CONTRIBUTIONS TO MANAGEMENT SCIENCE

Reza Zanjirani Farahani
Nasrin Asgari · Hoda Davarzani
Editors

Supply Chain and Logistics in National, International and Governmental Environment

Concepts and Models

Physica-Verlag
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Contributions to Management Science

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This book is dedicated to
Professor Hartmut Stadtler
whose book and mentorship
paved the way for us to acquire a
better understanding of
Supply Chain Management

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Preface

Logistics is an integral part of our everyday life. Today it influences more than ever a large number of human and economic activities. In this book, authors try to illustrate some advanced logistics and supply chain management topics, recently mentioned by academic and industrial personnel. This book has been organized in 12 chapters such that the reader can study each chapter not only independently as shown in Fig. 1; but also as part of a whole. If someone wants to study the book more deeply, the suggested approach for this study is shown in Fig. 2.

So the readers of this book may be divided into at least two groups: (1) students in Master's courses or higher, who can use this book in their courses as a whole, and (2) experts who want to learn more about a new topic in logistics and supply chain management; this group may want to read a chapter about a special topic that is found in this book.

In the context of global competition, the more latent topics in logistics supply chain management are fast growing. This book falls within this perspective and presents 12 chapters that well illustrate the variety and complexity of these topics. This book is organized as follows:

Chapter 1 introduces logistics and supply chain management and contains some primal definitions about these two concepts; some obstacles, prerequisites and infrastructures of modernized logistics and supply chain management and global supply chain management are illustrated.

Chapter 2 concentrates on performance measurement scales and indicators. Performance measurement is the process of quantifying the effectiveness and efficiency of action. Performance measurement systems are described as the overall set of metrics used to quantify both the efficiency and effectiveness of action. After demonstrating the importance of performance measurement, SCOR indicators and taxonomy, as well as balanced scorecards are presented as more popular approaches.

Chapter 3 is about the global supply chain management system. "Global" referes to transactions involving individuals or firms in more than one country. Supply chain management includes integration and coordination activities such as logistics, marketing, sourcing, etc. This chapter focuses on globalization and its challenge;

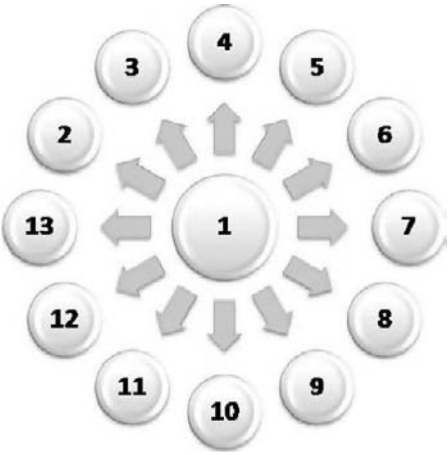

Fig. 1 Sequencing the chapters independently

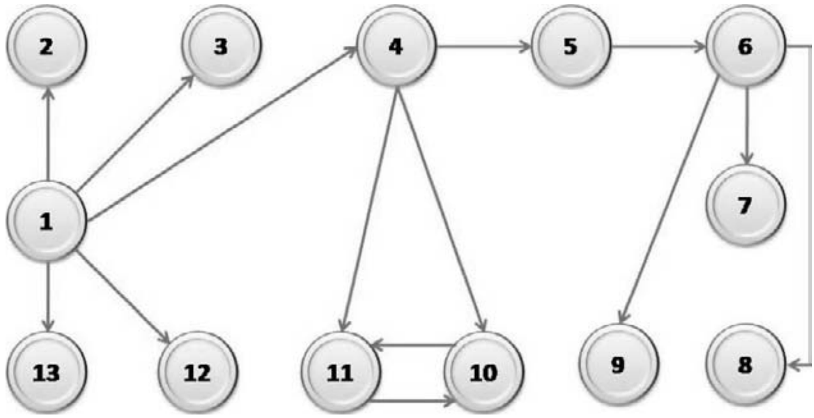

Fig. 2 Sequencing the chapters dependently

we assume that you have enough knowledge of SCM and explain the difference between domestic and global supply chains.

Chapter 4 is about national logistics cost. Logistics cost measurement is a proper indicator of the past and the future. As a lead indicator, Logistics cost measurement would support national policy making and the targeted deployment of operational and capital resources. This chapter demonstrates the importance of calculating logistics cost, its complexity and major components. At the end, this chapter illustrates some calculating methods and their results.

Chapter 5 focuses on spatial planning. One of the key parts of development planning for the economic sector is planning for the geographical and spatial development of economic activities, which is crucial in achieving balanced and sustainable development. Spatial planning includes methods that the public sector utilizes to influence the future distribution of the activities in the space. When speaking about the spatial aspects of logistics activities, we are concerned about the geographical and location characteristics of the logistics industry and the consequences of those locations. This chapter introduces Core Geographical Dimensions of Logistics, The Role of Public Sector in Spatial Planning and Spatial Planning for Logistics.

Chapter 6 is about supply network design. It is important to know the essentials in a distribution network design. To achieve this, this chapter has a general overview of distribution networks and some of their models. Then, in the next parts, it focuses more on the national and international parts of this story and the theoretical points mentioned here are illustrated in three case studies.

Chapter 7 contains some useful concepts in outsourcing and privatization. Privatization has gained worldwide acceptance in the past decade. This chapter tries to gather some privatization definitions and related literature. After that, some steps, methods, results, management, monitoring and challenges are illustrated. At the end, some case studied are demonstrated to exhibit theories in practice.

Chapter 8 concentrates on export clusters. Industrial clusters, especially export-oriented clusters, are the new and emerging strategies for companies and countries to achieve export development throughout the world. A cluster is a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementaries. This chapter introduces clusters, especially export ones, and one of its famous models, cluster structure and success factors. At the end of this chapter, the theoretical aspects are illustrated by some case studies in practice.

Chapter 9 discusses some of the fundamental aspects of Green Supply Chain Management (GrSCM). First, it discusses GrSCM, its origins, advantages, barriers, and initiatives. Next, it reviews green design, green operations, green procurement, and GrSCM frameworks. The chapter ends with a description of the role of governments and international organizations in promoting and developing green supply chain practices.

Chapter 10 is about logistics and supply chain management in times of disaster. This chapter provides an overview of the growing significance of disasters and the role of logistics in improving the humanitarian response. Second, it discusses relief logistics and its differences from commercial logistics. Finally, it reviews relief logistics subsystems and describes some of its critical subsystems.

Chapter 11 tries to demonstrate military logistics and supply chain. This chapter explains the fundamental differences between corporate and army supply chain management and investigates the supply chain management in The United States Department of Defense (DoD). This chapter ends with concepts in practice by depicting a case in Finland.

Chapter 12 is about logistics and supply chain management information systems. In order to improve agility, many companies have decentralized their value-adding activities by outsourcing and developing virtual enterprise (VE). This fact highlights the importance of information technology (IT) in integrating suppliers/partnering firms in virtual enterprises and supply chain. Supply chain management (SCM) is an approach that has evolved from the integration of these considerations. So this chapter concentrates on this important reality and illustrates developing IT in SCM and related literature. This chapter continues with e-government concept and its related issues.

This manuscript ends with Chap. 13, presenting some case studies related to supply chain management in different countries.

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Tehran, Iran
March, 2009

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Contents

Chapter 1
Overview

Reza Zanjirani Farahani, Nasrin Asgari, and Hoda Davarzani

In recent years, the area of supply chain management (SCM) has become very popular. This is evidenced by marked increases in practitioner and academic publications, conferences, professional development programs and university courses in the area. While interest in SCM is immense, it is clear that much of the knowledge about SCM resides in narrow functional silos such as purchasing, logistics, IT and marketing. This growing area of knowledge needs more attention; first of all, there isn't any manuscript considering the new eras of this discipline; in addition, most of the existent texts concentrate on the missing theoretical aspects and empirical evidences. This book tries to consider both sides and, at the end of each chapter, theories are illustrated by case studies.

This chapter introduces logistics and SCM and contains some primary definitions about these two concepts. Some obstacles, pre-requisites and infrastructures of modernized logistics and SCM and global SCM are also illustrated.

1.1 Definition of Logistics

Logistics is an integral part of our everyday life. Today, more than ever, it influences a large number of human and economic activities. The word "logistics" is derived from the Greek adjective "logistikos" meaning "skilled in calculating". The first administrative use of the word was in Roman and Byzantine times when there was a military administrative official with the title Logista. But some researchers believe that the term logistics comes from the French word "logis" meaning dwelling, originally designated the art of organizing the transportation, resupplying, and housing of the troops of an army (that of Napoleon). From the 1960s on, the term logistics has been used in the business field to refer to the means and methods related to the physical organization of a company, and specially the flow of materials before, during, and after the production (Langevin and Riopel 2005). Since the 1990s, logistics have been given increased attention both in academy and in industry.

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Logistics is a diverse and dynamic function that has to be flexible and has to change according to the various constraints and demands imposed upon it and with respect to the environment in which it works. Therefore, so many terms have been used, often interchangeably, in the literature and in the business world. One quite widely accepted view shows the relationship as follows: (Baker 2006)

$$\text{Logistics} = \text{Supply} + \text{Materials Management} + \text{Distribution}.$$

Logistics is also concerned with the physical and information flows and storage forms of the raw material until the final distribution of the finished products (Baker 2006).

Logistics deals with the planning and control of material flows and related information in organizations, both in public and in private sectors. Broadly speaking, its mission is to get the right materials to the right place at the right time, while optimizing a given performance measure (e.g. minimizing total operating cost) and satisfying the given set of constraints (e.g. a budget constraint). The key issue is to decide how and when raw materials, semi-finished and finished goods should be acquired, moved and sorted. Logistics' problems also arise in firms and public organizations producing services. This is the case in garbage collection, mail delivery, public utilities and after-sales service (Ghiani et al. 2004).

The question of the most appropriate definition of logistics and its associated namesakes is always an interesting one. There are a multitude of definitions which can be found in textbooks and articles. A selected few are:

– "Logistics is… the management of all activities which facilitate movement and the co-ordination of supply and demand in the creation of time and place utility" (Heskett et al. 1973).
– "Logistics management is… the planning, implementation and control of the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customer requirements" (CSCMP, 2006 cited in Riopel et al. 2005).
– "Logistics is… the positioning of resource at the right time, in the right place, at the right cost, at the right quality." (Chartered Institute of Logistics and Transport (UK, 2005, cited in Riopel et al. 2005)).
– "In the military context, logistics is concerned with the supply of troops with food, armaments, ammunitions and spare parts, as well as the transport of troops themselves" (Ghiani et al. 2004).
– "In civil organizations, logistics' issues are encountered in firms producing and distributing physical goods" (Ghiani et al. 2004).

