Usha Ramanathan
Ramakrishnan Ramanathan *Editors*

Supply Chain Strategies, Issues and Models

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Preface

In the twenty-first century, supply chain operations and relationships among supply chain partners have become highly challenging. This has necessitated new approaches to understand the complexities of managing supply chains, e.g., the development of new models. The literature on supply chain management has a number of such novel approaches, e.g., Vendor Managed Inventory (VMI), Quick Response, Accurate Response, Just in Time (JIT), and Lean and Agile production to improve performances of supply chains. Recently, the web-based collaborative tool Collaborative Planning Forecasting and Replenishment (CPFR) has added an extra value to information sharing between retailers and suppliers. It is hoped that new research has sought to extend this list, some of which have been explored in greater detail in this book. It is believed that contributions from academics from various geographical locations with a wide spectrum of knowledge will offer refreshing, novel, and insightful ideas.

This book features studies that have used mathematical modeling, statistical analyses, and also descriptive qualitative studies. The chapters have covered many relevant themes related to supply chains and logistics including supply chain complexity, information sharing, quality (six sigma), electronic Kanbans, inventory models, scheduling, purchasing, and contracts. To facilitate easy reading, we have organized chapters that deal with supply chain-related issues first, followed by studies on inventory, scheduling, purchasing, and logistics. The final chapter gives an assessment of supply chain strategies in the light of recession of recent years (from 2008).

This book begins with an interesting study in dealing with the increasing complexity in contemporary supply chains. The modern supply chains are characterized by different combinations of strategies, such as lean, JIT, and other collaborative arrangements, to meet the demand variability (Ramanathan & Muyldermans, 2010; Shah & Ward, 2007). In "Supply Chain Complexity and Strategy", Subramanian and Rahman provide an overview of supply chain complexity and suggest appropriate supply chain strategies based on material flow and contractual relationships, to align product and process complexities. It is essentially a qualitative study focussing on how supply chain managers can leverage product and process complexities into competitive advantage.

In the competitive market place, exchange of quality information among supply chain members plays an important role in managing competition

(Ramanathan, 2013; Forslundand & Jonsson, 2007). The next two chapters of this book provide an insight into importance of quality and value of information sharing in supply chains. In "A Systematic Approach to Analyze the Information in Supply Chain Collaboration: A Conceptual Framework", Ramanathan models supply chain information by listing all available information and then validate importance of information so as to use in various SC processes. This chapter provides a descriptive approach to information sharing, which can help managerial decision-making in two ways—managers can identify the important information based on its attached quality attributes and can revisit the supply chain collaboration for further information need. In "The Value of Information Sharing in a Multi-Stage Serial Supply Chain with Positive and Deterministic Lead Times", Kalpakam et al. study the benefit of information sharing and quantify the benefits (in terms of the reduction in the total demand variation and the reduction in inventory) in a multi-stage serial supply chain with more than three stages of positive and deterministic lead times. This chapter has developed interesting mathematical models and can appeal to students and researchers interested in modeling the impact of information sharing in supply chains.

In "Six Sigma in Supply Chain", Shokri discusses quality improvement and performance measurement practice in supply chains. This chapter specifically focuses on Six Sigma, which is a performance measurement tool, quality improvement tool, a problem solving methodology, and a business improvement strategy. It is essentially a descriptive study to understand the interrelationship between different perspectives of Six Sigma.

"A Case Study on E-Kanban Implementation: A Framework for Successful Implementation" provides generic guidelines on how Kanban can be successfully implemented across an organization in the context of an electronic supplier. In this chapter, MacKerron et al. provide a qualitative analysis using a case study conducted within a European manufacturing SME. The interesting contribution of this chapter is a simple eight-step approach for implementing an electronic supplier Kanban to help managerial decision-making.

"A Comparative Study of Periodic-Review Order-Up-To (T, S) Policy and Continuous-Review (s, S) Policy in a Serial Supply Chain Over a Finite Planning Horizon" considers a serial supply chain operating with deterministic and known customer demand, considering relevant costs (review, order, holding, and backlog) at every installation over a finite planning horizon. Using interesting mathematical programming models, Sethupathi et al. present an evaluation of two order policies: periodic-review order-up-to S policy (i.e., (T, S) policy) and (s, S) policy.

"Modeling of Scheduling Batch Processor in Discrete Parts Manufacturing" focuses on the subject of scheduling, which is a very important component of supply chain management. Using mathematical (integer) programming models, Mathirajan et al. develop strategies for efficient scheduling of batch processors in three real-life applications, namely, automobile gear manufacturing, semiconductor manufacturing, and steel casting industries. These models will help supply

chain managers in identifying scheduling strategies that aim at optimizing the benefit of available resources.

