GPS tracking, software availability)
- Environment concerns
- Cost of operation
- Road infrastructure (flyovers, new roads)

III. Analysis of Continuity Forces in terms of their Vitality, Desirability, and Burden

The "vital, desirable, and burden (VDB) analysis" is carried out and is as shown in Table 14.1.

IV. Analysis of Change Forces in Terms of their Impact

The "impact analysis" is carried out and is as shown in Table 14.2.

V. Strategic Direction Diagram for the Current Scenarios

Strategic direction diagram: the strategy landscape can be summarized on the strategic direction diagram, which in a simple manner puts continuity and change of factors at one place. It gives continuity in terms of factors to be maintained and brings out change in terms of reduce or rise from the current reality (Fig. 4.1).

Table 14.1 VDB analysis

Category	Continuity force
Vital	Distribution network, customer base, performance
Desirable	Manpower, infrastructure
Burden	Technology, infrastructure

Table 14.2 Impact analysis

Category	Change force
High impact	Cost of operation, productivity, customer needs
Medium impact	Competition
Low impact	Environmental concerns

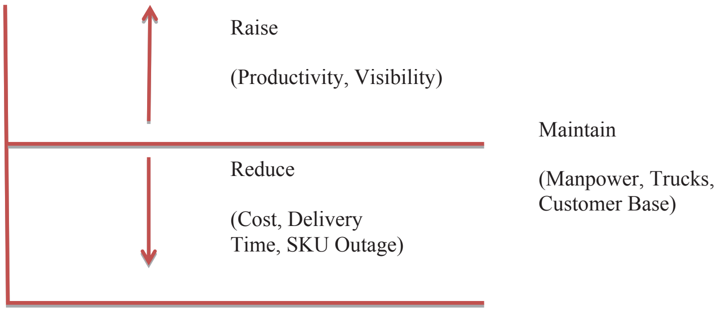


Fig. 14.1 Strategic direction diagram for secondary transport

VI. Strategy Formulation Matrix of the Current Scenario

Strategy formulation matrix is used for ideation of transport strategy. This matrix relates relevant combinations of continuity and change forces to generate strategies and is shown in Table 14.3.

Table 14.3 Strategy formulation matrix for secondary transport

	Change forces					
Continuity forces	Competition	Customer needs	New technology	Environment concerns	Productivity	Road infrastructure
Infrastructure			Use GPS for tracking			
Technology			Use software for analyzing			
Culture		Train manpower				
Distribution network						
Customer base						Use latest road maps
Performance			Dynamic routing			
Current packaging					Use bigger packages like palate	
Current product mix						

VII. Identification of Correct Strategy

It was decided that we should use new technology, GPS, for tracking of vehicle movement in a territory. We should map that movement in the latest infrastructure map (road map). We should analyze that data and optimize the route movement.

Main Objectives of Strategy

- Strategic territory planning.
- Optimizing daily routing of vehicles, thus reducing the number of vehicles in each territory.
- Enhancing visibility by tracking of all vehicles by using vehicle telematics (GPS).
- Creating an analytics dashboard.

Benefit of Strategy

The project would have the following benefits: reduce costs by reducing:

- Mileage
- Overtime
- Fuel usage
- Maintenance cost

Improve productivity by:

- Balancing capacities and workloads
- Improving resource utilization
- Optimizing the assignment of sales, service, and delivery sequence
- Optimizing sales, service and delivery routes
- Arrange same route pick-ups and deliveries

Improve customer service by:

- Increasing visibility
- Reduce resolution time
- Better planning for growth, holidays, and seasonal swings
- Taking last minute orders

Pilot Project for Implementing the One Part of the Strategy

As the initial pilot was done between 15th March and 15th April 2013, we have selected a part of Ghaziabad as the territory (territory related information available in Appendix B). We created a team of sales persons and supply chain persons. The team obtained infrastructure data from MapmyIndia, did an analysis of the sales volume for the purpose of allocating resources based on the sales volume. They redefined the sales territory, redrew the routes, and installed the monitoring system on ten vehicles. They also created a dashboard to monitor and capture cost.

Impact of the Application

As part of the pilot, the team generated various reports, such as:

- Vehicle utilization report
- Mileage report
- Geo fence trip report
- Halt report
- Idle report
- First exit report through SMS

The team found significant reduction in important parameters like mileage, fuel consumption, and maintenance cost for that territory (Appendix C).

14.6 Conclusion

In terms of the overall transportation cost, the average monthly cost of INR 2.22 lakhs in FY 2011–2012 (April to March) came down to INR 2.05 lakhs between April to September in FY 2012–2013 (details in Appendix D). The team attributed 60 % of this savings to the program with a confidence level of 90 %. While for a single sub-territory, the amount may not be great, the project has been very well received. The projected savings to the company, once this, is implemented across all territories (with a conservative assumption of 5 % reduction of vehicles) is INR 3 Crores after accounting for the GPS hardware and operation costs (calculations are given in Appendix E).

With regard to intangible outcomes, the team has benefited tremendously. Change management was a big issue here but project team was able to overcome the initial reluctance of the sales team, and got them enthused as well, once they understood and accepted the advantages. Some of the barriers the team faced, such as change management, peak season sales, nontransparency of data, support from vendors, were challenging. The results are in compliance to the research problem and suggested that the flexibility in articulating a suitable strategy for transportation management impacts the overall efficiency of the transportation system.

The present study even though has made significant contributions for practitioners, academics, and logistics managers; nevertheless, there are a few limitations such as:

- Study considered a limited number of issues associated with flexibility in transportation management as part of logistics and supply chain of Indian soft drink industry.
- The critical issues associated with the research question, in select firm under study, were derived from brainstorming sessions with senior managers in select firm and as such may have been subject to usual limitations of such surveys.
- For empirical study, only one firm has been selected hence the findings may not be applicable for the entire industry.
- Apart from above limitations, limitations in the research methodology employed in this study are also to be mentioned—methodological limitation is regarding the way some of the variables were constructed. Therefore, it is possible that the results may reflect biased views of sales mangers force/managers of the sample banks. However, due attempt was made to rectify this by using other sources of information.

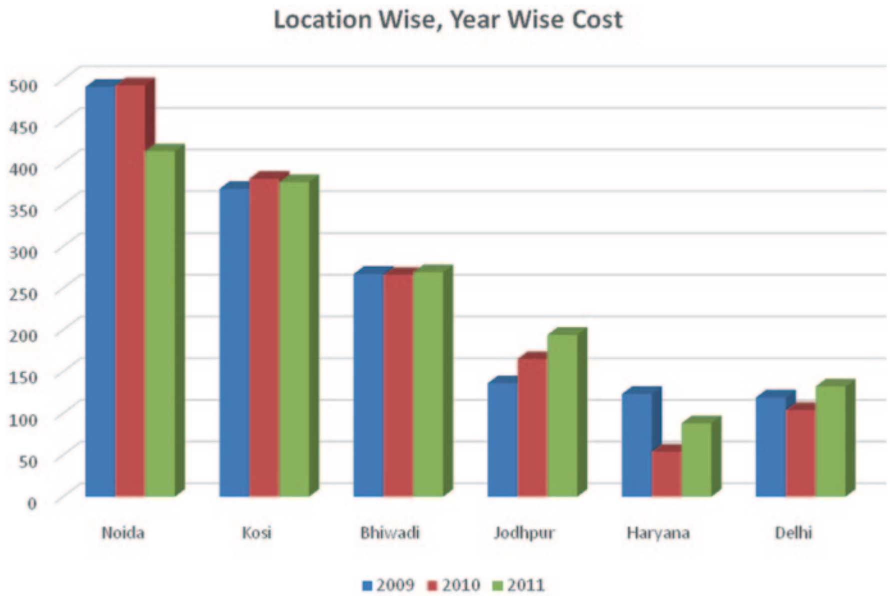
The following suggestions emerged for future research in this area:

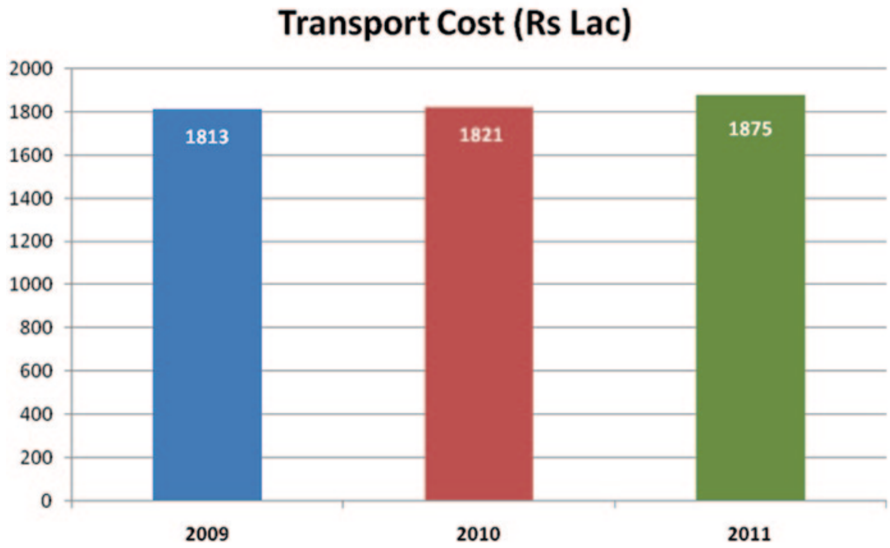
- Future research attempting a comparison between two or more firms in the Indian soft drink industry for their improved "flexibility in transportation management strategy for improved efficiency."
- A cross-sectoral study for a comparative study of logistics firms.
- The findings generated by this study can be further extended by bringing more verticals of logistics.

Appendix A—Transportation Cost

Total Transportation Cost—Location wise, Year wise

Territory	2009	2010	2011
Noida	307	358	401
Kosi	491	493	414
Bhiwadi	369	381	377
Jodhpur	267	266	269
Haryana	136	165	194
Delhi	123	54	88
Goa	119	104	132
Total	1813	1821	1875


Location Wise, Year Wise Cost
500
450
400
350
300
250
200
150
100
50
0
Noida
Kosi
Bhiwadi
Jodhpur
Haryana
Delhi
2009
2010
2011


Transport Cost (Rs Lac)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1813
1821
1875
2009
2010
2011

Appendix B—Territory Information for Ghaziabad

Territory	WUP
C&F	Ghaziabad
Number of CE	2
Number of sales man	34
Number of route	28
Number of vehicles	32
Number of outlet	1760
Average sale per day	3500 cases
No of routes	28
Average sale of depot	3500 per day
Total outlet of depot	1760
Average outlet	63 per route
Average outlet covered	50 per vehicle
Average sale per day/per outlet	02
GPS installed on	10 vehicles

Appendix C—Consumption Pattern

	April 12	May 12	June 12	July 12	Aug 12	Sep 12
Mileage (km)	12,876	12,044	11,870	11,450	11,388	11,270
Fuel (litres)	2476	2316	2283	2202	2190	2167
Maintenance (INR)	20,000	22,000	21,000	18,500	19,000	20,000

Appendix D—Transportation Cost

Figures are in lakhs INR

	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Cost in 2011–2012	2.20	2.21	2.22	2.23	2.22	2.19	2.21	2.21	2.19	2.19	2.22	2.33
Cost in 2012–2013	2.14	2.07	2.04	2.01	2.00	2.06	2.23	2.30	2.09	2.20	2.30	2.45

Appendix E—Estimates of Annual Savings

OPEX (Operational Expenditure) saving (monthly)

- One vehicle out of ten reduce after merging the route and design the routing network of secondary vehicles.
- Operation cost (fuel saving) = Rs. 9500
- Maintenance cost = Rs. 6000
- Driver/helper salary = Rs. 11,000
- Statutory documents = Rs. 2300
- Less GPS hardware cost = Rs. 130
- Less GPS operation cost = Rs. 350
- *OPEX saving = Rs. 28,320*
- *OPEX saving of 1 year = Rs. 339,840*

Capex (Capital Expenditure) Saving

Cost of one vehicle	Rs. 400,000
Net saving of one vehicle	Rs. 739,840

Approx saving of 41 vehicles (if 5% vehicles are reduced) after implementing the project = Rs. 30,333,440

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Part IV
Flexibility in Technology and Innovation Management

Chapter 15
Research and Development (R&D) Continuity of Biotech Start-ups in Financial Crisis

Takao Fujiwara

15.1 Introduction

As a research background, the continuity of research and development (R&D) for biotech drug-discovery start-ups has likely become difficult since the 2008 Lehman Shock, because they are facing "long time to build" until the final product or a proof of concept is completed. Under such a condition, a research question is, "how is it possible to plan the continuity of applied R&D projects under a mismatch between recent reluctant attitudes of capital market or venture capital (VC) based on short-term fluctuation and long-term basic research progress as an antibody preparation, regenerative medicine, and personalized medicine?"

As per the keywords, first, a start-up is defined as a portfolio of real options by regarding the entrepreneur's ideas as the investment opportunities (Smith and Smith 2004). Second, as the methodology used here, real-options analysis is an investment method to utilize the asymmetrical payoff idea as downside risk hedging and upside opportunity seeking (Dixit and Pindyck 1994).

The representative previous studies on real options, based on background studies on financial options (Black and Scholes 1973; Merton 1973; Cox et al. 1979), include concept creation and sophistication (Myers 1977; Kester 1984; Trigeorgis and Mason 1987; Kulatilaka and Marcus 1992), fundamental studies of real-options models (Margrabe 1978; Geske 1979; Roberts and Weitzman 1981; McDonald and Siegel 1986; Majd and Pindyck 1987; Carr 1988; Dixit and Pindyck 1994; Trigeorgis 1996), and practical guidelines (Copeland and Antikarov 2001). Real-options analysis attempts to apply financial engineering or financial option's knowledge to real assets in order to analyze the value of flexible decisions of the irreversible investment under risk conditions.

As author's earlier studies, the effectiveness of real options was proved by overcoming the deficit valley to some extent (Fujiwara 2008a), and option–games

T. Fujiwara (✉)
Institute of Liberal Arts and Sciences, Toyohashi University of Technology, 1-1 Hibarigaoka, Tenpaku, Toyohashi, Aichi 441-8580, Japan
e-mail: fujiwara@las.tut.ac.jp

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approach, which was integrated between real options and game theory, was also applied to demonstrate the optimization of a trade-off between the flexibility value of real options and the commitment value of game theory (Fujiwara 2008b). For the explanation about the large difference in numbers of the US biotech start-ups and those of Japan, timing option was applied based on the concept of eternal American call option with dividend (Fujiwara 2011).

As a research framework and methodology, the Dixit model on switching model for business entry and exit is used here to evaluate the value of the present sustenance-oriented inertial decision making (Dixit 1989). This model especially holds the image of hysteresis as the deferment of decision making on investment as sunk cost under uncertainty.

A research objective is to figure out a clear relationship between the survival of biotech start-ups and the deferment function of decision making of real options.

The organization of this chapter is consisted of analysis of present investment conditions for biotech start-ups to continue R&D, the basic theory on decision deferment function of real options, and a sequential compound switching option based on an assumed case of drug development, where it is made clear the flexibility value of the selection from a independent development as benchmark or a strategic partnership, according to the unfolded future conditions. Furthermore, based on the same assumed data, decision support with indices is tried by the selection mapping of risk or potential in market and technology, and the 3-D figures of sensitivity analysis on net present value (NPV) with each risk and with market volatility.

15.2 Present Condition Analysis

15.2.1 Initial Public Offering (IPO) Condition for Japan's Biotech Start-Up

Compared with the USA, Japan's incubation supporting system for biotech start-ups has been not so complete. Samurai Biotech Association was established for industrial proposal to be governed by 20 companies including main biotech start-ups and VC in July 2009 (Pharma Japan Web 2013), in addition to the existing Japan Bioindustry Association. There were 36 listed biotech companies till September 2013. During 2013 (until September), MEDRx was listed on the Mothers (the Initial Public Offering (IPO) emerging market in the Tokyo Stock Exchange) in February, PeptiDream was on the Mothers in June, and ReproCELL was on the JASDAQ-Growth (another emerging market in the Tokyo Stock Exchange, different from JASDAQ-Standard) in June.

While after the Lehman Shock, IPO market condition for biotech start-ups has been recovering from the stagnation; a few listed biotech start-ups such as Takara Bio and OncoTherapy Science are recently facing a financial adversity as they shift from positive to negative profits. Another listed biotech start-up, R-Tech Ueno, is exceptionally maintaining the positive profits; however, their business is not drug discovery but contracted manufacturing.

Thus, compared with the USA's biotech start-up number of 1500, of which 300 listed companies are equivalent to one-fifth ratio, and Japan's biotech start-up number is 500, whose one-seventeenth is the listed company ratio. Even under unfavorable conditions of capital market and ecosystem for biotech start-ups in Japan, there are some biotech start-ups, which can be finance enough R&D resources through out-license agreements.

15.2.2 The US Biotech Financing Condition

From 2007 to 2008 around the Lehman Shock 2007–2010 as in Table 15.1, regardless of 103.04 % increase of R&D cost to $ 23.7 billion, the industry's net income has become history's first positive profits as $ 3.7 billion (previous year, $ −0.6 billion) mainly by 111.0 % annual increase of revenues to $ 99.5 billion (Burrill & Company 2011). As a result, the cash equivalents also increased by 106.2 % to $ 75.6 billion mainly by major biotech companies. After 2009, while revenues and R&D cost declined to $ 91.0 billion and $ 19.0 billion, respectively, net income further increased to around the range between $ 4.3 billion and $ 7.5 billion, respectively. Then, the industry can be considered as being matured. Even in the turbulent economy, as the cash equivalents have also increased to $ 74.7 billion and $ 112.1 billion, this makes them possible to continue R&D for the next few years.

Next, if the financing is classified into capital financing and partnerships, while the 2008 US domestic total financing $ 35.9 billion: capital financing $ 16.2 billion (75.3 % level to previous year) and partnerships $ 19.7 billion (114.5 % to previous year) had declined to the weighted average 92.8 %, both sources recovered afterward.

A breakdown of 2008 capital financing includes mainly IPO, Private Investment in Public Equity (PIPE), follow-on, debt as borrowed capital, and VC. First, while 2008 IPO rapidly declined to 0.3 %, except in the case of Bioheart $ 6 million, after

Table 15.1 Lehman Shock and the USD Biotech Finance. (Data: Burrill & Company 2011)

	Each year-end (USD B)				Each year ratio to 2007		
	2007	2008	2009	2010	2008 (%)	2009 (%)	2010 (%)
Revenues	89.6	99.5	91.6	91.4	111.0	102.2	102.0
R&D cost	23.0	23.7	19.3	19.5	103.0	83.9	84.8
Net income	−0.6	3.7	4.3	7.5	−616.7	−716.7	−1250.0
Cash equivalents	71.2	75.6	74.7	112.1	106.2	104.9	157.4
Partnerships	17.2	19.7	33.9	34.0	114.5	197.1	197.7
Capital finance:	21.5	16.2	25.5	31.1	75.3	118.6	144.7
IPO	2.0	0.006	1.2	1.2	0.3	60.0	60.0
PIPE	1.6	1.1	1.7	1.8	68.8	106.3	112.5
Follow-on	6.3	2.1	6.3	3.2	33.3	100.0	50.8
Debt	6.7	5.3	11.2	17.8	79.1	167.2	265.7
VC	4.2	5.1	4.4	4.8	121.4	104.8	114.3
Other	0.6	2.6	0.7	2.1	433.3	116.7	350.0

IPO Initial Public Offering, *PIPE* Private Investments in Public Equity, *VC* venture capital

2009 it recovered to 60 % level, $ 1.2 billion. After PIPE declined to $ 11 billion, 68.8 %, it recovered to the same level as that of 2007 since 2009. The follow-on is showing cyclical trend of recovery and re-decline after decline to $ 2.1 billion, 33.3 %. The debts temporarily declined to $ 5.3 billion, 79.1 %, but rapidly increased to $ 11.2 billion and $ 17.8 billion. While VC was $ 5.1 billion and accounted for 31.5 % of capital financing only in 2008, it kept 10 %, the same level as in 2007 since stable trend of 2009. Then it seems difficult to expect VC as a future core investor in biotech start-ups. Then, capital market except debts is considered difficult.

In contrast, after partnership financing surpassed the amount of capital financing, the standard had been $ 34.0 billion. As the financing weight of partnership had continually been over the financing standard of financial market, it has a potential to make an impact on the R&D continuity of biotech start-ups.

According to the 2008 large partnership examples, there were $ 1.4 billion, an aptamer treatment project for inflammation between Archemix and GlaxoSmithKline, and $ 1.25 billion, a stem cell treatment project between Osiris and Genzyme. Even in 2009, there were $ 1.9 billion, drug-discovery cooperative project between PTC Therapeutics and Roche, and $ 1.5 billion, a painkiller license contract between Nektar Therapeutics and AstraZeneca (Online Wall Street Journal 2009). As per another promotional reason of partnerships for biotech start-ups except stagnation of capital market, there is a patent cliff of blockbuster drugs as Lipitor and Singular held by large pharmaceutical companies. For example, in contrast of stock price declines of Pfizer and Merck during December 2007 and early 2009, those of Gilead Sciences and Celgene were relatively stable except Amgen even during financial crisis. Thus, the expectation to technology seems robust against turmoil of capital market.

As a result, in 2009 each mega Merger and Acquisition (M&A) movement can be considered as a sign for strategic shift of large pharmaceutical companies from chemosynthetic drugs to biotech drugs, as Roche's acquiring Genentech for additional $ 46.8 billion, Pfizer's Wyth in $ 68.0 billion, and Merck's Schering-Plough in $ 41.0 billion, by absorbing biotech drugs such as Avastin, Enbrel, and Remicade.

While the stock price of Human Genome Sciences jumped up, when the antibody drug BENLYSTA arrived in the market in 2009, the company was bought for $ 3.6 billion by GlaxoSmithKline in July 2012. And following M&As mean large pharmaceutical companies' absorbing biotech start-ups' technologies, such as the $ 6.2 billion deal of Cephalone by Teva in October 2011, and the $ 1.1 million deal of Pharmasset by Gilead Sciences in November, 2011.

This kind of technological development capability has the possibility of showing robustness against financial crisis. And in the near future, increase of partnerships and M&As is forecasted between the large pharmaceutical companies who have received pressure to change into biotech companies, or large biotech companies who regard financial crisis as a chance to buy biotech start-ups and the biotech start-ups who have promising technologies but lack financial robustness. Recently, there are more early start examples from clinical trial phase 1 or preclinical trial stage instead of previous usual stage as clinical trial phase 2.

Thus, for biotech start-ups, the optimal timing decision becomes important whether they must continue their independent R&D for a while or must change into cooperative development with strategic partnership under some risks as capital market, demand market, or technological development, although there are some rebound after financial crisis. Therefore, in the next section, we examine this type of tool for switching decision.

15.3 Decision Deferment Function of Real Options

15.3.1 A Basic Theory

Here, we examine Dixit's model on the relationship between uncertainty and decision deferment on business entrance or exit, of which Marshall's criterion is modified by sunk cost under uncertainty and is using an analogy of hysteresis (Dixit 1989).

Assuming μ=business growth rate, ρ=expected asset payoff rate capital asset pricing model (CAPM), the relationship between both, above, variables $\rho > \mu$, σ=volatility, c=operational variable cost, e=sunk cost at business entrance, and x=sunk cost at exit, each Marshallian trigger criterion of investment C_I and exit C_A is respectively:

$$C_I = c + p \cdot e$$

$$C_A = c - p \cdot x$$

These equations instruct that the optimal behavior is entrance if market price $P > C_I(\textit{entrance price} = P_H)$, and instruct it as exit if $P < C_A(\textit{exit price} = P_L)$. Otherwise, if $C_I \leq P \leq C_A$, the optimal behavior shows each path dependent inertia or status quo maintaining like in Hysteresis curve as shown in Fig. 15.1, by meaning business continuity even negative profits during an interval $[P : P_H \rightarrow P_L]$, and entrance reluctance even positive profits. However, the size of the interval is mainly dependent on interest rate and sunk costs. That is, the sensitivity to investment irreversibility becomes low without uncertainty.

However, according to Dixit's model of business entry and exit under uncertainty where price behavior can be modeled as random walk by geometric Brownian movement, the optimal investment guideline approaches to Marshallian trigger criteria during both interval $[P : P_H \rightarrow C_I]$ and $[P : P_L \rightarrow C_A]$ if $\sigma \rightarrow 0$, thus it is approximately a deterministic condition. Otherwise, inertia interval becomes larger by expanding the gap between P_H / C_I and P_L / C_A, if there is a risk $\sigma > 0$ in addition to each sunk cost $x > 0$ and $e > 0$ (see Appendix). That is, as a value of option to defer can be positive for prudential watching the condition without immediate investment under risk, the band can extend between criteria where operational firm's endurance

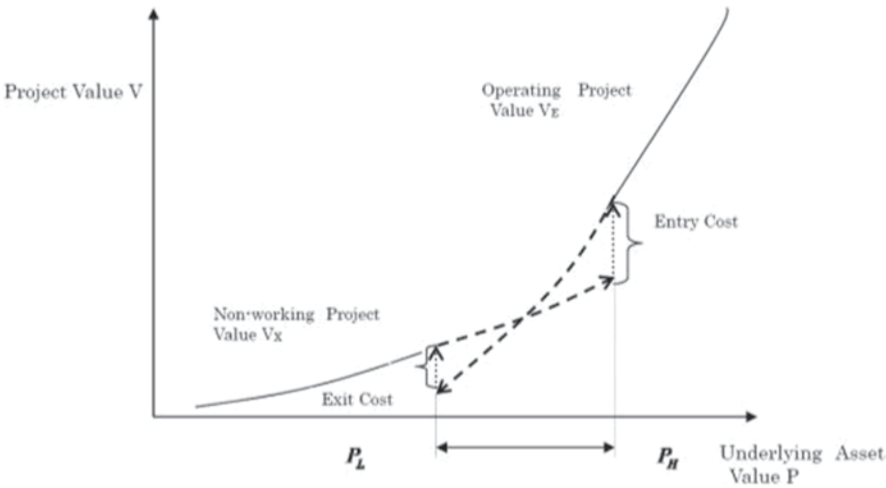

Fig. 15.1 Conceptual image of between the sunk costs and the inertial investment behavior for business entry and exit. (Source: Dixit 1989)

without profits and dormant firm's reluctance to entry with positive profits by entry trigger price $P_H > C_I$ and exit price $P_L < C_A$. And like a high-tech industry, along with increase of business growth rate μ, both ratios P_H / C_I and P_L / C_A decline. Then with easy entrance and lower exit threshold, it is likely that the founding and the enduring companies increase without profits, and matching the situation that only a limited number of companies have positive profits of 1500 biotech start-ups in the USA.

In Dixit–Pindyck model, if inserting a temporal stop as a neutral alternative between business entry and exit, along with the increase of restarting cost similar to sunk cost at temporal stop with the above condition, there are inertial trends such as reluctance to restart the stopped operations or to stop the restarted operations depending on the path selected by chance (Dixit and Pindyck 1994). In contrast, along with an increase in maintenance cost for temporal stop of the operation, the response behavior shows quick restart of temporal stopped operations and reluctance to stop restarted operations.

This kind of decisions and deferment on business entry or exit and R&D continuity as learning options can be considered to apply to decision making at drug development process.

15.4 Application of Real Options to Drug Development

Here, sequential compound switching option is applied, based on an assumed case of a drug discovery biotech start-up (Copeland and Antikarov 2001).

15.4.1 Presumption of a Case Study

First, the assumed data were received personally from Dr. J. Mun, real-options valuation and modified to be suitable for this topic (Mun 2006). Here, two projects at drug development are classified. The first project is classified as an independent development (base case) after clinical trial second phase forward third phase for niche market as orphan drugs which even biotech start-ups have the potential to process, and second is a cooperative development by strategic partnership between a biotech start-up and a large pharmaceutical company. In the case of cooperative development, compared to the base case, it is assumed that each investment size is 1/2 during clinical trial third phase and Biologic License Application (BLA)and 1/4 at market introduction stage, and 1/3 as revenue size after market arrival, respectively. As for our study on decision making for license fee elements such as upfront, milestones, and royalty, it will be provided at another opportunity.

And both projects are assumed that revenues are subject to patent expiration (20 years) and risk-adjusted NPVs (raNPVs) are negative by considering probability of success (POS) at a drug development. That is, if it is assumed that each stage of drug development is independent, the POS of each stage can be multiplied. The raNPV can be set to negative value from summing up the present expected value of cash-out of each investment multiplied by POS until each stage and the present expected value cash-in of revenues after tax from market introduction multiplied by POS of market arrival. Then the assumption starts from non-go sign to invest without any improvement.

For example, the raNPV of base case is (see Fig. 15.2):

$$\begin{aligned} raNPV_B &= \sum_{t=0}^{20} raNPV[CFin(t)] \\ &\quad - \sum_{t=0}^{20} raNPV[CFout(t)] \\ &= 18.57 - 20.58 = -2.01 < 0 \end{aligned}$$

Similarly, the raNPV of cooperative development is (see Fig. 15.3):

$$raNPV_c = 6.19 - 15.42 = -9.23 < 0$$

Then, according to this assumption, the raNPV is always negative, whatever the base case of drug development or the cooperative development for saving the deficit valley is selected. Furthermore, when decision making is rigid, the choice between investment at the present time or not investing forever, it is reasonable not to invest.

Time Point	Stage	CF(Out)	POS	Prob.	PV of CF(Out)	raPV of CF(Out)	Sum of raPV of CF(Out)	Cf(In)	PV of CF(In)	Sum of raPV of CF(In)
0	Drug Discovery						20.58127473			18.57080389
1	Preclinical Study	3.75	0.4	0.4	3.571428571					
2	Preclinical Study	3.75	1	0.4	3.401360544	2.789115646	Sum of PV of CF(Out)			Sum of PV of CF(In)
3	Phase I Clinical Trial	6	0.65	0.26	5.183025591	3.160511824	157.2988002			488.2171485
4	Phase II Clinical Trial	8	0.4	0.1	6.581619798					
5	Phase II Clinical Trial	8	1	0.1	6.268209332	2.600586959				
6	Phase III Clinical Trial	15	0.55	0.06	11.19323095					
7	Phase III Clinical Trial	15	1	0.06	10.66021995					
8	Phase III Clinical Trial	15	1	0.06	10.15259043	3.261068392				
9	Biologics Licensing	10	0.7	0.04	6.446089162					
10	Biologics Licensing	10	1	0.04	6.139132535	2.786660151				
11	Market Introduction	150	0.95	0.04	87.70189336	5.983331763		200	26.9175971	
12	After Market Introduction							480	53.8351943	
13								755	70.5652286	
14								1000	77.8865658	
15								1000	64.9054715	
16		rf	0.05					1000	54.0878929	
17		WACC	0.2					1000	45.0732441	
18								1000	37.5610368	
19								1000	31.300864	
20								1000	26.0840533	
21								0	0	
22								0	0	

Fig. 15.2 Cash flow of independent drug development

Time Point	Stage	CF(Out)	POS	Prob.	PV of CF(Out)	raPV of CF(Out)	Sum of raPV of CF(Out)	Cf(In)	PV of CF(In)	Sum of raPV of CF(In)
0	Drug Discovery						15.42310017			6.190267965
1	Preclinical Study	3.75	0.4	0.4	3.571428571					
2	Preclinical Study	3.75	1	0.4	3.401360544	2.789115646	Sum of PV of CF(Out)			Sum of PV of CF(In)
3	Phase I Clinical Trial	6	0.65	0.26	5.183025591	3.160511824	69.22674869			162.7390495
4	Phase II Clinical Trial	8	0.4	0.104	6.581619798					
5	Phase II Clinical Trial	8	1	0.104	6.268209332	2.600586959				
6	Phase III Clinical Trial	7.5	0.55	0.057	5.596615475					
7	Phase III Clinical Trial	7.5	1	0.057	5.330109976					
8	Phase III Clinical Trial	7.5	1	0.057	5.076295215	2.34569561				
9	Biologics Licensing	5	0.7	0.04	3.223044581					
10	Biologics Licensing	5	1	0.04	3.069566268	1.893943065				
11	Market Introduction	37.5	0.95	0.038	21.92547334	2.633247067		66.7	8.97253238	
12	After Market Introduction							160	17.9450648	
13								252	23.5217429	
14								333	25.9621886	
15								333	21.6351572	
16		rf	0.05					333	18.0292976	
17		WACC	0.2					333	15.0244147	
18								333	12.5203456	
19								333	10.4336213	
20								333	8.69468443	
21								0	0	
22								0	0	

Fig. 15.3 Cash flow of cooperative drug development

15.4.2 Application of Real Options

Next, we examine three investment alternatives among a sequential compound option as base case, a sequential compound option as cooperative development, and a sequential compound switching option between the above two options, based on the same assumed drug development project. As already explained, a sequential compound option is suitable to overcome, to some extent the deficit valley by a milestone type investment.

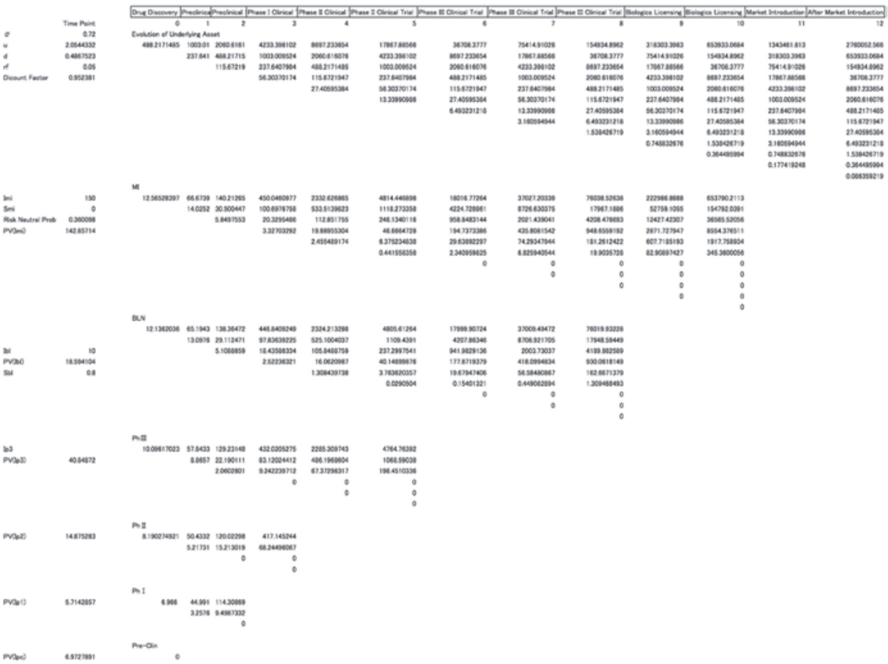

Fig. 15.4 Sequential compound option of base case

First, Fig. 15.4 shows the result of the process from the preclinical stage to the market introduction by applying a sequential compound option.