In this chapter, we consider logistics as its definition in the Council of Logistics Management (2003) cited by Riopel et al. (2005): "Logistics is that part of the supply chain process that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customers' requirements."

This definition highlights the key features of logistics (Taylor 1997):

– It is concerned with movement and storage of materials
– It is concerned with managing information flows that underpin the materials' flow
– Its scope ranges across the whole supply chain from the raw materials' point of origin to the finished products' final consumption
– It requires a single logic to plan and organize this flow of materials throughout the supply chain
– It has two key objectives: (a) achieving appropriate customer-service standards and (b) doing so in a cost-effective manner.

From a historical perspective, the development of the logistics system in any society may be viewed as an evolutionary process. Starting with a basic, low level system characterized by limited movement and storage facilities, constraining consumers to live near the source of production, a logistics system gradually evolves over time to meet the changing logistics' requirements of a given society. Needless to say, the level of sophistication of the "evolved" system is largely a function of the national infrastructure in which the system operates. Society adapts the system to satisfy its specific needs (Razzaque 1997).

1.2 Definition of SCM

The term SCM has been created by two consultants, Oliver and Webber, as early as 1982 (Stadtler 2008) and came into widespread use in the 1990s. Prior to that time, businessemen used terms such as "logistics" and "operations' management" instead (Hugos 2003). The supply chain in Oliver and Webber's view lifts the mission of logistics to become a top management concern, since "... only top management can assure that conflicting functional objectives along the supply chain are reconciled and balanced... and finally, that an integrated systems strategy that reduces the level of vulnerability is developed and implemented" (Oliver and Webber 1992, cited in (Stadtler 2008).

There are numerous definitions for supply chain in textbooks and articles. A selected few are:

– "A supply chain is the alignment of firms that bring products or services to market" (Lambert et al. 1998).
– "A supply chain consists of all stages involved, directly or indirectly, in fulfilling a customer request. The supply chain not only includes the manufacturer and suppliers, but also transporters, warehouses, retailers, and customers themselves" (Chopra and Meindel 2007).
– "A supply chain is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers" (Ganeshan and Harrison 1995).

If this is a supply chain, then we can define SCM as the things we do to influence the behavior of the supply chain and get the results we want. Some definitions of SCM are:

– "The systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole" (Mentzer et al. 2001).
– "SCM is the coordination of production, inventory, location, and transportation among the participants in a supply chain to achieve the best mix of responsiveness and efficiency for the market being served" (Hugos 2003).

Supply chains encompass the companies and the business activities needed to plan, source, make, deliver, and return (SCC 2006). Businessmen depend on their supply chains to provide them with what they need in order to survive and thrive. Every business fits into one or more supply chains and has a role to play in each of them (Hugos 2003).

Coordinating material, information and financial flows within a large multinational firm is a challenging and rewarding task. Obviously, forming a supply chain out of a group of individual companies with the purpose of acting like a single entity is even harder (Stadtler 2008). The pace of change and the uncertainty about how markets will evolve has made it increasingly important for companies to be aware of the supply chains they participate in and to understand the roles they play. Those companies that learn how to build and participate in strong supply chains will have a sustainable competitive advantage in their markets (Hugos 2003).

During 1990s, several authors tried to put the essence of SCM into a single definition. Its constituents are (Stadtler 2008):

– The object of the management philosophy,
– The target group,
– The objective(s), and
– The broad means for achieving these objectives.

The objective of SCM obviously is the *supply chain* which represents a "… network of organizations that are involved, through upstream and downstream linkages, in different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer" (Christopher 1998, p. 15 cited in Stadtler 2008). In a broad sense, a supply chain consists of two or more legally separated organizations, being linked by material, information and financial flows. These organizations may be firms producing parts, components and end products, logistic service providers and even the (ultimate) customer himself. So, the above definition of a supply chain also incorporates the target group – the ultimate customer (Stadtler 2008).

A network usually will not only focus on flows within a (single) chain, but also will have to deal with divergent and convergent flows within a complex network resulting from many different customer orders to be handled in parallel. In order to ease the complexity, a given organization may concentrate only on a portion of the overall supply chain (Stadtler 2008).

In a narrow sense, the term supply chain is also applied to a large company with several sites often located in different countries. Coordinating material, information and financial flows for such a multinational company in an efficient manner is still a formidable task. Decision-making, however, should be easier, since these sites are part of a large organization with a single top management level. A supply chain, in the broad sense, is also called an *inter-organizational* supply chain, while the term *intra-organizational* relates to a supply chain in the narrower sense. Irrespective of this distinction, a close cooperation between the different functional units like marketing, production, procurement, logistics and finance is mandatory (Stadtler 2008).

The objective governing all endeavors within a supply chain is to increase competitiveness. This is because no single organizational unit now is solely responsible for the competitiveness of its products and services in the eyes of the ultimate customer, but the supply chain as a whole. Hence, competition has shifted from a single company to supply chains. Obviously, to convince an individual company to become a part of a supply chain requires a *win–win situation* for each participant in the long run, while this may not be the case for all entities in the short run (Stadtler 2008).

There are two broad means for improving the competitiveness of a supply chain. One is a closer *integration* of the organizations involved and the other is a better *coordination* of material, information and financial flows. Overcoming organizational barriers, aligning strategies and speeding up flows along the supply chain are common subjects in this respect. We are now able to define the term *SCM* as the task of integrating organizational units along a supply chain and coordinating material, information and financial flows in order to fulfill (ultimate) customer demands with the aim of improving the competitiveness of a supply chain as a whole (Stadtler 2008).

1.3 Background of Logistics and SCM Researches

The field of business logistics has evolved substantially over the past several decades (see for example, Kent and Flint 1997; Langley 1986; Miyazaki et al. 1999). From the 1960s on, the term logistics has been used in the business field to refer to the means and methods related to the physical organization of a company, and specially the flow of materials before, during, and after the production (Langevin and Riopel 2005). In the 1960s, business logistics was primarily concerned with two groups of functions, materials management and distribution (Riopel et al. 2005).

The 1970s brought an increasing focus on the interdependence of these functions (Heskett et al. 1973; Heskett 1977) cited in Riopel et al. (2005), and logistics “expanded” in the following years to include a more integrated perspective (Hutchinson 1987; Ballou 1992; Blanchard 1992; Langford 1995) cited in Riopel et al. (2005).

Other contributors to the evolution of the logistics in organizations in the 1980s were improvements in the information technologies and communications, the emergence of third party firms offering varied logistic services, and new techniques such as distribution resource planning and just-in-time (Robeson et al. 1994).

Since the 1990s, logistics have been given increased attention both in academy and in industry. The logistics industry continues to change radically and to grow in importance. The quality of the logistics managers and staff has also developed with the growth in responsibility and scope which a job in logistics entails (Baker 2006).

Logistics research is influenced by economic and behavioral approaches. The economic approaches focus their attention on cost minimization and profit maximization while the behavioral approaches focuse on psychological and sociological aspects. Owing to the influence of the two entirely different thoughts, many researchers have shown their concern towards research methods in SCM and logistics, by giving suggestion either on quantitative side (positivist paradigm or analytical school) or on the qualitative side (interpretive paradigm or behavioral school) (Sachan and Datta 2005).

Sahay et al. (2003) traces back SCM to Forrester in 1958 and 1961 who identified the dynamics of the response to be changed in demand. But more accepted historical aspect is the term SCM which has been created by two consultants, Oliver and Webber, as early as 1982 (Stadtler 2008) and came into widespread use in the 1990s. Prior to that time, businesses used terms such as "logistics" and "operations management" instead (Hugos 2003) (Fig. 1.1).

The characteristics and the quality of a product or service sold to a customer largely depend upon several firms involved in its creation. This brought about new challenges for the integration of legally separate firms and the coordination of

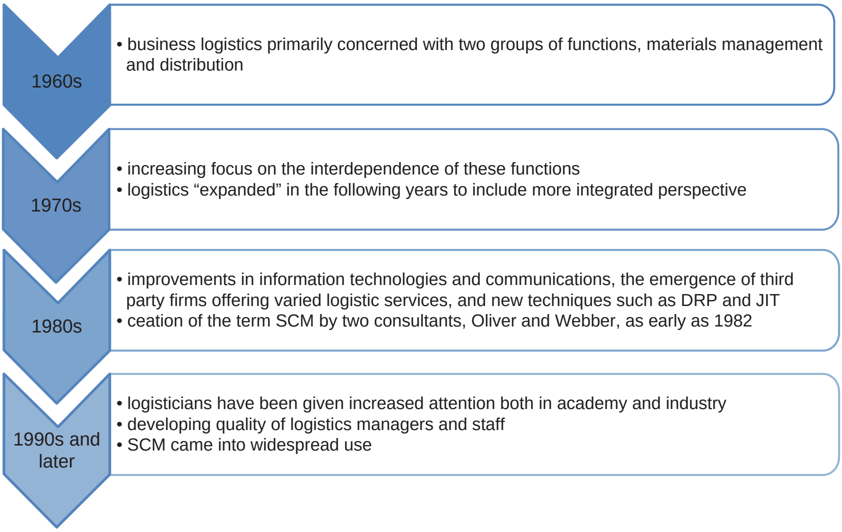

Fig. 1.1 Historical aspect of logistics and supply chain management

materials, information and financial flows not experienced in this magnitude before. A new managerial philosophy was needed – SCM (Stadtler and Kilger 2008).

As with many management philosophies, impressive gains reported from pilot studies, are promised. A few principles often build the main body of such a new management philosophy. Since there are usually many more facets involved in successful management of a company, some neglected factors may give rise to improvements achievable by the next management philosophy highlighted a few years later. Still, each management philosophy usually contains some building blocks which are advantageous and will survive over a longer period of time (Stadtler and Kilger 2008).

No great phantasms are needed to forecast that SCM will not be the ultimate managerial philosophy, although in our opinion it has many more facets than most of its predecessors. Since there are several facets to look at, SCM is difficult to grasp as a whole (Stadtler and Kilger 2008).

In recent years, the area of SCM has become very popular. This is evidenced by marked increases in practitioner and academic publications, conferences, professional development programs and university courses in the area. While interest in SCM is immense, it is clear that much of the knowledge about SCM resides in narrow functional silos such as purchasing, logistics, IT and marketing (Burgess et al. 2006).