Purchasing is often included in the framework of supply chain management, especially in the context of SMEs. This is a topic covered in "Cooperative Purchasing in Small and Medium-Sized Enterprises" using a qualitative perspective. In this chapter, Wantao investigates typical advantages of cooperative purchasing for SME retailers, and critical success factors for managing a purchasing group, using a case study of a purchasing group established by Chinese SME retailers. The study suggests that a successful purchasing group can help SME retailers survive in today's competitive marketplace. This study also provides practical insights for retail managers to consider when developing a purchasing group in dynamic environments, in order to achieve the benefits of cooperative purchasing.

Supply chain managers are often faced with the issues of outsourcing, with specific reference to third-party logistics or otherwise. This is the subject of "Supply Chains with Service Level Agreements", which uses mathematical modeling to model supply chain contracts. In this chapter, Dinesh Kumar studies supply chain contracts with delivery guarantees and other service level agreements and how such supply chains can be managed effectively. The author uses an array of mathematical techniques to model supply chains with service level agreements across industries.

Continuing with the theme of "Supply Chains with Service Level Agreements," "The Role of Logistics in E-Commerce Transactions: An Exploratory Study of Customer Feedback and Risk" focuses exclusively on logistics. Logistics is a very important component of supply chains and it is important to understand contributions of logistics in a wider context. In "The Role of Logistics in E-Commerce Transactions: An Exploratory Study of Customer Feedback and Risk", Ramanathan et al. focus on the role of logistics in the e-commerce context from a risk perspective. They report an exploratory study to understand how customers view logistics performance in deciding performance of sellers in e-commerce. Since it has been observed that risk plays a stronger role in online transactions compared to offline transactions, the authors study how the importance of logistics performance is influenced by risk characteristics of products sold through e-commerce websites. Data for analysis have been derived from customer feedback available in eBay. Based on Chi square tests and the Marascuilo procedure, the authors find that the importance of logistics services increase as risk characteristics of products decrease from high to low.

In the final chapter, we aim to provide some interesting strategies to supply chain managers to cope with the recent (post-2008) recessional economic issues. In "Supply Chain Strategies in Difficult Times", Bentley examines the strategic decisions taken by supply chain managers during the current (post-2008) economic recession. A longitudinal approach has been adopted, and a series of questionnaire survey rounds have been carried out in three countries. The findings can contribute to the understanding of how companies evolve their supply chain strategies when dealing with a significant change in the external environment.

In this book, the editors have sought to include a right mix of research studies dealing with various pertinent issues of supply chain management, with focus on qualitative as well as quantitative research. It is hoped that these studies provide interesting practical insights into supply chain managers across the globe and also stimulate more interesting research ideas in the minds of young and experienced researchers.

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Supply Chain Complexity and Strategy

Nachiappan Subramanian and Shams Rahman

Abstract The purpose of this chapter is to provide an overview of supply chain complexity and suggests appropriate supply chain strategies based on material flow and contractual relationships, to align product and process complexities. The material flow strategies considered for product and process alignment are lean, agile, leagile and risk hedging. The strategies considered for the contractual relationship are types of relationship, integration and preferred channel of operation. We substantiate the link between strategies and types of complexities using a case study. The discussion of this chapter is useful to supply chain managers for leveraging product and process complexities into competitive advantage.

1 Introduction

Complexity science is the study of the phenomena that emerge from a collection of interacting objects. To a certain extent, complexity could be defined as the situation in which a collection of objects are competing for some kind of limited resource. In some instances, it is difficult to exactly define complexity, in such scenarios it could be viewed in terms of its characteristics, such as when a system contains a collection of many interacting objects or "agents", the behaviour of these objects is affected by memory or "feedback". The objects can then adapt their strategies according to their history: whether the system is typically

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"open", appears to be "alive", or exhibits emergent phenomena which are generally surprising (and may be extreme). Emergent phenomena typically arise in the absence of any sort of "invisible hand" or central controller (Johnson 2007).

The objective of this chapter is to provide an overview about complexities and explain complexity types and measures. The focus is to understand product and process complexities in supply chain. The major contribution of this chapter is to propose an alignment model to mitigate complexities using material flow and contractual relationship strategies.