In this figure, the top row is arranged by each scheduled development stage, followed by a value behavior of the project as underlying asset, and each option value from fifth to first option based on the decision making from exercising the option to stop or continuing the project at each endpoint of a stage. Here, as a compound option, for example, by considering the following as a fifth option is a call option while treating the project as underlying asset, fourth option is also a call option while treating fifth option as underlying asset, and so on until the first option, it becomes an idea as option of options. That is, a function is to hedge against downside risk by stopping and to catch a promising chance to invest in the next stage over the deployed future gradually clearing condition. Based on forecasting through this scheme, it is possible to calculate total investment effect at the present time.

Figure 15.5 is an expanded part of Fig. 15.4, and shows the first option as total option value of this compound option. The result means that even if investing at the preclinical stage and at the start of this project, expanded NPV (ENPV) that is expected to reflect the option's contribution is still zero. That is, while this milestone type compound option could improve the investment criterion: $ENPV = 0$ from negative $raNPV(-2.01)$ at the previous rigid decision-making case, the value is still not positive, and cannot prove the investment validity.

		Ph Ⅱ				
PV(Ip2)	14.87528		8.190274921	50.4332	120.023	417.145244
				5.21731	15.21302	68.24496067
					0	0
						0
		Ph Ⅰ				
PV(Ip1)	5.714286		6.966	44.991	114.3087	
				3.2576	9.498733	
					0	
		Pre-Clin				
PV(Ipc)	6.972789		0			

Fig. 15.5 State of ENPV = 0 (base case)

Second, this cooperative project has a trade-off between saving investment amount and shared revenues, compared with the above independent project. In order to reflect the contribution and risk with partnership, we assume cooperative development success factor (CDSF) $CDSF = 1.039$, cooperative development failure factor (CDFF) $CDFF = 1/CDSF = 0.962$ as binomial process, and separate the value behavior of the underlying asset into upside and downside parallel cases. Figure 15.6 shows the sequential compound option under this assumption.

However, as Fig. 15.7 shows, even under this assumption, the ENPV is also zero. That is, from a perspective of "NPV" as an investment criterion, while this option could improve to $ENPV = 0$ by a milestone type flexible decision from the present negative expected value $raNPV = -9.23$ with an inflexible decision, the value is still not positive nor it can be the proof for investment.

However, simply making a sequential switching option including the flexibility, which can select the suitable mode between the above independent or cooperative development styles at the endpoint of clinical trial second phase for third stage, depending on that time's condition, we can improve the ENPV as a sort of NPV into a positive value (Fig. 15.9).

A summary of value behavior of sequential compound switching option is shown in Fig. 15.8. While each mode project has separately $ENPV = 0$ and cannot support investment, simply inserting the flexibility to select which mode is best for next stage halfway in the common process makes the investment criterion of the integrated project $ENPV > 0$, and can give a signal for investment in this project.

Figure 15.10 shows the selection policy of each option at binomial process according to value behavior of underlying asset calculated by Excel as above each option. And if calculated by backward induction to understand whether the project start is right or not, based on the assumption of this policy to future volatility of underlying asset, it is possible to get the above favorable result.

				Stage	Drug Disco	Preclinical	Preclinical	Phase Ⅰ Clinical	Phase Ⅱ Clinical	Phase Ⅱ Clinica	Phase Ⅲ Clinic	Phase Ⅲ Clinic	Phase Ⅲ Clinica	Biologics L	Biologics L	Market Intr
				Time Point	0	1	2	3	4	5	6	7	8	10	11	12
Smi	0.95				Evolution of Underlying Asset											
Sbi2	1				162.73905	334.33651	686.87203	1411.132701	2899.077885	5955.961887	12713.33481	26118.69725	53659.11906	110239.08	226478.82	465285.61
Sbi	0.7					79.213599	162.73905	334.336508	686.8720255	1411.132701	3012.141922	6188.2444	12713.33481	26118.697	53659.119	110239.08
Sp33	1						38.557398	79.21359948	162.7390495	334.336508	713.6600345	1466.166876	3012.141922	6188.2444	12713.335	26118.697
Sp32	1							18.76790058	38.55739825	79.21359948	169.0858724	347.3756318	713.6600345	1466.1669	3012.1419	6188.2444
Sp3	0.55								9.135317947	18.76790058	40.06113678	82.30292986	169.0858724	347.37563	713.66003	1466.1669
Sp22	1									4.44663662	9.491595347	19.4998487	40.06113678	82.30293	169.08587	347.37563
Sp2	0.4										2.248822412	4.620055448	9.491595347	19.499849	40.061137	82.30293
Sp1	0.65											1.094619382	2.248822412	4.6200554	9.4915953	19.499849
Spc2	1												0.532808454	1.0946194	2.2488224	4.6200554
Spc	0.4													0.2593457	0.5328085	1.0946194
															0.1262371	0.2593457
CDSfactor	1.039															0.0614462
CDFfactor	0.962463908															
σ	0.72															
u	2.054433211										11776.82955	24194.70974	49706.41521	102118.51	209795.66	431011.17
d	0.486752256										2790.257829	5732.398351	11776.82955	24194.71	49706.415	102118.51
rf	0.05										661.0895337	1358.164293	2790.257829	5732.3984	11776.83	24194.71
Dicount Factor	0.952380952										156.6304615	321.7868219	661.0895337	1358.1643	2790.2578	5732.3984
Risk Neutral Prob	0.360098041										37.11010418	76.24023049	156.6304615	321.78682	661.08953	1358.1643
											8.792413809	18.06342693	37.11010418	76.24023	156.63046	321.78682
											2.083166897	4.279727257	8.792413809	18.063427	37.110104	76.24023
												1.013986187	2.083166897	4.2797273	8.7924138	18.063427
													0.493560064	1.0139862	2.0831669	4.2797273
														0.2402415	0.4935601	1.0139862
															0.1169381	0.2402415
																0.0569199
				MI												
		PV(Im)	35.714286		6.3344237	33.433105	70.001042	223.9273368	1157.862902	2386.1563	8921.938117	18327.97131	37629.70387	110338.51	226443.11	
						7.17089	15.467248	50.69965847	267.0176176	557.1257169	2098.160266	4325.925902	8898.218171	26116.302	53623.405	
							3.062514	10.51521548	57.71834575	124.626309	481.4178735	1008.452666	2090.931662	6161.7221	12677.621	
								1.813761541	10.65503445	24.5765357	100.8987697	222.4511676	478.0965268	1433.9282	2976.4276	
									1.444388474	3.653409374	16.54220841	40.38037115	95.97111311	313.78255	677.94575	
										0.314145529	1.590671464	4.420093185	12.25247053	48.388958	133.37159	
											0.04209191	0.122734647	0.357878591	1.4907548	4.3468511	
												0	0	0	0	
													0	0	0	
														0	0	
															0	
											8263.204295	16976.28298	34856.1081	102208.12	209759.94	
											1942.087938	4005.673416	8241.076342	24189.985	49670.701	
											444.4400067	932.5759621	1935.236521	5705.3242	11741.115	
											92.20519918	204.4738702	441.2080261	1325.7948	2754.5435	
											14.63442812	36.23183013	87.23120331	288.16276	625.37525	
											1.266942844	3.624209063	10.36351918	42.318919	120.91618	
											0.013516144	0.039411354	0.114918487	0.4786967	1.3958185	
												0	0	0	0	
													0	0	0	
														0	0	
															0	
				BLN												
					6.1164297	32.686999	69.074455	222.3247504	1153.656112	2381.739172	8913.505416	18319.11698	37620.40681			
		PV(Ib)	9.2970522			6.6965001	14.764408	49.26239791	262.8108283	552.7085882	2089.727565	4317.071567	8888.921119			
							2.6796149	9.54975056	54.18975464	120.2091802	472.9851732	999.5983306	2081.63461			
								1.390466567	8.680190244	21.2722463	92.46606937	213.5968322	468.7994747			
									0.81927431	2.27238801	11.42956589	31.52603576	86.67406096			
										0.0655656	0.347601697	1.013562253	2.955418373			
											0	0	0			
												0	0			
													0			
											8254.771594	16967.42865	34846.81104			
											1933.655237	3996.81908	8231.77929			
											436.0073063	923.7216267	1925.939469			
											83.77249881	195.6195348	431.910974			
											9.612022312	27.37749475	77.93415116			
											0.125432578	0.365745414	1.066467022			
											0	0	0			
												0	0			
													0			
				PhⅢ												
		PV(Ip3)	20.42436		5.0766445	28.969194	64.487189	214.9145516	1134.204341	2361.314811						
						4.5232585	11.245384	41.85219919	243.3590566	532.2842279						
							1.0938875	4.836248461	34.737983	99.78482						
								0.039889667	0.290782968	0.847886081						
									0	0						
										0						
				PhⅡ												
		PV(Ip2)	14.875283		3.6061435	22.622745	55.27868	200.0392682								
						2.0623794	6.0136356	26.97691575								
							0	0								
								0								
				PhⅠ												
		PV(Ip1)	5.7142857		2.38186	17.180568	49.564395									
						0.1026622	0.2993499									
							0									
				Pre-Clin												
		PV(Ipc)	6.9727891		0											

Fig. 15.6 Sequential compound option of cooperative development

		Ph Ⅱ			
PV(Ip2)	14.87528	3.606143	22.62274	55.27868	200.0392682
			2.062379	6.013636	26.97691575
				0	0
					0
		Ph Ⅰ			
PV(Ip1)	5.714286	2.38186	17.18057	49.56439	
			0.102662	0.29935	
				0	
		Pre-Clin			
PV(Ipc)	6.972789	0			

Fig. 15.7 State of ENPV = 0 (cooperative development)

				Stage	Drug Disco	Preclinical	Preclinical Stud	Phase I Clinical	Phase II Clinica	Phase II Clinica
			Time Point	0	1	2	3	4	5	6
Smi	0.95			Ph Ⅲ						
Sbl2	1	PV(Ip3)	40.84872	10.119645	57.911784	129.28138	432.0205275	2285.309743	4764.76392	
Sbl	0.7	PV(Ip3CD)	20.42436		8.9234747	22.27435	83.24620793	486.1968604	1068.59038	
Sp33	1					2.1076645	9.384009305	67.88971075	196.4510336	
Sp32	1						0.039889667	0.290782968	0.847886081	
Sp3	0.55							0	0	
Sp22	1								0	
Sp2	0.4									
Sp1	0.65			Ph Ⅱ						
Spc2	1	PV(Ip2)	14.875283	8.1973174	50.467443	120.07287	417.145244			
Spc	0.4				5.2269426	15.241098	68.37092448			
						0	0			
CDSfactor	1.039						0			
CDFfactor	0.9624639									
σ	0.72			Ph Ⅰ						
u	2.0544332	PV(Ip1)	5.7142857	6.973034	45.025266	114.35859				
d	0.4867523				3.2672253	9.5268127				
rf	0.05					0				
Dicount Factor	0.952381									
WACC	0.2			Pre-Clin						
Risk Neutral Prob	0.360098	PV(Ipc)	6.9727891	0.0002448						

Fig. 15.8 Value behavior of switching option

		Ph Ⅰ		
PV(Ip1)	5.714286	6.973033955	45.02526646	114.3585884
			3.267225334	9.526812733
				0
		Pre-Clin		
PV(Ipc)	6.972789	0.000244839		

Fig. 15.9 State of ENPV > 0 (switching option)

Drug Discovery	Preclinical Study	Preclinical Study	Phase I Clinical Trial	Phase II Clinical Trial	Phase II Clinical Trial
Continue		Continue	Continue		Phase III
		Continue	Continue		Phase III
		Stop	Stop		Phase III
			Stop		Coop Dvelop
					Stop
					Stop

Fig. 15.10 Option selection policy

Next, we will examine the contributing factors for investment improvement and a policy of this integrated project with switching option.

15.4.3 Characteristics of Analyzed Result

Base case mode is considered as a series of dichotomy decisions to select whether business continuity or stop to hedge against irreversibility of investment under technological and economical uncertainties in the development process as a sequential compound option. On the other hand, cooperative development mode is another alternative to search for business opportunity with partnership modeled by binomial process of underlying asset combining CDSF and CDFF at the endpoint of a clinical trial, in addition to saving investment for deficit valley in return for relative lower revenues by sharing.

This relationship is, under mapping between binominal process of underlying asset value right after the endpoint of clinical trial phase 2 and CDSF (CDFF can be ignored because of negative side), understandable from the effective length of search in addition to the upside-opportunity utilizing and downside-risk hedging along with the increased potential of value by cooperative development (see Table 15.2). That is, binomial value variable stages at time point 5 in Fig. 15.10 correspond to vertical stages (market binomial risk) in Table 15.2, and in parameters, quantitative thresholds of technological risk (or potential) in cooperative development that can change reasonable selection in table do so to horizontal CDSF (technological risk) in Table 15.2.

Table 15.2 Selection map among both modes and stop

		Cooperative Development Success Factor (CDSF)					
		1.039	1.79	2.03	2.09	4.27	18.00
Market binomial level	a	P	P	P	C	C	C
	b	P	P	C	C	C	C
	c	P	C	C	C	C	C
	d	C	C	C	C	C	C
	e	S	S	S	S	C	C
	f	S	S	S	S	S	C

$\sigma = 0.72$, P= Phase III, C= Coperative Development, S=Stop

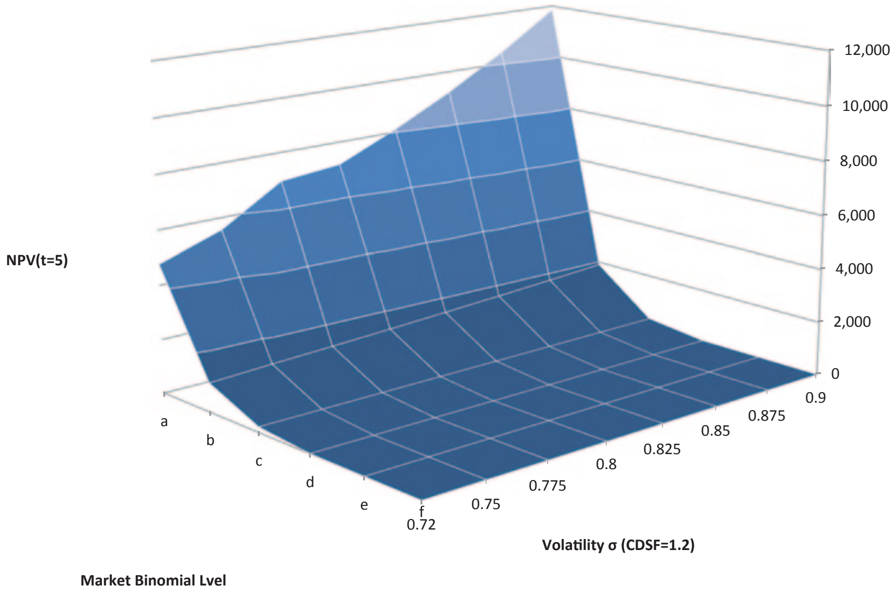

Fig. 15.11 NPV and market volatility in independent development

As an interpretation on the map, necessary decision is immediate proceeding into clinical trial third phase even by independent development under feasible financial resources if product market is favorable binomial process condition (condition close to a of binomial value stage in Table 15.2), in contrast, is prompt stop if unfavorable condition (condition close to f), and is search decision for opportunity including partnership as cooperative development if limited midrange area (condition d). However, at higher technological potential, decision guideline is still supporting the option of immediate stop if market (binomial) risk is unfavorable, but the opportunity of search for cooperative development with promising partner expands rather than immediately proceeding to clinical trial third phase for independent development if opportunity expanding conditions are favorable. Furthermore, if technological potential can increase by partnership, the table shows that reasonable action is searching for partner in cooperative development or the deferment of stop decision even at unfavorable market risk condition. That is, as risk generally includes both positive and negative sides, each decision among mode selection between base case and search or stop is finally dependent on payoff function consisting of additional investment amount and probably expected revenues. But here from mapping, it is possible to consider the opportunity for proper search expands along with increase of uncertainty.

At even independent development without any cooperative development, there are opportunities to increase the business value independently depending on the finances from growth option, along with volatility σ (Fig. 15.11). In addition, after examining the relationship of the NPV with market binomial risk and cooperative potential (Fig. 15.12), and with market volatility and cooperative potential (Fig. 15.13) at the endpoint in clinical trial second phase at time point 5, if inte-

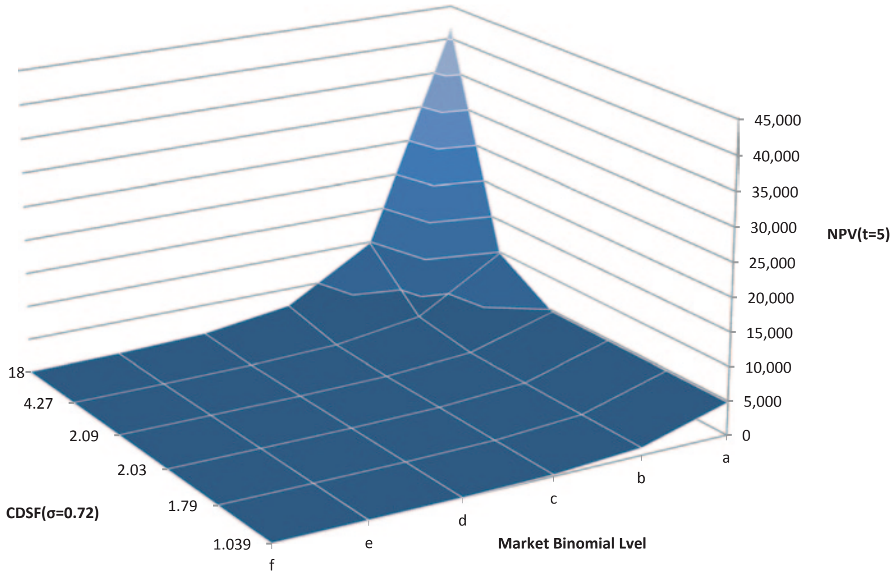

Fig. 15.12 NPV and cooperative development potential

grated 4D (dimensional) indicators (including market binomial risk, cooperative potential, market volatility, and NPV) could be formulated, it will become much easier to select a suitable strategy among independent development, cooperative development, and stop. For example, Fig. 15.14 compares each NPV of binomial variable level b (and d) at each CDSF stage between proceeding into clinical trial third phase (P) and cooperative development (C). Then from using these parameters, it is possible to select a suitable strategy for each binomial variable level.

Furthermore, if $NPV = 0$ or a curve of scrap value of put option with out-license is added, it is expected to make a rational decision among more realistic alternatives.

From the above discussion, the map in Table 15.2 shows each most promising region among independent development continuity, cooperative development, and stop options in 3D of market binomial risk, cooperative development potential, and NPV. It is possible to use a selective index including boundary region depending on each condition.

Sequential compound switching option can make shift into cooperative development if possible to find more promising partners with higher synergistic and saving investment effects over some thresholds, even to some extent shared revenues, while making risky and expensive independent development as a benchmark under financing constrains. This sequential compound switching option is considered as a method to investment irreversibility under uncertainty, even including learning option to search for promising partners more than some thresholds.

In addition to sequential compound option for deficit valley with downside-risk hedge and upside-opportunity utilization, if possible to forecast and make index search-needed partner by CDSF, it can contribute to decision timing support at shift

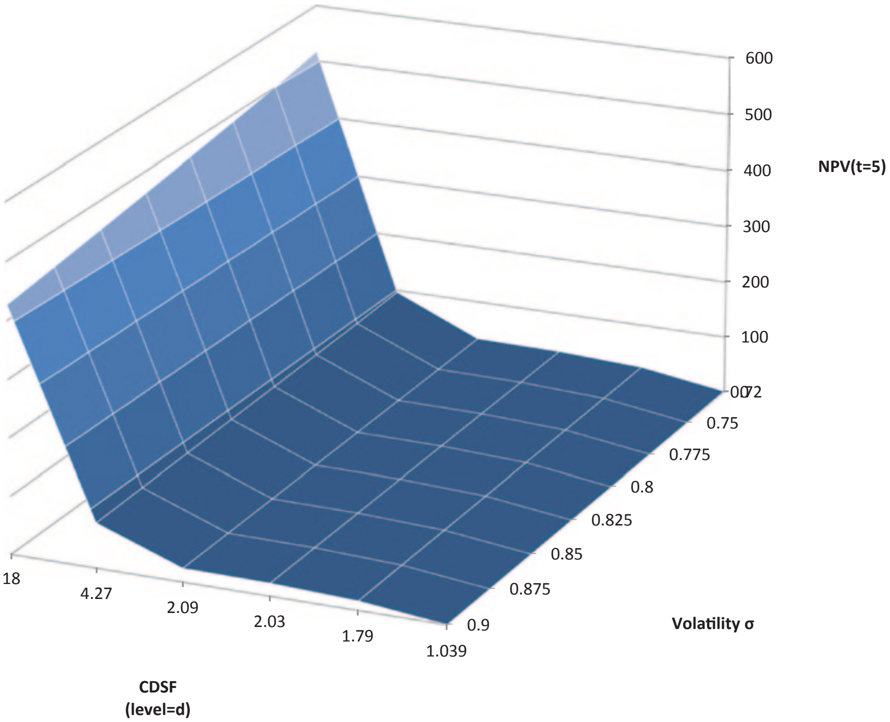

Fig. 15.13 NPV with cooperative development potential and market volatility

into cooperative development by switching option. Especially if the project has the aptitude for future derivation, it is also reasonable to invest sunk cost in searching for promising partners from a long-term perspective rather than reckless independent development.

As high volatility means not only risk but also opportunity, it is possible to additionally invest in searching for promising partners rather than deciding to stop projects by just "sit and see" even in unfavorable conditions. However, it is necessary in the future to start the work of parameter's estimation and test on CDSF, etc., based on the models of jump-diffusion or option-games and the practical data.

15.5 Conclusion

In foregoing discussion, we examined the option characteristics of decision deferment functions, the opportunity effects of searching for partners in the neutral midway between stop and independent development, and the utilization conditions of these options.

While decision deferment has usually been discussed only by sunk cost, it is understandable to expand the applications by making indicators of project selection from option flexibility (to up and down both side fluctuations) related with CDSF.

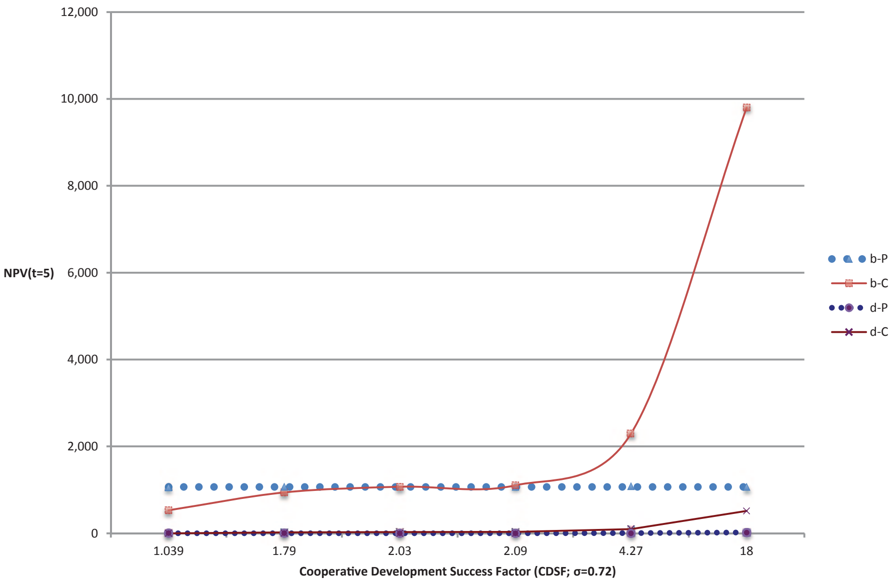

Fig. 15.14 Relationship between independent and cooperative developments

R&D is evaluated as a learning option at decision deferment stage in halfway between business entry and exit decisions. Further, in order for biotech start-ups to enforce robustness against deficit valley, the continual enrichment of technological and product portfolio is required including independent and cooperative development projects. Also, stochastic optimization as a management tool is possibly used to select project candidates quickly as integer number under limited resources for efficient frontier. This topic will be discussed later at some other occasion.

However, as future remaining challenges, there are still parameter measurement and estimation, optimal combination of license fee elements for overcoming deficit valley, and development of improvement methods on forecasting precision. Additionally, effective logic on repetitive information asymmetrical game has also necessity to find for development competition with rivals.

Appendix

At Dixit model of business entry or exit under risk modeled as random work of value behavior as geometric Brownian motion, respective trigger price derived of business entry and exit is (Dixit 1989):

$$P_H = \frac{\rho - \mu}{\rho} \frac{\beta}{\beta - 1} C_I$$

$$P_L = \frac{\rho - \mu}{\rho} \frac{\alpha}{\alpha + 1} C_A$$

$$\beta = \frac{(1-\alpha) + [(1-\alpha)^2 + 4b]^{1/2}}{2}$$
$$-\alpha = \frac{(1-\alpha) - [(1-\alpha)^2 + 4b]^{1/2}}{2}$$
$$\alpha = \frac{2\mu}{\sigma^2}, b = \frac{2\mu}{\sigma^2}.$$

Thus, it can be explained that if volatility is at a risk scale of $\sigma \to 0$, each fraction of α and β approaches 1, then a fraction consisted of risk interest rate ρ and growth rate μ works enough, on the other hand, if $\sigma > 0$, each function of fraction α and β expands, then it amplifies the deferment function.

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Chapter 16
Stakeholder Engagement Methodology in the Context of Innovation Management

Anuradha Alladi, Ravi Shankar Pillutla and Sreenivasa Divi

16.1 Introduction

For any project's success, it is essential to get the buy-in from relevant stakeholders. The involvement of stakeholders helps bring success in any project. Similarly for an innovation to implement successfully, application of SEM is essential (Alladi and Desik 2015). Any Organization's success depends on its ability to adapt to impending change.

From an organization's perspective, change may mean a new or a different way of working that results in improved productivity, reduced rework or better results. Innovation is one of the reasons for change. Managing innovation therefore is crucial in any organization. Innovation management (IM) is a process of managing innovation from idea generation through idea conversion to idea diffusion (Hansen and Birkinshaw 2007). IM involves various stakeholders, who have affect or influence over an innovation. Involving stakeholders at the right time will enable timely interaction and help manage innovations effectively.

Innovation can happen at every level of working in an organization, taking it from strategic to day-to-day operations. Development of a new idea or a method to better or improvise the existing way of working can also be called innovation. Innovation is doing something different providing value. Innovation involves taking new ideas all through its implementation (Govindarajan and Trimble 2005).

The process of IM involves many stakeholders, understanding their needs from innovation point of view. The chapter discusses various stages in the innovation processes, IM, and the process of involving various stakeholders.

The authors in this chapter have discussed SEM(Alladi and Vadari 2011), IM and competence development framework (CDFW) in detail. With the help of a case illustration, authors have applied SEM to implement an innovation called CDFW (Pillutla and Alladi 2012), while going through various phases of SEM. The

A. Alladi (✉) · R. S. Pillutla · S. Divi
Tata Consultancy Services Limited, Hyderabad, India
e-mail: alladi.anuradha@tcs.com

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execution of CDFW methodology and results from the execution are also shared as part of this chapter, along with its advantages.

16.2 Stakeholder Engagement

Stakeholder engagement is a process of engaging stakeholders in a particular context to obtain desired results. In the context of IM, stakeholders will be involved from the idea generation through its implementation. Each stakeholder plays a vital role in achieving goals of an innovation. Stakeholder engagement involves time, resources and commitment to take the engagement forward.

16.2.1 Need for Stakeholder Engagement

In any IM process, there are various stakeholders involved from the idea generation to idea diffusion. There will be a different set of stakeholders at each phase of the IM process. During to the implementation of an idea, the end users will also act as stakeholders, as a result of an innovation.

The entire process of innovation value chain involves various stakeholders from different levels and positions. Each stakeholder will look for how and what way the innovation helps them. For instance, a sales person will look for the new feature of a given product, finance will look for what would be the investment and return on investment, a customer-facing person will look for what benefits it can provide to the end users, etc. While an innovative idea is generated, evaluated and diffused, it needs to ensure that each stakeholder is receiving their share in the process International Finance Corporation (IFC).

16.2.2 Stakeholder Engagement Methodology (SEM)

In the context of IM, stakeholders play a vital role in generating ideas, sharing ideas and to take these ideas further to implement within the organization. Table 16.1 elaborates various phases of the SEM. In any process, engagement will be effective when the team involves all the stakeholders from within and outside the organization for effective results.

Stakeholder engagement deals with who the stakeholders are, identifying them, needs of the stakeholders, strategy to engage the stakeholder, etc., from the methodology perspective. Right communication strategy and on-time communication will help take the innovation to the next level. Similarly understanding what role each stakeholder plays and what position each one holds over a given engagement will help arrive at the right strategy to engage, resulting in successful engagement and adding value to the engagement (The Stakeholder Engagement Manual, Vol. 1 and 2).

Table 16.1 SEM phases

Sl. No	Stakeholder engagement phases	Activities
1	Communication	Communication medium to which the team would like to interact with stakeholders
2	Think strategically to identify stakeholders	Identify list of stakeholders in a given context
3	Analyse and plan	Gather list of needs/requirements/issues of stakeholders
4	Strengthen engagement capacities	The team tries to understand what preparation is required to engage stakeholders
5	Design engagement process	The engagement team needs to identify the right strategy to engage stakeholder based on the interest and influence they are positioned at
6	Engage, review and report	Engage stakeholders, review progress and report

The SEM methodology is domain independent; it can be applied to any industry/domain social activities or construction-related subjects. Stakeholder engagement is a systematic way of engaging stakeholders, to help gather more ideas from the employees in an organization to develop and integrate into new processes, products or services (UNEP Manual on SEM, Vol. 2).

Communication Communication plays a central focus, which revolves around the stakeholder engagement process. It will ensure that the feedback at each phase will help strengthen the engagement. Communication mode can be any one of the following. In person, periodical meetings, status updates, bulletins, emails, etc.

Think Strategically to Identify the Stakeholders The key phase in stakeholder engagement is to identify strategic priorities for stakeholders in the given context. What material issues are important for them? Are these needs/issues/requirements within the scope of the program? Whom to engage? What strategy needs to be applied to engage, etc.

Analyse and Plan To come up with a basis for stakeholder engagement, the team needs to be aware of who their stakeholders are and what their needs and expectations are. The needs gathered should be complete in all respects; not omitting any stakeholders nor the needs and requirements expressed as part of stage think strategically. This also involved capturing unstated requirements of business.

Strengthen Engagement Capacities It is essential at this stage that the team is equipped enough to understand who their stakeholders are, the needs and issues of these stakeholders, in complete form. The engagement process enables the team to respond to their needs and requirements in a coherent manner.

Design Engagement Process This stage of engagement is very crucial for the engagement team, as the team needs to plan effectively to carry out the engagement process with the identified stakeholders. Influence and interest matrix can be used to understand the position each stakeholder has over the process.

Engage, Review and Report The engagement will be carried out based on the quadrant each stakeholder was placed on in the interest and influence matrix, i.e. partner, engage, empower and monitor. Stakeholders are informed about the solution development and its progress over telephone calls, periodical team meetings, status updates and workshops.

16.3 Innovation

Innovation is an idea which is put through a particular process and becomes the business process both at the strategic and operational level. Innovation is doing things differently. Innovation is a novel idea or method to achieve better results. For an innovation to be successful, organizations need to invest in people, time and resources. Creating a culture of innovation requires commitment from the leadership teams.

According to Rosabeth Kanter, “Innovation is a complex parallel processes, involving lot of chain of actions in the process of its implementation”. Kanter further states, “Innovation gets rediscovered as a growth enabler every half a dozen years” (Moss Kanter 2006).

Innovation Management
IM is a process, a journey, involving many phases. The journey of innovation management involves a lot of stakeholders, starting from idea generation to idea diffusion. Many studies have shown that out of total number of ideas generated in an organization, only 5–10 % of them will be actually converted into products, processes or services.

IM is about managing innovation initiative in an organization. IM is applied to develop products, processes and innovation itself. IM involves people at all levels to contribute for the development of an idea into its desired outcome. IM is the responsibility of all the stakeholders not limited to the originator of the idea or the research and development teams in the organization (The innovators Tool Kit, HBR and Govindarajan and Trimble, HBR).

IM focuses on implementing new ideas, processes or products in the organization. It helps to introduce a new product or service in less time and easing the concept of time to market. The innovation can be managed to obtain the desired results. The process of managing innovation will be effective when the team involves relevant stakeholders from within the organization (Narayana 2012), i.e. from the time idea generation through idea conversion to idea diffusion (Table 16.2).

Innovation involves taking a new idea all through its implementation, involving a number of phases termed as IM. The IM has three phases (1) idea generation, (2) idea conversion, and (3) idea diffusion. Accordingly, IM is construed as managing the innovation.

Idea generation involves three sub functions, internal sourcing, Cross pollination and external sourcing. Whereas idea conversion has two phases namely idea selection and idea development. Idea diffusion includes the spread of idea implemented or integrated into the organizational processes.

Table 16.2 IM process

Sl. No	Phase name	Outcomes
1	Idea generation	List of ideas generated, stakeholders involved to share their ideas, problems, solutions
2	Idea conversion	List of ideas reviewed, based on their relevance use of technology to make it usable form
3	Idea diffusion	Ideas diffused as part of the processes, services or a new product or service as a result of an innovation

16.4 Competence Development Framework (CDFW)

CDFW was explored initially and developed into a consumable framework. The framework was piloted in a couple of projects to monitor and review the effectiveness. The CDFW can be applied for any domain and technology.

The CDFW helps to build project-specific competence in associates. It is an intermediary approach to build competence between the formal knowledge training and project induction program. CDFW helps to build competencies among the freshers, based on the competencies derived from the project deliverables. The project team will prepare the list of competencies required to complete a project. Based on the items on the list, the competence assets (CAs) are prepared by the experts in the technology/domain area who also have project experience. The trainees are expected to execute these CAs, while following the process steps, to complete a given task (Pillutla and Narayana 2012).

The CA will have three sections: (1) requirement statement, (2) process steps, and (3) acceptance criteria.

Requirement Statement This section in the CA talks about what is the problem statement, what are the instructions required adhering to, and what the outcome from the stated problem is, that it want to accomplish.

Process Steps It is a list of steps provided in the competence assets to help the fresher to execute. These are a set of instructions to be followed in a systematic manner that when executed will derive the desired outcomes. It is very important to identify the applicable process steps to accomplish a given task.