There is a difference between the concept of SCM and the traditional concept of logistics. Also traditional logistics focuses its attention on activities such as procurement, distribution, maintenance, and inventory management. SCM acknowledges all of the traditional logistics and also includes activities such as marketing, new product development, finance, and customer service. In the wider view of supply chain thinking, these additional activities are now seen as a part of the work needed to fulfill customer requests. SCM views the supply chain and the organizations therein as a single entity. It brings a systematic approach to understanding and managing the different activities needed to coordinate the flow of the products and services to best serve the ultimate customer. This systematic approach provides the framework through which best respond to business requirements that otherwise would seem to be in conflict with each other (Hugos 2003).

1.4 Obstacles, Pre-Requisites and Infrastructures of Modernized Logistics and SCM

Product proliferation is rampant today. With customer demanding ever more customized products, manufacturers have responded with mass customization and even segment-of-one view of market. In addition to the increasing variety of the product types, the life cycle of the products has been reducing. Customers are constantly demanding improvements in delivery lead-times, cost, and product performance. More than these, supply chains today are more likely than ever to be global (Chopra and Meindel 2007), so classic logistics and SCM could not be effective ever after and there exists a serious need for being modern and changing dramatically.

Like every new coming system, logistic and SCM, especially in their modern conditions, encounter with some barriers. This section covers obstacles that, unless removed or worked around, will cause some serious problems in implementation. These could be cultural, legal, administrative, and resource barriers (Gansler et al. 2004). To change a business-as-usual organizational mindset requires strong leadership commitment from the very top levels. Most offices often resist sharing demanded information with suppliers, who therefore must forecast and plan based on the best guesses of their need (Gansler et al. 2004). The critical success factors for the B2B world will require: (a) a solid global supply chain organization; (b) appropriate levels of integration and standardization; and (c) executive support of these initiatives. Implementing these systems may require additional training and cultural changes on the part of suppliers, customers, and internal functions (Handfield and Nichols 2002). Governmental laws and agency rules enacted to spur economic development, to promote disadvantaged business segments, or – in some cases – to help constituent causes, occasionally create unintended hurdles to SCM change and modernization. These statutes and regulations may keep departments and agencies from acting quickly. Time consuming and meaningless paperwork could be a troublesome outcome of some legalizations (Gansler et al. 2004). Establishing trust between parties in a supply chain is perhaps the greatest challenge. Legal staffs may produce "airtight" contractual agreements that fail to include mechanisms for addressing the inevitable conflicts which are short of legal action. This can result in a situation where an organization may win the legal battle at a future point in time but be eliminated from the marketplace in the interim. Conflict management in inter-organizational relationships is becoming an increasingly difficult task. The fragile bond of trust, once broken, becomes extremely difficult to repair and some supply chain relationships eventually break under the strain (Handfield and Nichols 2002).

Although the topic of integrated SCM appeals to many practitioners, consultants and academics, the difficulty involved in implementing this strategy is evident. The integrated management of information and materials across the supply chain offers the benefits of increasing the value-added by supply chain members, removing waste, reducing cost and improving customer satisfaction. However, deploying and managing this strategy is a significant and challenging endeavor (Handfield and Nichols 2002). Business usually can cause some problems for modernizing SCM. Poor accounting records in general, the lack of activity-based costing and preventing from sharing information could be some barriers in improving SCM (Gansler et al. 2004). In many cases, problems occur in the implementation of information systems so that the appropriate information is not readily available to the people who need it. In other cases, the information is available but supply chain members are reluctant to share it due to their lack of trust and their fear that the information will be revealed to competitors (Handfield and Nichols 2002).

Many business IT systems are outdated and ill-equipped in order to interface with other systems to handle modern problems in a timely way; and upgrading old or implementing new and integrated IT systems, training personnel, ensuring adequate information security, establishing new SCM-focused contracts, and other logistics' transformation activities need adequate and sustained funding levels to achieve change and modernization; so insufficient funding could be another hurdle of implementing modern logistics and SCM (Gansler et al. 2004).

Inventory management from a supply chain perspective is not less difficult. Although inventory systems are continuously improving, the need to expedite late shipments never seems to disappear. There are always delays in shipments for a variety of reasons. Slowdowns resulting from customs when crossing international borders, adverse weather conditions, poor communication, and, of course, simple human errors are inevitable. With the double-edged sword of lower inventory levels and increasing demand for improvements in fill rates and on-time delivery performance, managing inventory throughout a supply chain becomes increasingly complex and demanding (Handfield and Nichols 2002).

1.5 Challenges of Union Countries and Global SCM

The last decades of the twentieth century witnessed a considerable expansion of supply chains into international locations, especially in the automobile, computer, and apparel industries (Meixell and Gargeya 2005). The world is a small place because of advancements in communication and transportation. Conducting business on a global basis has become an industrial norm. In virtually every industry, businesses have learnt that they are now part of extended enterprises with trading partners around the world. Companies of all sizes can discover that some part of their supply chain contains a manufacturer in a distant land (Assaf et al. 2006). Both dot-coms and old economy companies are now paying more attention to collaborative logistics (Li and Lin 2006). In this new and ever-expanding environment, international procurement has become a major challenge, and success requires a number of skills that are not otherwise required for typical domestic procurement. Demand for top, knowledgeable, and experienced supply chain planning and import personnel is on the rise to meet these challenges (Assaf et al. 2006).

As a company contemplates on procuring products either domestically or globally, many critical elements must be considered while analyzing cost, time, quality, service, and liability factors. With the growing emphasis being placed on SCM and the drive for optimization of the process steps across an end-to-end value chain, strategic and global purchasing has taken center stage and has become the popular means for obtaining product (Assaf et al. 2006).

Today's fast-paced and ever-changing business world has created so much turmoil that we find ourselves struggling to find a steady ground. The economy continues to fluctuate and every executive is trying to come up with a strategy that is going to generate positive returns and "clot the bleeding." Procurement is no stranger to this turmoil, with purchasing executives being held accountable for increased prices in raw material and natural resources that have been well beyond their control. There are very few procurement professionals who have not had to write to their vendors and plead for lower costs through these troubling times. Fortunately, there are strategies that may offer some help (Assaf et al. 2006).

Most of us look beyond our borders for the answers to our problems; initially, we looked at the countries like China, India, and many other Eastern nations to provide us with cheaper raw materials. We were even willing to sacrifice some levels of quality in order to meet prescribed cost reductions that were handed down to us. Once we were determined that we have exhausted all sources of materials, then we decided to actually outsource people, too, which led us to the increased import of cheaper visible and invisible trade. Although these strategies can be very fruitful, there are many factors that were overlooked or unknown, which have an impact on the true results of our procurement efforts (Assaf et al. 2006).

Clearly, the difference in cultures is a topic that has been covered in almost every business book, seminar, and classroom. The field of global procurement has evolved to a level where the focus is no longer on understanding based solely on the cultures and logistics, but on the impacts of recent events on our actions and our movements. One of the most difficult hurdles to overcome in global procurement is the distance between our vendors and us. There are many companies that have been burned on transactions which resulted in the material that were not shipped, which saw some recourse in the form of a letter of credit. Then, we had instances where substandard material was shipped and this was met with pre-shipment samples or inspections, but this never guaranteed that the sample would be an accurate representation of the shipment. There are dozens of books that have addressed these issues, yet the recent developments of the world have made these instances seem somewhat trivial. Many recent events have changed the rules for those of us who have worked in organizations where we had the luxury of traveling to our vendor's countries to negotiate and develop relationships. Typically, these sources are located in third-world countries and these nations sometimes have suffered political unrest and may have different beliefs. This is especially prevalent in situations between East, Middle East, and West. Such events have forced us to pay more attention to both our relationships and our movements (Assaf et al. 2006).

Using the latest information and communication technologies to interconnect manufacturers, retailers, and transporters, these companies can easily exchange information with others. However, the use of information technologies is not all that is necessary to enhance global logistics competence. It is even more important to effectively manage the relationships with all supply chain partners (Li and Lin 2006).

For many global supply chain networks that can comprise hundreds of companies with over several tiers of suppliers and intermediate customers, there are numerous presenting risks to be considered and tackled. Generally speaking, these risks can be classified into two types: risks arising from within the supply chain network and risks external to it (Goh et al. 2007). For the former, the attributes are due to the interaction between the firms across the entire supply chain network. This set of internal risks can encompass supply risk, demand risk, and trade credit risk, for instance. External risks, on the other hand, arise from the interactions between the supply chain network and its environment, such as international terrorism, and natural disasters like SARS.

One of the challenges in global SCM is the development of decision-making frameworks that accommodate diverse concerns of multiple entities across the supply chain (Narasimhan and Mahapatra 2004). In global supply chain, decision making about the design of supply chain extends to include the selection of facilities at international locations, and the special globalization factors with which this involves. These design decisions may be decentralized, in a way that a manager at each facility makes decisions, or may be centralized so that decisions across facilities are coordinated. Ideally, managers make these choices consistent with the firm's supply chain strategy (Meixell and Gargeya 2005).

However, experts maintain that global supply chains are more difficult to manage than domestic supply chains (MacCarthy and Atthirawong 2003). Substantial geographical distances in these global situations not only increase transportation costs, but complicate decisions because of inventory cost tradeoffs due to the increased lead-time in the supply chain. Different local cultures, languages, and practices diminish the effectiveness of the business processes such as demand forecasting and material planning. Similarly, infrastructural deficiencies in developing countries in transportation and telecommunications, as well as inadequate worker skills, supplier availability, supplier quality, equipment and technology provide challenges normally not experienced in developed countries. These difficulties inhibit the degree to which a global supply chain provides a competitive advantage (Meixell and Gargeya 2005).

Furthermore, global supply chains carry unique risks that influence performance changes, including currency exchange rates' uncertainty, economic and political instability, and regulatory environmental variability (Meixell and Gargeya 2005). Currency exchange rates affect the price paid for goods that are purchased in the supplier's currency and thereby influence the timing and volume of the purchases as well as the financial performance of the supply chain (Carter and Vickery 1988, 1989). Accordingly, practitioners are well advised to factor these risks into their decisions when designing global supply chains (Meixell and Gargeya 2005).

1.6 Logistics and SCM in Developing Countries

The past two decades have witnessed a number of important developments in the business world affecting business firms in both developed and developing countries. A relentless search for the "best" possible mixture of inputs such as cheap labor, raw materials, and energy, among others, by many advanced country corporations, has resulted in the decoupling of the comparative advantages from different regions of the world where they are found. To enhance value-adding capabilities, many supply chains have shifted their attention from manufacturing to various Third World locations so that the "best" inputs can be combined in a single cohesive value-adding conversion system (Alotaibi et al. 1993).