The rest of the chapter is organised as follows: Section 2 defines complexity and space of complexity. Section 3 discusses product and process complexities. Measurement of complexity at different level is discussed in Sect. 4. Different types of supply chain strategies for product flow and contractual relationship are discussed in Sect. 5. Complexity strategy alignment model is proposed in Sect. 6. Illustration of the model is done through a case study in Sect. 7. Outcome of the findings are discussed based on the two aspects viz. complexities and strategies in Sect. 8. Managerial insights of the study are outlined in Sect. 9. Finally, Sect. 10 summarises the chapter and outlines the potential scope of future work.

2 Definition of Complexity and Space of Complexity

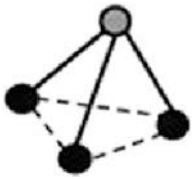
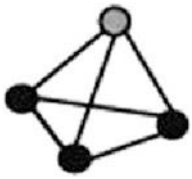
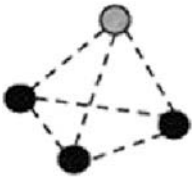
There is no agreed definition of complexity. However, researchers have attempted to explain complexity in various different ways based on numbers of structural components, its differentiation, degree of heterogeneity (relational), level of analytical sophistication (cognitive) and multiple part interactions (linear and non-linear) (Blau and Schoenher 1971; Price 1972; Price and Mueller 1986; Wang and Tunzelmann 2000; Choi and Krause 2006; Chapman 2009). For the purpose of this chapter we adopt the definition of complexity suggested by Johnson's (2007)

> *Complexity is a study of the phenomenon which emerge from a collection of interacting objects competing for limited resource.*

The space of complexity is that state which the system occupies and which lies between order and chaos. It is a state which embraces paradox; a state where both order and chaos exist simultaneously. It is also the state in which maximum creativity and possibility exist for realisation and exploration. In consideration of the space of complexity, chaos is defined as the deterministic behaviour of a dynamic system in which no system state is ever repeated (Chapman 2009; Wilding 1998).

One way to understand the different states of a given situation, from 'order' to 'chaotic', is through understanding various linkages between available resources () and competing objects () as shown in Table 1.

Table 1 Different state (*Source* Anklam, three mapping tools, theappgap.com)

State	Broad explanation	Representation
Simple (order)	Linkages exist between resources and competing objects (shown in figure with thick lines in the next column). However, there may or may not exist intra-linkages among competing objects (shown in dotted lines)	
Complicated	Both intra-linkages among competing objects and inter-linkages between resources and objects exist	
Complex (Chaos)	Intra-linkages among competing objects exist. However, inter-linkages between resources and competing objects may or may not exists	
Chaotic	Neither intra nor inter-linkages exist	

3 Complexity Types

Supply chain complexities can be classified with respect to product and process. These are discussed below:

3.1 Product Complexity

Product complexity refers to number of components, materials, process stages, technologies, performance criteria, technological difficulty in design, manufacture and assembly of a product. Heavy electrical equipment, nuclear power plants, military systems and flight simulators are considered as complex products (Walker et al. 1988; Hobday 1998; Wang and Tunzelmann 2000). We make an attempt, through a literature review, to classify the factors based on the tangible and intangible nature of both product and process. We classify tangible product complexities into the categories of numerousness and differentiations, as well as

number of interacting pairs and level of inter-relationship (see Table 2). Intangible product complexities are classified based on the appearance style and comfort, safety and ease of handling (see Table 3).

Table 2 Tangible product complexity factors

Complexity factors	Description of complexity elements	Complexity level
Numerousness	• Number of components for assembly products • Number of materials for all product types, except software (number of lines in this case) • Number of process stages • Number of technologies • Number of performance criteria	• Low level of complexity = presence of lesser number of components/ technologies/materials/stages/ performance criteria • Moderate level of complexity = presence of average number of components/ technologies/materials/stages/ performance criteria • High level of complexity = presence of extensive number of components/technologies/ materials/stages/performance criteria
Differentiations	Technological difficulty in design, manufacture and assembly	• Low level of complexity = presence of lesser difficulty in design, manufacture and assembly • Moderate level of complexity = presence of average difficulty in design, manufacture and assembly • High level of complexity = presence of higher difficulty in design, manufacture and assembly
Number of interacting pair and level of inter-relationships	Degree of interrelatedness or connectivity (number of interfaces among components and strength of interrelation between components)	• Low level of complexity = presence of lesser number of interacting pairs and low level of inter-relationships • Moderate level of complexity = presence of average number of interacting pairs and low level of inter-relationships • high level of complexity = presence of extensive number of interacting pairs and low level of inter-relationships