Acceptance Criteria An acceptance criterion is set by the expert in the field for every competence asset prepared. This section states the time allowed for a fresher to execute the process steps. If the fresher is not able to execute these steps in a given time, he/she has to iterate the process till the acceptable time limit is reached.

Once a fresher executes the process steps and meets the acceptance criteria, the trainee will declare himself/herself to be competent in a given area, subject or technology (Table 16.3).

Table 16.3 Competence asset structure in CDFW

Sl. No	Competence assets	Description
1	Requirement statement	To perform a given task
2	Process steps	Log in… Pwd…
3	Acceptance criteria	10 mts

16.5 Applying SEM During Idea Diffusion Phase

IM and stakeholder engagement are mutually dependent on each other. No innovation can emerge or sustain without stakeholders. Similarly, it is the stakeholders who contribute towards innovation based on their needs or issues, whether it is the generation of ideas or diffusing an idea. Stakeholders are involved when there is a change or conception of a new idea. In the process of IM how the stakeholder engagement was inherently built in to bring out the designed outcomes is discussed in the chapter with the help of a case illustration. Figure 16.1 provides the details of various IM phases, wherein case illustration talks about only idea diffusion (Table 16.4).

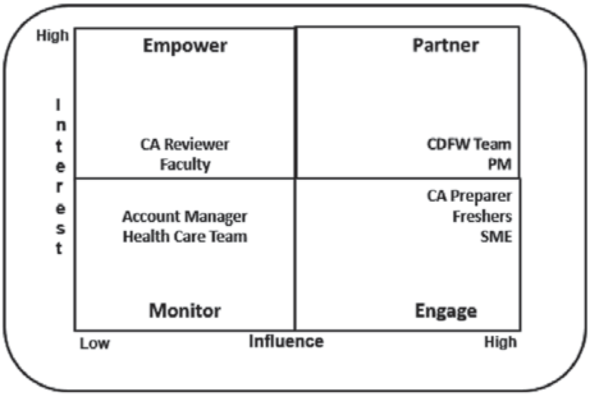

Fig. 16.1 SEM strategy applied in HC team. (Sawitz 2006)

Table 16.4 Phases in SEM and IM process

IM phases	Stakeholder engagement methodology phases					
	Commu-nication	Think strategically to identify stakeholders	Analyse and plan	Strengthen engagement capacities	Design engagement process	Engage, review and report
Idea generation						
Idea conversion						
Idea diffusion	●	●	●	●	●	●

The authors were provided with an innovation called CDFW implementation as part of innovation diffusion phase in one of the Industry Solution Unit (ISUs). The case is about how the application of SEM helped to overcome the challenges to implement CDFW and bring new joinees on board in less time. The SEM is applied during the idea diffusion phase of IM, wherein stakeholders are different during the implementation process.

The CDFW was implemented to scale up the employees learning time. Compared to the normal mode of class room training, the new way of up scaling of employees using the CDFW has resulted in reducing the learning time from 1 to 2 days to less than 4 h.

16.5.1 Background for the Case Illustration

During initial studies, the availability of skilled resources was identified as one of the pain areas. Unlike other formal educational and training methods where knowledge is imparted and individuals apply the knowledge to bring out an output/outcome, is a time-consuming process. In projects with short duration, scaling up and meeting the schedule are real challenges.

Researchers worked on the pain area and came up with CDFW. The CDFW will help to train the resources in less time compared to the formal training methods. As a result, completing the project with the skilled resources is addressed.

The health care package predominantly being used in hospitals in the USA and Europe is identified for implementing the CDFW. The package has various activities to be performed by the hospital personnel to serve the patients. The health care (HC) team is involved in customizing the health care package based on the specific requirements provided by the individual health care facility.

The HC team had challenges in bringing the freshers on board, as the associates were taking more time than the project can afford, conversant with the health care facility processes, and make them a productive resource. CDFW is identified to help address these challenges the team is currently encountering. As part of the case, the freshers were briefed about the package and provided the CA to execute.

16.5.2 Challenges and Need for SEM in the Process

To implement CDFW process in the health care project, CA are required to be prepared. The team identified two resources to prepare the assets, because of the project demands these resources could not spend any time to prepare, which was delaying the process. Hence, the implementation team identified three resources and distributed the CA preparation work among them. Similarly, we have identified another team of three associates to review these assets, who have experience with the project activities as well as the domain.

Since we involved more associates into the asset building process, we felt the need to apply SEM, as each stakeholder has a specific role to play in the process. This list of activities requires lot of coordination, explains the benefits of implementing the CDFW, list of tasks to be performed, sequence of the tasks to be completed, associates movement across the projects, availability of systems to execute, etc., which demanded SEM implementation.

Once assets are prepared, the review team should be available to review them. The CDFW implementation team had to coordinate with the reviewers by giving them adequate notice so that they are able to spend time to review the assets. If these associates are involved in key project activities and are unable to spare time to review, it will result in losing time. We had to request their time in advance while the assets are under preparation itself, so that the review process is complete in time.

Without reviewing the assets, these cannot be provided to the freshers for execution, this is a limitation the framework has. The review process will help identifying the gaps and filling them as required.

Bringing more associates into the asset building and review process resulted in completing the work in less time, and more awareness about the framework resulted in internal proliferation of the framework in other projects as well.

16.6 Implementation of CDFW Innovation

In this chapter, we have taken a case of one of the health care package module admission, discharge and transfer (ADT). The freshers were provided with the CA to execute. The time taken and the process steps followed were recorded and shared as part of this chapter.

From the stakeholder engagement perspective, the CDFW execution team identified stakeholders as project team, subject matter experts (SMEs), trainees, project manager and seniors in the team. Their need was to understand the health care package, perform and test various activities to be carried out in a typical hospital management arena before they deliver it to the customer.

SEM phase-wise processes were followed to implement the CDFW, and were elaborated in the following section in HC team. Names of the stakeholders involved in the CDFW case implementation and their roles and responsibilities are illustrated in Table 16.5.

Table 16.5 Roles and responsibilities of stakeholders in the health care context

Role	Responsibility
CA preparer	Person involved in preparing competence asset
CA reviewer	Team involved in reviewing competence asset
SME	Subject matter expert
CDFW team	Competence development framework team
HC team	Health care (HC) team
Freshers	To executive the competence assets
PM	Over all owner for implementation process
Faculty	Person who owns induction process in account

The CDFW team identified experts or SME in the given area as one of the stakeholders to prepare the assets. The CDFW team identified another team of experts who can review these assets prepared, before providing them to freshers to execute the process steps. There were five freshers allocated to the team to undergo induction process using the CA. The freshers were briefed about the package information before they actually executed the process. Time taken to execute the assets was recorded as per the acceptance criteria. Those who could not complete the process within the time were requested to iterate the process till they met the acceptance criteria.

16.6.1 SEM Phase 1—Communication

A good communication is essential in motivating stakeholders. Various modes were used to communicate with the stakeholders, e.g. Mails, emails, common forums.

Sl. No	Key activities	Stakeholders involved	Outcomes
1	Periodical communication	Project manager	Periodical communication, clarity in the process
2	Assessment of project needs	CDFW execution team	List of stakeholders both direct and indirect
3	Project execution plan to share	CDFW execution team	Project plan with schedule available
4	Roles and responsibilities	CDFW execution team	Each stakeholders roles and responsibilities

16.6.2 SEM Phase- 2—Think Strategically to Identify Stakeholders

As a part of "think strategically", the team has identified the following stakeholders to implement the innovation idea. The identification of stakeholders was done based on what, why and who criteria with respect to the project.

Sl. No	Key activities in SEM phase	Stakeholders involved	Outcome
1	Identify the objective of the engagement	PM, CDFW executive team	Purpose of the engagement
2	Identify the stakeholders	PM, HC team	List of the stakeholders
3	Capture the needs of the stakeholders	CDFW execution team	Needs and requirements list
4	To involve the faculty	Faculty	Availability of faculty
5	Clarity on what to accomplish	PM, HC team	Benefits from the implementation
6	Identify resources to prepare and review Assets	PM, HC team	SME, reviewer, CA preparer identified

16.6.3 SEM Phase- 3—Analyse and Plan

As part of the phase, needs and requirements of the stakeholders are captured. Following are some of the activities being carried out during this phase:

Sl. No	Key activities in SEM phase	Stakeholders involved	Outcomes
1	Analyse the needs of the stakeholders	PM, CDFW execution team	Establish the relevance of the needs to the project
2	To train the new associates into the project	PM, CDFW execution team	Induction plan and process
3	To bring down the training time	CDFW execution team	Save training time, as faster productivity
4	To make associates productive in the least possible time	CDFW execution team	Resources are productive in less time compared to the earlier method of induction
5	To save faculty time	CDFW execution team	Less involvement of faculty
6	Self-motivated training to take ownership for the learning	Freshers	Freshers can learn on their own and practice the process steps
7	Iterate process to become efficient and complete within the acceptable time	Freshers	To ensure that the freshers internalize the process and complete the exit test within acceptable time
8	Evaluation compared to the experts' time	CDFW execution team	Data consolidation for the entire batch

16.6.4 SEM Phase-4—Strengthen Engagement Capacities

To prepare the stakeholders for engagement, the team has come out with following areas that require focus to engage the stakeholders along with the responsibilities to take up the engagement further.

Sl. No	Key activities in SEM phase	Stakeholders involved	Outcomes
1	Application of competence development framework in the project	CDFW execution team	Benefits of training the freshers in a different way
2	Application of stakeholder engagement methodology in the project	PM, CDFW execution team	Benefits of bringing the team together to accomplish the task of inducting the freshers and making them productive in less time compared to the earlier method

Sl. No	Key activities in SEM phase	Stakeholders involved	Outcomes
3	Prepare the team for engagement	HC team, CDFW execution team	Team is aware of what to do and the purpose behind it
4	Team to prepare the CAs	HC team	Identify the list of assets required
5	Execute the CAs by cross-functional team to identify and fix the gaps	HC team	Will help in identifying the gaps
6	Detailed process steps built into the CAs will help to execute	HC and CDFW execution team	The assets are complete in form
7	Conforming to the methodology while preparing CAs	CDFW execution team	Application of the CDFW methodology in to the competence assets
8	Review CAs and provide inputs as and when required	CDFW execution team	Review to identify the gaps to fix
9	Understand the process flow	CDFW execution team	Step-by-step process helps to execute better and faster
10	Influence vs interest mapping document	CDFW execution team	Will help understand the position of the each stakeholder

16.6.5 SEM Phase-5—Design Engagement Capacities

We arrived at the strategy based on the interest vs influence matrix, wherein, each stakeholder based on their interest and influence with respect to the engagement and in the execution of CA has been mapped. For example, engaging an SME to prepare the CA, he scores high influence but low interest, he needs to be motivated, and explaining him the benefits the team will gain over a period of time will actually help the CDFW team to convince him to prepare the CA. To prepare an asset, it requires some time and effort which is very precious for a person like SME. Other stakeholders based on their role were placed in the matrices; respective engagement strategy was applied to engage them as part of the engagement process.

The key activities during the design engagement strategy phase are:

Sl. No	Key activities in SEM phase	Stakeholders involved	Outcomes
1	Influence vs interest matrix with engagement strategy	CDFW execution team	Position of the stakeholder is ascertained, which will help in engaging the stakeholders with appropriate strategy
2	CAs prepared	SME in HC team	Assets are prepared based on the project skills and requirements
3	CAs reviewed	SME in HC team, CDFW execution team	Reviewed assets are available by the SMEs

Sl. No	Key activities in SEM phase	Stakeholders involved	Outcomes
4	Identify gaps in the process steps	HC review team	Gaps are listed and worked out
5	Update the CA with the identified gaps	CA reviewer	Gaps are fixed, competence assets are complete with required relevant information

16.6.6 SEM Phase-6—Engage, Review and Report

The CDFW team engaged the stakeholders listed above to carry out the engagement based on the preparation carried out under different phases and involved stakeholders based on various criteria explained through interest and influence matrix above. For example, the account manager was informed about the progress we were making during the processes; the CDFW team and the project manager were partnering to ensure that the CDFW implementation was carried out without delay. Both were actively involved in resources to prepare CA, review the assets, getting them validated and identify the gaps before executing these assets.

Similarly freshers, SME and CA have high influence over the process and low interest; they need to be motivated to involve in the process, to bring out the desired results. CA reviewers required to be empowered to review the process steps and provide their comments and gaps if any while executing. They are also required to be empowered to do the given tasks since they have good knowledge about the package and are experts in executing the processes pertaining to the health care package.

Sl. No	Key activities in SEM phase	Stakeholders involved	Outcomes
1	Explain the CA execution process	HC & CDFW E team	Aware of the CDFW methodology
2	Provide the CAs to the freshers	HC & CDFW E team	Availability of the CA to the freshers
3	To execute the CAs	Freshers	Following the process steps
4	Record time taken to execute the CAs	Freshers, HC Team	Time to execute the assets is recorded
5	Monitor the execution process	CDFW E team	Ensure procedure is followed while executing the assets
6	Record the execution details	HC team	Record the qualitative and quantitative details of execution process
7	Consolidate data of execution of each CA	HC Team	Time taken by each associate for each competence asset is recorded and consolidated

Table 16.6 Health care case illustration where SEM was adopted to implement CDFW

Application of SEM phases during implementation of CDFW	Processes followed in the project to implement the CDFW
1. Communication	1. Emails, one to one, phone calls, periodical meetings, etc
2. Think strategically to identify stakeholders	1. Need for additional resources
	2. Allocating freshers into the team
	3. Make the freshers productive in less time
3. Analyse and plan	1. Training them on ADT module
	2. Save the faculty time
	3. Save training time
4. Strengthen capacities for engagement	1. List of assets identified (7) in ADT
	2. Identify SMEs to prepare the assets
	3. List of assets prepared (7) and reviewed
	4. Assets are tested to identify gaps if any
	5. Update assets per review comments and gaps
5. Design engagement strategies	1. Use of interest and influence matrices to ascertain the stakeholder position over the project, to come up with the right strategy to engage
	2. Reviewed assets are available for use
6. Engage, review and report	1. Share the ADT module functionality
	2. Share the CDFW and the expectations
	3. Freshers to execute the assets
	4. Time to execute the assets is captured
	5. Consolidate data for every associate for each asset

Applying SEM, while implementing the CDFW, in the health care project is tabulated in a summary form (Table 16.6).

16.6.7 CDFW Implementation Data

Table 16.7 explains various assets in the ADT module, and the freshers identified to undergo the execution of the CA and the execution time is recorded. The table also has time required by an expert to perform and an acceptable time for the freshers to complete the process steps.

There are seven CAs available, and the CDFW process is explained to the freshers, and the assets for execution are provided to each fresher. Freshers are requested to record the time taken to execute the process steps. Similar process followed for all the five freshers for seven assets, the below table presents their execution data. Those who could not complete were requested to iterate the process till they met the acceptable time limit to complete the process steps prescribed in the assets (Table 16.7).

Table 16.7 Implementation data of freshers' as part of competence development process

Competency assets/resource	Time taken for execution in minutes						
	CA-1	CA-2	CA-3	CA-4	CA-5	CA-6	CA-7
Expert	8	5	10	10	6	4	5
Acceptable level	16	10	20	20	12	8	10
Trainee 1	14	10	12	16	12	8	9
Trainee 2	15	10	13	15	11	8	8
Trainee 3	13	9	12	17	10	7	10
Trainee 4	14	9	14	14	12	6	10
Trainee 5	12	10	11	13	11	8	10

16.6.8 Advantages of Applying CDFW and SEM

The HC team had the following benefits by implementing the CDFW in the health care project while applying SEM:

1. Understanding the CDFW process, resulting in well-defined process steps and error-free end product
2. Understanding the ADT module, while breaking into deliverable slices
3. Self-motivated learning, productive freshers resulting in enhanced productivity
4. Gain knowledge about the package in less time, and clarity on tasks to be performed
5. Reduced training time for faculty, freshers and other resources
6. Opportunity to learn new concepts
7. Improved team cohesion, resulting in completion in the given time
8. The process resulted as a part of project induction process
9. Extended the practice to other modules under the package in the same project

16.7 Flexibility with the Application of SEM

SEM has helped to ensure that we identify stakeholders involved and provide sufficient clarity with respect to their role and contribution towards completion of a given tasks to each stakeholder. The methodology also helped to cope with various challenges posed on the way such as resources moving out, reviewers' not available, unavailability of systems, reworking on the process steps, etc., all these because SEM gives us a handle on these issues to see from the stakeholders view. The whole exercise of CDFW implementation and training the freshers took 2–3 months time to complete, as we have adopted SEM.

16.8 Conclusion

In this chapter, we discussed the SEM, various phases involved in SEM, innovation, IM, three phases in IM, and the application of stakeholder engagement in the innovation context. Application of SEM in an innovation, i.e. CDFW in the health care context, and its implementation against the SEM phases is illustrated.

In this chapter, SEM has been applied to engage the stakeholders to prepare the CA, review the assets and execute these assets to train the trainees while implementing an innovative idea. The chapter describes the use of SEM in diffusing an innovation offering such as CDFW as per the lifecycle phases of IM. The innovation offering "Competency Development Framework" (CDFW) has been taken through the IM–idea diffusion phase in the health care project and along with it illustration and data on execution details are elaborated in this chapter.

In many instances, there exists certain stakeholder on the innovation value chain whose perception of value about an innovation is quite varied and difficult to fulfil. In such situations, unless there is a systematic approach that one can adopt to engage each stakeholder, it is not possible for an innovation endeavour to be successful. The SEM clearly demonstrates this benefit by which one can engage with the stakeholder. Also the SEM is independent of the level or type of innovation and hence can be applied in all innovation contexts. By applying SEM one can enhance the success of an innovation endeavour in itself. Further research can be done to make it more rigorous as possible.

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Chapter 17
Strategic Flexibility and Its Leveraging Effects on Technological Exploitation

R. C. Pathak, Rajesh Pathak and Sumati Sidharth

17.1 Introduction

More often than not most decisive actions, compelling vision, and great strategies are prerequisites of success, but unfortunately these are always the ingredients of failure too. This is due to the top management basing their decisions and forecast on the predictable future which is generally not so, as future is mostly unpredictable. One has to adapt strategic agility to cope with the uncertainties of the future for the productivity of the corporations. To cope with such happenings, one has to be valiant like a warrior. And, the problem can be (to a great extent) solved by 'strategic flexibility'. At the same time, the 'core strategic vision' (CSV) is also very important for developing a product with competitive technological exploitation (Raynor 2007).

Herein, a case study of Compaq and Dell computers is discussed. Along with that technology breakthrough of Johnson and Johnson Development Corporation (JJDC) and reverse engineering example of integrated field shelter (IFS) are discussed briefly and suitably presented.

17.1.1 Strategic Flexibility

We have witnessed beforehand that 'strategy paradox' requires a new way of thinking about strategy and uncertainty.

R. C. Pathak (✉)
JSPM's Imperial College of Engineering & Research, Pune, India
e-mail: rcpathakindia@yahoo.com; rcpathakindia@gmail.com

R. Pathak
PRTM, London, UK

S. Sidharth
DIAT, Girinagar, Pune, India

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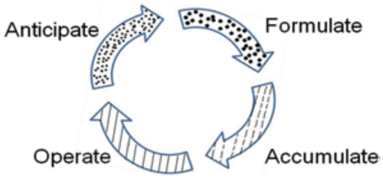

Fig. 17.1 Strategic flexibility depiction

As we know, 'flexibility means change within existing constraints', which is helpful in solving many problems. It can also be defined as the ability to change or react with little penalty in time, effort, cost or performance (Sushil 2000; Pathak 2006). Herein, real options are created for implementing new, different, effective, commitment-based strategies for competitive markets, for operating outside the spaces beyond constraints (Shimizu and Hill 2004; Raynor 2007).

Holveck in 2004 has adopted four basic components of strategic flexibility given as follows:

- *Anticipate*: In the business scenario the existence of strategic risk is a function of the unpredictability of the future where the 'possibility space' should be ascertained and change drivers identified.
- *Formulate*: In the present situations, the business scenario is visualized/appreciated by 'optimal strategy', and determines various core elements.
- *Accumulate*: Here in above 'core elements' can be pursued with appropriate commitment and options should have contingent elements.
- *Operate*: Combining the core elements, 'optimal strategy' and external environments are monitored.

The interplay of above four elements can be explained in Fig. 17.1.

17.2 CSV

There are various types of vision like turnel vision, impaired vision, blindness, shortsightedness, hallucination, exceptional vision, 20/20 vision, peripheral vision, foresighted vision, and finally 'CSV'. A good CSV is sufficiently focused (McGrath 2007).

17.2.1 Deliberate and Emergent Strategy

The ability to foretell about tomorrow and future is what we call strategy deliberateness. These can be explained from Fig. 17.2.

As we know strategy is linked to the future and the future is unknown and unpredictable, this makes strategy a fascinating and at the same time frustrating factor.

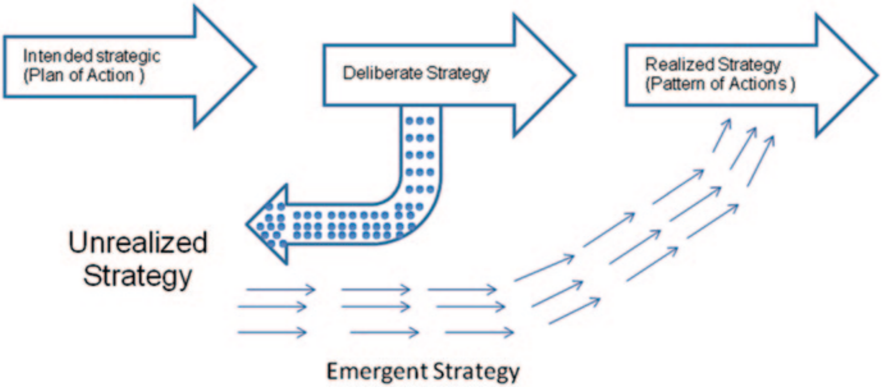

Fig. 17.2 Deliberate and emergent strategy

Thus, the ‘tension’ becomes a central point to the strategy formation (Bob de wit and Ron Meyer 2004). When people act deliberately, they ‘think’ before they ‘do’. Herein, the ‘power of intuition’ and ‘power of simplicity’ both work simultaneously/concurrently (Klein 2004; Trout 2001). The various parameters of deliberating the strategies are:

Direction	Optimism
Commitments	Programming
Coordination	Flexibility

17.3 Case Studies

17.3.1 Case Study (I): Compaq and Dell Computers

Right from the start during 1983 Compaq computer had a crystal-clear CSV, i.e. having the best portable computer in the world. During 1991, its CSV started faltering and revenues declined from $ 3.6 billion to $ 3.3 billion and the company was barely profitable.

With the change of CEO and founder, Rod Canion to CEO Eckhard Pfeiffer, in 1992, a new CSV was evolved and implemented.

Pfeiffer changed the following:

- Higher cost platform strategy was changed to low-cost platform strategy.
- Manufacturing costs were reduced by shortening cycle-time.
- Reduced overhead cost.
- Administrative cost was cut to half.
- Compaq slashed its R&D investment from 6 to 2% of revenue.

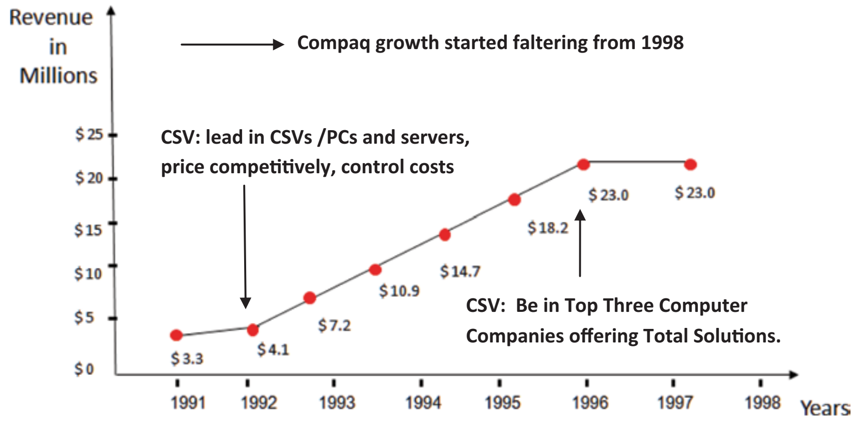

Fig. 17.3 Compaq faltered in 1998—change of CSV

New CSV brought Compaq at peak of computers growth by 1997 but by 1998 growth became flatter and Compaq lost $ 2.7 billion and then the growth declined (Refer Fig. 17.3).

With a clear and strategic development of CSV, during 1999, Dell computer overtook Compaq as the new leader in the PC industry.

17.3.2 Case Study (II)—JJDC

Holveck felt in 2004 that JJDC was in danger of slipping into strategic irrelevance. JJDC created strategic flexibility for J&J's 200 plus operating companies. This turned in a focused manner a high-return strategy to profitable productivity, which otherwise could not have been done. Thus, enhancing the performance and lowering the risk was achieved (Raynor 2007).

17.3.3 Case Study (III)—IFS

For the development of this IFS, author Pathak (1997) was himself responsible for doing reverse engineering of a product known as 'Koenig Shelter' by a small country Switzerland. Swiss had developed this shelter way back in 1972.

'Reverse engineering' channels are also one of the powerful tool for technology transfer. The knowledge of ability to transfer the tacit knowledge of developers is done during process of product development (Khalil 2000).

The IFS shelter is self-contained for approximately an infantry platoon (30 persons) who can be protected from nuclear, biological, chemical (NBC) warfare from toxic vapours and the personnel can survive for at least 96 h living inside the module. Some of the salient features of IFS are:

- Made of prefabricated galvanized steel components in modular construction concept.
- Overall diameter 2.5 m and 28 m long.
- It has three living modules, ventilation system, connecting modules and entry/exit connectors.
- IFS is structurally strong enough to withstand the nuclear blast (overpressure) of 7.5 t/m^2 and circular pressure for earth covered portions and 15 t/m^2 longitudinal pressure for portions not covered by earth.
- Special fasteners for quick erection and dismantling.
- The heart of the system is ventilation/filtration system, three nos, blower filter of 200 cum/h capacity with prefilter and composite Hepa filter integrated with flash sensor.
- Herein, power supply of two nos generator sets of 5 KVA capacity each, water supply of two nos 1000 l tanks, sewage disposal chemical toilets/pumps are installed which provide sufficient radiation protection to the personnel as well as equipments.

17.4 Conclusion

In this chapter, we have observed that 'strategic flexibility' has been applied to overcome 'strategic paradox scenario', 'strategic flexibility', 'emergent strategies', and 'CSV' have been briefly deliberated. The three case studies of technological developments/exploitations and reverse engineering have been suitably cited while discussing the cases. The three case studies presented in the chapter are:

- Compaq and Dell computers based on CSV.
- JJDC has brought out 'strategic flexibility' dimensions for keeping JJDC in the market main stream, overcoming strategy paradox.
- Last, the third case of IFS has been briefly presented as 'reverse engineering' dimension, which is a powerful tool of transference of technology (TOT).

All the above cases amply justify the technology and its technological development through CSV, 'strategic flexibility' and 'reverse engineering' for IFS. The developed IFS also has gone into production today.

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Chapter 18
A Framework Conceptualization for National Technological Competitiveness

Sudhir Kumar Mittal, Kirankumar Momaya and Sushil

18.1 Introduction

The notion of competitiveness centers on the business ability, productivity, and performance of a firm, sector, or nation in relative sense. There are mainly three foundations for global competitiveness, viz., (a) company competitiveness; (b) sector competitiveness; and (c) country competitiveness. The company competitiveness refers to the ability of a company to design, produce, and/or market products superior to those offered by its competitors, allowing for both price and non-price merits. Sector competitiveness indicates the extent to which a business sector or industry (as collective ability of the firms under the sector) provides potential for growth, return on investment, and human resource development (Momaya et al. 2006). The country competitiveness points to the extent to which the environment of a nation is favorable or detrimental to business (D'Cruz and Rugman 1992). A nation's level of competitiveness reflects the extent to which its residents are enabled for rising prosperity. The country competitiveness depends on a collective set of institutions, policies, and factors that determine its level of productivity. The overall economic competitiveness of a country depends on a number of pillars, such as institutions, infrastructure, macroeconomic stability, health and primary education, higher

S. K. Mittal (✉)
Department of Management Studies, Indian Institute of Technology Delhi, Vishwakarma Bhawan, Shaheed Jeet Singh Marg, New Delhi 110016, India
e-mail: mittalsudhirkumar@gmail.com

K. Momaya
Shailesh J. Mehta School of Management (SJMSOM), Indian Institute of Technology Bombay, Powai, Mumbai, India
e-mail: momaya@som.iitb.ac.in

Sushil
Department of Management Studies, Indian Institute of Technology Delhi, Vishwakarma Bhawan, Shaheed Jeet Singh Marg, New Delhi 110016, India
e-mail: sushil@dms.iitd.ac.in, profsushil@gmail.com

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education and training, goods market efficiency, labor market efficiency, financial market sophistication, technological readiness, market size, business sophistication, and technological innovation (GCR 2012–2013). The competitiveness can be quickly evaluated on criteria such as size, growth rate, exports, trade balance, etc.

Technological competitiveness can be understood as the technological ability of a firm or a nation to make it competitive such that it is able to ensure not only its survival but also a sustainable growth with superior performance matrices. This refers to the technological ability to establish market advantage with higher quality and less expensive new goods and services as compared to those from competing firms or countries. The firms not furnished with adequate technology, technology acquisition strategy, and innovation initiatives may find it difficult to compete in an open economy in the long run (Banwet et al. 2003). As per ITCD (2009), technological competitiveness refers to the ability to provide cutting-edge technical capabilities, higher performance metrics, fuel economy, or consistent dependability. Many a times, technological competitiveness can be more significant than price competitiveness in international trade, predominantly in the industries heavily dependent upon advanced technology, such as telecom, aerospace, etc. In the contemporary world, national competitiveness is largely based on technology since the science and technology establish the influential elements in the new productive forces. Porter and Stern (2001) have envisioned that those developing nations progress ahead, which count heavily on technology for their economic development with a conviction that science and technology will define the future basis of their competitiveness. Fuller (2006) assessed that amidst all the prominent fears over offshoring, industry development, and even terrorism, one concern always engages the thought banks of even the developed nations like the USA, that is, the technological competitiveness of the nation. There are two main determining factors which explain investments and exports for a country, viz., technological capabilities and the extent of economic development (Narula and Wakelin 1998).

The purpose of this chapter is to review the literature and identify the key measures and frameworks related to the technological competitiveness, and further synthesize the findings from the literature into a framework depicting the dynamics of the national technological competitiveness. The chapter provides thought-provoking insightful views for key stakeholders to align their strategies to enhance technological and overall competitiveness.

18.2 Findings from Literature

Literature has been reviewed in this section under the topics such as views of strategic thinking for managing competitiveness, globalization of technology, importance of technology development, innovation, national innovation system and sectoral innovation system, measuring technological competitiveness and strength of national innovation system, policy interventions and strategies to enhance technological competitiveness, and role of industry and business associations.

18.2.1 Three Views of Strategic Thinking for Managing Competitiveness

Since competitiveness of firms, sectors, and nations differ to a large extent in a dynamic and evolving manner, the fundamental aspect is to understand the strategic reasons behind it (Porter 1990a). As compiled by Peng (2006), there are three fundamental views of strategic thinking, that provide inputs to formulate the strategy for a firm, which ultimately determines the competitive performance, as shown in Fig. 18.1.

While the industry-based view primarily emphasizes on the external opportunities and threats, the resource-based view largely focuses on the internal strengths and weaknesses. The institution-based view argues the impacts from factors such as the government, regulations, and society while shaping the strategy. A suitable combination of all three of them may determine the strategies for the firms for the competitive performance.

i. Industry-based view
   The industry-based view suggests that before working on the firm's strategy it is important to examine the five competitive forces affecting an industry, viz., (1) interfirm rivalry, (2) bargaining power of buyers, (3) bargaining power of suppliers, (4) threat of new entrants, and (5) threat of substitutes (Porter 1979).
   As the forces influencing the competition in an industry and their fundamental causes are assessed, a firm's strengths and weaknesses can be identified and a strategy can be formulated to bring out a locus that is less exposed to these five forces. While the firms' activities narrowly interrelate with the settings of national competitiveness, a lot of consideration has been given to the inside of the firms rather than the outside; however, the location factor no longer remains exogenous to firms (Cho et al. 2008). This is specifically true for MNCs since they could easily change locations through national borders. Thus, enhancement

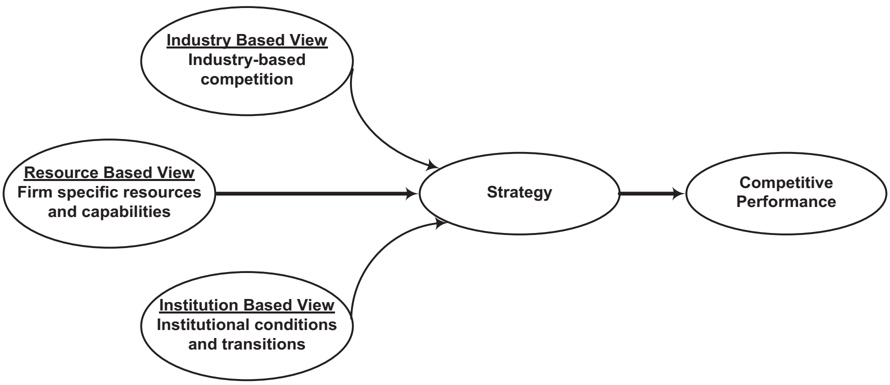

Fig. 18.1 Three views of strategic thinking for managing competitiveness. (Adapted from Peng 2006)

of firm competitiveness and sustainability of MNCs has connection with competitive advantages of nations. Location does matter for innovation and firms need to expand their methods to the management of innovation, hence, by crafting and commercializing innovation in the most conducive location, captivating active steps to acquire locational strengths, and proactively improving the setting for innovation and commercialization in locations where they function (Porter and Stern 2001). The competitiveness of a firm in a given environment depends on the factors like context for firm strategy and rivalry, factor (input) conditions, demand conditions, related and supporting industries as per the "diamond" model (Porter 1990).

ii. Resource-based view

The resource-based view advocates that the firm-specific resources and capabilities mostly distinguish successful firms from firms akin to failure. Four empirical indicators of firm resources to create persistent competitive advantage are value, rareness, imitability, and sustainability (Barney 1991). These resources and capabilities can be viewed as bunches of tangible and intangible assets, including a firm's management abilities, its executive practices and procedures, and the information and knowledge base it manages. The impact and applicability of the resource-based view is significant on all the major subject areas like human resource management, economics, entrepreneurship, marketing, and international business (Barney et al. 2001). The resource-based theory describes persistent higher firm performance by concentrating on the differentiating ability of firms to grow novel capabilities as environments change (evolutionary economics) and rents created by this differentiating ability to grow further novel capabilities (neoclassical economics; Barney 2001a). The main assumption in the resource-based view is that resources and abilities can be heterogeneously disseminated through competing firms, that these dissimilarities can be long-lasting and can help elucidate why certain firms consistently outclass other firms. Managers can apply resource-based logic to any resource whose worth can be derived from the market environment in which the resource is to be used (Barney 2001b).