Many developing countries, on the other hand, have benefited from such strategies. Growing popularity of international subcontracting and global sourcing of finished products by industrial nations have prompted many developing countries to open up their economies to foreign investors search for cheap labor, land and other raw materials (Razzaque 1997).

It is not denied that the availability of adequate logistics facilities is a vital requirement for attracting foreign investment to any new location. It has been suggested that global manufacturing strategies provide the greatest competitive advantage when they are appropriately supported through key value-added logistics activities (Fawcett et al. 1993).

With the ever increasing popularity of the globalization of business, better logistics facilities and their management are bound to assume important roles in international business. It is not surprising that firms in many of the advanced nations are increasingly feeling the necessity to refine their distribution networks to respond to the changing environment (Taylor and Closs 1993).

Legacies of the past are the challenges with which many less developed countries are faced in order to develop their logistics systems. These are fundamental problems inherited not only from their embryonic trappings, but also from the lack of understanding of logistics' role and importance. There exists a stream of research on logistics and supply chain in developing nations (Razzaque 1997). However, studies about logistics challenges in developing countries are rare and scarce.

Studies on several countries in Eastern Europe (Murray 1993; Bloomen et al. 1994), Asia (Speece and Kawahara 1995) and Africa (Dadzie 1990) have identified numerous reasons for the poor state of logistics in the developing world. Weak logistics systems have appeared to be a common phenomenon in the Eastern European countries. For example, the Hungarian logistics scene has been characterized by outmoded production, distribution and supply systems, poor transportation infrastructure and inefficient third-party transportation. Uncertainty in demand and supply coupled with long manufacturing cycle times lead to excessive stock holding. Lack of warehousing facilities, poor information technology and inadequate cost data have tended to aggravate the problems of decision making. According to Murray (1993), these problems are due to the management inertia and incremental but unimpressive improvements in logistics. In the former Soviet Union, poor transportation, political instability, national rivalries, bureaucracy, shortage of investment funds (Hastings 1994), and ineffective organization structures (Rodnikov 1994) have been major obstacles to the development of logistics. In Poland, major difficulties had appeared to revolve around the nation's adjustment to market economy, ownership and management of the transportation enterprises (Rydzkowski and Spraggins 1994). Similarly, the major impediments to the Bulgarian logistics system have been traced to the state ownership of the production units, distribution system, warehouses and transportation companies. Lack of expertise and training for implementation of modern methods of logistics management (Bloomen et al. 1994) have also been cited as problems of logistics in Bulgaria.

Using Ghana's example, Dadzie (1990) contends that logistics network configuration problems in the developing countries derive from the planners' short-term outlook that emphasizes overcoming immediate problems. For example, the problem of designing a transport network suitable for modern Ghana have owed its origin to the sub-optimally designed and poorly maintained existing transport network and poor loading-unloading facilities of the Ghanaian ports. The existing system has emphasized cost minimization for a narrow customer service objective that lacks long-term vision.

Similar problems exist in Asia; in the People's Republic of China, the fault lying in inadequate transportation infrastructure, bureaucratic inefficiency and corruption (Speece and Kawahara 1995). Rapid industrial modernization and economic reform have been features of the Chinese economy since the 1980s, and have made substantial environmental problems. Under competitive, regulatory, and community pressures, it has become increasingly important for organizations to balance economic and environmental performance. In response to these problems, the Chinese government has been developing approaches to environmental management, such as establishing more strict environmental regulations, promoting cleaner production, and encouraging ISO 14001 certification (Zhu and Sarkis 2004).

Although Korea has made some significant economic strides after the Korean war, especially in the manufacturing areas of semi-conductors, heavy construction equipment, ship building, automobile and consumer electronics, there were very few large scale, modern-style retailing outlets in Korea until the 1980s (Han et al. 2002); and after that retailing, transportation and logistics improved gradually in Korea.

A comparative study of the logistics management in Hungary, China, Korea, and Japan (Handfield and Withers 1993) indicates that apart from issues pertaining to centrally planned economies, there has been a lack of managerial skills in logistics, especially in Hungary and China.

The demands of economic modernization place competing requirementss upon developing countries' manufacturing managers who are also required to act responsibly towards the environment. As Zhu and Sarkis (2004) mentioned, one of the major problems in developing countries logistics is technological matters and some of these countries try to remove this shortage.

Hence, in improving logistics and SCM in developing countries, some essential infrastructures are required; including: (a) legal infrastructure, (b) hardware infrastructure, and (c) software infrastructure.

Legal infrastructures could be:

- Export/import policies and appropriate custom tariff specification/definition
- Procedures' stability and capital risk reduction
- A reasonable interest rate definition in bank
- Third party logistics support
- National quality standards' definition for logistics and SCM

Hardware infrastructures could be:

- Augmenting new roads and improving the existant ones
- Augmenting new warehouses and mechanizing the existant ones

– Reducing custom affairs cycle time and lead-times of releasing goods from custom
– Improving ICT infrastructure in order to smooth information sharing and financial transactions

Software infrastructures could be:

– Encouraging insurance organizations for supporting third party logistics and enhancing the variety of insurances
– Defining appropriate monitoring procedures
– Defining effective roadmap for modernizing and implementing logistics and SCM
– Increasing integration culture within partners
– Training and improving leaders' and experts' knowledge on logistics and supply chain
– Enhancing research and development
– Developing commitment to research and learning
– Improving international partnership
– Encouraging competitiveness

1.7 Research Trends in Logistics and SCM

SCM is a relatively "young" field with exponential growth of the interest for researchers. However, a set of dominant characteristics can be found. Most notably, there is a reliance on the manufacturing and consumer goods' industries for empirical as well as analytical illustration; a conceptual framing of SCM mostly as a process; a predomination of transaction cost economics and strategy-based competitive advantage of theoretical grounding; the presence of mostly descriptive-type theories; strong positivist paradigmatic stances in the research methods employed; and the utilization of analytical, conceptual, and empirical statistical sampling and case study methods. These dominant characteristics appear to have prevented plurality of the ideas in terms of how the area is conceptualized, theoretically described and researched, making the development of the field a narrowly concentrated one (Burgess et al. 2006).

This, in turn, has prevented wider dissemination and greater acceptance of the ideas outside the functional areas with which SCM has traditionally been associated. Consequently, the soundness and robustness of the ideas underpinning SCM have not been fully tested. If this pattern continues, then there is a risk that SCM will get confined to a narrow intellectual base. This could lead SCM to be considered unworthy of serious scholarship by the broader academic community.

SCM is a growing area of knowledge and practice. Gilmore (2006) has offered his general thoughts on the top trends in supply chain and logistics. While there are similar lists in general news, entertainment and other categories, he really has notfound much similarities among them in the supply chain. The generalized ones are as below (Gilmore 2006):

(a) *Voice technology in distribution goes mainstream.* It has been buildt for the last couple of years, but voice technology in order picking and other distribution processes seemed to really go mainstream last years, as price and performance continue to increase, and the recognition of the available productive achievements become much more widely understood.
(b) *Labor unions at an inflection point.* A Delphi analysis on auto parts maker has shown an inconclsive push to a dramatical reduction in North American union wages and moved many operations offshore. If this trend continues, it could have big implications for supply chain costs and offshoring decisions.
(c) *Concern over commodities.* Though it abated in the fourth quarter of 2005, concern over the availability and price of raw materials, from copper to rubber, caused many companies to rethink supply chain strategies, sign very long term agreements, and even, return to a level of vertical integration. Caterpillar blames a revenue shortfall in part on the inability to receive needed levels of supersized tires, that in turn took the blame on the rubber shortfalls.
(d) *Continued supply chain vendor consolidation.* Most of these actions have been seen in recent years, including supply chain software pioneer Manugistics being acquired by JDA, Symbol Technologies agreeing to be acquired by Motorola, "roll up" company SSA being acquired by another roll up company Infor, and many more. Make no mistake – in a maturing software market, it's now all about acquiring customers and taking out overhead costs through acquisitions.
(e) *Focus on risk management.* Following a lot of academic research and work in recent years, a huge number of companies turn their attention to supply chain risk mitigation in future.
(f) *Supply chain icons stub their toes.* Dell and Wal-Mart as the supply chain leaders have been mentioned for a long time, most of us say it without thinking – or often knowing – why. Both these leaders had the overall troubles in 2006, with no clear path back to glory for either one. It shows supply chain advantage is never forever, and if Wal-Mart someday loses its current level of dominance, it will have huge industry ramifications across the supply chain and so on.
(g) *RFID[1] slows – but grows.* Many observers, including Supply Chain Digest and certainly a number of RFID-focused vendors, have seen little momentum in terms of real action in the EPC[2]-based consumer goods-to-retail market, in part as Wal-Mart moved much its attention to a series of other supply chain, store strategy and external issues, rather than the RFID roll out. The number of consumer goods manufacturers doing anything meaningful with RFID is still just a handful, and RFID announcements on the retailer side were very quiet in coming years. On the other hand, strong progress with RFID in a wide variety of other markets and applications is seen, as a supporting technology, not a cause in itself.

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[1] Radio frequency identification.

[2] Electronic product code.

(h) *Global supply chain gets serious.* Huge numbers of companies tend to be globalized. Global supply chain is not a logistics sub-discipline – it's an area where performance can mean the difference between company success and mediocrity or worse.
(i) *The greening of the supply chain.* It is just starting to ignite, but it could be one of the most significant trends in coming years. An early leader in this concept is Wal-Mart. From energy efficiency to alternative fuels to packaging and much more, the supply chain will increasingly be colored green.

Sachan and Datta (2005) have shown the status of SCM and logistics research from research methods' standpoint, data analysis techniques, data sources, and levels of analysis. They have shown that present researches are more rigorous than past ones. Rigor implies care in avoiding randomly concluding any results the research did not actually reveal. It means that research should represent reality and output should be applicable in real life problems. Then, only the research community can actually support and justify the claims it makes. The following points offer some direction for future research:

(a) Earlier SCM and logistics researchers have looked at the operational and financial aspects of supply chains. Major problems were inventory management, network optimization, facility layout and locations and demand forecasting. The most common research methods used were simulations and mathematical modeling. Researchers were also interested in finding out the "whatness" of the aspect of the phenomenon for which the survey method was used. But, with time and maturity in the discipline, the research questions changed to "how" and "why". In addition, the nature of problems also changed; problems such as, how functions within a company can be integrated, how companies can coordinate their activities, and the chain of customer service to customer satisfaction to customer value. All these problems involve behavior issues and are affected by factors like culture, relationship, trust and power. This brings the opportunity to behavioral research methods, which can bring more insights to what we know about supply chain today (Sachan and Datta 2005).
(b) Positivist approach assumes that the whole is equal to the sum of its parts while SCM is based on "systems thinking". In this paradigm, it is assumed that the whole differs from the sum of its parts due to synergy effects, i.e. knowledge depends on the system and how it is defined. One can easily see that the underlying assumption of the research methods and discipline are contracting with each other. Owing to these positivist methods' dominance, the research in the discipline is not able to look at the system holistically, and more research as is focusing on the function or on the firm level (Sachan and Datta 2005).
(c) If SCM were well-developed in conceptual and research methodological terms, it would be reasonable to anticipate a "clear line of sight" from definitions all the way through to theory and research methods. Overall, such a pattern was not found in the literature reviewed by (Burgess et al. 2006). In fact, the opposite

could be claimed for the descriptive features of SCM literature and definitional issues groupings, where great diversity was found.

(d) However, the diversity is narrowed down with respect to theoretical perspectives and shrank even more when it came to research methods. Such shrinkage may be explained in terms of the dominance of the positivist approach and positivism's ability to be censured by not publishing articles outside its own framework. Even allowing for such practices, a wider range of theories and research methods should have been supported.

(e) The lack of diversity in research methodology is explained by the fact that a sizable minority of the articles had a clear line of sight from the definition through to the theoretical stance taken and research method employed. This clear line of sight is most likely due to the dominance of the operations management discipline, which in turn is focused towards a process view, manufacturing industry, economic theory and positivist research methodologies. Researchers outside of the operations management field have only recently started to lay claims to the SCM territory. The challenge for operations management researchers is to demonstrate why continuation of such a limited range of research methods is most useful in light of the changing nature of SCM. So, one of the main directions for the future research could be SCM meta-analysis based on analysis framework (Burgess et al. 2006).

(f) Arlbjorn and Halldorsson (2002) stated that central element or the hard core of logistics is the "flow thinking" (Sachan and Datta 2005). The hard core may be formulated as follows: Directed toward the flow of materials, information and services, along the vertical and horizontal value chain (or supply chain) that seeks to coordinate the flows and is based on system thinking (a holistic view), where the unit of analysis essentially is the "flow". By emphasizing the flow thinking, he clearly means that research should focus on inter-organizational level and researcher should treat supply chain as one system. But this inter-organizational level research is currently less in the discipline as compared with the focal (function or firm level) research. More research is needed at inter organization level, only then one can develop an appreciation of the concept supply chain.

(g) The development of new discipline is based on the usage of concepts, definitions, theories, rules and principles from other disciplines. There are many theories from other disciplines that are potentially relevant to the examination and study of various logistics issues. Stock (1997) has recommended 53 theories of other disciplines like anthropology, sociology, computing, economics, philosophy, political science and psychology which can be used in logistics research. But at present, the theories and methods of other disciplines are applied in very few papers (Sachan and Datta 2005).

(h) Most of the authors in the published papers are from North America (mainly US) and Europe, and the context taken by them is also from these countries. It would be better if in future these researchers also investigate supply chain issues of the other parts of the world, especially the developing countries which are now becoming either the sourcing centers or markets of many companies. It is recommended that in future, research should not overlook the above-mentioned points, only then the objective to increase the value of products and services to customer in the supply chain vis-a-vis improved customer service and quality, and lower total cost can be achieved. It is hoped that this work will act as a catalyst in compressing the learning curve with respect to research methods' practices in SCM and logistics, and also accelerate the use of greater methodological rigor in future research (Sachan and Datta 2005).

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Chapter 2
Performance Measurement

Sara Sharahi and Maryam Abedian

As supply chains continue to replace individual firms as the economic engine for creating value during the twenty-first century, understanding the relationship between supply chain management (SCM) practices and supply chain performance (SCP) becomes increasingly important.

Performance measurement is the process of quantifying the effectiveness and efficiency of action. Effectiveness is the extent to which a customer's requirements are met and efficiency measures how economically a firm's resources are utilized when providing a pre-specified level of customer satisfaction. Performance measurement systems are described as the overall set of metrics used to quantify both the efficiency and effectiveness of action (Shepherd and Gunter 2006).

There have been relatively few attempts to systematically collate measures for evaluating the performance of supply chains and integrating performance measures thereof:

– Performance measures based on strategic, operational or tactical focus (Gunasekaran et al. 2004)
– Performance measures based on reliability, responsiveness, cost and asset (Huang et al. 2005; Lai et al. 2002)
– Performance measures based on goals of supply chain (Otto and Kotzab 2003)
– Instrument to measure the collaboration in a supply chain consisting of two members, suppliers and retailers (Simatupang and Sridharan 2005)
– Assessing the performance of supplier relationships (Giannakis 2007)
– Integration of performance management process for delivery service in customer/supplier dyads (Forslund and Jonsson 2007)

2.1 Importance of Measurement

The role of measures and metrics in the success of an organization cannot be overstated because they affect strategic, tactical and operational planning and control. Performance measurement and metrics have an important role to play in setting

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objectives, evaluating performance, and determining future courses of actions (Gunasekaran et al. 2004).

Harrington states that “If you cannot measure it, you cannot control it. If you cannot control it, you cannot manage it. If you cannot manage it, you cannot improve it”. In fact, the lack of relevant performance measures has been recognized as one of the major problems in process management and the management of supply chain (Lai et al. 2002).

The output of the processes enabled by the supply chain must be measured and compared with a set of standards. In order to be controlled, the process parameter values need to be kept within a set limit and remain relatively constant. This will allow comparison of planned and actual parameter values, and once done, the parameter values can be influenced through certain reactive measures in order to improve the performance or re-align the monitored value to the defined value (Gunasekaran et al. 2004). Many companies have not succeeded in maximizing their supply chain’s potential because they have often failed to develop the performance measures and metrics needed to fully integrate their supply chain for maximizing effectiveness and efficiency. Thus, control of processes in a supply chain is crucial in improving performance and can be achieved through measurement (Gunasekaran et al. 2004).

2.2 Properties of Performance Measures

There is special need to consider bellow properties in performance measurement:

– The discrete sites in a supply chain do not maximize efficiency if each pursues goals independently. They point to incomplete performance measures existing among industries for the assessment of the entire supply chain (Gunasekaran et al. 2004). Traditionally, the focus of performance measurement has been on process operations within the organizational boundaries of a firm. In the context of SCM, performance measurement involves not only the internal processes, but also requires an understanding of the performance expectation of other member firms in the supply chain, backward from the suppliers and forward to the customers. Coordination between the various parties in the supply chain is the key to its effective implementation (Lai et al. 2002).
– Measurements should be understandable by all supply chain members and should offer minimum opportunity for manipulation (Gunasekaran et al. 2004).
– Inequality does not lead to metrics that can present a clear picture of organizational performance (Gunasekaran et al. 2004).
– Companies often, have a large number of performance measures to which they continue to add based on suggestions from employees and consultants. They fail to realize that performance assessment can be better addressed using a few trivia. Actually they are not trivial, rather they are among the factors most critical to success (Gunasekaran et al. 2004).

- The metrics that are used in performance measurement and improvement should be those that truly capture the essence of organizational performance (Gunasekaran et al. 2004).
- For effective performance measurement and improvement, measurement goals must represent organizational goals and metrics selected should reflect a balance between financial and non-financial measures that can be related to strategic, tactical and operational levels of decision making and control (Gunasekaran et al. 2004).
- Traditional performance measures such as profitability are less relevant for measuring SCP because they tend to have an "individual focus" and fail to consider chain-wide areas for performance improvement. The use of integrated measures, together with non-integrated measures, motivates firms to consider chain-wide performance, rather than their own individual performance measures (Lai et al. 2002).

2.3 Process Management System Analysis

Performance measurement systems can be analyzed at three levels: the individual metrics; the set of measures, or performance measurement system as an entity; and the relationship between the measurement system and the internal and external environment in which it operates (Shepherd and Gunter 2006). Some of the key considerations offered for analyzing performance measurement systems in (Shepherd and Gunter 2006) are explained below:

- Individual performance measures
  - What performance measures are used?
  - What they are used for?
  - How much do they cost?
  - What benefit do they provide?
- Performance measurement system
  - Have all the appropriate elements (internal, external, financial, non-financial) been covered?
  - Have measures which relate to the rate of improvement been introduced?
  - Have measures which relate to the long-term and short-term objectives of the business been introduced?
  - Have the measures been integrated, both vertically and horizontally?
  - Do any of the measures conflict with any other?
- Relationship with internal and external environments
  - Do the measures reinforce the firm's strategy?
  - Do the measures match the organizational culture?
  - Are they consistent with the recognition and reward structure?

– Do some measures focus on customer satisfaction?
– Do some measures focus on what the competition is doing?

Two approaches for determining SCP measures, process-oriented and goal-oriented approaches, explained in the next sections.

2.4 Process-Oriented Approach

Among the extant SCP conceptualizations, the supply chain operations reference model (SCOR), developed by the Supply Chain Council, provides a useful framework that considers the performance requirements of member firms in a supply chain (Lai et al. 2002). The SCOR model is a process reference model, which contains a standard description of management processes, a framework of relationships among the standard processes, standard metrics to measure process performance, management practices that produce best-in-class performance, and a standard alignment to software features and functionality (Huang et al. 2005).

The SCOR model views activities in the supply chain as a series of interlocking interorganizational processes with each individual organization consisting of five components: plan, source, make, deliver, and return. Each of these components is considered as a critical intra-organizational process in the supply chain with five measurement criteria: (1) supply chain reliability, (2) responsiveness, (3) flexibility, (4) costs, and (5) assets. The first three criteria deal with effectiveness-related (customer-facing) performance measures, while the other two are efficiency-related (internal-facing) performance measures of a firm. Customer-facing measures are concerned with how well a supply chain delivers products/services to customers, e.g. delivery performance. Internal-facing measures are concerned with the efficiency with which a supply chain operates, e.g. cash-to-cash cycle time (Lai et al. 2002).

2.4.1 SCOR Model Level One Performance Measure (Huang et al. 2005)

The SCOR model endorses 13 performance metrics. A company cannot be best in all 13 of the level 1 metrics, so it should wisely target its strength in several, those by which it differentiates itself in the market, while ensuring that it stays competitive in the others. In practice, most companies typically choose among 4–6 of the 13 performance metrics to focus on.