Hunt (2000) suggests that competition is not about apportioning limited resources but about generating more resources, and that competition is hence "pro-society." However, there is a need to rigorously formalize the resource-based view, answer the causal "how" questions, incorporate the temporal component, and integrate the resource-based view with demand heterogeneity models (Priem and Butler 2001).

iii. Institutions-based view

The institution-based view typically signifies the regulatory, policy, social, political, and ethical aspects for the firms. Institutions are the rules of the context in a social order or, more strictly, the humanly formulated constrictions that profile human communications (North 1990). Institutional change contours the way societies develop through stages and hence is crucial to understand chronological evolution. The main role of institutions in a society is to decrease ambiguity by founding a stable edifice to human exchanges. From contracts, codes of conduct, and customs of behavior to statute law and common law, and bonds among entities, institutions are emerging and hence, are recurrently varying the options offered to humans. As per Scott (2001), "Institutions are social structures that have attained a high degree of resilience; Institutions are composed of cultured-cognitive, normative, and regulative elements that, together with associated activities and resources, provide stability and meaning to social life; Institutions are transmitted by various types of carriers, including symbolic systems, relational systems, routine, and artifacts; Institutions by definition connote stability but are subject to change processes, both incremental and discontinuous." Scott (2001) further says that an institutional framework is supported by three "pillars," viz., regulatory, normative, and cognitive. The regulatory pillar supports formal institutions and the normative and the cognitive pillars support informal institutions (Peng 2006). Formal institutions include laws, regulations, and rules (such as competition and regulation policy, intellectual property rights regime, contract law, and their enforcements). Their primary supportive pillar—the regulatory pillar—is the coercive power of government. Informal institutions include norms, culture, and ethics. Because norms define how things should be done, the normative pillar speaks of how the values, beliefs, and norms of other pertinent actors influence the conduct of individuals and firms. The cognitive pillar points to the adopted and assimilated morals and beliefs that influence individual and firm conduct.

18.2.2 Globalization of Technology

One of the important aspects about the technological competitiveness at country level is the globalization of technology. While international generation, transmission and diffusion of technology is seen as the path to progress, at the same time it is a phenomenon which displaces the national systems of innovation such that any effort by national governments to nurture technological advancement locally are made redundant and futile. As ideally, globalization is a set of mutually beneficial interactions between countries and MNCs to enhance competitiveness of each participant, benefits countries enjoy from globalization should be understood in terms of national competitiveness; and statistical analysis shows that paybacks from globalization are unevenly disseminated across countries (Kim 2006).

There are three distinct categories of technological globalization (Archibugi and Michie 1995): (a) the global exploitation of technology; (b) global technological collaboration; and (c) the global generation of technology. The majority of inventions are already exploited globally and this process is continuing at a rapid pace. As far as global technological collaboration is concerned, the main determinant is the competence of the partner rather than access to markets. The third category of global generation of technology is much weaker than the first two. The large firms of developed countries, however, have a much lower propensity to undertake research and development (R&D) in host countries. These firms do not decentralize strategic activities of the R&D. Further, the tendency to operate from host countries, in some cases, is due to a long tradition of foreign direct investment. In the case of smaller countries, the relative lack of technological expertise at home and the inadequacy of domestic infrastructure is the reason behind a large share of R&D performed abroad by home base. Even though globalization permits the diffusion of knowledge at a much higher speed than in the past, this does not essentially imply that the developing countries become successful to gain from technological progresses. This strongly depends on the nature of the technology and of the policies applied in both developed and developing countries (Archibugi and Pietrobelli 2003).

From the host developing countries' point of view, the actual benefit of technology globalization, especially global technology generation, are from the knowledge spillover consequence of the several linkages in the innovation system of the country. The various linkages of the foreign R&D are to the local universities/R&D institutions, local human resource, and local firms. The benefits also depend upon the preparedness of the local systems and existence of incentives to accentuate the process (Mrinalini and Wakdikar 2008). Many of the developed countries also sometimes narrowly focus their competencies using resource-based approach or specific market-oriented approach (e.g., a small domestic base at the edges of global markets), and thus run the risk of losing competitiveness. Even they can be much benefited from inward FDI, thereby getting complementary resources such as newer technology, capital, human resource, and international market access (Scott-Kennel 2004).

Another aspect affecting the competitiveness is the affiliates' position to introduce and utilize unique resources from home country to enhance the affiliates' competitiveness in the host country, and making the capabilities and resources available to the local firms. This provides gain to the host country in the form of higher industry production and productivity, prospects for employment, native supply and exports, and absorption of superior technologies. Spillovers are also observed in the form of transfer of human resources, skills, information, and expertise. However, for developing countries, the gains from FDI are many a times not so impending because of foreign dominance and large gaps in the technological capabilities. In the line of technology globalization, one of the obvious policy aspects is to attack the barriers to free and open trade. However, in addition to this, some of the policy aspects for even a developed country like the USA for enhancing competitiveness in the long run are upgrading the educational system, promoting scientifically and technically skilled work force, increasing government sponsored commercial R&D expenditure, offering monetary incentives for domestic R&D, and offering monetary incentives to boost long-term capital investment by business (Merchant 1997).

A number of countries, including large ones like India, China, and the USA, have leveraged the rising internationalization of innovation to counterbalance weakness in their own national innovation systems. Yet, globalization brings out critical questions of autonomy, security, and equality and, in turn, the political tussle over these three concerns outlines the pace and the scope of the globalization of science and technology. Major deterioration on any one of these measures could result inconsiderably less backing among policy makers and the public for the globally networked system of innovation that looks to be emergent (Segal 2008). The developed economies have been the proponents of open investment policy regimes for the developing economies in order to increase their business reach. It may be a different matter that many of the advanced countries themselves did not use such liberal foreign investment policy during their own development phase (Chang 2004). MNEs and FDI may well result in an upsurge in productivity and exports, but they may not essentially result in improved competitiveness of the domestic sector or enhanced industrial capacity, which eventually decides economic progression in the long run (Lall and Narula 2004). It may be worthwhile to conclude that FDI may provide the much needed growth opportunities if the domestic industrial sector has the necessary technological capacity to gain from these externalities.

18.2.3 Importance of Technology Development, Innovation, and National Innovation System

Even though the global generation of technology is one of the successful phenomenon, it is imperative to complement it with a rugged national system of innovation to sustain the long-term competitiveness. Some of the definitions of national innovation systems are quoted in OECD publication National Innovation Systems (OECD 1997), and are reproduced here. The national system of innovation has been defined as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify, and diffuse new technologies" (Freeman 1987). As per another definition, the national system of innovation could be defined as "the elements and relationships which interact in the production, diffusion, and use of new and economically useful knowledge and are either located within or rooted inside the borders of a nation state" (Lundvall 1992). As per Nelson and Rosenberg (1993), it is "a set of institutions whose interactions determine the innovative performance of national firms." Patel and Pavitt (1994) say that it is "the national institutions, their incentive structures and their competencies, that determine the rate and direction of technological learning (or the volume and composition of change generating activities) in a country." As per Metcalfe (1995), it is "that set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies, and which provides the framework within which governments form and implement policies to influence the innovation process. As such, it is a system of interconnected institutions to create, store, and transfer the knowledge, skills, and artifacts which define new technologies."

If the phrase "national innovation system" is to be explained by each term, then: "national" depicts the part of a national government, which cannot be overlooked in any innovation process, though some institutions are transnational; "innovation" is the process by which companies accomplish and adopt product designs and engineering processes that are novel to them; and "system" is understood to be a set of institutions whose exchanges define the innovative performance of firms or a set of institutional actors who play a key part in inducing innovative performance (Nelson and Rosenberg 1993). The concept of industrial competitiveness has been there for more than last six decades with the origin of industrial economics and the structure–conduct–performance framework (Mason 1939; Clarke 1985). Industrial development implies the formation and growth of a range of innovation systems centered on specific technologies or industries and such national innovation systems are made up of three components: firms and other organizations, networks, and institutions (Jacobsson and Bergek 2006). The firms are found within the whole value chain. Other organizations include universities and other parts of the educational subsystem, industry, and other professional organizations, bridging organizations, other interest organizations, such as Greenpeace and government bodies. A national innovation system could be understood to be a mechanism whereby as a whole, the innovation is established and achieved in a nation. From this viewpoint, the element of examination is the national economy and the major actors influencing the innovation process are the government, universities, government-sponsored laboratories, and private companies (Lee and Han 2002). The vitality of innovation in a location is shaped by national innovative capacity (Porter and Stern 2001). National innovative capacity is a country's potential—as both a political and economic entity—to produce a stream of commercially relevant innovations. The national innovative capacity framework has three broad elements, viz., (1) common innovation infrastructure, (2) cluster-specific environment for innovation, and (3) quality of linkages between the first two elements. Figure 18.2 portrays the details of the broad elements in the national innovative capacity.

The important policy choices take account of the protection of intellectual property, the degree of tax-based incentives for innovation, the degree to which antitrust

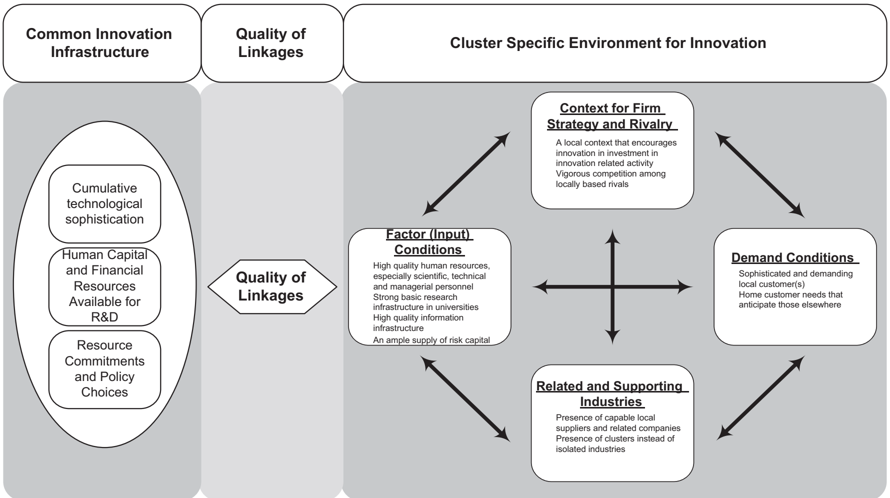

Fig. 18.2 Elements of national innovative capacity framework. (Adapted from Porter and Stern 2001)

enforcement boosts innovation-based competition, and the extent of liberalism in the economy to trade and investments. A strong common innovation infrastructure essentially includes national investments and innovation-related policy selections sustained over decades. While the common innovation infrastructure creates the elementary environment for innovation, it is eventually business firms that bring together and commercialize innovations that take place unevenly in clusters, that is, geographic concentrations of interrelated firms and institutions in a specific area. The analysis of the cluster-specific innovation can be done in "diamond" framework (Porter 1990). The interconnection between the common innovation infrastructure and a country's industrial clusters is both ways, that is, robust clusters strengthen the common innovation infrastructure and in turn also gain from it. Various formal and informal organizations and networks, that are called "institutions for collaboration," can link them. A significant example is a country's university system, which delivers a conduit between technology and companies. Without robust linkages, upstream scientific and technical progresses might diffuse to other countries more rapidly than they could be exploited domestically (Porter and Stern 2001).

As per GCR (2012–13), even though considerable advantages can be attained by refining the different pillars of competitiveness, all but one of them (viz. technological innovation) ultimately fall toward waning returns. There is a high correlation between technology management and competitiveness (Momaya and Ajitabh 2005). In the long run, standards of living can be expanded only with technological innovation. The national innovation system is fallout of the various systemic approaches to analyze the innovative and economic performance of the countries (OECD 1997). The countries where the national innovation system is more advanced dominate world trade and generate structurally positive external balances. The reverse is the case for countries where the national innovation system is less established (Resende and Torres 2008). The comparative advancement of the national innovation system in an economy is significant to explain its competitiveness, its extent of external susceptibility, and the intensity of its external constriction to growth. Thus, stimulating the development of the national innovation system in developing countries is an approach to steadily shrink the gap in growth rates among countries.

Higher intensities of technical collaboration, technology diffusion, and personnel mobility add to the enhanced innovative capacity of firms on account of products, patents, and productivity (OECD 1997). The technology development and diffusion has been found to be a key factor for the economic performance of the countries. Technological competitiveness is one of the main factors that impacts on the international competitiveness of a country. Technology evaluation needs to be a regular phenomenon for competitiveness enhancement. This regular assessment needs to be carried out on technological assets and related investments, R&D, and technology development and its management process (Banwet et al. 2003). There is a strong positive impact of the domestic R&D intensity and its efficient exploitation on the economic growth of a country and this may be generalized to countries even other than the advanced OECD nations (Ho et al. 2005). Business R&D activities are an important input to a country's scientific and technological development and contribute directly to increased domestic productivity and growth (Mani 2005).

There is a close correlation between the extent of economic advancement, measured as GDP per capita, and the extent of technological advancement, measured as R&D or patent statistics; moreover, technology gap models of economic development are established to explain a substantial part of the concrete variations in growth rates, among both countries and periods (Fagerberg 1987). The firms exposed to enhanced product market competition display a greater inclination to embrace technological innovations (Goel and Rich 1997).

On the flip side, there is also a robust link between R&D activities and the level of income, suggesting that R&D activities become important only after a country reaches a certain stage of development and the countries that are behind in technology, grow by catching up technologically, not by advancing the technological frontier (Birdsall and Rhee 1993). Technology development positively influences almost all the aspects of the national competitiveness for the countries who have reached to a certain stage of development (Wang et al. 2007). Moreover, the firms having acquired the technology from a donor firm or a lab discover that implementation and adaptation issues are hard to tackle due to tacit technology knowledge and dearth of technical or managerial or market-linked systems and practices. They result in technological failures denoting the conditions where significant nonconformities from anticipated opportunities and effects arise. The failures take account of loss of access opportunities, or rejection of technology by the market, or failure at technology refining procedures (Madanmohan 2000).

18.2.4 Sectoral System of Innovation

The notion of sectoral systems of innovation complements the concept of national innovation system. A sectoral system of innovation and production consist of the set of heterogeneous agents carrying out market and nonmarket exchanges for the generation, adoption, and use of (new and established) technologies and for the creation, production, and use of (new and established) products that relate to a particular sector. The agents are individuals (e.g., consumers, entrepreneurs, and scientists) and organizations (firms—e.g., users, producers, input suppliers; subunits of firms—e.g., R&D or production departments; non-firms—e.g., universities, financial institutions, government agencies, trade unions, technical associations; group of organizations—e.g., industry associations) at various levels of aggregation, with specific learning processes, competencies, organizational structure, beliefs, objectives, and behaviors (Malerba 1999, 2002). Sectoral systems have a knowledge base, technologies, inputs, and (potential or existing) demand. The definition of sectoral system brings out some points which contrast with the standard definition of a sector. The industrial organization definition of a sector identifies the sectoral boundaries as given and static, and the firms as the key players who utilize alike technologies, inputs, and techniques, produce goods which satisfy particular functions to customers, and be involved in market interactions, transactions, and strategic positions about competition, cooperation, and command (Malerba 1999).

As against this, the sectoral system of innovation has three building blocks, viz., knowledge and technology, actors and networks, and institutions (Malerba 2004).

As per the first block, any sector can be characterized by a specific knowledge base, technologies, and inputs. Links and complementarities at the technology, input, and demand levels take account of interdependencies among vertically or horizontally related sectors, the conjunction of earlier separated products or the rise of fresh demand from the existing one. Second, the firms are the main assorted players in the creation, acceptance, and usage of novel technologies. The players also include users and providers that have varied associations with the innovating, fabricating, or trading firms. Other players in sectoral systems are nonprofit establishments, government organizations, and local authorities, etc. They support innovation, technological dissemination, and fabrication by firms in many ways; however, their role significantly varies across sectoral systems. Third, in all sectoral systems, institutions perform a key role in influencing the rate of technological transformation, the organization of innovation-related actions, and their performance. Cognition, actions, and interactions of agents are molded by institutions, which comprise norms, routines, common habits, established practices, rules, laws, standards, etc. The extent of the roles of different actors and institutions varies in cross-country comparisons of the innovation systems, for instance, the substantial yield of business firms in Japan and the USA is dissimilar from the setup in the European Union, where the related scientific activities are led by academic and government research institutes (Miyazaki and Islam 2007).

18.2.5 Measuring Technological Competitiveness and Strength of National Innovation System

There are mainly four components which determine the innovation performance of a sector, viz., (1) creation of new produces and types of innovation related expenditures; (2) extent of interactions among the stakeholders and the systemic nature of the knowledge base; (3) extent of imitation of new produces and formulation of new processes; and (4) the innovation intensity and the level of technological opportunities (Castellacci 2003). Further, there are various dimensions of technological competitiveness at country level, industry level, and the firm level, which can be used to measure the technological competitiveness (Banwet et al. 2003). In the context of this chapter, the dimensions of the technological competitiveness at the country level include, R&D activities, transfer of technology, investment (both public and private) in science and technology, centers of excellence in strategic science and technology, cultural diffusion of science and technology, digital communication, returns from IT investments, productivity, environmental quality management, cooperation and networking, superior technology, continuous innovation, technological innovation and diffusion, and technology selection strategy and prioritization among them.

To measure the extent of the effectiveness of the national innovation systems, many input, output, and process variables have been identified. These variables have been classified in the major building blocks of the national innovation system, viz., innovation-related efforts, institutional framework settings, innovation-related knowledge base, openness for information and conducive financial conditions. Further, another building block is added, viz., sectoral specifics, to cater to the effect of the sectoral configuration of an economy on the institutional settings of a national innovation system as well as the organization and course of innovative actions in a country (Balzat and Pyka 2005). Innovation and technological advancements are the results of communications and relationships among the players in the system, viz., enterprises (primarily joint ventures and other technical collaborations), universities, and government research institutes. The capacity and valuation of national innovation systems depends on four types of knowledge or information exchanges: (1) exchanges among enterprises; (2) exchanges among enterprises, universities, and public research institutes, which includes joint research, co-patenting, co-publications, and other informal associations; (3) diffusion of knowledge and technology to enterprises, which includes industry acceptance rates for innovative technologies and diffusion through procurement of machinery and equipment; and (4) personnel mobility, that is, movement of technical workforces within and between the public and private enterprises (OECD 1997).

Porter and Stern (2001), suggest that the US patents are, by and large, the prominent indication of innovative intensity. Other measures of innovation accomplishment include patterns of exports in the global high-technology marketplaces. The measuring factors for common innovation infrastructure are the hired scientists and engineers, the overall R&D outlay, the portion of GDP dedicated to spending on higher education, the efficacy of intellectual property protection, the economy's conduciveness to international trade, and the R&D tax policies. The measuring factors for cluster-specific innovation environment include the portion of nationwide R&D outlay financed by the private sector to echo the overall private R&D environment, and the relative focus of patenting activity across technological arenas to reveal the degree of technological specialization. The measuring factors for quality of linkages comprise the share of nationwide R&D outlay within the university segment. Linkages also develop via channels which are relatively difficult to measure, such as venture capital setups, the top institutes, and other informal company setups. Furman et al. (2002) use the same parameters to assess the national innovation capacity for 17 OECD countries. Hu and Mathews (2005) perform similar measurements for finding the national innovative capacity in East Asian countries, Korea, Taiwan, Hong Kong, and Singapore. In addition, Hu and Mathews (2008) perform the assessment of the national innovative capacity for China in a similar manner. For the general competitive structure for a nation, Cho et al. (2008) recommended a dual double diamond methodology and proposed a number of parameters for the factor conditions, business context, related and supporting industries and demand conditions of a nation having added scope dimensions of international–domestic settings, and the source dimension of physical–human aspects.

As per Godin (2006), the pertinent measures for science, technology, and innovation policy are (i) input—research budget or gross expenditures on research and development (GERD); and (ii) output—patents, high-technology products, marketed innovation, number of scientists a country generates, yield of scientific or technological form, efficiency, economic growth, productivity, profitability, and quality of life. OECD (1997) lists these parameters as, (i) input—R&D expenditure by private sector, R&D tax credits, subsidies and grants, expenditure in training and information technology; (ii) process—technological alliance among enterprises, joint research undertakings, co-patenting, co-publications, personnel mobility, intellectual property rights (IPR) rules, labor market policies, exchange programs to enable collaborations, adaptation of technology after Transfer of Technology (TOT), new products, patents; and (iii) output—technological balance of payment (net exports or imports of technological knowledge), embodied technology flows (technologies attained from imports of capital goods and intermediary products—flow of machinery, equipment and components that incorporate new technology), and dissemination of equipment and technologies as a result of R&D.

Banwet et al. (2003) use assets–process–performance (APP) framework to identify the corresponding dimensions. The dimensions of competitive assets are (a) technological infrastructure and domain knowledge expertise; (b) R&D and technology development-related investments, facilities, and commitment; (c) technological investments; (d) intangibles such as human capital and employee flexibility, quality of customer services; (e) human resources engaged in technology areas; (f) professional wages and ability to raise funds; and (g) average age and experience of software professionals.

The dimensions of competitive processes are (a) research and technology management—including research organization collaboration, technology development and transfer, and innovation; (b) change management and knowledge management; (c) synergies among network linkages, shareholders, and integrated project management; (d) strategic planning; (e) implementation processes—self-help, QA practices, talent management process; and (f) human resource development (HRD) process.

The dimensions of competitive performance are (a) employee and customer satisfaction; (b) intangibles such as branding and goodwill, industry–institute interactions; (c) international—technology-related exports, technological trade balance; (d) competitive leadership; (e) quality and productivity; (f) international certifications; (g) customer complaints; and (h) Compound Annual Growth Rate (CAGR). Castellacci (2003) suggests that the relevant indicators for innovation performance of a sector are size of innovators, technological regimes, technological trajectories, and nature of innovation, firms' strategies.

Some more constructs for technological competitiveness include country's technological alignment, socioeconomic structure, technological setup, industrious capability, and technological standing (Porter et al. 2006). First four in this list are the input constructs and the technological standing is the output construct. Some of the variables under these constructs include the value of high tech exports, royalty or license fee, receipts, the students registered for secondary education, the students registered for tertiary education, FDI (net inflow, balance of payments), patent submissions by nonresidents, Electronic Data Processing (EDP) machines procurements, the number of scientists and engineers involved in research and experimental activities, royalty and license receipts and payments, communication (internet hosts per capita, telephone lines per capita, mobile subscriptions per capita), patent submissions by residents, scientific and technical publication, R&D outlays, the total electronics manufacturing, producing value added services, etc. Mittal et al. (2013) use many of these measures to assess the technological competitiveness of a number of countries.

18.2.6 Policy Interventions and Strategies to Enhance Technological Competitiveness

To improve the technological competitiveness, the policies that are oriented to enhance the exchanges among the actors and institutions in the system and that target augmenting the innovative capacity of firms in terms of identifying and absorbing technologies are the most valuable. A set of framework policies related to regulations, taxes, financing, competition, and intellectual property can facilitate or hinder the several types of exchanges and knowledge movements (OECD 1997). Critical aspects in refining national technological competitiveness might exist in the competitiveness course of nurturing the emerging sectors, specifically crafting facilitating environment, cooperative returns, robust commercialization abilities, infrastructure formation, mass awareness, and entice global resources by means of alliances (Momaya 2008). Countries which are not scientifically progressive need to cultivate substantial capacity and motivation before obstacles to technology implementation can be overcome, and public policy aspects in specific areas will stimulate public deliberations and significantly impact technology implementation (Silberglitt et al. 2006). Policy interventions in the innovation systems incorporate a range of activities comprising those found within science and technology policies, tax policies, standardization measures, formation of early markets via, for example, procurement policies and so on (Jacobsson and Bergek 2006). For an innovation system to evolve and perform well, seven functional requirements need to be fulfilled, viz., (1) knowledge development and diffusion; (2) influence on the direction of search; (3) entrepreneurial experimentation; (4) market formation; (5) legitimation; (6) resource mobilization; and (7) development of positive externalities.

As per Archibugi and Pietrobelli (2003), the FDI or the import of foreign technology, either embodied or disembodied, has a negligible learning impact on the technological competitiveness of a developing host country per se, unless when accompanied by local policies to promote learning, human capital, technologies capabilities, and access to knowledge and technology. Hence, government policies have a significant role to treat FDI as a learning platform and as a conduit of technology transfer. In other words, the industrial policy through FDI needs to be linked to technology policy through FDI. An undue focus of technology-intensive activities in the hands of foreign Trans-National Corporations (TNCs) could have the drawback to enhance the dependency on the strategic selections of foreign firms and many a times even hinder the development of domestic firms. A policy fostering both externalities as well as spillovers is desirable for the developing countries.

However, the TNCs' initial investment is generally outlined in the background of the host country's prevailing technological, human resource, and supplier abilities (Mortimore and Vergara 2004). It is up to the host countries to implement state policies which persuade, cajole, or incentivize the TNC for refining and upgrading the abilities to persist with further technologically advanced industrial activities, generating higher gains for domestic firms and employees in the course. Hence, success rests not only on drawing the investment but also on extending its existence in the host country on the basis of dynamic not static relative advantages. For this purpose, government policy must always gauge the impact of TNC investments in order to assess the extent to which both TNC goals and host country's developmental priorities are fulfilled. Some tangible and clearly defined idea of improvements in technology transfer and assimilation, human resources, production linkages, and enterprise development is a prerequisite for outlining how FDI supports in expanding and upgrading national industry. This is because liberalization and growing cross-border economic activity linked with globalization are largely irreversible.

This indicates that conventional policy tools are not as potent as they might have been earlier (Lall and Narula 2004). Nevertheless, it is still a matter of conjecture what the long-term developmental effects of many of the supranational and bilateral agreements will be. Market forces cannot act as a substitution for the role of governments in developing and supporting a proactive industrial policy. One of the striking differences among national innovation systems in developed and developing nations is the extent of government participation in the course of innovation (Lee and Han 2002). Generally, such participation of the government is more in developing nations than in developed nations. Mittal (2003) suggests a number of ways for the government, which is the chief policy and regulatory authority, to expedite R&D in the Indian telecom sector, which is augmented by more details on several exchanges related to the technological competitiveness by Mittal et al. (2009). One of the important aspects is the technological self-sufficiency of domestic firms pertaining to foreign firms. Moreover, to encourage R&D in the business firms, governments can provide both financial incentives, for example, tax incentive and research grants, and vital nonfinancial settings, for example, policies on human resources development and the implementation of industrial standards (Mani 2005). The capability of a firm to position its technology as an industry standard is a significant determining factor of its long-lasting competitive spot and success. Once there is success in development of technology and the formation of industry standards based on it, there are different competitive strategies possible, like aggressive sole provider, passive multiple licensing, aggressive multiple licensing, and selective partnering (Hill 1997).

For developing countries lagging in the technology race, one of the key questions is how to catch up with the technology and how to leapfrog for the same. According to Lee (2005), there is a great uncertainty involved with the technological know-how and transfer of technology aspects if the frontrunner firms decline to vend or provide license to promising catching-up firms which then have to design the products on their own. But at the same time, if the latecomer succeeds in designing its own products, this crisis becomes an opening for leapfrogging type catch-up with, however, the risks of choosing the right technology/standards and creation of initial markets. The government involvement in the latecomers' technological catch-up is important, even though the precise methods of involvement could be different across sectors and stages. The government can play the role of enabling the implementation of particular standards and thus inducing the creation of marketplaces at the appropriate time. Ownership of the firms is also an important factor since FDI cannot be counted upon the technological progress of the latecomer nation seven though they can aid as early learning. However, a country must be able to use a particular frame of opening which might emerge in the evolution of a technology system to catch-up if they implement suitable social, industrial, and technology policies; else it would carry on to lag behind (Perez and Soete 1988). The technological catch-up framework consists of the incentive to innovate, capability to innovate and opportunity to innovate, which affect each other. The five key elements for successful catch-up are (Liu 2007): (1) finding mismatch area: innovation in low end market, (2) technology opportunity: new technology from other industry or existing industry, (3) governmental support: market for technology, stage-skipping, (4) licensing and outsourcing strategy: role of FDI and university, and (5) innovation strategy: path-following or stage-skipping.

Further aspect of augmenting technological competitiveness is enabling cooperative strategies and although the governments can expedite the cooperation, the actual cooperation needs to be managed by firms and industrial houses for ensuring mutual business gains to both sides (Momaya and Kuroda 2008). From the alternative type of cooperation such as vertical partnerships, cross-industry agreements, complementary alliances, the most relevant needs to be evolved. In emerging trend of open innovation, innovation from India that spread fast at the base of the pyramid can complement the high- tech/end/cost innovations that countries like Japan excel at. The relevance of the meta-national learning methodology (as against the domestic "black box" methodology) is derived from the competitive advantage of home country, industry, and company (Asakawa 2007). While this method is usually taken as suitable for firms which try to offset their home country drawbacks, the meta-national approach rests suitable for firms that want to deal with corroding country and industry competitiveness. However, a firm in an industry with feeble competition and appropriability conditions has a greater degree of consortia participation (Sakakibara 2002). A firm's R&D abilities, network formation due to earlier consortia, encounter with other firms in product markets, age, and earlier participation in large-scale consortia also positively influence its propensity of consortia formation. For companies to accumulate advanced scientific and technological knowledge and promote their long-term core technology development, the major generic strategies are (1) setting technology paths in accordance with business domain; (2) continuous efforts to nurture corporate core technologies; and (3) establishing mechanism for technology fusion and learning through strategic alliances (Kobayashi 2005).

Technological competitiveness, which is the way forward for developing countries to face the catch-up challenge, is dependent on three key factors, viz., access to competitive technology, constant innovation of soft technology, and provision of a macro environment system that is favorable for innovation (Zhouying 2005). A country may be technologically successful but problems of low absorption and the nation's incapability to arrange for complementing assets for the appropriation of such innovations may avert such successes from being converted into direct commercial benefits; therefore, policy action would perform main part by expanding the capability to absorb and exploit innovation (Howells and Michie 1998). Further, the policies need to be fine-tuned in order to create a level playing field even for the small-scale innovator (Sunder 2004). Sternberg and Buffalo (1996) contend that to prevent the industrial deterioration, there are two kinds of policy objects: Ecosystem (a vital concern of environmental policy) and emergent bodies of technological knowledge (an essential concern in industrial competitiveness policy). The capability of MNCs to grow integrated technological networks by the added advancement of economic integration is said to influence and be influenced by national technological competitiveness (Cantwell and Janne 2000). It is necessary to have accountable care activity to guarantee environment, safety, and health and its technological buildup that in turn leads to added bolstering of competitiveness along with developing technology in particular area and synthesis of technologies among different areas (Kawachi 2004). Explanations for the variations in competition in most of the countries looks to be country or regionally specific, instead of industry specific, probably signifying that domestic or international policy changes have some influencing consequence (Uchida and Cook 2005).

For countries to succeed in the present global environment, governments would need to place the concept of continuous policy review and management innovations in the center of their philosophy (Kaul 1996), and adapt according to the situation, manage change with continuity and strategic flexibility (Sushil 1994, 2005, 2013, 2015). Though some aspects of continuity and change are reflected in all the strategies, the confluence of continuity and change is the strongest, that is, "strategic flexibility for integrating opposites" typified as "flowing stream strategy." Adapting according to the situation and the need and managing change with continuity may be the key strategies for success. Bhat (2010) demonstrates various aspects strategic management of innovation through confluence of continuity and change. The main aspects in the area of management of technology are strategic management of technology, technology planning and forecasting, technology transfer and acquisition, development and innovation management, technology and organization issues, and adoption and implementation of new technologies (Husain and Sushil 1997).

18.2.7 Role of Industry and Business Associations

One of the significant players in the sectoral system of innovation is the industry and business associations. The retreat of planning and the adoption of market-friendly policies has been linked with a new form of government–industry interaction, viz., the emergence of industry associations which lobby for policy and arrange for other joint possessions for fellows of the association (Athreye and Chaturvedi

2007). Industry associations accomplish vital information and harmonization roles in developing nations, usually recompensing for insufficiencies in the business environment, when challenged with the need to compete on external markets. The contributions by business associations could be classified according to the common functions of horizontal coordination, vertical coordination, decreasing information costs, setting standards, and upgrading skills and technology (Doner and Schenider 1999). A usual characteristic of developmental business associations is internal strength that hinges on greater member density, valued membership benefits (selective incentives), and effective internal representation of member interests. Internal strength, however, is not enough. Two additional contextual or enforcement factors, that is, robust states and competitive markets, make sure that associations utilize their strength for productive culminations. Apart from the high member density, strong associations have valuable selective incentives, effective intermediation, and balanced relationships among members and staff. Associations can provide certain institutional solutions which aid in lowering the transaction costs, mitigate the principal–agent complications, and decrease the hurdles to joint activities which are intrinsic in several modern-day development challenges (Doner and Schenider 2000).

As per Nadvi (1999), there is a series of facilitating actions which associations can perform, viz., (1) the provision of services like technical and managerial advice; (2) information services which assist in linking local producers with distant markets, such as information on markets, prices, competitors, trade policies and trade figures; (3) technology support which helps local producers in upgrading, both in process and product technologies along with moving up the value chain into areas like design and R&D; (4) the networking of local producers to local and global trade fairs which arrange for exposure to local firms and brings external buyers to the cluster; (5) benchmarking services which assist local producers in comparing their performance with international best practices; and (6) technical support to conform to new global standards and the development of local quality tagging. Furthermore, the industry associations initiate processes of institutional reforms by demanding better practices (e.g., IPR legislation), thereby filling the gap between institutional mechanisms required for supporting new growth and the prevalent institutions in new technology areas (Athreye and Chaturvedi 2007). Business associations in developing countries, such as India, have proved to be vital sources of ideas for regulations and have helped infilling the vacuum of negligible regulations.

18.3 Framework Conceptualization

To conceptualize a framework for better understanding of the national technological competitiveness, a synthesis of the concepts reviewed from literature is carried out in this section.

The industry and resource-based views can partially be expanded based on the study by Rugman and D'Cruz (1993), Moon et al. (1998), Furman et al. (2002), Hu and Mathews (2005, 2008), and Cho et al. (2008). Thus, the factor conditions (with industry level resources), demand conditions, firms' rivalry, supporting industries in the international and domestic contexts may be added in the framework. Here, the factor conditions may include both physical and human factors. Apart from the firm and industry level resources, there is also an influence of national level resources such as cumulative technological sophistication, human capital, and financial resources. These national resources along with the resource commitments, policy choices, and other formal (regulatory) and informal (normative and cognitive) institutions (Nelson and Rosenberg 1993; Metcalfe 1995; Malerba 1999, 2002, 2004; Scott 2001; Balzat and Pyka 2005; Jacobsson and Bergek 2006; Peng 2006) may form the common innovation infrastructure. Further, there needs to be quality linkages among all the factors, which may be provided with the help of universities, industry/business associations, government-sponsored research laboratories, and other research bodies in the public sector domain (Furman et al. 2002; Lee and Han 2002), which may be called as supporting actors. Similarly, Lee and Han (2002) further identify the domestic and foreign firms as the other main actors in the system, which may be called as business actors.

Figure 18.3 shows the initial conceptualization of the framework with the major constructs. This shows that the output variable, viz., "technological competitiveness of a country," depends on five major variables, viz., (i) capability of industry for technological innovation, (ii) availability of resources for technological innovation, (iii) supportiveness of institutions for technological innovation, (iv) focus on technological innovation-oriented strategies by supporting actors, and (v) focus on technological innovation oriented strategies by business actors. This is a simplistic view of the framework with no relationships depicted among input variables.

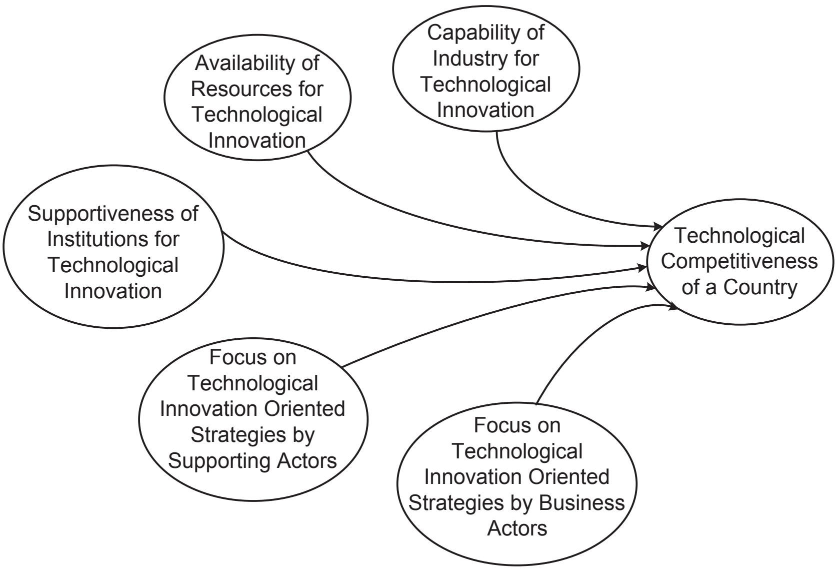

Fig. 18.3 Conceptualization of major constructs

Further, to understand the interplay of the identified measures, an initial attempt has been made to identify their interdependencies. The capability of industry, the availability of resources, and the supportiveness of institutions for technological innovation, influence the competitive strategies, processes, and practices pertaining to the technological innovation and R&D activities of the supporting actors and the business actors (Lee and Han 2002), in a two-way manner. This, in turn, determines the competitive performance and the technological competitiveness of the actors and that of the nation (again in a two-way manner). This leads to the development of a macro-level framework as exhibited in Fig. 18.4.

The macro-level framework with the broad constructs can be decomposed into the detailed components of the institutions, resources, industry, strategies, and the actors. As per the detailed components of the research framework, the capability of the industry for technological innovation shows the double diamond model at the national and international level (including the physical and human factors). The availability of resources show the technological sophistication (knowledge base—Malerba 2004), human capital, and financial resources at the levels of international, national, industry, and firm. The supportiveness of the institutions shows mainly the

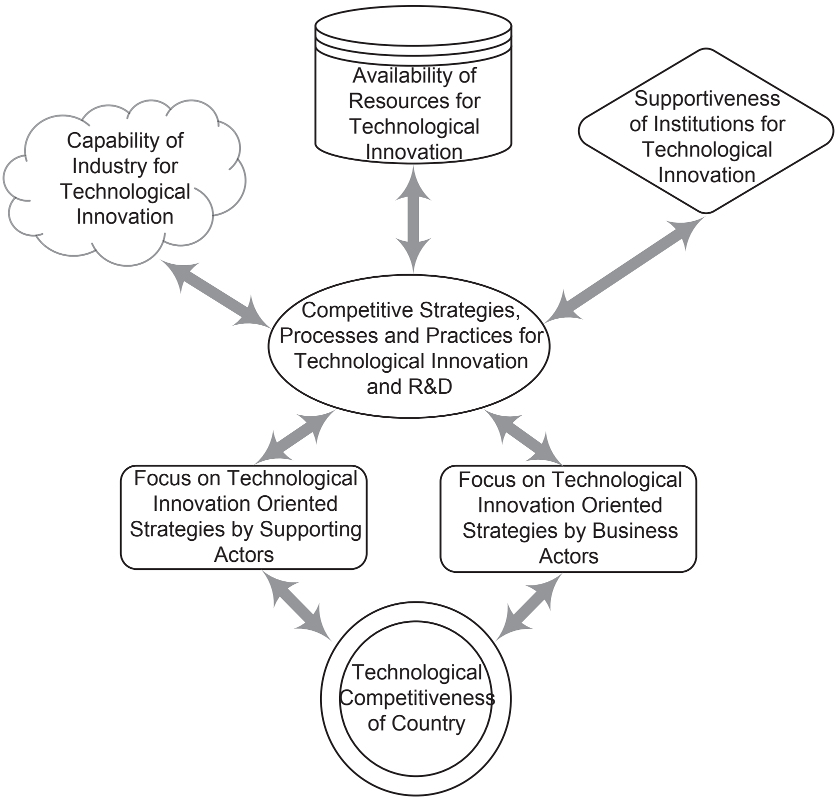

Fig. 18.4 Conceptualization of macro-level framework for national technological competitiveness

government as the key actor giving policies for technology sector FDI, imports, and exports; policies and regulations for technology standardization and deployment; IPR laws and enforcements; policies for technical education, R&D investments, subsidies, grants, and taxation; abiding international laws, agreements, treaties, and enforcement commitments; values, norms, culture, ethics, and beliefs. The focus on technological innovation-oriented strategies by supporting actors involve the R&D activities of academic institutes and universities, public–private partnership projects, public sector R&D firms, government-sponsored research laboratories, role of industry and business associations, R&D funding from venture capital, and other business funding agencies.

The focus on technological innovation-oriented strategies by business actors involve those of domestic private R&D firms, locally hosted domestic–international R&D joint ventures, locally hosted foreign R&D firms. The competitive strategies, processes, and practices for technological innovation and R&D include the seven functional requirements for an innovation system (Jacobsson and Bergek 2006), the three strategies related to globalization of technology (Archibugi and Michie 1995; Archibugi and Pietrobelli 2003), the collaborative strategies (Liu 2007), the four strategies for enhancing innovation performance (Castellacci 2003), and the

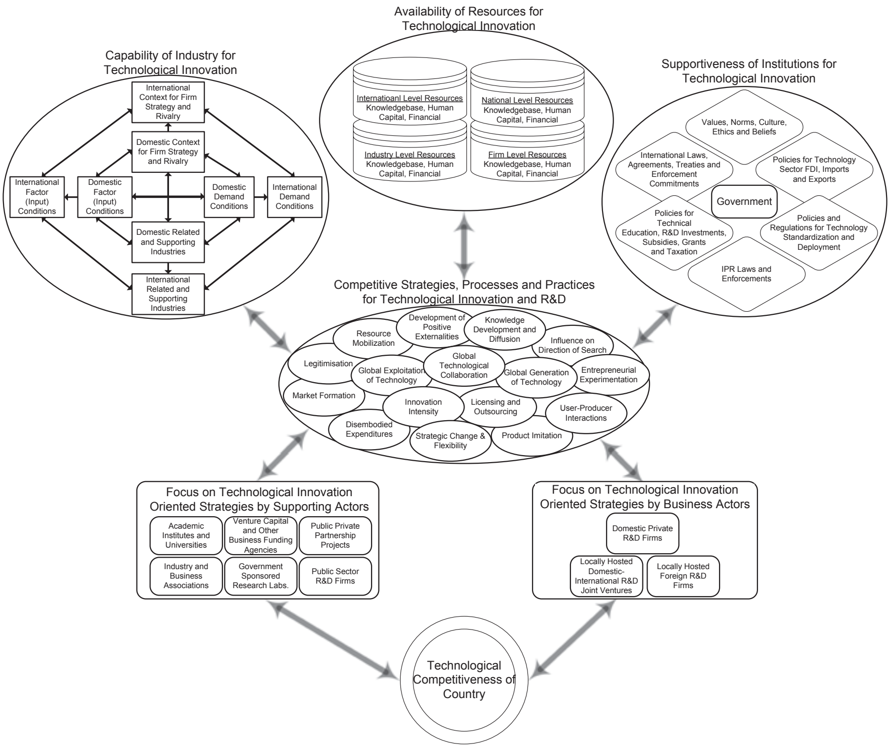

Fig. 18.5 Conceptualization of micro-level framework for national technological competitiveness

strategic change and flexibility (Sushil 1994, 2005, 2013). Thus, these components are (1)knowledge development, and diffusion; (2) influence on the direction of search; (3) entrepreneurial experimentation; (4) market formation; (5) legitimation; (6) resource mobilization; (7) development of positive externalities; (8) global exploitation of technology; (9) global technological collaboration; (10) global generation of technology; (11) licensing and outsourcing; (12) innovation intensity; (13) disembodied expenditures; (14) product imitation; (15) user–producer interactions; and (16) strategic change and flexibility. Figure 18.5 exhibits the conceptualization of micro-level framework.

18.4 Conclusion

Technological innovation has emerged as a key theme for the national competitiveness in the long run. In context of national technological competitiveness, the key driving aspects are industry capability, resource availability, and institutional support for technological innovation. Based on these aspects, the business actors and supporting actors define their strategies oriented toward the technological innovation, and the supporting processes and practices. The combined resulting actions, thus, profile the technological competitiveness of the country. Each of these macro constructs have further been decomposed into a number of micro aspects. The macro- and micro-level conceptual frameworks have, thus, been evolved. The micro-level framework is a unique contribution which combines multiple theories and gives the key stakeholders and actors various pivot points of actions to shape the technological competitiveness of their country in the long run. However, the empirical treatment to validate this framework needs further investigation.

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Part V
Business Flexibility

Chapter 19
Development of Marketing Flexibility for e-Commerce by Assessing Impact of Mobile Devices on Sales with Multiple Classes of Customers

Jun Yoshii and Ushio Sumita

19.1 Introduction

The potential of the Internet has been expanded substantially by a new generation of mobile devices, opening the door for rapid growth of m-commerce. While the traditional fixed-PC access to the Internet continues to be vital for exploiting the advantages of the Internet, the mobile access appears to attract more people because of its flexibility, allowing one to have accesses to the Internet in a ubiquitous manner. Accordingly, e-commerce is now in the process of being converted into m-commerce.

Because of the fact that the mobile technology is still young, the study of the impacts of mobile devices on e-businesses is also rather new in the literature. Barwise (2001) and Hammond (2001) predict the evolutional trend of m-commerce in the foreseeable future. Chae and Kim (2003) discuss the business implications of m-commerce, and Wu and Hisa (2004) propose the hypercube innovation model for analyzing the characteristics of m-commerce with focus on three axes: changes in business models, changes in core components, and stakeholders. Siau et al. (2004) and Park and Fader (2004) investigate the benefits of m-commerce to consumers and how e-commerce has changed the consumer behavior. Roto (2005) and Kim (2006) provide the current state of mobile devices and m-businesses. Buyukozkan (2009) develops an analytical approach for determining the m-commerce user requirements. All of these papers are empirical, qualitative, or static in their analytical nature. To the best knowledge of the authors, the problem of how to capture performance differences between e-commerce and m-commerce based on a mathematical

J. Yoshii (✉) · U. Sumita
Graduate School of Systems and Information Engineering, University of Tsukuba,
1-1-1 Tennoudai, Tsukuba 305-8573, Ibaraki, Japan
e-mail: yoshii40@sk.tsukuba.ac.jp; jun.yos.0104@gmail.com

U. Sumita
e-mail: sumita@sk.tsukuba.ac.jp

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stochastic model has been largely ignored in the literature. To fill this gap, in a recent paper by Sumita and Yoshii (2010), a mathematical model is developed and analyzed for comparing e-commerce via the traditional fixed-PC access only with m-commerce which accommodates both the fixed-PC access and the mobile access.

While the semi-Markov model proposed in Sumita and Yoshii (2010) opens a door for stochastic analysis of m-commerce consumers so as to capture behavioral differences between e-commerce and m-commerce, it still has some limitations. For example, only mobile accesses may be available in certain time segments of a day, for example, during commuting hours, which is not incorporated. The paper also fails to distinguish the sales contributions by different consumer groups. In a subsequent paper by Sumita and Yoshii (2012), these pitfalls are overcome by extending the original semi-Markov model in two different directions. First, the extended model accommodates a general number of time segments of a day so that a variety of consumer behaviors for accessing the Internet could be incorporated. Second, the sales contribution of each consumer class can be captured separately. This paper is further extended in Yoshii and Sumita (2013) by incorporating multiple customer classes. More specifically, a general number of customer classes are considered for responding to the situation that e-business managers have to deal with many customer segments. Furthermore, the sales contribution of each time segment can be treated separately. While this generalization complicates the underlying semi-Markov analysis substantially, the complex spectral decomposition still enables one to invert the matrix Laplace transforms involved into the real domain, thereby establishing a foundation for development of computational procedures to assess the stochastic performance measures of interest.

To enhance the marketing flexibility, this chapter addresses itself with the question of how to allocate the promotion budget between the PC promotion and the mobile promotion based on the most extended model by Yoshii and Sumita (2013). The optimal budget allocation is numerically determined so as to maximize the expected number of products to be sold within a fixed period $[0, t]$, or to minimize the time required to sell K products. Associated risk control measures are also considered, where, for each of the two random variables above, the probability of its value being greater (or less) than a certain threshold is maximized (minimized), subject to its expectation staying above 90 % (or 110 %) of the maximum (minimum) case. It turns out that the expected value optimization and the risk control optimization yield the same optimal budget allocation for both of the two random variables. A conjecture is presented based on these numerical results.

The structure of this chapter is as follows. In Sect. 19.2, a mathematical model is introduced formally, which extends the previous models of Sumita and Yoshii (2010, 2012), for capturing the customer behavior in m-commerce based on a semi-Markov process approach. Section 19.3 is devoted to dynamic analysis of the semi-Markov model. Computational algorithms are developed in Sect. 19.4 for evaluating the probabilities of purchasing and not-purchasing by time t. The two stochastic performance measures are introduced in Sect. 19.5 and the associated distributions are derived explicitly which can be computed using the numerical algorithms developed in Sect. 20.4. Numerical examples are given in Sect. 19.6 for illustrating behavioral differences between m-commerce customers and traditional e-commerce customers. The optimal strategy is also discussed in Sect. 19.6. Finally, some concluding remarks are given in Sect. 19.7. Proofs of lemmas and theorems are omitted because of the limited number of pages allowed and for better readability. Interested readers are encouraged to contact the authors for obtaining the note of the proofs.

Throughout the chapter, vectors and matrices are indicated by underbar and double underbar, respectively, for example, $\underline{\xi}$, $\underline{\underline{P}}(t)$, etc. The vector with all components equal to 0 is denoted by $\underline{0}$. The ith unit vector is written as $\underline{u}_i$, and the identity matrix is denoted by $\underline{\underline{I}}$.

19.2 Development of Mathematical Model for m-Commerce Customer Behavior: Semi-Markov Process Approach

For capturing the m-commerce behaviors of customers in multiple classes, we consider a semi-Markov model where a customer of Class i moves up monotonically to Class $i+1$ in due course. More specifically, let $\{J(t): t \geq 0\}$ be a semi-Markov process defined on $\mathrm{N} = \bigcup_{i=1}^{M} N_i$, where $N_i = \{(i,1),\cdots,(i,N),(i,B_1),\cdots,(i,B_N),(i,\neg B_1),\cdots,(i,\neg B_N)\}$. It should be noted that one customer is represented by one semi-Markov process. It is assumed that for a customer in Class i, the initial state is given by $(i, 1)$. Typical transitions of the semi-Markov process on N are depicted in Fig. 19.1.

Here, the state space N_i describes the behavior of customers in Class i, starting at state $(i, 1)$. The state (i, j) corresponds to the jth segment of a day and the customers move from state $(i, 1)$ toward state (i, N), representing the end of the day, in a lattice continuous manner. At the end of a day, each customer in Class i remains in the same class with probability p_{ii} or changes its class to Class $i+1$ with probability $1-p_{ii}$. This means that any customer in state (i, N) returns to state $(i, 1)$ with probability p_{ii} or moves to state $(i+1, 1)$ with probability $1-p_{ii}$ at the beginning of the following day. The two sets of states $\{(i,B_1),\cdots,(i,B_N)\}$ and $\{(i,\neg B_1),\cdots,(i,\neg B_N)\}$ contain absorbing states, where the former set corresponds to the decision of purchasing the

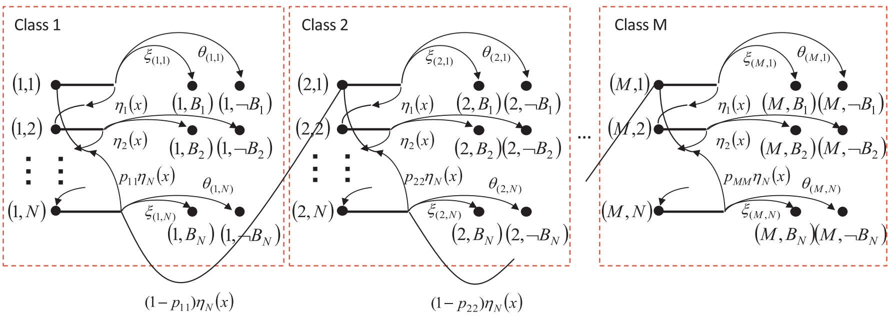

Fig. 19.1 Transition structure of the semi-Markov process

product, while the latter set represents the decision of not purchasing the product. It should be noted that one customer is represented by one semi-Markov process. Assuming that customers behave independently, the entire market can be represented by the independent sum of such semi-Markov processes.

It may be natural to assume that one day is decomposed into multiple time segments, each having a different predetermined length. To assure analytical tractability, however, we treat them as independent random variables for the time being. The case of constant lengths will be dealt with by considering sequences of such random time segments, as we will see. More specifically, given that neither the decision of purchasing nor that of not purchasing is made, we assume that the dwell time of the semi-Markov process in state (i, j) is absolutely continuous with probability density function (p.d.f.) $a_{(i,j)}(x)$, $i = 1,\cdots,M$, $j = 1,\cdots,N$. The corresponding distribution function, the survival function, and the hazard rate function are denoted by

$$A_{(i,j)}(x) = \int_0^x a_{(i,j)}(y)dy; \quad \overline{A}_{(i,j)}(x) = 1 - A_{(i,j)}(x); \quad \eta_{(i,j)}(x) = \frac{a_{(i,j)}(x)}{\overline{A}_{(i,j)}(x)} \tag{19.2.1}$$

Since one semi-Markov process corresponds to one customer, it is natural to assume that $a_{(i,j)}(x) \stackrel{def}{=} a_j(x)$ for $i = 1,\cdots,M$, $j = 1,\cdots,N$. The states (i, B_j) and $(i, \neg B_j)$ for $i = 1,\cdots,M$, $j = 1,\cdots,N$ are absorbing and the dwell time in any of those states are infinite. The corresponding survival functions can then be written as

$$\overline{A}_{(i,B_j)}(x) = \overline{A}_{(i,\neg B_j)}(x) = U(x), \quad i = 1,\cdots,M, \quad j = 1,\cdots,N, \tag{19.2.2}$$

where $U(x)$ is the unit step function defined by $U(x)=0$ if $x<0$ and $U(x)=1$ if $x\geq 0$.

For those customers in Class i, the Internet accesses occur in state (i, j) via a fixed PC (a mobile device) according to a Poisson process with intensity $\lambda_{(i,j)}$ ($\mu_{(i,j)}$), $i = 1,\cdots,M$, $j = 1,\cdots,N$. The corresponding probability of purchasing (not purchasing) for each access is denoted by $\alpha_{(i,j)}$ ($\beta_{(i,j)}$) with $0<\alpha_{(i,j)}+\beta_{(i,j)}<1$, and the customer remains undecided with probability $1-(\alpha_{(i,j)}+\beta_{(i,j)})>0$. Consequently, the transition intensity from state (i, j) to state (i, B_j) and that from state (i, j) to state $(i, \neg B_j)$ are given respectively by

$$\begin{aligned} \xi_{(i,j)} &= \{\lambda_{(i,j)} + \mu_{(i,j)}\}\alpha_{(i,j)}; \\ \theta_{(i,j)} &= \{\lambda_{(i,j)} + \mu_{(i,j)}\}\beta_{(i,j)}, i = 1,\cdots,M, j = 1,\cdots,N. \end{aligned} \tag{19.2.3}$$

These differences together with probability p_{ii}, representing the population growth of the mobile access users, characterize the impact of mobile accesses on e-commerce in our model. In general, one may construct customer classes in such a way that the intensity for the use of mobile devices for time segment j increases as i increases, that is, $\mu_{(i,j)} \leq \mu_{(i+1,j)}$. In this case, one has $\xi_{(i,j)}\leq\xi_{(i+1,j)}$ and $\theta_{(i,j)}\leq\theta_{(i+1,j)}$ for $i = 1,\cdots,M-1$, $j = 1,\cdots,N$.

To deal with the case in which the segments of a day are deterministic, we subsequently choose, for each $j \in \{1,\cdots,N\}$, a sequence of distribution functions $(A_j(k,x))_{k=1}^{\infty}$ such that $A_j(k,x) \to U(x-\tau_j)$ as $k \to \infty$, where τ_j is the constant dwell time in state (i, j), $i=1,\cdots,M$, $j=1,\cdots,N$.

19.3 Dynamic Analysis of the Semi-Markov Process

In this section, we explicitly derive the transition probability matrix $\underline{\underline{P}}(t)$ of the semi-Markov process $J(t)$ discussed in Sect. 19.2, where $\underline{\underline{P}}(t)$ is defined by

$$\underline{\underline{P}}(t) = [P_{(i,j)(m,n)}(t)]; \quad P_{(i,j)(m,n)}(t) \overset{def}{=} \mathrm{P}[J(t)=(m,n) \mid J(0)=(i,j)]; \\ (i,j),(m,n) \in N. \tag{19.3.1}$$

For this purpose, the age process $X(t)$ associated with the semi-Markov process $J(t)$ is introduced as the elapsed time since the last transition of $J(t)$ into the current state at time t. Clearly, the bivariate process $[J(t), X(t)]$ becomes Markov and the first step of our analysis is to evaluate the joint distribution function defined by

$$F_{(i,j)(m,n)}(x,t) = P[X(t) \le x, J(t)=(m,n) \mid J(0)=(i,j)], \tag{19.3.2}$$

and the corresponding joint p.d.f.

$$\frac{d}{dx} F_{(i,j)(m,n)}(x,t) = f_{(i,j)(m,n)}(x,t). \tag{19.3.3}$$

For notational convenience, we define

$$C_{(i,j)} = \xi_{(i,j)} + \theta_{(i,j)}, \quad i=1,\cdots,M, \quad j=1,\cdots,N. \tag{19.3.4}$$

By observing the probabilistic flow of the bivariate process $[J(t), X(t)]$ at time t, one sees, for $i,m \in \{1,\cdots,M\}$, $j,n \in \{1,\cdots,N\}$ and $x>0$, that

$$f_{(i,j)(m,n)}(x,t) = f_{(i,j)(m,n)}(0+,t-x)\overline{A}_n(x)e^{-C_{(m,n)}x}; \tag{19.3.5}$$

$$f_{(i,j)(m,B_n)}(x,t) = f_{(i,j)(m,B_n)}(0+,t-x)\overline{A}_{B_n}(x); \overline{A}_{B_n}(x) = 1; \tag{19.3.6}$$

$$f_{(i,j)(m,\neg B_n)}(x,t) = f_{(i,j)(m,\neg B_n)}(0+,t-x)\overline{A}_{\neg B_n}(x); \overline{A}_{\neg B_n}(x) = 1. \tag{19.3.7}$$

These equations can be interpreted in the following manner. For the process to be in state (m, n) at time t with age x for $n=1,\cdots,N$, as shown in (19.3.5), it should have entered the state at time $t-x$, and there has been no transition to any other state until time t. Since states (i, B_n) and $(i, \neg B_n)$ for $n = 1,\cdots,N$ are absorbing, for the process to be in one of the states at time t with age x, it should have entered the state at time $t-x$, explaining (19.3.6) and (19.3.7).

For describing the boundary conditions with respect to x, one has, for each $(i, j) \in N$,

$$f_{(i,j)(1,1)}(0+,t) = \delta_{\{(i,j)=(1,1)\}}\delta(t) + p_{11}\int_0^\infty f_{(i,j)(1,N)}(x,t)\eta_N(x)dx; \tag{19.3.8}$$

$$f_{(i,j)(m,1)}(0+,t) = \delta_{\{(i,j)=(m,1)\}}\delta(t) + p_{mm}\int_0^\infty f_{(i,j)(m,N)}(x,t)\eta_N(x)\,dx \tag{19.3.9}$$

;

$$+(1-p_{m-1,m-1})\int_0^\infty f_{(i,j)(m-1,N)}(x,t)\eta_N(x)\,dx\,,\ m = 2,\cdots,M$$

$$f_{(i,j)(m,n)}(0+,t) = \delta_{\{(i,j)=(m,n)\}}\delta(t) + \int_0^\infty f_{(i,j)(m,n-1)}(x,t)\eta_{n-1}(x)\,dx\,, \tag{19.3.10}$$
$$m = 2,\cdots,M,\ n = 2,\cdots,N$$

Here, $\delta_{\{ST\}} = 1$ if statement ST is true, and $\delta_{\{ST\}} = 0$ otherwise. The delta function $\delta(t)$ is the unit operator associated with convolution, that is, $g(t) = \int_0^\infty g(x)\delta(t-x)dx$ for any integrable function $g(t)$ on $[0,\infty)$. In addition to the boundary conditions in (19.3.8) through (19.3.10), one sees that

$$f_{(i,j)(m,B_n)}(0+,t) = \xi_{(m,n)}\int_0^\infty f_{(i,j)(m,n)}(x,t)dx, m = 1,\cdots,M, n = 1,\cdots,N; \tag{19.3.11}$$

$$f_{(i,j)(m,\neg B_n)}(0+,t) = \theta_{(m,n)}\int_0^\infty f_{(i,j)(m,n)}(x,t)dx, m = 1,\cdots,M, n = 1,\cdots,N. \tag{19.3.12}$$

Equations (19.3.5) through (19.3.12) can be solved for $f_{(i,j)(m,n)}(0+, t)$ and $f_{(i,j)(m,n)}(x, t)$ by taking double Laplace transforms with respect to x and t. To facilitate this analysis, we introduce certain matrix- and vector-producing operators. More specifically, given a vector $\underline{h} = [h_1,\cdots,h_N]^{\mathrm{T}} > \underline{0}$ and $\underline{z} = [z_1,\cdots,z_N]^{\mathrm{T}} > \underline{0}$, let $\underline{\underline{M}} - OP_I : R^N \rightarrow R^{N\times N}$ and $\underline{\underline{M}} - OP_{II} : R^N \rightarrow R^{N\times N}$ be defined as below.

$$\underline{\underline{M}} - OP_I(\underline{h}) = \begin{bmatrix} 0 & h_1 & 0 & \cdots & 0 \\ 0 & 0 & h_2 & \cdots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \cdots & h_{N-1} \\ h_N & 0 & 0 & \cdots & 0 \end{bmatrix}, \tag{19.3.13}$$

$$\underline{\underline{M}} - OP_{II}(\underline{z}) = \begin{bmatrix} 1 & z_1 & z_2 & \cdots & z_{N-1} \\ \frac{z_N}{z_1} & 1 & \frac{z_2}{z_1} & \cdots & \frac{z_{N-1}}{z_1} \\ \frac{z_N}{z_2} & \frac{z_1 z_N}{z_2} & 1 & \vdots & \frac{z_{N-1}}{z_2} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \frac{z_N}{z_{N-1}} & \frac{z_1 z_N}{z_{N-1}} & \frac{z_2 z_N}{z_{N-1}} & \cdots & 1 \end{bmatrix}. \tag{19.3.14}$$

Given $\underline{h} = [h_1, \cdots, h_N]^{\mathrm{T}} > \underline{0}$, we also define V-$OP_I$: $R^N \to R^N$ as shown below,

$$\underline{V} - OP_I(h) = [b_1, \ldots, b_N]^T \text{ where } bj = \prod_{i=1}^{j} hj. \tag{19.3.15}$$

Between the operators $\underline{\underline{M}} - OP_I$ and $\underline{\underline{M}} - OP_{II}$, the following relationship exists, where proof is omitted.

Lemma 3.1 *Let* $\underline{h} = [h_1, \cdots, h_N]^{\mathrm{T}} > \underline{0}$ *and define* $\underline{b} = [b_1, \cdots, b_N]^{\mathrm{T}} =$ V-OP_I(h). *One then has*

$$\frac{1}{1-b_N}[\underline{\underline{M}} - OP_{II}(\underline{b})] = [\underline{I} - \underline{\underline{M}} - OP_I(\underline{h})]^{-1}.$$

We are now in a position to evaluate the joint p.d.f. given in (19.3.3). For notational convenience, the following Laplace transforms are introduced.

$$\alpha_j(s) = \int_0^\infty e^{-sx} a_j(x) dx \quad for \quad j = 1, \cdots, N, \tag{19.3.16}$$

$$\beta_j(s) = \int_0^\infty e^{-sx} \overline{A}_j(x) dx = \frac{1-\alpha_i(s)}{s} \quad for \quad j = 1, \cdots, N, \tag{19.3.17}$$

$$\begin{aligned} &\underline{\underline{\hat{s}}}(0+, s) = [\hat{s}_{(i,j)(m,n)}(0+, s)]; \\ &\quad \hat{s}_{(i,j)(m,n)}(0+, s) \overset{def}{=} \int_0^\infty e^{-st} f_{(i,j)(m,n)}(0+, t) dt \quad for \quad (i,j),(m,n) \in \mathbf{N}, \end{aligned} \tag{19.3.18}$$

$$\begin{aligned} &\underline{\underline{\hat{\phi}}}(x, s) = [\hat{\phi}_{(i,j)(m,n)}(x, s)]; \\ &\quad \hat{\phi}_{(i,j)(m,n)}(x, s) \overset{def}{=} \int_0^\infty e^{-st} f_{(i,j)(m,n)}(x, t) dt \quad for \quad (i,j),(m,n) \in \mathbf{N}, \end{aligned} \tag{19.3.19}$$

$$\underline{\underline{\hat{\hat{\phi}}}}(v,s)=[\hat{\hat{\phi}}_{(i,j)(m,n)}(v,s)]\,;$$
$$\hat{\hat{\phi}}_{(i,j)(m,n)}(v,s)\overset{def}{=}\int_0^\infty e^{-vx}\hat{\phi}_{(i,j)(m,n)}(x,s)dx \quad for \quad (i,j),(m,n)\in \mathbf{N}\,, \tag{19.3.20}$$

$$\underline{\underline{\hat{\xi}_i}}(s)=DIAG\left\{\xi_{(i,1)}\beta_1(s+C_{(i,1)}),...,\xi_{(i,N)}\beta_N(s+C_{(i,N)})\right\} \quad for \quad i=1,\cdots,M, \tag{19.3.21}$$

$$\underline{\underline{\hat{\theta}_i}}(s)=DIAG\left\{\theta_{(i,1)}\beta_1(s+C_{(i,1)}),...,\theta_{(i,N)}\beta_N(s+C_{(i,N)})\right\} \quad for \quad i=1,\cdots,M, \tag{19.3.22}$$

$$\underline{\alpha_i}(s)=[\alpha_1(s+C_{(i,1)}),\ldots,\alpha_{N-1}(s+C_{(i,N-1)}),p_{ii}\alpha_N(s+C_{(i,N)})]^T \quad for \quad i=1,\cdots,M, \tag{19.3.23}$$

$$\underline{b_i}(s)=[b_{i,1}(s),\ldots,b_{i,N}(s)]^T=\underline{V}-OP_I(\underline{\alpha_i}(s)) \quad for \quad i=1,\cdots,M. \tag{19.3.24}$$

Here, $DIAG\{a_1,\cdots,a_N\}$ denotes an $N\times N$ diagonal matrix with diagonal elements $a_1,\cdots,a_N$.

Using the operators $\underline{\underline{M}}-OP_I$ and $\underline{\underline{M}}-OP_{II}$, we define the following Laplace transform matrices in $R^{N\times N}$.

$$\underline{\underline{B_i}}(s)=\underline{\underline{M}}-OP_I(\underline{\alpha_i}(s));\quad \underline{\underline{W_i}}(s)=[\underline{\underline{I}}-\underline{\underline{B_i}}(s)]^{-1} \quad for \quad i=1,\cdots,M. \tag{19.3.25}$$

Finally, by defining the Laplace transform matrices $\underline{\underline{\psi_i}}(s)$ and $\underline{\underline{\phi_i}}(s)$ as

$$\underline{\underline{\psi_i}}(s)=\begin{bmatrix}\underline{\underline{B_i}}(s) & \underline{\underline{\hat{\xi}_i}}(s) & \underline{\underline{\hat{\theta}_i}}(s)\\ \underline{\underline{0}} & \underline{\underline{0}} & \underline{\underline{0}}\\ \underline{\underline{0}} & \underline{\underline{0}} & \underline{\underline{0}}\end{bmatrix} \quad for \quad i=1,\cdots,M \tag{19.3.26}$$

and

$$\underline{\underline{\varphi_i}}(s)=\begin{bmatrix}\underline{\underline{D_i}}(s) & \underline{\underline{0}} & \underline{\underline{0}}\\ \underline{\underline{0}} & \underline{\underline{0}} & \underline{\underline{0}}\\ \underline{\underline{0}} & \underline{\underline{0}} & \underline{\underline{0}}\end{bmatrix};$$
$$\underline{\underline{D_i}}(s)=\begin{bmatrix}0 & 0 & \cdots & 0\\ \vdots & \vdots & \ddots & \vdots\\ 0 & 0 & \cdots & 0\\ (1-p_{ii})\alpha_N(s+C_{(i,N)}) & 0 & \cdots & 0\end{bmatrix} \quad for \quad i=1,\cdots,M, \tag{19.3.27}$$

the following theorem can be shown. Proof is omitted again for the readability of the chapter.