Those chosen tend to fall into five defining categories: supply chain reliability, supply chain responsiveness, supply chain flexibility, supply chain costs, and efficiency in managing assets (working and fixed capital) in the supply chain. A description of these metrics is given below:

- Delivery reliability
  - Delivery performance
  - Fill rates
  - Perfect order fulfillment
- Responsiveness
  - Order fulfillment lead times
- Flexibility
  - Supply chain response time
  - Production flexibility
- Cost
  - Cost of goods sold
  - Total SCM cost
  - Value-added employee productivity
  - Warranty/return processing costs
- Assets
  - Cash-to-cash cycle time
  - Inventory days of supply
  - Asset turns

- *Delivery performance.* The percentage of orders delivered on time with respect to the total number of orders delivered. The components of delivery performance include total number of orders received, number of orders scheduled to customer's request date, total number of orders delivered, percentage of orders delivered on time (to request date), number of orders delivered on-time to commit date, and percentage of orders delivered on-time to customer commit date. It affects the balance sheet on accounts receivable.
- *Fill rate.* Fill rate is the percentage of ship-from-stock orders shipped within 24 h of order receipt. The fill rate affects the balance on accounts receivable and is calculated as: (number of orders filled from stock shipped within 24 h of order receipt)/(total number of stock orders).
- *Order fulfillment lead time.* The average actual lead time consistently achieved from customer authorization of purchase order to final installation/order completion at customer end. It affects the inventory on balance sheet. It is calculated as: (sum of lead time required for each order fulfillment from purchase order authorization to final installation)/(total number of orders).
- *Perfect order fulfillment.* The percentage of orders meeting deliver performance, with complete and accurate documentation and without any shipping damage. Components of perfect order fulfillment include all items and quantities delivered on-time (using customer's definition) and documentation for packing slips, bills of lading, and invoices. It is calculated as (total orders shipped on time and in

full-orders without faulty documentation – orders with shipping damage)/(total orders).

- *Supply chain response time.* The time it takes the integrated supply chain to respond to abnormal (significant) change in demand. It is calculated as (order fulfillment lead time + source cycle time) and it affects the inventory on the balance sheet.
- *Production flexibility.* Production flexibility can be seen in two parts, upside flexibility and downside flexibility. Upside flexibility is the number of days required to achieve an unplanned sustainable 20% increase in production. Downside flexibility is the percentage of order reduction sustainable at 30 days prior to delivery with no inventory or cost penalties. The production flexibility is dependent upon internal manufacturing capacity, direct labor and material availability and affects inventory on balance sheet.
- *Total logistics management cost.* The sum of supply chain related costs for order management, material acquisition, inventory carrying, finance and planning, and MIS costs. It is calculated as sum of the costs.
- *Cost of goods sold.* The cost associated with buying raw materials and producing finished goods. This cost includes direct cost (labor, material) and indirect cost (overhead).
- *Value added productivity.* It is calculated as; (total product revenue – total material purchases)/total employment (in full time equivalents).
- *Warranty cost or returns processing cost.* It includes materials, labor, and problem diagnosis for product defects. A warranty cost has impact on inventory on balance sheet.
- *Cash-to-cash cycle time.* Cash-to-cash cycle time is a measure of the time required in days to convert cash paid to suppliers into cash received from customers, including the inventory required. It is calculated as (inventory days of supply + days sales outstanding-days of payables). It impacts inventory, accounts payable, accounts receivable, and total assets on the balance sheet.
- *Inventory days of supply.* Total gross value of inventory at standard cost before reserves for excess and obsolescence.
- *Asset turns.* Total turns of capital employed. It impacts inventory, accounts payable, accounts receivable, and fixed assets on the balance sheet. It is calculated as total gross product revenue divided by total net assets.

2.4.2 Measurement in Strategic, Tactical and Operational Levels (Gunasekaran et al. 2004)

The strategic, operational and tactical levels are the hierarchies in function, wherein policies and trade-offs can be distinguished and suitable control can be exerted.

Such a hierarchy is based on the time horizon for activities and the pertinence of decisions to and influence of different levels of management. This approach classifies indices according to its importance and has a significant role in supply chain identification.

- The *strategic level* measures influence the top level management decisions, very often reflecting investigation of broad based policies, corporate financial plans, competitiveness and level of adherence to organizational goals.
- The *tactical level* deals with resource allocation and measuring performance against targets to be met in order to achieve results specified at the strategic level. Measurement of performance at this level provides valuable feedback on mid-level management decisions.
- *Operational level* measurements and metrics require accurate data and assess the results of decisions of low level managers. Supervisors and workers are to set operational objectives that, if met, will lead to the achievement of tactical objectives.

In this section, a framework for performance measures and metrics is presented, considering the four major supply chain activities/processes (plan, source, make/assemble, and deliver).

These metrics were classified as strategic, tactical and operational to clarify the appropriate level of management authority and responsibility for performance. Some measures appear in more than one group, indicating that those measures may be appropriate at more than one management level.

Plan

- Strategic
  - Level of customer perceived value of product
  - Variances against budget
  - Order lead time
  - Information processing cost
  - Net profit vs. productivity ratio
  - Total cycle time
  - Total cash flow time
  - Product development cycle time
- Tactical
  - Customer query time
  - Product development cycle time
  - Accuracy of forecasting techniques
  - Planning process cycle time
  - Order entry methods
  - Human resource productivity
- Operational
  - Order entry methods
  - Human resource productivity

Source

- Strategic

There are no metrics

- Tactical
  - Supplier delivery performance
  - Supplier lead time against industry norm
  - Supplier pricing against market
  - Efficiency of purchase order cycle time
  - Efficiency of cash flow method
  - Supplier booking in procedures
- Operational
  - Efficiency of purchase order cycle time
  - Supplier pricing against market

Make/assemble

- Strategic
  - Range of products and services
- Tactical
  - Percentage of defects
  - Cost per operation hour
  - Capacity utilization
  - Utilization of economic order quantity
- Operational
  - Percentage of defects
  - Cost per operation hour
  - Human resource productivity index

Deliver

- Strategic
  - Flexibility of service system to meet customer needs
  - Effectiveness of enterprise distribution planning schedule
- Tactical
  - Flexibility of service system to meet customer needs
  - Effectiveness of enterprise distribution planning schedule
  - Effectiveness of delivery invoice methods
  - Percentage of finished goods in transit
  - Delivery reliability performance

- Operational
  - Quality of delivered goods
  - On time delivery of goods
  - Effectiveness of delivery invoice methods
  - Number of faultless delivery notes invoiced
  - Percentage of urgent deliveries
  - Information richness in carrying out delivery
  - Delivery reliability performance

2.4.3 SCP in Transport Logistics (Lai et al. 2002)

In this section, we investigate the construct of, and develop a measurement instrument for SCP with a focus on the intermediary component, i.e. transport logistics, in a supply chain process.

Transport logistics in a supply chain is usually an intermediary that facilitates the physical flows of goods from a point of origin, i.e. shipper, to a point of destination, i.e. consignee.

The SCOR model provides a useful framework, it represents a systematic approach to measuring performance with inputs from, and outputs to, member firms in the supply chain and considers performance assessment on a supply chain-wide basis, not just on that of an individual component. Based on SCOR performance measures, three dimensions of SCP in transport logistics are identified. These are:

- Service effectiveness for shippers (SES)
- Operations efficiency for transport logistics service providers (OE)
- Service effectiveness for consignees (SEC)

SES and SEC measure how well the activities are performed to meet the requirements of shippers and consignees, respectively. OE refers to the efficiency of a transport logistics service provider in the use of resources to perform its service activities. These three dimensions of SCP in transport logistics are congruent with the critical components of supply chain success postulated in the SCOR model.

A total of 26 measurement items are generated for the measurement instrument: nine for SES, eight for OE and nine for SEC as shown below:
SES

- SES-reliability
  - Fulfill promises to shippers (e.g. time vehicle arrival; offer competitive rates)
  - Solve shippers' problem (e.g. suggest best routing)
  - Perform services for shippers right the first time
  - Provide services at the time promised to the shippers (e.g. on-time delivery to exhibition site; higher shipping frequency than rival companies)
  - Keep shippers' records accurately (e.g. correct invoice)

- SES-responsiveness
  - Tell shippers exactly when services will be performed (e.g. location and opening hours of the depots/container freight station)
  - Give prompt services to shippers (e.g. special packaging for furniture/piano, etc.)
  - Willingness to help shippers (e.g. give advice on shipping schedule or packaging; track and trace status of the cargoes shipped)
  - Timely response to shippers' requests (e.g. delivery/transshipment of the cargoes at short notice)

OE

- OE-cost
  - Reduce order management costs (e.g. minimize order handling through EDI)
  - Reduce costs associated with facilities/equipment/manpower used in providing the services (e.g. use IT to track and trace the status of shipped cargoes)
  - Reduce warehousing costs
  - Reduce transportation costs
  - Reduce logistics administration costs (e.g. build good relationships with related organizations such as customs, bureau of commodity inspection, port authority)
- OE-asset
  - Improve the rate of utilization of facilities/equipment/manpower in providing the services
  - Improve number of cash to cash cycle time (the average days required to turn a dollar investment in facilities/equipment/manpower providing the shipping services into a dollar collected from customers)
  - Improve net asset turns (working capital)

SEC

- SEC-reliability
  - Fulfill promises to consignees (e.g. advise arrival schedules; complaint handling)
  - Solve consignees' problems (e.g. provide warehousing; repackage cargoes)
  - Perform services for consignees right the first time (e.g. pack and remix cargoes)
  - Provide services at the time promised to the consignees (e.g. availability of cargoes for collection)
  - Keep consignees' records accurately (e.g. error-free records of consignees' addresses and opening hours)

- SEC-responsiveness
  - Tell consignees exactly when services will be performed (e.g. advise estimated time of arrival via fax/mail)
  - Give prompt services to consignees (e.g. advise regulations regarding discharge of overweight/over-length cargoes)
  - Willingness to help consignees (e.g. suggest inland routing)
  - Timely response to consignees requests (e.g. transshipment arrangement)

2.4.4 Taxonomy of Measure of SCP in More Detail (Shepherd and Gunter 2006)

Since relying exclusively on cost indicators can produce a misleading picture of SCP, distinguishing between cost and non-cost measures (time, quality, flexibility and innovativeness) is important.

Measures of time and quality reflect the ability of a supply chain to deliver a high customer service, whilst flexibility and innovativeness indicate the ability to cope with rapid changes in demand or supply. Flexibility and innovativeness are considered to be important strategic drivers of supply chain development in the future (Shepherd and Gunter 2006).