Theorem 3.2 *Let* $\hat{\underline{\underline{\xi}}}(0+,s)$ *and* $\hat{\underline{\underline{\varphi}}}(v,s)$ *be as in (19.3.18) and (19.3.20), respectively. One then has the followings.*

a) $\hat{\underline{\underline{\xi}}}(0+,s)$

$$=\begin{bmatrix} \underline{\underline{L}} & & & \\ & \underline{\underline{L}} & & \\ & & \ddots & \\ & & & \underline{\underline{L}} \end{bmatrix}\begin{bmatrix} \underline{\underline{V}}_1(s) & \underline{\underline{V}}_1(s)\underline{\underline{\phi}}_1(s)\underline{\underline{V}}_2(s) & \cdots & \cdots & \prod_{i=1}^{M}\underline{\underline{V}}_i(s)\underline{\underline{\phi}}_i(s)\underline{\underline{V}}_M(s) \\ & \underline{\underline{V}}_2(s) & \cdots & \cdots & \prod_{i=2}^{M}\underline{\underline{V}}_i(s)\underline{\underline{\phi}}_i(s)\underline{\underline{V}}_M(s) \\ & & \ddots & \ddots & \vdots \\ & & & \underline{\underline{V}}_{M-1}(s) & \prod_{i=M-1}^{M}\underline{\underline{V}}_i(s)\underline{\underline{\phi}}_i(s)\underline{\underline{V}}_M(s) \\ & & & & \underline{\underline{V}}_M(s) \end{bmatrix}$$

where $\underline{\underline{L}}$ *is a matrix in* $R^{3N\times 3N}$ *defined by* $\underline{\underline{L}}=\begin{bmatrix} \underline{\underline{I}} & \underline{\underline{0}} & \underline{\underline{0}} \\ \underline{\underline{0}} & \underline{\underline{I}} & \underline{\underline{0}} \\ \underline{\underline{0}} & \underline{\underline{0}} & \underline{\underline{I}} \end{bmatrix}$ *and* $\underline{\underline{V}}_i(s)=[\underline{\underline{I}}-\underline{\underline{\psi}}_i(s)]^{-1}$ *for* $i=1,\cdots,M$.

b) $\hat{\underline{\underline{\varphi}}}(v,s)=\hat{\underline{\underline{s}}}(0+,s)\times DIAG\{\beta_1(s+v+C_{(1,1)}),$

$$\cdots,\beta_N(s+v+C_{(1,N)}),\frac{1}{s+v},\cdots,\frac{1}{s+v},\frac{1}{s+v},\cdots,\frac{1}{s+v},$$

$$\cdots\beta_1(s+v+C_{(M,1)}),\cdots,\beta_N(s+v+C_{(M,N)}),\frac{1}{s+v},\cdots,\frac{1}{s+v},\frac{1}{s+v},\cdots,\frac{1}{s+v}\}$$

Let the Laplace transform of $\underline{\underline{P}}(t)$ with respect to t be denoted by $\underline{\underline{\pi}}(s)$, that is,

$$\underline{\underline{\pi}}(s)=\int_0^{\infty}e^{-st}\underline{\underline{P}}(t)dt. \qquad (19.3.28)$$

From the definition of $\underline{\underline{P}}(t)$ in (19.3.1), one easily sees that $\underline{\underline{\pi}}(s)=\hat{\hat{\underline{\underline{\phi}}}}(0,s)$. The next theorem is then immediate from Theorem 3.2.

Theorem 3.3

$$\underline{\underline{\pi}}(s)=\hat{\underline{\underline{\varphi}}}(0+,s)$$

$$=\hat{\underline{\underline{s}}}(0+,s)\times DIAG\{\beta_1(s+C_{(1,1)}),\cdots,\beta_N(s+C_{(1,N)}),\frac{1}{s},\cdots,\frac{1}{s},\frac{1}{s},\cdots,\frac{1}{s},$$

$$\cdots\beta_1(s+C_{(M,1)}),\cdots,\beta_N(s+C_{(M,N)}),\frac{1}{s},\cdots,\frac{1}{s},\frac{1}{s},\cdots,\frac{1}{s}\}$$

So far, we have assumed that the dwell time of the semi-Markov process in state (i, j) is absolutely continuous with p.d.f. $a_j(x)$, $j = 1, \cdots, N$, given that neither the decision of purchasing nor that of not purchasing is made. In reality, however, the segments of a day should be treated as constants τ_j, $j = 1, \cdots, N$. This case can be dealt with by considering a sequence of Laplace transforms of p.d.f's $(\alpha_j(k,s))_{k=1}^{\infty}$ where $\alpha_j(k,s) \to e^{-s\tau_j}$ as $k \to \infty$, $j = 1, \cdots, N$. We emphasize this limit by using the symbol ~, that is, $\tilde{\alpha}_j(s) = e^{-s\tau_j}$. At the limit, the corresponding matrix Laplace transform $\underline{\underline{\tilde{\pi}}}(s)$ of the transition probability matrix $\underline{\underline{\tilde{P}}}(t)$ can be obtained by substituting $\tilde{\alpha}_j(s) = e^{-s\tau_j}$ into Theorems 3.2 and 3.3.

Let $P_{i:Buy}(t)$ and $P_{i:\neg Buy}(t)$ be the probability of a customer in Class i having decided to purchase the product by time t and that of a customer in Class i having decided not to purchase the product by time t, respectively. The corresponding Laplace transforms are denoted by $\pi_{i:Buy}(s)$ and $\pi_{i:\neg Buy}(s)$. These Laplace transforms can be derived directly from Theorems 3.2 and 3.3 with substitution of $\tilde{\alpha}_j(s) = e^{-s\tau_j}$ and by employing the appropriate initial probability vector, that is, $\underline{u}^{\mathrm{T}}_{(i,1)}$ for those customers in Class i. More formally, one has the followings.

$$\pi_{i:Buy}(s) = \sum_{m=i}^{M} \sum_{n=1}^{N} \tilde{\pi}_{(i,1)(m,B_n)}(s); \quad \pi_{i:\neg Buy}(s) = \sum_{m=i}^{M} \sum_{n=1}^{N} \tilde{\pi}_{(i,1)(m,\neg B_n)}(s) \tag{19.3.29}$$

The next theorem describes Laplace transforms $\tilde{\pi}_{(1,1)(i,B_n)}(s)$ and $\tilde{\pi}_{(1,1)(i,\neg B_n)}(s)$ for $i = 1, \cdots, M$ and $n = 1, \cdots, N$, for which proof is omitted again.

Theorem 3.4 *Suppose that the jth segment of a day is represented by constants τ_j, $j = 1, \cdots, N$. Let $\tau = \sum_{j=1}^{N} \tau_j$, $\tau(i) = \sum_{j=1}^{N} C_{(i,j)} \tau_j$ where $C_{(i,j)}$ are as in (19.3.4). One then has the followings.*

a) $\tilde{\pi}_{(1,1)(i,B_n)}(s)$

$$= \frac{1}{s} \cdot \frac{1}{1 - p_{ii} e^{-s\tau} e^{-\tau(i)}} e^{-\sum_{j=1}^{n-1} (s + C_{(i,j)}) \tau_j} \xi_{(i,n)} \frac{1 - e^{-(s + C_{(i,n)}) \tau_n}}{s + C_{(i,n)}} \cdot \prod_{m=1}^{i-1} \frac{(1 - p_{mm}) e^{-s\tau} e^{-\tau(m)}}{1 - p_{mm} e^{-s\tau} e^{-\tau(m)}}$$

b) $\tilde{\pi}_{(1,1)(i,\neg B_n)}(s)$

$$= \frac{1}{s} \cdot \frac{1}{1 - p_{ii} e^{-s\tau} e^{-\tau(i)}} e^{-\sum_{j=1}^{n-1} (s + C_{(i,j)}) \tau_j} \theta_{(i,n)} \frac{1 - e^{-(s + C_{(i,n)}) \tau_n}}{s + C_{(i,n)}} \cdot \prod_{m=1}^{i-1} \frac{(1 - p_{mm}) e^{-s\tau} e^{-\tau(m)}}{1 - p_{mm} e^{-s\tau} e^{-\tau(m)}}$$

Theorem 3.4 enables one to develop computational algorithms for evaluating the purchasing probabilities $P_{i:Buy}(t)$ and the not-purchasing probabilities $P_{i:\neg Buy}(t)$, which are of principal interest to this chapter. This issue is addressed in the next section.

19.4 Development of Computational Algorithms for Evaluating Purchasing and Not-Purchasing Probabilities by Time t

The purpose of this section is to invert the Laplace transforms given in Theorem 3.4 into the real domain, so as to develop computational algorithms for evaluating the decision probabilities at time t via (19.3.29). For notational convenience, the following intervals are introduced for $k=0, 1, 2,\dots$

$$Int[k,n] \overset{def}{=} \left\{ t : k\tau + \sum_{j=1}^{n-1} \tau_j \le t < k\tau + \sum_{j=1}^{n} \tau_j \right\} \tag{19.4.1}$$

Here, $Int[k, n]$ represents the nth segment of the kth day. We also write $\lfloor x \rfloor$ to mean the integer part of a real number x. The following functions also play a role to simplify the expressions of the decision probabilities. We define for $i = 1,\cdots,M$:

$$D_i = \frac{1}{p_{ii}} \cdot e^{\tau(i)} \cdot e^{-\sum_{j=1}^{n-1} C_{(i,j)}\tau_j} \cdot \prod_{m=1}^{i-1} \frac{1-p_{mm}}{p_{mm}}; \tag{19.4.2}$$

$$\underline{d}_i = [d_i(1),\dots,d_i(k),\dots d_i(T)]^{\mathrm{T}}; \quad d_i(k) = \begin{cases} 0 & if \ k=0 \\ (p_{ii}e^{-\tau(i)})^k & else \end{cases} \text{; and} \tag{19.4.3}$$

$$\begin{aligned} \underline{H}_i &= [H_i(1),\dots,H_i(k),\dots,H_i(T)]^{\mathrm{T}}; H_i(k) \\ &= CONV(\underline{H}_{i-1},\underline{d}_i)_k \quad starting \ with \ \underline{H}_0 = \underline{u}_1. \end{aligned} \tag{19.4.4}$$

Here, $CONV(\underline{a},\underline{b})$ denotes the discrete convolution of two vectors defined on $\{0,1,\cdots\}$ whose nth component is given by $CONV(\underline{a},\underline{b})_n = \sum_{m=0}^{n} a_m b_{n-m}$. We now derive the absorption probabilities into states (i, B_n) and $(i, \neg B_n)$ starting at state (1, 1). Proof is omitted again for better readability.

Theorem 4.1 *Let Int[k, j] and $H_i(k)$ be as in (19.4.1) and (19.4.4), respectively. Let τ and $C_{(i,j)}$ be as in Theorem 3.4 and define $M(t) = \left\lfloor \frac{t}{\tau} \right\rfloor$. Then, the absorption probabilities $\tilde{P}_{(1,1)(i,B_n)}(t)$ and $\tilde{P}_{(1,1)(i,\neg B_n)}(t)$ can be obtained as follows.*

a)

i) For $t < M(t)\tau + \sum_{j=1}^{n-1} \tau_j$,

$$\tilde{P}_{(1,1)(i,B_n)}(t) = \frac{\xi_{(i,n)}}{C_{(i,n)}} \cdot D_i \cdot \sum_{k=0}^{M(t)} H_i(k) \cdot (1 - e^{-C_{(i,n)}\tau_n}).$$

ii) For $t \in Int[M(t), n]$,

$$\tilde{P}_{(1,1)(i,B_n)}(t) = \frac{\xi_{(i,n)}}{C_{(i,n)}} \cdot D_i \cdot \sum_{k=0}^{M(t)} H_i(k) \cdot \left(1 - e^{-C_{(i,n)}\tau_n}\right)$$
$$+ \frac{\xi_{(i,n)}}{C_{(i,n)}} \cdot D_i \cdot e^{C_{(i,n)}(M(t)\tau + \sum_{j=1}^{n-1}\tau_j)}$$
$$\cdot H_i(M(t)+1) \cdot \left(e^{-C_{(i,n)}(M(t)\tau + \sum_{j=1}^{n-1}\tau_j)} - e^{-C_{(i,n)}t} \right).$$

iii) For $t \geq M(t)\tau + \sum_{j=1}^{n-1}\tau_j$,

$$\tilde{P}_{(1,1)(i,B_n)}(t) = \frac{\xi_{(i,n)}}{C_{(i,n)}} \cdot D_i \cdot \sum_{k=0}^{M(t)+1} H_i(k) \cdot (1 - e^{-C_{(i,n)}\tau_n}).$$

b)

i) For $t < M(t)\tau + \sum_{j=1}^{n-1}\tau_j$,

$$\tilde{P}_{(1,1)(i,\neg B_n)}(t) = \frac{\theta_{(i,n)}}{C_{(i,n)}} \cdot D_i \cdot \sum_{k=0}^{M(t)} H_i(k) \cdot (1 - e^{-C_{(i,n)}\tau_n}).$$

ii) For $t \in Int[M(t), n]$,

$$\tilde{P}_{(1,1)(i,\neg B_n)}(t) = \frac{\theta_{(i,n)}}{C_{(i,n)}} \cdot D_i \cdot \sum_{k=0}^{M(t)} H_i(k) \cdot \left(1 - e^{-C_{(i,n)}\tau_n}\right)$$
$$+ \frac{\theta_{(i,n)}}{C_{(i,n)}} \cdot D_i \cdot e^{C_{(i,n)}(M(t)\tau + \sum_{j=1}^{n-1}\tau_j)}$$
$$\cdot H_i(M(t)+1) \cdot \left(e^{-C_{(i,n)}(M(t)\tau + \sum_{j=1}^{n-1}\tau_j)} - e^{-C_{(i,n)}t} \right).$$

.iii) For $t \geq M(t)\tau + \sum_{j=1}^{n-1}\tau_j$,

$$\tilde{P}_{(1,1)(i,\neg B_n)}(t) = \frac{\theta_{(i,n)}}{C_{(i,n)}} \cdot D_i \cdot \sum_{k=0}^{M(t)+1} H_i(k) \cdot (1 - e^{-C_{(i,n)}\tau_n}).$$

The decision probabilities at time *t* of principal interest to this chapter can now be computed from (19.3.29) based on Theorem 4.1.

19.5 Analysis of Dynamic Sales Volume and Sales Completion Time

Using the results of the semi-Markov model discussed in Sects. 19.3 and 19.4, we are now in a position to assess the impact of the mobile access to the Internet on enhancement of e-commerce. More specifically, we consider X customers classified into M classes, Class i, $i = 1, \cdots, M$, where the corresponding populations are denoted by

$$X = \sum_{i=1}^{M} X_i \quad ; \quad X_i = | \, Classi \, |. \tag{19.5.1}$$

Here, $|A|$ denotes the cardinality of a set A. The composition of X is defined as a vector

$$\underline{X} = [X_1, \cdots, X_M]. \tag{19.5.2}$$

Given $\underline{X}$, of interest is the distribution of the sales volume at time t. Also, of equal importance would be the distribution of the sales completion time for K products. In this section, we derive these two distributions explicitly. The effects of the mobile access to the Internet can then be analyzed by changing the composition $\underline{X}$ while the total number of customers X is fixed, where the intensity for the use of mobile devices for time segment j is assumed to increase as i increases for all $j = 1, \cdots, N$.

Theorem 5.1 *Let $K_i(t)$ be the number of products sold to those customers in Class i by time t. Then $K_i(t)$ has the binomial distribution with mean $X_i \cdot P_{i:Buy}(t)$, that is,*

$$Q_i(k,t) = P[K_i(t) = k] = \binom{X_i}{k} P_{i:Buy}(t)^k \{1 - P_{i:Buy}(t)\}^{X_i - k} \quad , k = 0, \cdots, X_i \tag{19.5.3}$$

We next turn our attention to the sales completion time for K products among those customers in Class i where $0 < K \le X_i$. More formally, let $T_i(K)$ be the time until K products have been sold among Class i, that is,

$$T_i(K) = \inf\{t : K_i(t) = K\}. \tag{19.5.4}$$

Let $\bar{H}_{i(K)}(t)$ be the survival function of $T_i(K)$, that is,

$$\bar{H}_{i(K)}(t) = P[T_i(K) > t]. \tag{19.5.5}$$

The next theorem then holds true.

Theorem 5.2 *Let $Q_i(k, t)$ and $\bar{H}_{i(K)}(t)$ be as in Theorem 5.1 and (19.5.5), respectively, where $0<K\leq X_i$. One then has*

$$\bar{H}_{i(K)}(t) = \sum_{k=0}^{K-1} Q_i(k,t). \tag{19.5.6}$$

The above analysis for the individual classes of customers should be integrated so as to capture the stochastic nature of the customer behaviors in the entire market. More specifically, let $K(t)$ be the number of products sold by time t in the entire market. As before, we also define $T(K)$ to be the time required for selling K products in the entire market where $0<K\leq X$. One then has the following theorem.

Theorem 5.3 *Let X, $K(t)$, K, and $T(K)$ be as described above. Let $\underline{Q}(t)=[Q(k, t)]^T$, where $Q(k, t)=P[K(t)=k]$ and define the survival function of $T(K)$ by $\bar{H}_{ALL(K)}(t)=P[T(K)>t]$. Then the following statements hold true.*

a) Let $\underline{Q}_i(t)=[Q_i(k,t)]^{\mathrm{T}}, i=1,\cdots,M$. One then has $\underline{Q}(t) = CONV[\underline{Q}_1(t),\cdots,\underline{Q}_M(t)]$ where $CONV[\underline{a}_1,\cdots,\underline{a}_M]$ denotes the M-repeated discrete convolutions of $\underline{a}_1,\cdots,\underline{a}_M$.

b) $\bar{H}_{ALL(K)}(t) = \sum_{k=0}^{K-1} Q(k,t)$.

19.6 Numerical Examples

The purpose of this section is to explore numerically how the mobile access to the Internet would enhance e-commerce. We assume that the time segments of a day are as given in Table 19.1.

The first segment and the third segment of a day represent the commuting hours from home to work and those from work to home, respectively, while the second segment, the fourth segment, and the fifth segment of a day correspond to the working hours, the evening hours, and the sleeping hours, respectively. Fixed PC accesses are not possible during the first segment and the third segment of a day. As reported in MakeYouGoHmm (2006), corporate employees often utilize company-fixed PCs

Table 19.1 Time segments of a day

State	Time segments	Length τ	Internet access
(*,1)	Commuting hours	1	Mobile
(*,2)	Working hours	8	Fixed PC only or Both fixed PC and mobile
(*,3)	Commuting hours	1	Mobile
(*,4)	Evening hours	6	Fixed PC
(*,5)	Sleeping hours	8	Nothing

Table 19.2 Basic parameters

State (i, j)	$\lambda(_{i,j})$	$\mu(_{i,j})$	$\lambda(_{i,j})+\mu(_{i,j})$	$\alpha(_{i,j})$	$\beta(_{i,j})$	$\xi(_{i,j})$	$\theta(_{i,j})$
(1,1)	0	1/48	1/48	0.03	0.01	1/1600	1/4800
(1,2)	1/48	1/48	1/24	0.03	0.01	1/800	1/2400
(1,3)	0	1/48	1/48	0.03	0.01	1/1600	1/4800
(1,4)	1/48	0	1/48	0.03	0.01	1/1600	1/4800
(1,5)	0	0	0	0.03	0.01	0	0
(2,1)	0	1/36	1/36	0.03	0.01	1/1200	1/3600
(2,2)	1/48	1/36	7/144	0.03	0.01	7/4800	7/14,400
(2,3)	0	1/36	1/36	0.03	0.01	1/1200	1/3600
(2,4)	1/48	0	1/48	0.03	0.01	1/1600	1/4800
(2,5)	0	0	0	0.03	0.01	0	0
(3,1)	0	1/24	1/24	0.03	0.01	1/800	1/2400
(3,2)	1/48	1/24	1/16	0.03	0.01	3/1600	1/1600
(3,3)	0	1/24	1/24	0.03	0.01	1/800	1/2400
(3,4)	1/48	0	1/48	0.03	0.01	1/1600	1/4800
(3,5)	0	0	0	0.03	0.01	0	0

for privately accessing the Internet. Accordingly, during the second segment of a day, fixed PC accesses are assumed to be available from time to time for the private use of the Internet. Mobile accesses are also possible if customers choose to do so. It is natural to assume that fixed PC accesses supersede mobile accesses during the evening hours at home. Accordingly, only fixed PC accesses are considered during the fourth segment of a day. Since the fifth segment of a day represents sleeping hours, the customers are inactive in using the Internet.

The basic values of the underlying parameters are set as in Table 19.2.

It should be noted that the intensity of the use of mobile devices change from 1/48, 1/36 to 1/24 as customer classes change from $i=1$, 2 to 3. The decision probabilities $\alpha_{(\mathrm{i,j})}$ for purchasing and $\beta_{(\mathrm{i,j})}$ for not purchasing are different across customer classes, regardless of different access times in a day and regardless of the fixed PC access or the mobile access. The total number of customers is given as $X=10{,}000$. While these parameter values are set without a solid realistic foundation, numerical examples provided in this section assure the speed and the efficiency of the proposed numerical algorithms, thereby demonstrating the usefulness of the model if the appropriate field study finds a way to set these parameter values realistically.

The following five cases are considered (Table 19.3).

It should be noted that the degree of the mobile use is strengthened in the order of 1), 2), 3), 4), and 5).

In Fig. 19.2, the survival functions for $K(240)$, that is, the number of products sold by time $t=240$, are plotted for the five cases in the order of 1), 2), 3), 4), and 5) from left to right.

Table 19.3 Cases considered for study

Case	X_1	X_2	X_3
1)	5000	5000	0
2)	5000	2500	2500
3)	2500	5000	2500
4)	2500	2500	5000
5)	0	5000	5000

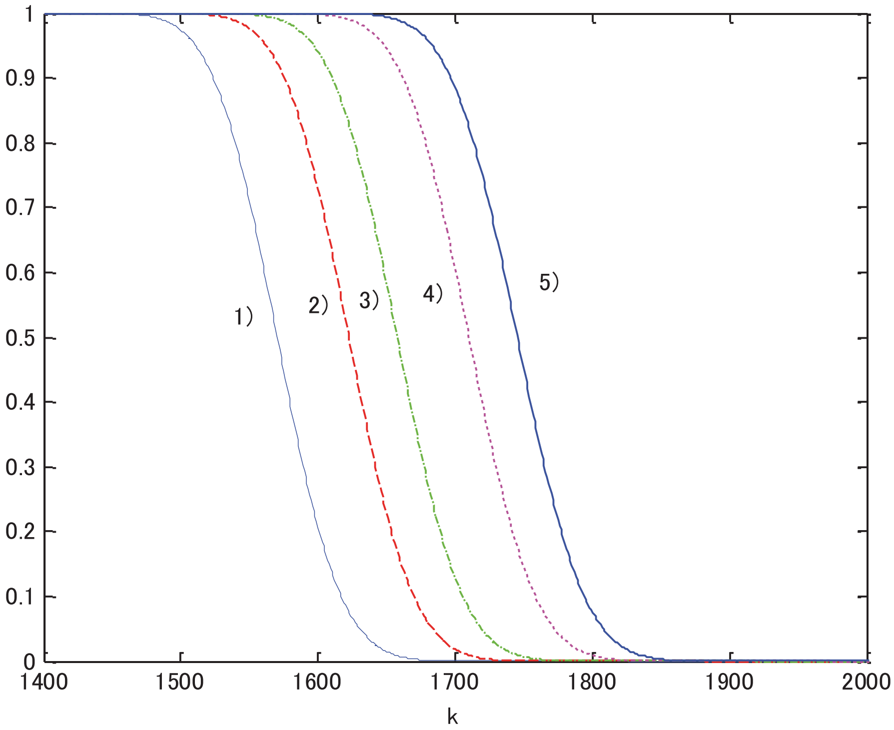

Fig. 19.2 Survival function of $K(240)$

It can be readily seen that $K(240)$ increases stochastically in this order. With probability 0.7, for example, 1551 products or more can be sold for case 1), while this number increases from 1603, 1638, and 1690 to 1725 as the case moves from 2), 3) and 4) to 5), respectively. The monotonicity of the variance given in Fig. 19.3 reflects the fact that the support interval of $K(240)$ increases as the case moves from 1) to 5).

Figures 19.4 and 19.5 provide the counterparts of Figs. 19.2 and 19.3 for the survival function for $T(2000)$, that is, the sales completion time for $K = 2000$ products, except that the leftmost curve now corresponds to case 5) and the rightmost curve represents case 1).

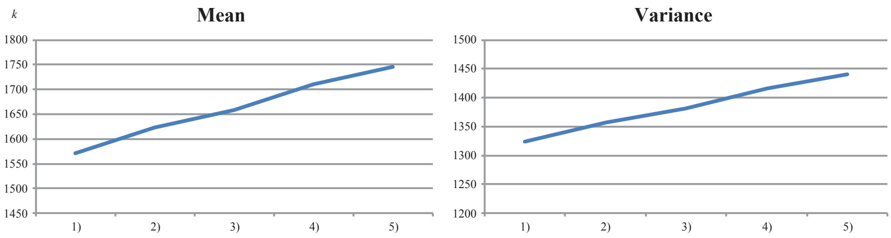

Fig. 19.3 Mean and variance of $K(240)$

We observe that $T(2000)$ decreases stochastically as the case moves from 1) to 5). With probability 0.7, $T(2000)$ is greater than or equal to 296 for case 1), while this number decreases from 291, 288, and 272 to 269 as the case moves from 2), 3), and 4) to 5), respectively. The expected sales completion time and its variance are depicted in Fig. 19.5.

While the monotonicity of the expected value is observed again, the variance fluctuates visibly in a rather strange manner. This fluctuation phenomenon may be explained by the fact that the fifth period of a day, denoted by τ_5, affects the distribution of $T(2000)$ differently for different cases. The flat parts observed in Fig. 19.4 correspond to τ_5 representing the sleeping hours during which customers are inactive in the use of the Internet. One realizes that the flat parts appear differently for five different curves which may result in the fluctuation of the variance.

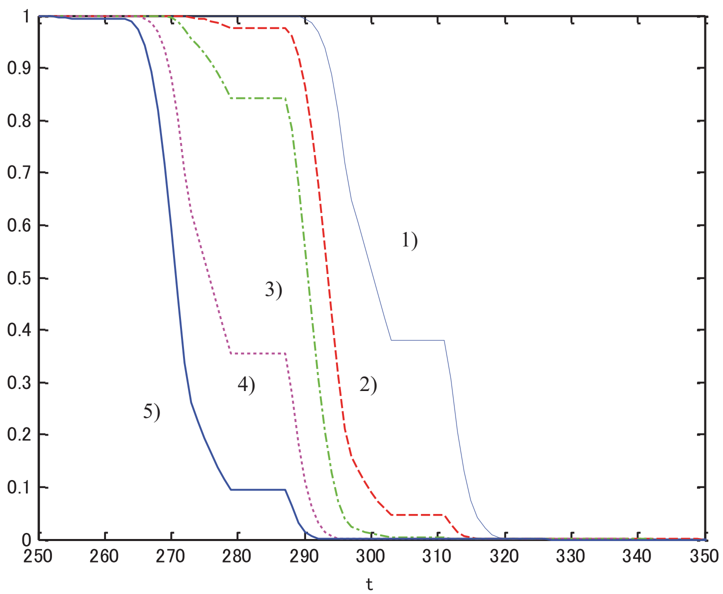

Fig. 19.4 Survival function of $T(2000)$

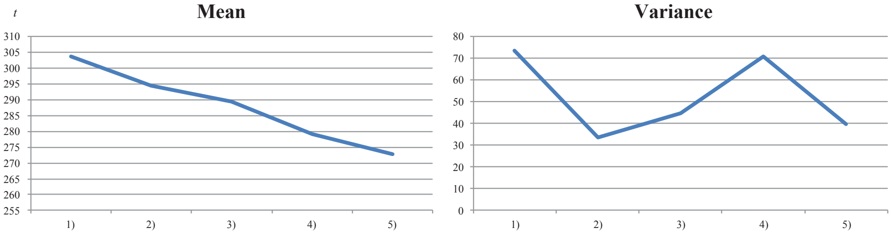

Fig. 19.5 Mean and variance of T(2000)

To demonstrate the usefulness of the computational procedures developed in this chapter for deriving information managerial implications, we consider a promotion campaign to be conducted during the working hour (time segment 2) with budget\$B$. It is assumed that the budget can be allocated to the PC campaign with\$(1-\rho)B$ and the mobile campaign with\$\rho B$, $0 \le \rho \le 1$. Furthermore, we assume that the campaign effect can be expressed by changing Poisson intensities for PC accesses and mobile accesses through the following functions.

$$\lambda_{(i,j)}(\rho) = c_P + \frac{h_{P:ij}\cdot(1-\rho)B}{1+g_{P:ij}\cdot(1-\rho)B}; \quad \mu_{(i,j)}(\rho) = c_M + \frac{h_{M:ij}\cdot\rho B}{1+g_{M:ij}\cdot\rho B} \tag{19.6.1}$$

It should be noted that the Poisson intensity for PC accesses would decrease while that for mobile accesses would increase as ρ increases from 0 to 1.

We recall that $K(t)$ is the number of products sold at time t and $T(K)$ is the time required to sell K products. Since the distribution functions of these two random variables are now dependent on ρ, we denote the two random variables by $K(t,\rho)$ and $T(K,\rho)$. Of interest are the following four optimization problems.

P1-A: Find ρ_K^* by solving $\max_{0\le\rho\le1} \mathrm{E}[K(t,\rho)]$.

P1-B: Find ρ_K^{**} by solving $\max_{0\le\rho\le1} \mathrm{P}[K(t,\rho) > \varepsilon_1 \mathrm{E}[K(t,\rho_K^*)]]$ subject to $\mathrm{E}[K(t,\rho)] > \varepsilon_2 \mathrm{E}[K(t,\rho_K^*)]$

P2-A: Find ρ_T^* by solving $\max_{0\le\rho\le1} \mathrm{E}[K(\underline{t},\rho)]$.

P2-B: Find ρ_T^{**} by solving $\max_{0\le\rho\le1} \overline{H}_{ALL(K,\rho)}(\varepsilon_1 \mathrm{E}[\mathrm{T}(K,\rho_T^*)])$ subject to $\mathrm{E}[T(K,\rho)] > \varepsilon_3 E[T(K,\rho_T^*)]$

For the numerical experiments to follow, the parameter values in (19.6.1) are set as follows. All other parameter values are as in Table 19.2.

$$B = 100.$$

$$c_P = c_M = 1/48.$$

$$h_{P:12} = h_{P:22} = h_{P:32} = 0.001.$$

$$h_{M:12} = 0.001, \quad h_{M:22} = 0.0015, \quad h_{M:32} = 0.002.$$

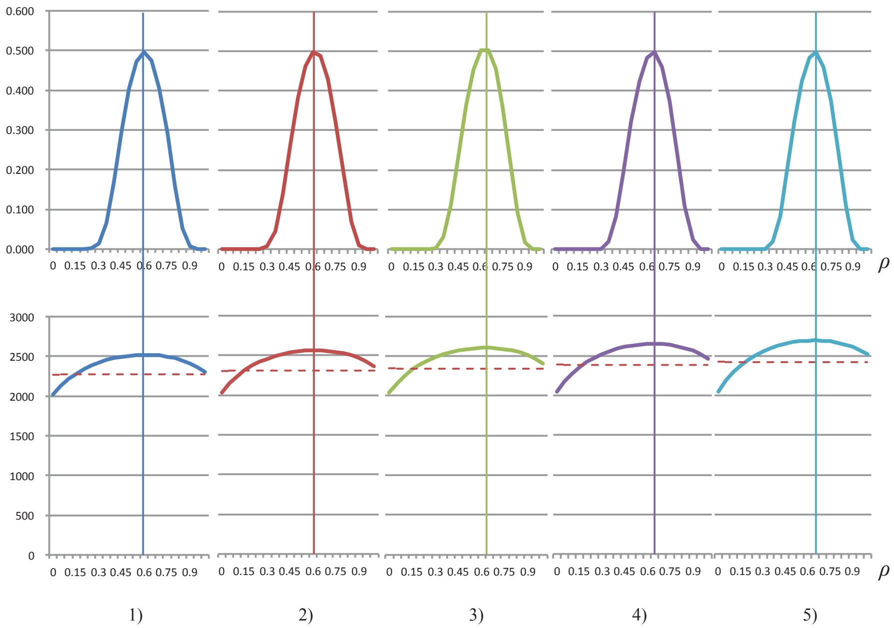

Fig. 19.6 : Graphic solutions to P1-A and P1-B

$$g_{P:i2} = g_{M:i2} = 0.02 \quad \text{for} \quad i = 1, 2, 3.$$

$$\varepsilon_1 = 1, \quad \varepsilon_2 = 0.9, \quad \varepsilon_3 = 1.1.$$

In Fig. 19.6 1) through 5), each pair of graphs aligned vertically represents the graphic solutions to P1-A (lower side) and P1-B (upper side) for different population mixes. The counterparts for P2-A and P2-B are exhibited in Fig. 19.7 1) through 5).

To the surprise of the authors, it turns out that $\rho_K^* = \rho_K^{**}$ and $\rho_T^* = \rho_T^{**}$ for all the cases. To see why this happens, the underlying survival functions are plotted in Figs. 19.8 and 19.9. These observations lead to the following conjecture.

Conjecture

1. For any $0 \le \rho \le 1$ with $\rho \ne \rho_K^*$, one has $K(t,\rho) \prec_{ST} K(t,\rho_K^*)$.
2. For any $0 \le \rho \le 1$ with $\rho \ne \rho_T^*$, one has $T(K,\rho) \succ_{ST} T(K,\rho_T^*)$.

Here, for two random variables X and Y, the stochastic ordering $X \prec_{ST} Y$ is defined by $\mathrm{P}[X > x] < \mathrm{P}[Y > x]$ for all $x > 0$. This conjecture will be addressed in due course and the result will be reported elsewhere.

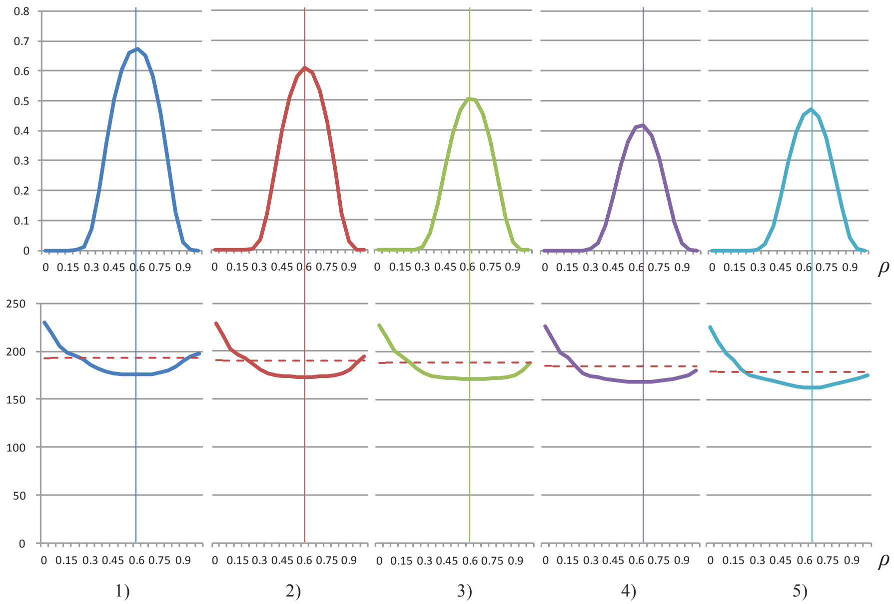

Fig. 19.7 Graphic solutions to P2-A and P2-B

19.7 Conclusion

Through a new generation of mobile devices rapidly spread in society, the way the Internet is used has been going under revolution, where the traditional e-commerce is in the process of being converted into m-commerce. However, because of the fact that the mobile technology is still young, the study of the impact of the mobile access to the Internet on e-businesses is rather limited, where pioneering papers are either empirical, qualitative, or static in their analytical nature and, to the best knowledge of the authors, three papers by Sumita and Yoshii (2010, 2012) and Yoshii and Sumita (2013) are the first in the literature for capturing behavioral differences between e-commerce and m-commerce based on a mathematical stochastic model. The purpose of this chapter is to discuss the optimal strategy concerning how to allocate the promotion budget between the PC promotion and the mobile promotion based on the most extended model by Yoshii and Sumita (2013).

Through dynamic analysis of the semi-Markov process, the two stochastic performance measures of interest can be evaluated: the distribution of the number of products sold by time t and the distribution of the time required for selling K products. This analysis, in turn, enables one to assess the impact of mobile devices on e-businesses by comparing such stochastic performance measures for m-commerce against those for traditional e-commerce. Numerical examples are

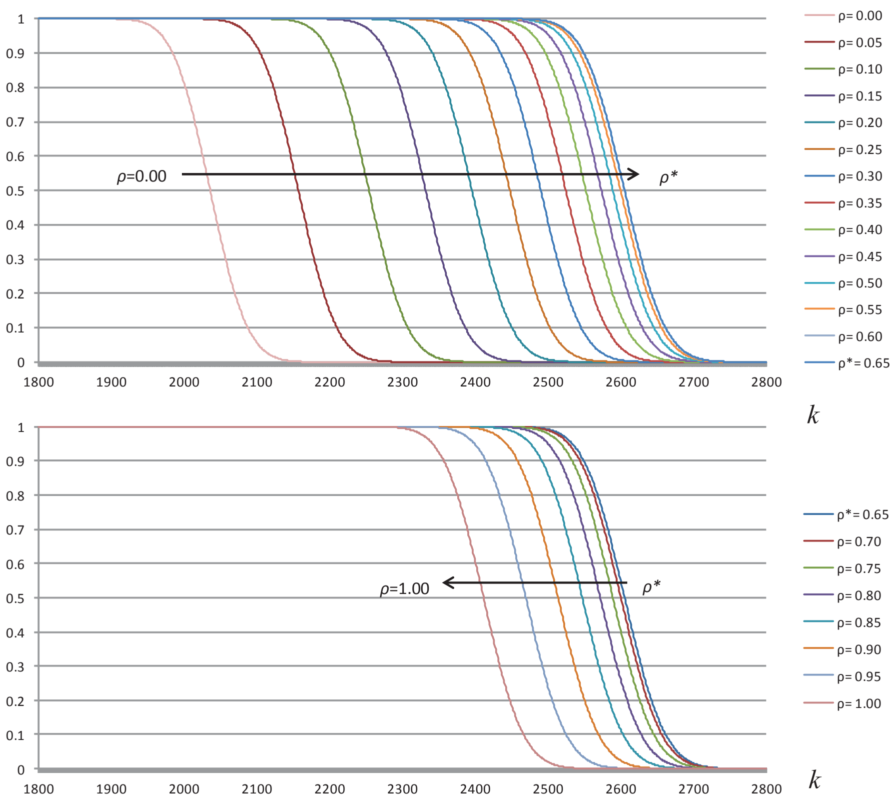

Fig. 19.8 Survival functions of $K(240,\rho)$

given for demonstrating the effectiveness of the computational procedures proposed in this chapter.

This line of research is still in its infancy. Extensive numerical experiments would be needed to extract more useful rules of thumb from the managerial point of view in conducting m-commerce. In addition, efforts should be made for estimating the values of the parameters involved in the analytical model from real data. These studies are in progress and will be reported elsewhere.

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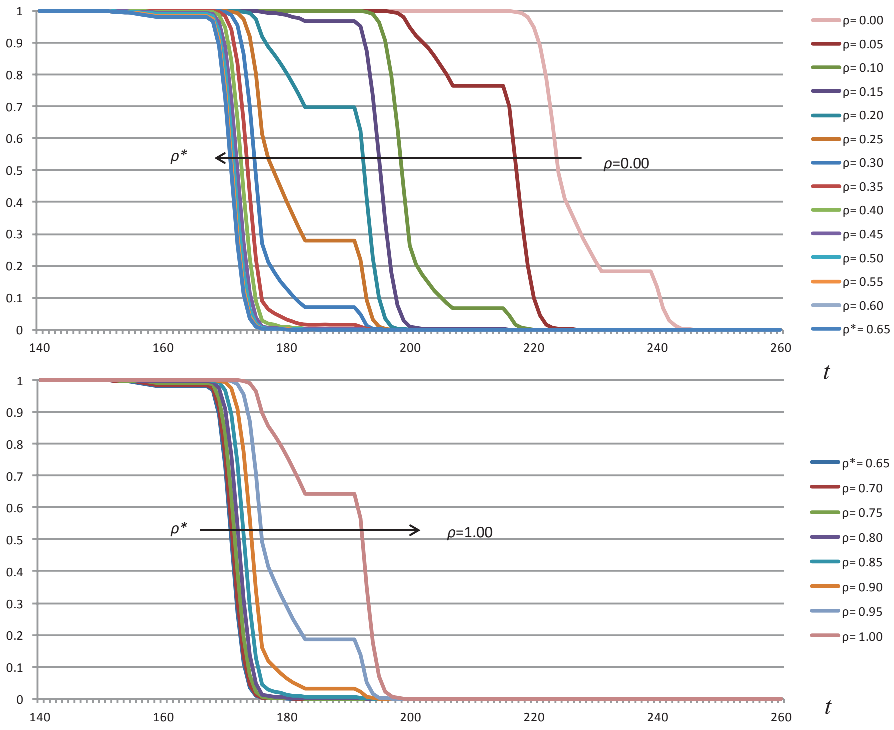

Fig. 19.9 Survival functions of $T(2000,\rho)$

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Chapter 20
Emotional Balancing and Change Outcomes During Post-merger Integration: A Case Study

Zeba Naz and Saboohi Nasim

20.1 Introduction

Mergers and acquisitions (M&As) are considered as an imperative growth strategy for business enterprises. They create most dramatic changes that people will experience in the organization. Human resources are one of the most important elements affecting success or failure to M&As decision. People issues are complementary to the success of M&A, but they are often ignored or overlooked at the time when decisions to merge are made. During an M&A, employees face uncertain situations that can be handled by middle managers by involving them with change process resulting in a successful integration.

Post-merger integration is a phase where the integration process is evaluated and the new entity is solidified. Employees consider this situation as highly uncertain, which leads to intense negative emotions. Researchers found that there is a reduced communication between middle managers and employees in this stage. An increased level of uncertainty, or rumors about reorganization, or assumptions about the change processes, may initiate these emotions. To reduce negative emotions, middle-level managers act as change agents, who facilitate change process by balancing employees' emotions.

There is a plethora of studies done on M&As in strategy and finance literature, but human aspect of merger is comparatively a less-explored area. The significant role of balancing employees' emotions by middle managers is often ignored, which facilitates smoother integration. This chapter aims to assess the role of middle managers during post-merger integration in the context of radical change.

Z. Naz (✉) · S. Nasim
Department of Business Administration, Faculty of Management Studies and Research, Aligarh Muslim University, Aligarh, India
e-mail: zeba.amu09@gmail.com

S. Nasim
e-mail: saboohinasim@gmail.com

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20.2 Literature Review

A review of literature identifies and explains issues like post-merger integration in the context of radical change, role of middle managers as change agents, negative emotions identified during such situations, and emotional balancing by middle managers.

20.2.1 Radical Change

Change can be defined as a modification to organization's structure, its processes and social system (Kiefer 2005). A radical or revolutionary transformation is believed to be a "trigger event" (Kiefer 2005) that has an impact on employees' self-identity and creates high uncertainty about their future roles in the organization, thus eliciting anxiety (Argyris 1989). When employees perceive that they are going to have different kinds of personal loss, they resist change efforts (Eriksson 2004). This brings out intense emotions, so it is vital that leaders across the organization adopt a disciplined approach to facilitate the employees' behavior from known to unknown situations (Isern and Pung 2007).

20.2.2 Post-merger Integration

An M&A is considered as one of the most appropriate examples of radical change, as it involves transformation of the organization system. It makes or creates opportunities to realize many corporate objectives, which can be easily achieved after the synergy of two enterprises complementing each other (Kiefer 2005; Mittal and Jain 2012; Agrawal et al. 2015). It provides enormous benefits other than financial ones such as improvement in operational efficiency, diversified managerial capabilities, market synergies, competent employees, technological enhancement, increased market share, risk diversification, rapid growth and development (Mittal and Jain 2012). Though the number of M&As is increasing, most of them do not reach the performance target (Emmanouilides and Giovanis 2006; Teerikangas 2012). Many researchers identified human resistance, cultural conflicts, and manager's inefficiency in managing post-integration phase as the reasons for poor performance of M&A (Szabla 2007; Teerikangas 2012).

Successful acquirers are more likely to conduct thorough human due diligence than unsuccessful acquirers (Marks and Mirvis 2011). M&A can bring important changes in the behavior of employees, which can be good or bad for the firm. Both the employees and managers are unprepared to cope with the new situation (Emmanouilides and Giovanis 2006). Integrating employees of merging entities, which can lead to value creation, is a difficult task. When the employees of two firms are brought together in a new environment, the situation leads to uncertainty or stressful psychological state (Herzig and Jimmieson 2006) and impacts employees' performance (Kiefer 2005; Teerikangas 2012; Mittal and Jain 2012; Agrawal et al. 2015).

20.2.3 Middle Managers as Change Agent

Radical change requires great innovative responsiveness by middle managers (Eriksson 2004). Middle management is usually referred to as "mediocrity" (Huy 2001) and also "linking pins" (Likert 1961), as they are considered as superior in one group and subordinate in other. Both top and lower levels are influenced by the action taken by middle managers.

Middle managers are far more effective in making change efforts possible than senior executives by leveraging informal networks (Huy 2001). They are considered important as they can identify the challenges posed by radical change and prepare themselves for managing the change as it occurs (Mittal and Jain 2012). Major restructuring of the organization poses challenge to both change agents and change recipients (Moosholder et al. 2000). The role, behavior, and attitude of managers have an impact on M&A processes. They can make a significant difference by making employees cope with the change and adjust in a new corporate life (Emmanouilides and Giovanis 2006).

20.2.4 Negative Emotions During Post-merger Integration

Mergers are generally perceived as threat rather than opportunity, which instill negative emotions in employees (Teerikangas 2012). The organization transformation can provoke emotional turmoil among change recipients (Moosholder et al. 2000; Huy 2002). Essential change in organization's structure, strategy, or other major issues elicits intense emotions (Eriksson 2004; Kiefer 2005). Negative reactions among employees occur, as they are affected directly due to the radical nature of the changes in the organization (Fugate et al. 2008).

Employees often appraise organizational change negatively as they perceive change as harmful and a situation of loss (Fugate et al. 2008). Emotional issues in the organization are usually neglected whereas change process is characterized by emotions. Moosholder et al. (2000) gave a concept of psychological ownership, which relates to expression of strong emotions when change affects ownership program. Accordingly, an individual has few moderating conditions that explain why he resists or accepts change. The first condition can be initiated by self and enhances a sense of growth; it is more likely to be accepted. The second condition could be when change is imposed or revolutionary; it is likely to be resisted.

The broad causes identified for arousal of negative emotions include decreased commitment, decreased motivation, mistrust in management, loss of identity, feeling of injustice, feeling of uncertainty, voluntary withdrawal, absenteeism, and survivor's syndrome. Undoubtedly, people who are separated from the organization during downsizing experience emotional turbulence (loneliness, pessimism, social isolation, and anger); they feel that the procedure is unfair. But the employees who were not even separated from the organization or layoffs survivors experience emotional impact, which is referred to as survivor syndrome that includes feeling of anger, anxiety, cynicism, threat to future employment, and resignation (Moosholder et al. 2000; Kiefer 2005).

20.2.5 Emotional Balancing by Middle Managers

Emotional balancing is a solution to radical change, which can smoothen the progress of the change process and can lead to organizational adaption by employees (Huy 2002; Nasim and Sushil 2011). It keeps emotions moderated and generates personal control over discontinuous and threatening change (Huy 2002). The criteria for considering change event as favorable or unfavorable depend on individual's goals and whether they have the required ability to achieve their goals during transformation. Employees who voluntarily adopt the change process display more favorable emotional reactions (Moosholder et al. 2000).

The literature analysis showed the unavoidable role of middle managers in facilitating change as they had unique characteristics of accountability and empathy, which make them linked to top management and employees. The possible middle manager roles identified during emotional balancing are discussed below:

Commitment to Change Projects (Huy 2002)—Commitment to change project is a state where managers feel they are aware of the change programs, have the required skills to implement it, feel motivated, and are empowered to take required action to share the vision exemplified by change (Jaros 2010). When managers demonstrate high commitment, they ensure to attain maximum employees' support to achieve the desired performance (Teerikangas 2012). Managers' low commitment to change projects leads to a situation of inertia, whereas high commitment with less attention to recipient's emotions results into chaos (Huy 2002).

Attending to Recipients Emotions (Huy 2002)—Middle-level managers should take care of their employees' emotions to reduce resistance to change projects (Huy 2001). Participation or involvement of managers in strategic change process will help the employees to know better what is expected from them and they can trust the management. Employee's commitment to change projects will reduce negative emotions (Kitchen and Daly 2002). Middle-level managers should formulate readiness creating strategies for the employees affected by change which may comprise individual's attitudinal and emotional willingness to embrace change (Moosholder et al. 2000).

Communication—Communication is a vital aspect in determining the success of organizational change process, as it can reduce the arousal of negative emotions among employees (Yongmie and Parrewe 2005; Teerikangas 2012). An important factor is how the information related to change is spread and how it is taken by employees (Kitchen and Daly 2002). Sharing of information about change by the middle managers will help employees understand the reasons for management decision and the need for change (Roberts and Appelbaum 2009).

Positive support by supervisor has a positive impact on job satisfaction and commitment, whereas fair treatment reduces the risks of withdrawal in layoffs and downsizing (Kiefer 2005). Employee's trust in the ability of management effects positive outcomes. Middle managers should have these factors for maintaining trust: ability, benevolence, and integrity (Creasy et al. 2009).

20.2.6 Research Methodology

Review of literature identified the significance of emotion management and middle-level managers' role during post-integration phase. In order to validate the variables, an inductive analysis is done on the basis of secondary data and case analysis by situation-actor-process and learning-action-performance (SAP–LAP) framework. The case study of Hindalco–Novelis merger is taken to analyze how the concept of emotional balancing by middle-level managers can facilitate the post-integration phase.

SAP–LAP can be defined as a framework for generating a model of enquiry for organizational change which can be further used for managerial implications (Sushil 2001). According to the SAP framework, S (situation) explains the issue or the problem to be dealt, A (actors) includes important people involved who are the decision makers, and P (process) shows the approach by which inputs or the issues are converted into outputs. Formation of SAP will lead to LAP framework where L (learning) depicts key learning from SAP, A (action) is the measures taken to solve the issue, and P (performance) is the actual outcome expected (Sushil 2000). Further the propositions for future research are given, which will depict the relationship between research constructs, emotional balancing, and change outcomes.

20.3 Case Study of Hindalco–Novelis

20.3.1 Background of the Merger

The India-based company Hindalco Industries acquired US-based Canada's Novelis for $ 6 billion in the year 2007 (The Indian Express, January 2013; www.novelis.com). Hindalco emerged as the leading rolled aluminium producer and the fifth largest integrated aluminium manufacturer in the world. Novelis has a global market leadership and a highly competent team, which makes it a perfect fit for Hindalco (India today, January 2013).

Hindalco conducted an extensive due diligence to smoothen the integration process. It did not go for immediate HR integration in order to reduce uncertainty among employees (Business Week, October 2011). Novelis was allowed to follow its own policies for the initial years before implementation of Hindalco's policies including human resource management (Live Mint, October 2007). Its management was retained and entire restructuring exercise was done after a consultative process with the Novelis labor union (Business Standard, March 2011). The motive behind this was to give some time for settling down and to understand the internal policies of the group before implementation. Employee engagement survey was carried out once every 2 years, formal feedbacks were taken from employees, and regular performance assessment by middle managers was done to enhance employees willingness to support the integration (Hindalco Sustainability Report 2011–2012).

20.3.2 SAP–LAP Analysis

The case study of Hindalco–Novelis merger is analyzed by using SAP–LAP framework. The data for the analysis are gathered from the public domain, which include Hindalco's annual reports and sustainability reports, and newspaper articles. The situations considered are recognized from the above sources, then actors effecting the situations are identified and similarly the corresponding processes, learning from the case, actions taken, and respective performance are specified. Further, the validation of the case is done by an informal interaction with the experts involved. The SAP–LAP analysis of the case is discussed below (Fig. 20.1, Table 20.1):

Situations Considered

- Hindalco acquired Novelis for $ 6 billion
- Several education and training programs for employees were started
- A perceived lack of two-way communication and relatively weak trust in leadership was identified
- Relocating North American headquarters from Cleveland, Ohio, to Atlanta, Georgia
- Operations cease at a primary aluminium smelter in Aratu
- Foil and packaging business at Bridgnorth, UK, was proposed to be closed due to European market and structural reasons, and sold off
- Beginning of the four-level development programs for middle managers
- Reported better than the results expected

Actors Involved

- Chairman of Hindalco
- Managing Director of Hindalco
- Shareholders of Novelis
- Regional presidents
- Middle managers
- Employees

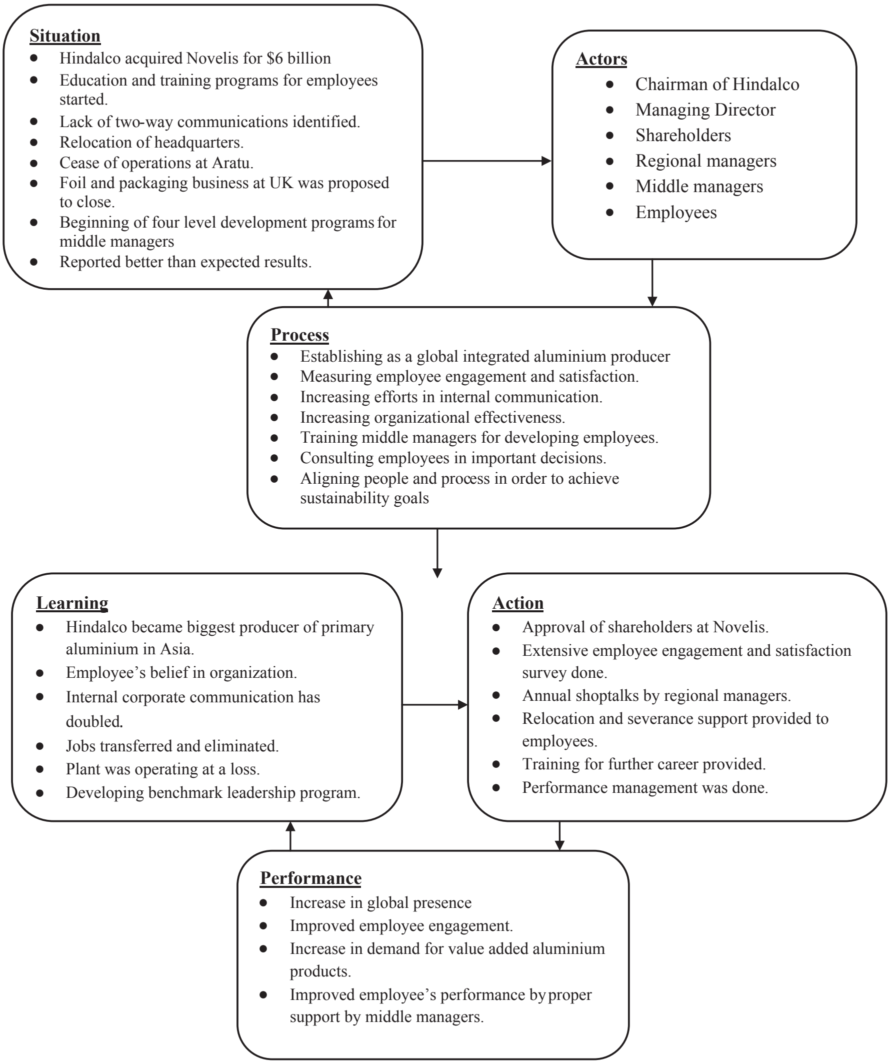

Fig. 20.1 SAP–LAP analysis of Hindalco–Novelis

Process

- Setting up as a global integrated aluminum producer with low-cost alumina and aluminum production facilities
- Providing employees with opportunities in their current jobs
- Measuring employee engagement and satisfaction
- Increased efforts in internal communication
- Enhancing organizational effectiveness
- Training middle managers for developing employees
- Aligning people and process to achieve sustainability goals

Table 20.1 SAP–LAP Analysis: Hindalco–Novelis Merger. (Source: Based on the case discussion above)

S.no	Situation	Actors	Process	Learning	Action	Performance	Year
1	Hindalco acquired Novelis for $ 6 billion	Chairman of Hindalco, managing director, and shareholders	Setting up as a global integrated aluminum producer	It emerged as the world's largest aluminum rolling company and one of the biggest producers of primary aluminum in Asia	Integration was completed after the approval of 2/3 of the votes cast by shareholders of Novelis	Increase in its global presence and access to the most advanced technology in the industry	2007
2	Several education and training programs for employees were started	Middle managers and employees	Measuring employee engagement and satisfaction	A relatively strong sense of pride, as well as belief, was demonstrated among employees	An extensive employee engagement and satisfaction survey was conducted	Improving overall employee engagement	2008
3	A perceived lack of two-way communications and relatively weak trust in leadership	Regional presidents and employees	Increased efforts in internal communication	Internal corporate communications among the staff has been doubled to enable these efforts	Regional presidents are visiting plants frequently annually, for "shop talks"	Employees review their performance and have career discussions with their line managers	2008
4	Relocating North American headquarters from Cleveland, Ohio, to Atlanta, Georgia	Chairman of Hindalco, employees	Enhancing organizational effectiveness	Eighty jobs were transferred to Atlanta and Fifty jobs were eliminated	Those who moved were offered relocation and severance support	Operational footprint has shifted to adapt to an increase in demand for value-added aluminum products	2010
5	Operations cease at a primary aluminium smelter in Aratu	Managing Director, middle managers, and employees	Finding a sustainable solution for the plant employees	Plant was operating at a loss; approximately 300 employees were affected	Employees were offered a severance package, extended health benefits, and job search assistance	Closure of the plant	2010

Table 20.1 (continued)

S.no	Situation	Actors	Process	Learning	Action	Performance	Year
6	Foil and packaging business at Bridgnorth, UK, was proposed to be closed	Chairman of Hindalco, middle managers, and employees	Improving the performance of the plant by restructuring	Around 319 Novelis employees, including trade union and other representatives, were consulted to discuss options and issues arising from the proposed closure	Support from a specialist outplacement agency helped the remaining employees search for opportunities and training to further their careers	Around 105 employees, along with the assets of the business were transferred to the buyer	2010
7	Beginning of the four-level development programs for middle managers	Middle managers	Training middle managers for developing employees	Developing benchmark leadership programs as compared to other MNCs	Performance management system was used to manage performance reviews for all managers	Developing leadership talent at Novelis by providing "a world-class leadership" development program	2011
8	Reported better than expected results	Top management, middle managers, and employees	Aligning people and process to achieve sustainability goals	The revenue insulated to some extent owing to the rupee depreciation	Adopted cost cutting measures in its operations	Improvement in profit margins	2013

20.3.3 Discussion

Hindalco's acquisition of Novelis is considered to be a successful merger as of now. The post-merger integration process was handled efficiently by middle managers who reduced the level of employee resistance. Proper due diligence was done and employee-friendly policies were framed. People management did not just suffer in these situations, sometimes they even hardly exist. Management understood the importance of talent management or talent retention during acquisition, as the alignment of key people internally and driving commitment and their motivation to deal with the challenges involved. The effort was to align the people and process to achieve the goals and growth plans, and to act as a single integrated company. Though it was not clearly mentioned, but from the secondary sources we have made an inference that a significant role was played by middle managers in balancing employees emotions during change process.

Commitment to Change Project Hindalco believed that enhancing commitment would be the key value driver for the company to move forward. Management was allowed to formulate and engage in annual goal setting to achieve respective business strategies (Hindalco Sustainability Report 2010–2011). Management development programs were formulated and job content was enriched for high-potential managers, with due recognition for achievements, which resulted in an overall improvement in commitment. General management program (GMP) was started for managers who have the ability to take higher responsibility (Hindalco Sustainability Report 2011–2012). These programs increased the level of commitment among middle managers, which in turn led to proper emotional balancing of employees.

Attending to Recipient's Emotions In order to create a growth culture, employees must understand how they can best contribute to the company's success. For this, they need regular feedbacks about their performance and support from their respective middle managers. By mutual discussion between superiors and subordinates, employees' objectives were translated into measurable goals. Annual self-performance reviews in discussion with superiors formed the basis for compensation reviews along with the target performance rating, which facilitated the discussion on areas for further development of employees as well as on bonding process between supervisors and subordinates. Regular employee surveys were conducted to monitor attitudes and identify the areas of improvement. Enabling policies such as global mobility, individual development program (IDP), talent pool, etc had ensured the work–life balance as well as fulfilling of aspirations of the young talent (Hindalco Sustainability Report 2010–2011). Employee's uncertainty was reduced by these programs and maximum support was attained.

Communication Hindalco aimed to maintain good record of communication between its employees and management. Employees have access to group's internal grievances process and communication channels via work councils or staff consultation. Regular communication meets and suggestions at each operating unit were organized. Integration planning is the stage wherein various points of contact with employees of both organizations are decided, highlighting the processes that will take time such as the performance-management process, recruitment process, exit process, and payroll process (Hindalco Sustainability Report 2011–2012). The idea here is that more communication is better than less communication. The core capabilities needed by an HR manager to overcome the hindrance to a successful M&A is the ability to understand cultural issues and to decide how much information should be circulated to reduce uncertainty and chaos. When Hindalco planned to cut cost and shed 9 % of Novelis workforce, they tried to create awareness by discussing every decision elaborately.

After the post-merger integration, Hindalco's financial performance improved. Involvement of middle managers facilitated the human integration, which also resulted in smoother technical and process integration.

20.4 Propositions for Future Research

Proposition 1—Emotional balancing by middle managers influence desired change outcomes, that is, smoother post-merger integration (Fig. 20.2).

Emotional balancing by middle managers is considered as a potential solution for radical change, which brings the desired outcome by reducing employees' resistance to change (Huy 2002). Middle managers dedicate a lot of extensive energy in finding the right balance between keeping the entity working and promoting radical change. Transformational leaders or middle managers comprehend their subordinate's emotional needs, which leads to greater interpersonal understanding and higher quality relationships (Groves 2006) which cause radical change outcomes.

Proposition 2—Employees emotions during change impact the desired change outcomes (Fig. 20.3).

In order to balance emotions in a constructive way, it should be identified accurately. Employees often judge organizational change negatively as they perceive change as harmful and a situation of loss (Fugate et al. 2008). The emotions expressed by the employees show what they feel about ongoing change process or

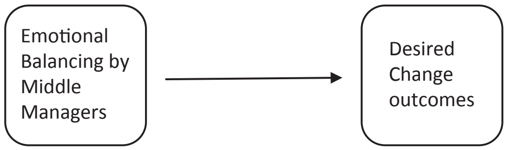

Fig. 20.2 **Emotional balancing affects desired change outcomes**

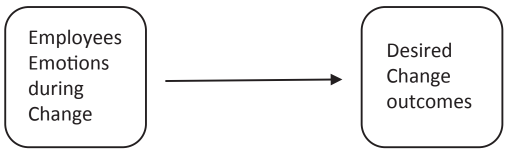

Fig. 20.3 **Employees emotions affect desired change outcomes**

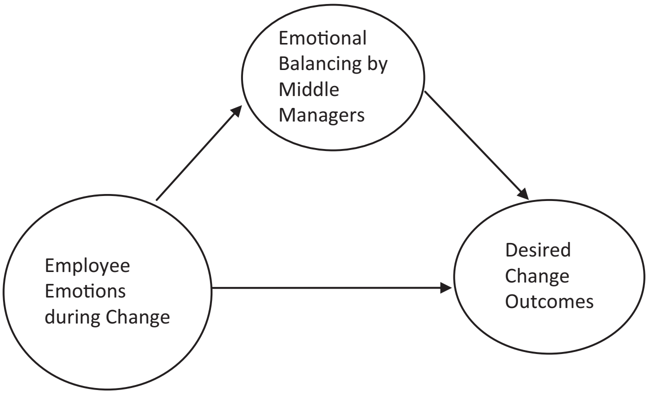

Fig. 20.4 Emotional balancing by middle managers acts as a mediating variable

how they may react to these situations (Moosholder et al. 2000) and their significance in determining the success or failure of change events (Kiefer 2005). Negative emotions are a signal of an employee's reluctance to support change (Kiefer 2005), which can be detrimental for the organization as well (Fugate et al. 2008).

Proposition 3—Emotional balancing by middle managers acts as a mediating variable between employee emotions and desired change outcomes (Fig. 20.4).

Emotional balancing of individuals is a part of radical change, which regulates emotion management during change processes (Huy 2002). Middle managers contribution in the acquisition process in a positive way gives a signal to the employees about the opportunity; on the contrary, lack of participation creates negative effect on the employees (Kiefer 2005; Teerikangas 2012; Vijayalakshmi and Bhattacharyya 2012). They are concerned with the employees' perception of fairness of work-related issues especially during the radical change, and assure employees participation in decision-making and involvement in change projects (Barton and Ambrosini 2013).

20.5 Conclusion

This chapter has explored the significant role of middle managers in balancing emotions during post-merger integration. Evidences from the literature reviewed, case study analyzed, and propositions developed prove that integration can become smooth by leveraging the role of middle managers. Integrating employees of merging entities to lead to value creation is a difficult task as they are the main obstacles for facilitating change. Middle managers are emotionally sensitive and can manage employees' negative mood that influences the change process. Human integration is a task that falls to middle managers. Middle managers are responsible for driving integration. Greater the degree of involvement of the middle-level management in communicating the change programs, the task of human integration becomes smoother and hence, affects human acceptance to change. Managers should identify the challenges posed by radical change so that they can understand and prepare themselves for managing change as it occurs. They should be included in implementing change project for better and desired change outcomes.

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Chapter 21
Technology Integration Among Stakeholders in Services Sector: A Case Study

G.V.R Sastry

21.1 Introduction

Transformations have been seen by Information and Communications Technologies (ICT) in Tourism, Banking and Insurance industries during recent past years. Fuelled by ICT-driven reengineering, a new paradigm shift is taking place, which has altered every segment of these industries. It has also led to the development of a whole range of opportunities and threats in these segments. ICT allows consumers to classify, customize, and buy integrated products; and encourage globalization by offering relevant tools for developing, managing, and distributing latest services worldwide. In addition, ICT also plays an important role for developing the competitive level of businesses that leads to further integration of industry services with the technology. ICT is becoming a crucial determinant of institutional competitiveness, and an extensive amount of technological expansion drives this evolution.

Recent enhancements in the technological aspects of the services sector allowed a comprehensive review of the business dynamics of the tourism, banking and insurance industries. The scenario of the strategic dynamics in these industries is correlated with each other on the upfront technological developments. The business dynamics, now emerged as the third stage, is a comprehensive integration of strategic diversification and strengthening of core areas of the business operations. The important aspect of the third stage, before it completes the stage, is that strategic diversification of these industries leads to a technological integration of the three sectors with optimum use of the strengths in the business segments.

This chapter presents a comprehensive framework towards the employment of SAP–LAP or situation, actor, and process along with learning, action, and performance for the strategic enquiry of services sector and develop models that are technologically usable taking into consideration various interrelationships along with

G. V. R Sastry (✉)
Center for Tourism and Technology Solutions, New Delhi, India
e-mail: shastrig@gmail.com

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their interpretation. This research has been done with the objective to develop the SAP–LAP framework in favour of strategic diversification that leads to technology integration of these services sector organizations. This chapter includes a study of product integration of tourism with banking and insurance sectors.

21.2 Conceptual Framework

Travel has always been a way of life in India. However, never before people undertook this activity with such vigor and dynamism that it became one of the most rapidly developing service industries in India. The middle class now comes with a better power to purchase, and hence, indulges in the travel more. As compared to other sectors, tourism grows at a significantly higher rate. Under ideal market conditions, it is easier for this segment to penetrate different economic segments and be counted as an attractive option for any developing economy to enhance its overall GDP. The growth of tourism is supported by technology integration with banking and insurance sectors.