So the measures were categorized according to their applicability to the five supply chain processes defined in the SCOR model (plan, source, make, deliver and return or customer satisfaction); whether they measure cost, time, quality, flexibility and innovativeness; and, whether they are quantitative or qualitative.

Consider these notations for the categories of performance measures: cost (C), time (T), quality (Q), flexibility (F), innovativeness (I), quantitative (QN), and qualitative (QL) for categories of performance measures based on (Shepherd and Gunter 2006).

Plan

- Sales C, QN
- Profit C, QN
- Return on investment (ratio of net profits to total assets) C, QN
- Rate of return on investment C, QN
- Net profit vs. productivity ratio C, QN
- Information carrying cost C, QN
- Variations against budget C, QN
- Total SCM costs C, QN
- Cost of goods sold C, QN
- Asset turns C, QN
- Value added productivity C, QN
- Overhead cost C, QN
- Intangible cost C, QN

- Incentive cost and subsides C, QN
- Sensitivity to long-term costs C, QN
- Percentage sales of new product compared with whole sales for a period C, QN
- Expansion capability C, QN
- Capital tie-up costs C, QN
- Total supply chain response time T, QN
- Total supply chain cycle time T, QN
- Order lead time T, QN
- Order fulfillment lead time T, QN
- Customer response time T, QN
- Product development cycle time T, QN
- Total cash flow time T, QN
- Cash-to-cash cycle time T, QN
- Horizon of business relationship T, QL
- Percentage decrease in time to produce a product T, QN
- Fill rate (target fill rate achievement & average item fill rate Q, QN)
- Order entry methods Q, QN
- Accuracy of forecasting techniques Q, QN
- Autonomy of planning Q, QL
- Perceived effectiveness of departmental relations Q, QL
- Order flexibility Q, QN
- Perfect order fulfillment Q, QN
- Mix flexibility F, QN
- New product flexibility F, QN
- Number of new products launched I, QN
- Use of new technology I, QN

Source

- Supplier cost-saving initiatives C, QN
- Percentage of late or wrong supplier delivery C, QN
- Supplier lead time against industry norm T, QN
- Supplier's booking-in procedures T, QN
- Purchase order cycle time T, QN
- Efficiency of purchase order cycle time T, QN
- Buyer-supplier partnership level Q, QL
- Level of supplier's defect-free deliveries Q, QN
- Supplier rejection rate Q, QN
- Mutual trust Q, QL
- Satisfaction with knowledge transfer Q, QL
- Satisfaction with supplier relationship Q, QL
- Supplier assistance in solving technical problems Q, QL
- Extent of mutual planning cooperation leading to improved quality Q, QL
- Extent of mutual assistance leading in problem-solving efforts Q, QL
- Distribution of decision competences between supplier and customer Q, QL

– Quality and frequency of exchange of logistics information between supplier and customer Q, QL
– Quality of perspective taking in supply Networks Q, QL
– Information accuracy Q, QL
– Information timeliness Q, QL
– Information availability Q, QL
– Supplier ability to respond to quality problems F, QL

Make

– Total cost of resources C, QN
– Manufacturing cost C, QN
– Inventory investment C, QN
– Inventory obsolescence C, QN
– Work in process C, QN
– Cost per operation hour C, QN
– Capacity utilization as incoming stock level, work-in-progress, scrap level, finished goods in transit C, QN
– Inventory cost C, QN
– Inventory turnover ratio C, QN
– Inventory flow rate C, QN
– Inventory days of supply C, QN
– Economic order quantity C, QN
– Effectiveness of master production Schedule C, QN
– Number of items produced C, QN
– Warehouse costs C, QN
– Stock capacity C, QN
– Inventory utilization C, QN
– Stockout probability C, QN
– Number of backorder C, QN
– Number of stockouts C, QN
– Average backorder level C, QN
– Percentage of excess/lack of resource within a period C, QN
– Storage costs per unit of volume C, QN
– Disposal costs C, QN
– Planned process cycle time T, QN
– Manufacturing lead time T, QN
– Time required to produce a particular item or set of items T, QN
– Time required to produce new product Mix T, QN
– Inventory accuracy Q, QN
– Inventory range F, QN
– Percentage of wrong products Manufactured Q, QN
– Production flexibility F, QN
– Capacity flexibility F, QN
– Volume flexibility F, QN
– Number of tasks worker can perform F, QN

Deliver

– Total logistics costs C, QN
– Distribution costs C, QN
– Delivery costs C, QN
– Transport costs C, QN
– Transport costs per unit of volume C, QN
– Personnel costs per unit of volume moved C, QN
– Transport productivity C, QN
– Shipping errors C, QN
– Delivery efficiency C, QN
– Percentage accuracy of delivery C, QN
– Delivery lead time T, QN
– Frequency of delivery T, QN
– Product lateness T, QN
– Average lateness of orders T, QN
– Average earliness of orders T, QN
– Percent of on-time deliveries T, QN
– Delivery performance Q, QN
– Delivery reliability Q, QN
– Number of on-time deliveries Q, QN
– Effectiveness of distribution planning schedule Q, QL
– Effectiveness of delivery invoice methods Q, QN
– Driver reliability for performance Q, QN
– Quality of delivered goods Q, QL
– Achievement of defect-free deliveries Q, QN
– Quality of delivery documentation Q, QL
– Delivery flexibility F, QN
– Responsiveness to urgent deliveries F, QN
– Transport flexibility F, QN

Return (customer satisfaction)

– Warranty/returns processing costs C, QN
– Customer query time T, QN
– Customer satisfaction (or dissatisfaction) Q, QL
– Level of customer perceived value of product Q, QL
– Customer complaints Q, QN
– Rate of complaint Q, QN
– Product quality Q, QL
– Flexibility of service systems to meet particular customer needs F, QL

2.5 Goal-Oriented Approach

If a goal-oriented approach is used, how should the performance of SCM is measured?

In order to answer this question, we suggest distinguishing between six perspectives on SCM. Each perspective follows a particular set of goals, which consequently leads to a particular set of performance metrics. The various perspectives are systems dynamics, operations research/information technology, logistics, marketing, organization and strategy. If researchers focus on only one particular perspective, they will neglect the others. The balanced scorecard approach, with its multidimensional view on organizational reality, tries to overcome this boundary (Otto and Kotzab 2003).

2.5.1 Six Perspectives to Measure the Performance of SCM (Otto and Kotzab 2003)

Three are six mentioned perspectives in SCP measurement, as follows:

1. *System dynamics-perspective.* This is the primary basis of the entire discussion in this field. Related contributions are still today among the most attractive ones regarding the transformation to practice.
2. *Operations research-perspective.* It can be characterized as a primarily method- or algorithm-oriented approach towards SCM. A supply chain is perceived as a resource network. SCM has to configure this network and to program the flows within the configuration according to a specific objective function based on algorithms.
3. *Logistic-perspective.* The supply chain is seen from a logistics perspective as a sequence of generic processes.
4. *Marketing-perspective.* Marketing recognized SCM in the past as a part of distribution, but recently it gained strategic importance as a potential driver for marketing's positive effect on the shareholder value. SCM is the tool to connect customers with products.
5. *Organizational-perspective.* From an organization point of view, a supply chain appears as a set of inter-organizational relationships.
6. *Strategy-perspective.* Strategy perceives SCM as a mean to vary certain competencies in a chain in order to maximize profits.

2.5.2 Performance Measures of Perspectives

Each perspective has its performance measures, which are explained below based on (Otto and Kotzab 2003):

System dynamics

- *Capacity utilization*. Degree of capacity utilization.
- *Cumulative inventory level*. Volume of kept inventory along the whole chain. May be measured as "days of supply" or as a currency equivalent. Inventory may also be measured as "dwell time", e.g. as the average number of days inventory sits idle in the pipeline compared to the average number of days it is moving.
- *Stock-outs*. Volume of stock-outs at the end user level. May be measured as a number of unsatisfied purchase orders or as the currency equivalent of the unsatisfied orders.
- *Time lags*. The length of the time lags occurring in the forwarding of demand information.
- *Time to adapt*. The time (number of days or weeks) needed to adapt to changes in demand. Supply chain adaptation is achieved as soon as all partners have accomplished their pursued operational parameters. It measures whether and how fast a supply chain manages to establish a good fit between the demand and supply patterns. "Time to adapt" measures the ability to respond rapidly to changes in demand, network design and sourcing.
- *Phantom ordering*. The volume of phantom ordering and order cancellations. They might be tracked in the manufacturers' ERP-system.

Operations research

- *Logistics costs per unit*. The percentage of the total landed costs that are consumed by the logistics processes. In this case, logistics should be defined as solely including the physical operations transport, storage and changeover.
- *Service level*. May be measured as the percentage of OTIF-orders (OTIF: on time–in full) or as a line item fill rate.
- *Time to deliver*. The time needed to move a particular inventory item from its point of storage to the customer. It may also be considered as the time required to serve the customer either by stock, assembly or make-to-order.

Logistics

- *Integration*. Number of interfaces to be crossed through the processing of an order.
- *Lead times*. Lead times represent the time needed to finish a process. Lead times may be compiled for different business processes like procurement, manufacturing, or distribution.
- *Order cycle time*. The time interval between the time a customer places an order and the time he/she receives the product.
- *Inventory level*. See above.
- *Flexibility*. Flexibility may be measured as the ability to change or react with little penalty in time, effort, cost, or performance.

Marketing

- *Customer satisfaction*. Customer satisfaction is a multi-dimensional construct. To measure the SCM-related fragments of customer satisfaction, it is recommended to focus on those elements, which are driven by the physical logistical operations like the share of OTIF-orders.

– *Distribution costs per unit*. The total costs incurred to make a finished product available for a customer.
– *Market share/channel costs*. Numerical and weighted distribution: How many distribution points can be delivered and what is their market share? What are the costs to serve this marketing channel (acquisition and physical distribution)?

Organization

– *Transaction costs*. Usually defined as a bundle of costs incurred by the processes of preparing routine business conduct. This bundle includes the costs of searching business partner, monitoring the performance of agents, or adapting contracts.
– *Time to network*. The length of time needed to establish a specified particular institutional arrangement.
– *Flexibility*. For an appropriate definition of flexibility see above. The flexibility of the institutional arrangement may measure how "easily" a particular organizational set can be changed.
– *Density of relationships*. The density of a relationship is a complex conceptual phenomenon. Thus, its measurement will always be subject to the conceptual foundation.