21.2.1 Technological Aspects

Technology has a history of making the most significant changes in the way any industry operates; tourism industry has also been affected by it strongly. It has given the power of Internet to consumers who can use it to make their own customized individualized itinerary and travel in the most convenient ways. These developments have also introduced new products in the market. These new technological innovations are done to accommodate the changing needs of today's fast-paced travelers. A change in consumer needs and expectations forces businesses to work more progressively. Tourism sector also works on the same lines. As time changes, the demands for consumers changes and new products or packages are required to be designed in order to keep them interested. It also puts pressure on the tourism professionals to work on such packages well in advance and make them available whenever demanded. With the help of technology in transportation and communication, people have become more aware about how to travel and where to travel. The world has become more accessible, which has led to the desire to experience more.

Khalifa and Liu (2003) said that in the past few years there has been an observation of substantial growth of services that are internet-based from both internet based companies as well as traditional ones that are working on the development of online services as a vital initiative and strategy for customer relationship management (CRM). Canel et al. (2000) have argued that, "we now happen to be the service economy." As Goldfinger (2004) puts it, "in last 5 years, deployment of internet in a large-scale as well as their related technologies has had a profound impact on some of the areas in the services sector, and has transformed their product mix, competitive strategies, and distribution channels." However, he also stated that, "it was just the beginning: there was more to be expected in the years coming ahead, having deeper transformations and being more far-reaching." Patton (2001) mentioned that, "there are organizations often jumping without clear strategies and objectives that their top management has directed them, into CRM initiatives and projects." Vinas (2001) places the argument that, "for any strategy of CRM to show benefits and returns, may take time."

21.2.2 Strategic Technology Framework

Key technology framework of the integration of tourism with banking and insurance services is on the basis of strategic- and products-based integration. Here, the tourism products, technically, must be interfaced and connected to banking and insurance services through an enhanced manner. The core area of the banking and tourism with regard to dynamics and technology merger and merger of business activities is through a specialized and created structured platform. Figure 21.1 emphasizes that the value addition of the insurance products has also integrated with tourism products using a similar technology platform.

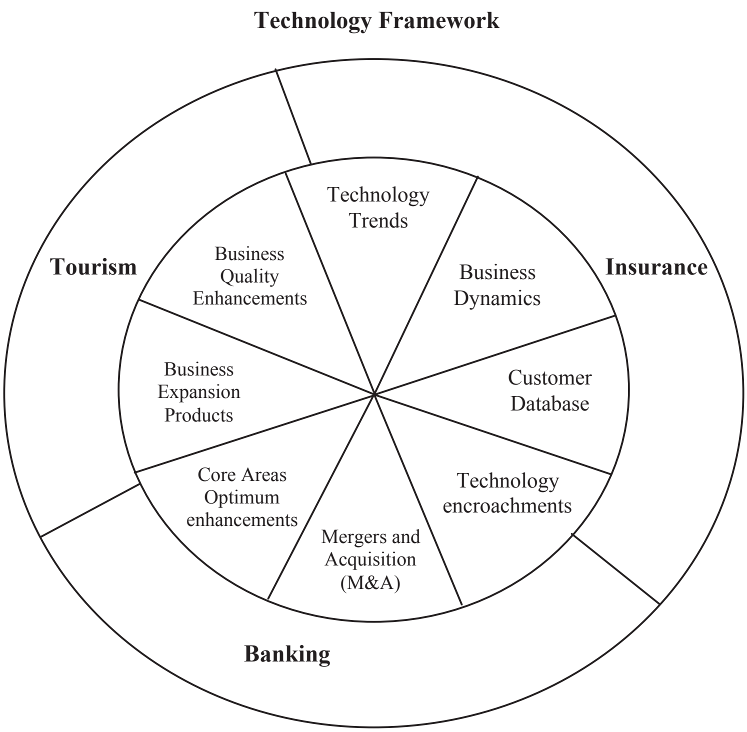


Fig. 21.1 Strategic technology integration framework

21.3 Methodology

This chapter applies the SAP–LAP framework for analyzing the incidence of managerial issues based on the organizational system factors relevant for increasing productivity in an Indian service sector organization.

Primary and secondary data: The major source of primary data, therefore, is the participant observation. Few discussion and interviews were conducted during the study among the people engaged. The interviews were based on unstructured, semi-structured, and open-ended questionnaires. These interviews helped in identifying the positive impact of culture, physical environment of organization, and managerial flexibility on organization performance. This also gave an insight of the obstacles faced by the employees in an organization. In addition to participant's observation, news, chapters, articles, books, journals, various government reports, etc., were referred for secondary data.

21.3.1 SAP–LAP Model of Integration Management

The SAP analysis brings out the key learning issues, which act as a base to take actions leading to performance. Largely, SAP–LAP models (Sushil 2000, 2001) that are developed are naïve or atomic models treating the basic components of SAP–LAP framework autonomously without the need to consider their reliance or dependence on each other. However, the presentation in the proposed framework is enriched using interpretive matrices (Sushil 2005, 2009).

SAP–LAP is an integrative framework comprising six basic components:

- The "circumstances" to be managed, which could be outside or inside the organization.
- The "actor(s)" managing the circumstances, which could be "internal" or "external" with reference to the company under observation.
- The "process(es)" managing the circumstances, which can again be "internal" or "external" to the organization.
- The key "learning" issues, related to the accomplishment of goals or key problem areas.
- The "action(s)" to be advised upon understanding what affects the performance of key objectives or areas.
- The "execution" regions related to "goals" to be attained or key result areas (KRAs).

An illustration of external and internal elements under situation, actor, and process is shown in SAP–LAP as a generic framework, which can be used in a variety of contexts, such as problem solving, change management, strategy formulation, supply chain management, marketing management, technology management, human resource management, and so on.

The first step in any problem context would be the identification of SAP elements, both external and internal. Care should be taken to identify only key elements. Similarly, key elements are to be identified for learning, action, and performance, as is done in LAP synthesis in general. SAP–LAP model forms the source of inquiry in management (Sushil 1997) which is equally applicable in service sector. It comprises three basic elements, i.e., situation (or circumstance), actor (or player), and process. A circumstance is to be taken care by the player or group of actors by means of processes. The circumstances for different players can be different (Sushil 2000); whereas, process for one player may give rise to a circumstance for the other.

Circumstance The current status of business along with the driving impetuses for the business' performance (Shukla et al. 2011)

Player The individuals, agencies, group of agencies/individuals that contribute to situation. The freedom of choice exists with actor that is also known as "external flexibility," which varies from organization to organization (Sushil 2000).

Process Depicts the overall transformation from input to output to recreate situation (Sushil 2001; Shukla et al. 2011).

The interaction and fusion of situation actor process (SAP) give rise to learning action performance (LAP) (Sushil 2000; Fig. 21.2).

21.4 Overview of the Case Study

Mahindra & Mahindra is the company headquartered in Mumbai and has a vast network with diversification into various fields. The core competence of this group is having interest in banking, insurance, and tourism.

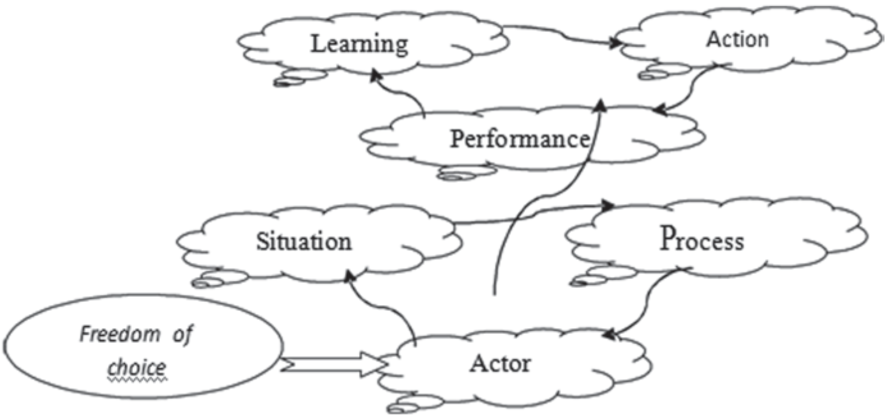


Fig. 21.2 SAP–LAP model

Mahindra & Mahindra Tourism It is one of the foremost Indian companies dealing with the holidays and recreational activities for every modern urban family in India, keeping its focus solidly set on growing business abroad. In the last 10 years, it has placed itself as business pioneers in the family holiday business of India. It used the methodology of running client-driven business practices that guarantee customer centricity, brilliance, creativity, and employee satisfaction. In addition to the new and one-time customers, more than 160,000 families come to visit every time, regularly to spend a substantially meaningful time with their peer groups.

Since 1996, the company has used dynamic business skills to grow bunch of resorts with brand support from Zest and Club Mahindra so that more variety can be offered to its customers. Its venture into home stays along with terra camps in the quiet and adventurous regions at different locations in India.

Over the years, it has made huge investments in developing IT frameworks to enable its operations streamline for productive and smooth administration. Its CRM framework tracks vital data and inclines it with the goal to serve customers in a better way.

It has won many awards and has received recognition around the globe. Mahindra Holidays received the perception as one Business Super brand in the year 2008, whereby its brand, Club Mahindra, turned into a customer-approved Super brand in 2009. There are seven resorts of it that won the prestigious award of RCI Gold Crown, in addition, it has also bagged the honor of Avaya Global Connect Customer Responsiveness in 2008.

Mahindra & Mahindra Insurance Services Mahindra & Mahindra entered into the insurance business in light of the fact that it saw a chance to give service in the regions wherever there is higher demand for financial services than formal system of banking could supply. Mahindra Finance and its subsidiaries provide an all inclusive range of financial and insurance services that provide a backing to both—businesses and individuals. This leading finance company offers loans for vehicles, business, or personal needs. It also has a general and life insurance company that serve both corporate and individual clients for their various needs. Its services are mainly targeted to help business owners and general public save their monetary interest in case of any eventuality. It currently has over 2.5 million customers in rural and urban India, and looks forward to growing their net reach to farther levels to empower people from all walks of life in creating a better future for them.

Mahindra & Mahindra Banking and Financial Services It believes that rural financing is one of the vital steps to eradicate poverty, and bring individuals and businesses to a level where they can compete with their urban counterparts. Needless to say, a country like India can develop only if its villages are developed. By extending its support to bring financial services to the doorstep of Indian villages, Mahindra & Mahindra Banking and Financial services give them the means to chase their own goals. Today, it is considered as one of the most trusted non-banking finance companies (NBFC) and the largest NBFC-offering services in rural India. It has offices across the remotest terrains that reach out to people with bespoke finance solutions. The components of M&M service sectors and their technology integration are shown in Figs. 21.3 and 21.4, respectively. Various departments of M&M technology integration are depicted in Fig. 21.5.

SAP–LAP Model of Inquiry After the careful study of the Mahindra & Mahindra integration technology applications, unstructured interviews were conducted with the management, workers from different departments, customers, visitors, and society.

The following drivers have been finalized using SAP–LAP framework, and the inquiry model is used for the SAP–LAP analysis on the strategic technology integration (Table 21.1).

21.5 Conclusion

The research outcome will concentrate on the effectiveness of integration process of the service sectors. The study first tries to identify the integration issues among these three industries—tourism, banking, and insurance. The expected framework suggested here can be used as a tool for measuring the integration process and its effects on organizational performance. This will contribute towards developing a framework for integrating the three service industries—tourism, banking, and insurance. The key tourism products and activities have been identified, and the importance of each activity in the performance of tourism industry has been discussed. The issues of product as well as strategic integration have been identified, and a

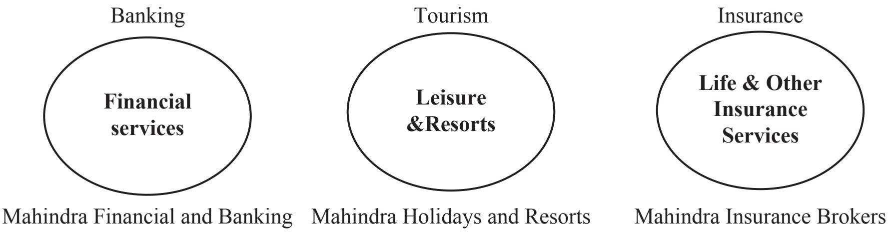
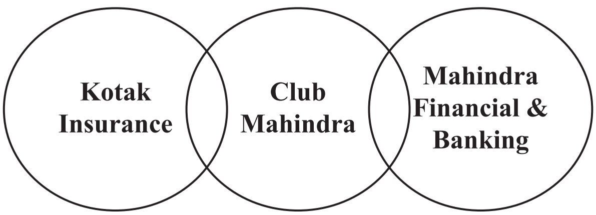


Fig. 21.3 Components of M&M services sectors

Fig. 21.4 Technology integration model—Mahindra & Mahindra services sectors



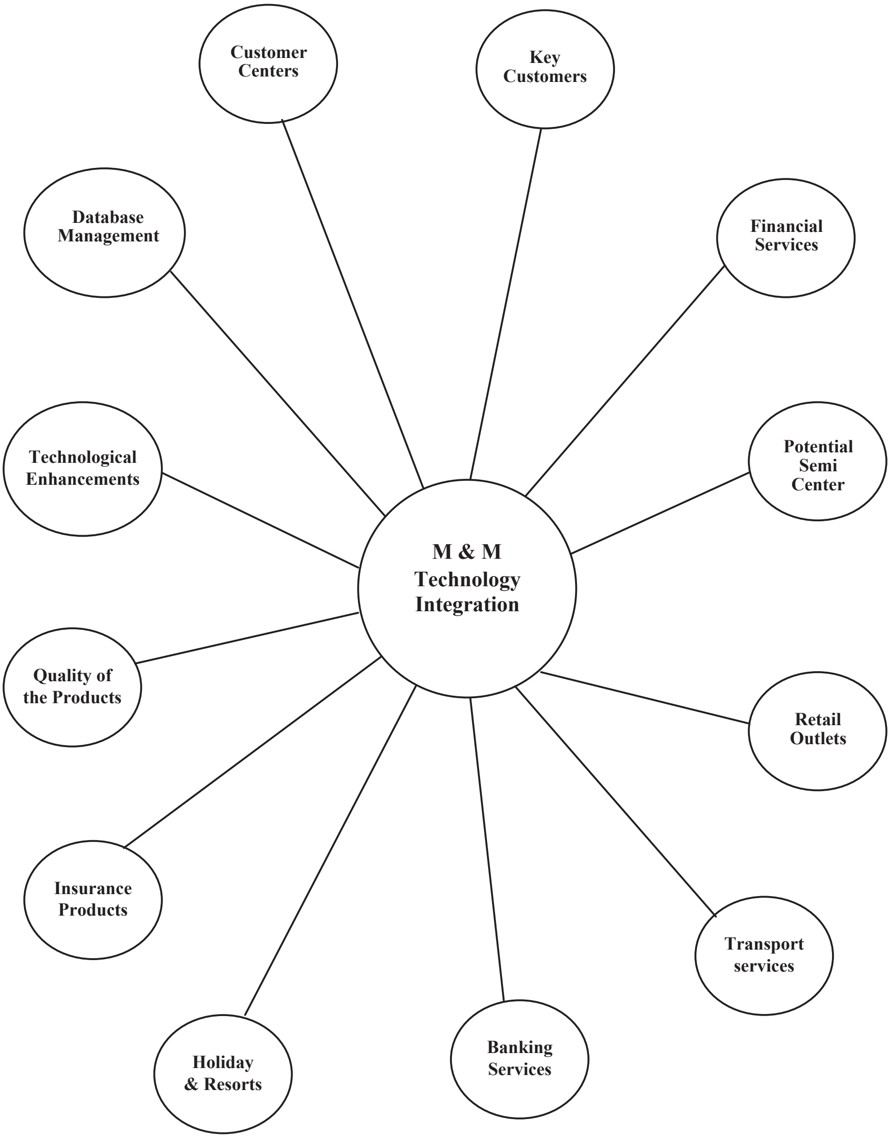


Fig. 21.5 Various departments of Mahindra & Mahindra technology integration

framework has been developed for guiding the integration process among these three sectors. This will be a contribution to both the managerial and academic side. The senior executives from tourism industries can use the final research outcome to improve performance by way of effective integration with other sectors.

Table 21.1 SAP–LAP model of inquiry

Stages	Issues
Situation	
How did we reach here?	Significant role in bringing the business domain together
What is the current scenario?	Important as, under one roof, all the three services are available
How is future expected to turn up?	Executives are familiar with delivery of services with diversification
	Emphasis on relationship building
	Expectation to deliver more productivity with regard to services
	Expectation of trust, transparency and responsiveness from customer/tourist
	More extensive interpretation plan and strategies for tourism
	Stimulate local people to cooperate in learning, understanding, and realizing the importance of conserving the sculptural sites/areas
Actor	
What does the world think about this?	Protection of the data from various integration services
What roles and capabilities are exhibited?	Gross impact on the consumer and tourist
How free are people to opt for the choices that suit them most?	Contributing to the protection of nature and the economic benefits of the local population
	Community involvement
	Need to work on the global level to improve the level of service, while lowering the cost
	Attitudes that motivate and support
	Stakeholders in the three service industries
Process	
What is the course of action?	Guide visitors around the site answer questions
What are the variables?	Quality and variety of services
What are the restrictions?	Modification in managerial culture and mind-set of employees
What can be altered?	Education programmers for conservation in line with principles of the significance of cultural activities
Why is it the course of action?	
How is it being performed?	Interlinking of in-house processes and their databases
What else?	Skillful employees
Why else?	Evaluation of the program
How else?	Development of mobile applications
Synthesis	
Learning	

Table 21.1 (continued)

Stages	Issues
Situation	
What are the main issues that associate with the situation?	Reduced motivation and commitment from the senior management
	Lack of decision-making and technical skills
What are the main issues that associate with the actor(s)?	Top managements need to prepare them from operational to strategic focus
	Unaffordability of IT solutions
What are the main issues that associate with the process(es)?	Selection procedure
	Architecture has been damaged by inconsiderate visitors carving their names and pictures
Action	
What can be done to recover from the situation?	The government and other agencies in the business ought to take better decisions for increasing awareness on benefits
What can be done to enhance the performance of the actor(s)?	Fair rewards
	Technology upgradation
What can be done to enhance the effectiveness of the process(es)?	Product integration
Performance	
How will the situation be affected by it?	Improved awareness due to better client service, and therefore, higher efficiency
	Customer satisfaction
What will be the impact on the actor(s)?	Improved availability of finance/loan
What will be the impact on the process(es)?	Better coordination between different services sectors
	Higher motivation
	Involvement of all stockholders in decision-making

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Chapter 22
Managing Demand Variability at Customer Level in a FMCG Company

Meenakshi Kumari, Ashok K. Pundir and L. Ganapathy

22.1 Introduction

Fast Moving Consumer Goods (FMCG) organizations often face the problem of high demand variability (DV) at the customer level and this leads to higher safety stocks and inventory at wholesale distributors. This chapter addresses a more specific problem in a FMCG company, where the sales across weekdays vary in an erratic manner. This leads to high sales on some particular weekday and since the inventory norms need to be maintained as per the sales spike, this leads to higher inventory and related stocking costs. Hence, there is a need to reduce the high sales spike and get the demand balanced across routes in order to reduce the inventory levels and costs.

In the present case study, the inventory norm at wholesale distributor for FMCG items is based on three components: safety stock, cycle stock, and transit in time. Safety stock contributes the largest at the customer level with the largest component of DV. Other components are supply variability and supply reliability. DV is the variation between estimate and actual sales. Supply variability is the transit in time variation from the warehouse service provider to wholesale distributors. Supply reliability is the variation in the stock availability at warehouse service provider.

A typical factor that contributes to increasing inventory norms is DV. There is a need for reducing DV because DV is the major contributor in the total inventory norm. Higher the DV, higher will be the total inventory that needs to be maintained at the wholesale distributors. The ill effects of higher inventory are higher working capital requirements, inefficiency in the shipment loads and larger godown space requirement, all of which add to the complexity in the entire process.

M. Kumari (✉) · A. K. Pundir · L. Ganapathy
National Institute of Industrial Engineering (NITIE), Mumbai, India
e-mail: meenakshikumari.8290@gmail.com

A. K. Pundir
e-mail: pundir.ashok@gmail.com

L. Ganapathy
e-mail: lganapathy@nitie.edu

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This chapter examines the problem of reducing the DV at the wholesale distributors for two different category groups in a FMCG company and then designing a heuristic to balance the sales across weekdays at customer level.

22.2 Literature Review

This chapter is an outcome of a case study in a FMCG company that aims to illustrate the opportunities for cost savings by reducing DV. Management of DV aims at reducing the peak demand based on certain parameters and thus reduces the inventory related costs. From the practical study of the FMCG sector, it is clear that stock delivery is through the replenishment model. The wholesale distributors maintain stock reserves to cater to demand from market. When the inventory is depleted it is replenished by the demand order generated by the distributor.

For example, suppose the wholesale distributor maintains an inventory of 500 for stock keeping units (SKU) A. When 100 units of SKU A are sold on day 1, the demand order of 100 is generated next day. This is replenished on the day of next shipment. The DV factor is based on the peak sales across weekdays. Hence, the distributors' inventory norm (safety stock quantity) is determined so as to provide adequate cover for peak sales at their level. A limited literature review is included in this chapter that provides some perspective and a basis for calculation of safety stocks.

Talluri et al. (2004) focused on safety stock evaluation considering demand and supply variability. They note that the inventory problem is due to inaccurate safety stock and the unscientific method of inventory norm calculation. They proposed an approach for estimating the lead time using sensitivity analysis for managing the made-to-stock inventories. They observed that inaccurate safety stock is due to the unscientific method of forecasting and supply variability (lead-time variability and transportation variability).

From the study of similar companies in the FMCG sector, it is observed that the high sales variability leads to high safety stock days and impacts profitability in three ways:

1. Working capital: High safety stock days will result in higher working capital
2. Inventory turnaround: The customer needs to maintain higher inventory, which in return increases the inventory turnaround period.
3. Godown space: Larger godown space is required to hold inventory, when safety stock days are higher.

These factors lead to higher investment and higher expenses leading to reduction in return on investment for the customers.

Nenes et al. (2010) presented a case study that determines the base stock levels needed for a fill rate. The modeling of demand was done using gamma distribution and Poisson distribution for slow moving items.

Germain et al. (2008) examined the link between organizational structure and supply chain process variability. In an unpredictable demand environment, the focus should be on cross-functional integration and it has an inverse relationship with financial performance. He noted that while the downstream variability in demand is mainly due to changes in orders and inconsistent deliveries, DV increases as one moves up the supply chain since the variability originating at each level or firm are interlinked by a channel. The approach is predictability of sales, reduction in forecast error, and market monitor to keep a check on sales pattern.

Boute et al. (2007) stated that an inventory control policy at the retailer level propagates customer DV. Smoothened order pattern reduces the lead time and generates a compensating effect on the retailer's safety stock.

Since forecasts are at best estimates of demand based on past data or causal variables, there is no guarantee of exactness in forecast. Forecasts are usually wrong (Arnold T. et al. 2008). Forecasting methods can be improved and better estimates obtained where possible by considering the factors causing the error.

Chopra et al. (2006) point out that forecasting is more accurate when demand has less uncertainty. In the present case, although the daily forecast is linear, there is a need to make the actual sales dispatch linear across weekdays. Thus, demand balancing across days can result in an improved forecast.

Researchers on managing strategic performance have pointed out the importance of aligning the forces of continuity and change (Sushil 2014a) at the execution level with the interests of multiple stakeholders in order to create a long-term win–win situation (Sushil 2014b). In line with this management thinking, our approach in this chapter for improved route balancing and inventory reduction takes into account the existing beat (route) patterns and rearranges them across different weekdays so as to balance the demand across weekdays. This ensures that the existing beat patterns are not disrupted even while savings are obtained.

22.3 Calculation of DV

In the present case study, the DV factors are forecasting issues, billing practices, and the route related problems. DV component is calculated considering the standard deviation of the forecast error. First, forecast improvement techniques such as mean absolute percentage error (MAPE), bias, and fidelity are implemented to improve the forecast. Second, even if the forecast gets improved the sales at customer level will be erratic. DV is given by Eq. (22.1).

$$\text{DV} = z \,{*}\text{sqrt}\left(\left(L+T\right) * \left(\sigma^2\right)\right) \tag{22.1}$$

where z is the target service level, L is the average lead time, T is the transit time variation and σ is the standard deviation of the forecast error.

22.4 Case Study

To protect the confidentiality of the company we do not provide the name of the company, product, and the sales data at any location.

22.4.1 Background

The aim of the project was to reduce the "DV" at the wholesale distributors during weekdays. It aimed to reduce the inventory related to SKU distribution and thereby reduce costs. The project had already been carried out in trade, marketing, and distribution divisions of the company covering two category groups. There was a business need felt to reduce DV and increase inventory turnover, thus improving return on working capital, reducing godown space requirement, and balancing the shipment load to retailers. To understand the context better, the following terms are explained briefly.

22.4.2 Out of Stock

Out of stock (OOS) can be one of the contributors to sales spikes. Since the all-India value for OOS percentage for FMCG is not high, it signifies that the OOS is not the prime factor for sales spike. In one of the FMCG companies, all India OOS percent was around 3 % for three consecutive months, which shows that the OOS is not the prime concern. Further improvements can be done to reduce this OOS by error capping at 3σ of the outliers. Presently, in many FMCG companies the outliers are removed in the inventory calculation method, which leads to higher OOS. This can be improved by capping the outliers at $\pm 3\sigma$.

22.4.3 Billing Practices

This is basically a data hygiene issue, and the major problem here is the difference between the date of summary billing and the date of actual sales. This can contribute to noise in demand forecast of sales on a daily basis.

22.4.4 Routing

First, multiple high volume routes are on the same day. Second, multiple high volume outlets are on the same route. This increases the sales volume on that day leading to sales spike.

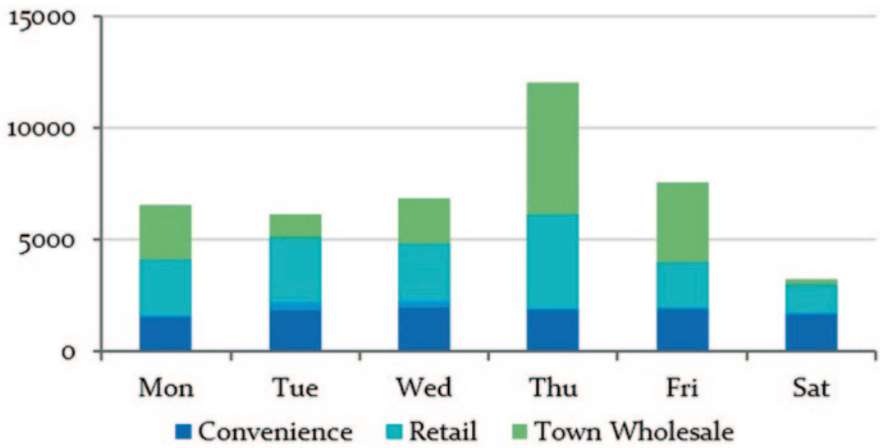

Fig. 22.1 Demand spike during the week (sale across weekdays)

As an illustration, the sales across weekdays are as shown in Fig. 22.1. It can be readily noted that the sales across weekdays is uneven. The prime reason for this is because of the combinations of routes taken by the sales distributors. The routes are designed based on geographical constraints, proximity of the areas, and outlet holidays; however the sales volumes or values are not taken into account. Figure 22.2 shows the behavior of sale spikes due to the routes taken by sales distributor. The major contributors for the sales volume are town wholesalers. Sales route causes spike on the town wholesale day.

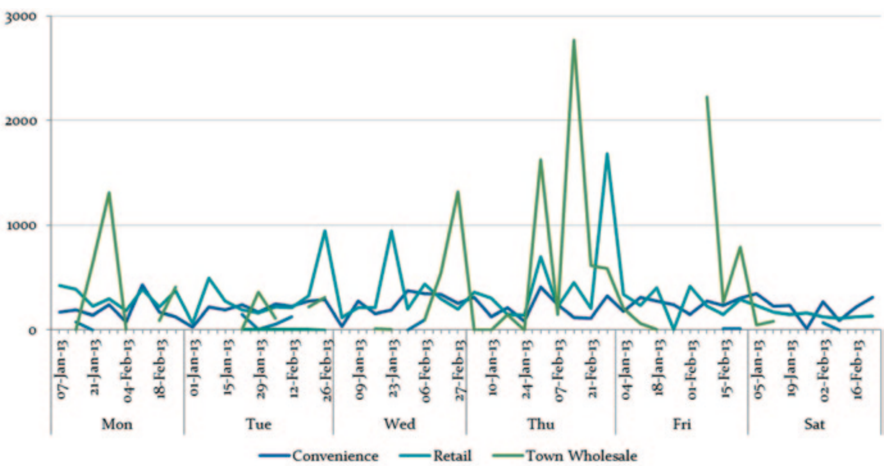

Fig. 22.2 Demand spike during the week (effect of the routes taken by sales distributor)

22.5 Proposed Method

The proposed approach is to balance the sales by "demand balancing," which is done through rerouting the beats taken from the wholesaler to the distributor. While doing so, the assumption is that the swapping of outlets within a beat will not be considered or disturbed, since they are designed based on other ground level considerations. Further, outlet swapping will increase the complexity to a large extent and its implementation will be difficult.

The approach used for demand balancing is the design of a software tool, which makes sales even. This tool takes into consideration the following constraints:

1. Market holidays
2. Number of sale distributors available on each day
3. Even distribution of sales person and sales volume, and
4. Payment constraints by outlets.

This is achieved in following three broad steps:

1. Interchange the high sales beat and low sales beat
2. Assign multiple high sales beat to different weekdays, and
3. Distribute multiple town wholesale channels uniformly across weekdays.

The above logic was implemented using Visual Basic (VB), which is a powerful tool for such applications (Holzner 2002).

22.6 Analysis and Results

The abovementioned developed tool was used to balance the sales of category group 1. Results for the category group 2 were obtained from the category group 1 routes. As can be seen in Fig. 22.3, the sales in the proposed approach show even distribution across the weekdays.

Then this VB-based tool was run across all the wholesale distributors for the eastern branch considering the benefits and limitations of adopting the tool for that distributor. For every category group, we have considered the impact on standard deviation. The servicing for the entire category group is on the same day. Since category group 1 is the major contributor in the sales volume, so we took the food category for balancing the sales and then we evaluated its impact on category group 2. It was observed that standard deviation across weekdays reduced for all the category groups.

Finally, we compared the company's inventory and impact on return on working capital. The impact on inventory was calculated for different SKUs and then the final impact was evaluated for different category groups (category group 1 and category group 2) for one particular distributor of the eastern branch. It was seen that inventories reduced by 3 days for both the category groups. Similar analysis was

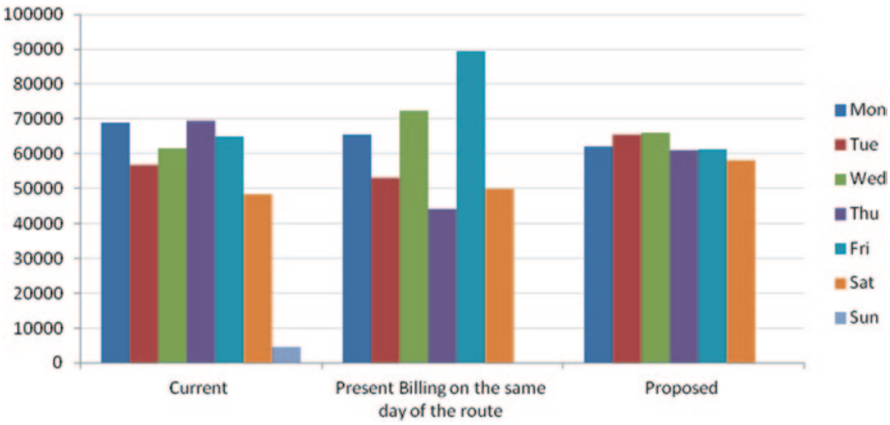

Fig. 22.3 Balanced demand with proposed method

done for all the eastern distributors. Figure 22.4 shows that the standard deviation is reduced by approximately by eight times.

The inventory reduction, calculated in this chapter, is determined from the formula of Eq. (22.1) modified as shown in Eq. (22.2):

$$\text{Inventory}=(z^*\text{sqrt}((\sigma^2)^*(L+T))+SV+SR) \tag{22.2}$$

Where

SV Supplier Variability
SR Supplier Reliability

It was seen that as per the proposed approach, approximately 8 % improvement in return on working capital could be achieved against the reduction in inventory by 3

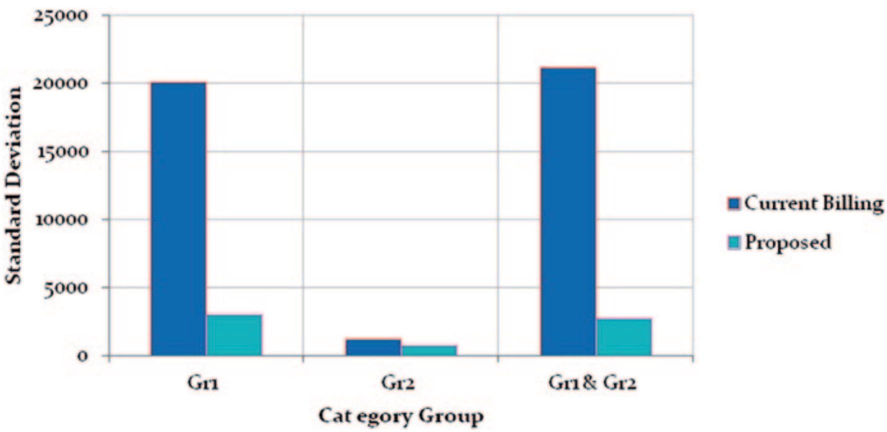

Fig. 22.4 Standard deviation for different category groups

days for different category groups. This also reduces the godown space requirement and balances the shipment loads.

22.7 Benefits Achieved and Scope for Further Improvement

The demand balancing tool was applied across the wholesale distributors discussed above and resulted in 8% improvement in the return on working capital across different category groups. This will also result in intangible benefits like efficient utilization of shipment loads, reduced godown space, and improved inventory turnaround period as discussed above.

The approach can be further improved by considering opportunities for outlet swapping of the nearby routes to obtain greater balance of the sales across weekdays. This option was not considered here because it increases the complexity and should be considered only if there is a scope of considerable improvement in sales balance without impacting the sales.

22.8 Conclusion

In today's competitive business environment, it is essential for companies to explore all opportunities for cost reduction to retain their competitive edge. This chapter demonstrates that scientific management of DV provides a viable opportunity for FMCG companies to reduce their inventory costs. It involves developing and adopting a heuristic method that is readily understood by the practitioners and can be implemented using simple tools to reduce the inventory. This also results in enhanced focus on better customer service and increased profits. The case study implementation shows that inventory turnover improves and thus managing DV can result in efficient supply chains and increased profits.

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