Strategy

– *Time to network*. See above.
– *Time to market*. The time to market is the time period required to design and develop a marketable product. It measures how long it takes the business to recognize a market opportunity, to translate it into a product or service and bring it to the market. It may be measured in weeks, months or years.
– *ROI of focal organization*. Return on investment.

2.6 Attributes of National Logistics Systems

The six general attributes of *World Competitive Yearbook* (Garelli 1999), i.e. infrastructure, performance, information systems, human resource, business and political environment and specific characteristics to make them more business-oriented, are shown below:

Infrastructure

– *Distribution infrastructure*. The distribution of goods and services is generally efficient/inefficient
– *Infrastructure maintenance and development*. Infrastructure maintenance and development is/is not adequately planned and financed
– *Water transportation*. Water transportation (crane handling, harbors, canals, ... meet/does not meet business requirement

Performance

– *Air cargo handling*. Cargo handling throughput
– *Customs administration*. Hinders/does not hinder the efficient transit of goods
– *Process management*. Process management (quality, time to market, … is/is not emphasize in country
– *Customer orientation*. Emphasize/does not emphasize customer satisfaction adequately

Information system

– *New information technology*. Implementation meets/does not meet business requirements
– *Electronic commerce*. Is/is not sufficient developed for business opportunities

Human resource

– *Labour regulations*. Regulations (hiring and firing practices, minimum wages, etc.) are too restrictive/are flexible enough
– *Immigration laws*. Prevent/do not prevent company from hiring foreign labor
– *Skilled labor*. Is/is not available in country's labour market
– *Industrial disputes*. Low/high working days lost per 1,000 inhabitants per year
– *Industrial relations*. Labor relations are generally hostile/productive
– *Employee training*. Is/is not high priority in companies
– *Worker motivation*. Identifies/does not identify with company objectives

Business environment

– *Export credits and insurance*. Are/are not available at reasonable prices for companies interested in exporting
– *Exchange rate policy*. Hinders/supports the competitiveness of enterprise
– *Cost of capital*. Hinders/does not hinder competitive business environment

Political environment

– *Political stability*. Risks of political instability

Table 2.1 Value chain measure categories organized using *The Balanced Scorecard* macro level categories (Bolstorff 2006)

Balanced scorecard categories										
Customer facing			Process				Financial		Employee	
Reliability	Responsiveness	Flexibility	Supply chain	Design chain	Customer chain	Aggregate	Profit	Growth	Performance	Development

Table 2.2 A draft list of value chain level 1 metrics (Bolstorff 2006)

		Balanced scored categories										
		Customer facing			Process			Financial		Employee		
Process model	Level 1 metrics	Reliability	Responsiveness	Flexibility	Supply chain	Design chain	Customer chain	Aggregate	Profit	Growth	Performance	Development
SCOR	Performance order fulfillment	*										
CCOR	Warranty fulfillment	*										
CCOR	Service order fulfillment	*										
DCOR	Product quality	*										
SCOR	Order fulfillment cycle time		*									
DCOR	New product development cycle time		*									
CCOR	Selling process cycle time		*									
CCOR	Return process cycle time		*									
SCOR	Upside supply chain flexibility			*								
DCOR	Engineering change order flexibility			*								
DCOR	Design reuse flexibility			*								
CCOR	Total returns management cost						*					
CCOR	Total customer chain management cost						*					
CCOR	Days sales outstanding						*					
SCOR	Total supply chain management costs				*							
SCOR	Inventory days of supply				*							
DCOR	Total design chain management cost					*						

(*continued*)

Table 2.2 (Continued)

		Balanced scored categories										
		Customer facing			Process			Financial		Employee		
Process model	Level 1 metrics	Reliability	Responsiveness	Flexibility	Supply chain	Design chain	Customer chain	Aggregate	Profit	Growth	Performance	Development
DCOR	Total warranty cost					*						
DCOR	New product revenue							*				
SCOR	Cost of goods sold							*				
ALL	Sales, general, and administrative cost							*				
SCOR	Cash-to-cash cycle time							*				
ALL	Asset turns							*				
ALL	Return on assets							*				
ALL	Gross profit margin								*			
ALL	Operating margin								*			
ALL	Net profit margin								*			
ALL	Revenue growth									*		
ALL	Gross profit growth									*		
ALL	Operating margin growth									*		

2.7 Using the Balanced Scorecards to Manage SCP (Bolstorff 2006)

While SCOR provides a proven model to measure SCP, it does not include measures for the other business processes in the value chain, i.e. product design, sales, etc. One tried and true method to organize your key performance indicators is the *balanced scorecards*. The balanced scorecards has four measurement categories including customer facing; internal process; company financial; and individual employee.

Based on three value chain projects using SCOR, DCOR[1], and CCOR[2], this section integrate these leading practice models to manage value chain metrics.

The SCOR level 1 metrics are organized into customer-facing and internal-facing categories. The customer-facing category is further separated into three performance attributes, reliability, responsiveness, and flexibility. The internal-facing category is separated into two performance attributes, costs and assets. We can integrate categories of SCOR with the balanced scorecard organizational framework as shown in Table 2.1. Customer utilizes the SCOR customer facing categories and as you will see from the metric list in Table 2.2 broadens the scope to include more than just customer delivery performance. Process organizes metrics by value chain process and for those metrics that are a result of multiple processes an aggregate category is added. Financial has categories for both profit and growth (an important aspect of value chain improvement). Employee utilizes two categories, one focused on performance and the other focused on development.

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Chapter 3
Global Supply Chain Management

Mohsen Sheikh Sajadieh

Nowadays with globalization, global supply chain management is becoming a very important issue for most of businesses. The main reasons of this trend are procurement cost reduction, purchasing risks control, revenues increasing and, etc. For instance, companies may set up overseas factories to benefit from tariff and trade concessions, lower labor cost, capital subsidies, and reduced logistics costs in foreign markets. Moreover, easy access to abroad markets and close proximity to customers result better organizational learning. On the other hand, improved reliability can be obtained as a consequence of closer relationship with suppliers.

There are some issues that should be considered in managing a global supply chain. First of all, the company should decide about its general outsourcing plan. For whatever reason, businesses may prefer to keep some aspects of supply chain nearer to home.

The second issue that must be incorporated into a global supply chain management strategy is supplier selection. It can be very difficult to comparing bids from a range of global suppliers. Companies usually jump on the lowest price instead of taking time to consider all of the other elements. On the other hand, selecting the right suppliers is influenced by a variety of factors, and thus there will be additional complexity in supplier selection due to the multi-criteria nature of this decision.

Additionally, companies must make decisions about the number of suppliers to use. Fewer supplies may result reduced inventory costs, volume consolidation and quantity discounts, reduced logistical costs, coordinated replenishment, improved buyer–supplier product design relationship, and thus better customer service and market penetration. However, small number of suppliers could lead to potential problems if one vendor is unable to deliver as expected, especially in global sourcing strategy.

Finally, companies who prefer to ship their manufacturing overseas may face some additional concerns. Questions about the number of plants as well as their locations can pose complex logistical problems.

In this chapter we will have a brief review on global supply chain management (GSCM). "Skjott-Larsen et al. (2007), Managing the global supply chain, 3rd

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edition" and "Mentzer et al. (2006), Handbook of Global Supply Chain Management" are in-depth presentations of the concepts and techniques of the profession. Readers are referred to these books for greater details about GSCM.

3.1 Global Supply Chain Drivers

Driven by the promise of low material, manufacturing and labor costs, and advanced by the desire to penetrate emerging markets, companies have been testing the waters of offshore supply since the 1980's. There are two dimensions of globalization: the geographic and the qualitative dimension (see Delfmann 1998). The former is used to describe the increased geographic scope of activities of worldwide companies as well as increased location and dispersion of manufacturing facilities. Supply chains are becoming more and more international and at the same time increasingly integrated, thus increasingly interdependent than in earlier years. This is referred to as the qualitative dimension of globalization. Moreover, new possibilities of optimizing the supply chains belong to the qualitative dimension.

While both dimensions are of major importance for logistics, the qualitative dimension is becoming the driving force of global SCM. There are four clusters of globalization drivers: market, cost, government, and competition (see Yip 1992). These drivers can be considered as descriptive variables for the ongoing globalization process. Effective global SCM calls first for an understanding of each driver and the way it operates. Each driver has the ability to directly affect the supply chain and enable certain capabilities for globalization.

3.1.1 Market Drivers

When considering the globalization process, the homogenization of customer needs can be considered on the market side. This frequently means long production runs and centralized manufacturing and distribution centers in order to generate and benefit from economies of scale. On the other hand, building dispersed production facilities that have a lot of excess capacity and take into account a multitude of local securities are no longer required, and instead replaced by fewer, larger and central production plants.

Another part of market driver can be referred to as channel globalization. A typical characteristic of the global customers is the coordinated or centralized ordering of materials or services. Companies as a customer now prefer to deal with few outsourced service providers, and distribution channel partners which are able to perform transportation, warehousing and other related services more effectively and at a better price than producers, distributors, retailers, or consumers could do on their own. Thus, global logistics service providers are preferred partners of globally operating companies.

3.1.2 Cost Drivers

Besides the drivers on the market side, there are also variables on the cost side. The global scale economies are the most apparent of these drivers. Production processes geographically concentrated for worldwide delivery require sophisticated logistics operations.

Global sourcing, sourcing efficiencies, favorable logistics, differences in country costs (including exchange rates), high product development costs and fast changing technology are essential for the supply chain focus. Global sourcing involves identifying, evaluating, negotiating and configuring supply across several geographies to reduce costs, maximize performance and lessen risks. Global sourcing focuses on the upstream side of the supply chain and denotes the globally dispersed supplier locations of a company. Companies are no longer restrained to local suppliers but are free to select their suppliers on a global scale. Companies are being challenged to increase the level of global sourcing to tap into opportunities and to fend off competition. Most of them are ill equipped for the challenge, though global sourcing employs the same set of activities as domestic sourcing; there is also greater complexity. They need to improve the skills of their purchasing organizations to pursue global sourcing effectively.

Favorable logistics denote transportation, procurement, distribution, maintenance, warehousing, inventory management, etc. The increasing productivity due to technological progress of logistics industry has considerable impact on the capability to globalize operations.

Another driving force of globalization is differences in country costs. For example, low-priced work forces and easy access to inexpensive raw materials in several countries are some of supply opportunities that can be employed in global SCM in order to enhance the overall competitiveness of the supply chain. Moreover, expensive markets with high profit margins in other countries are demand chances which can be used to increase supply chain's income.

3.1.3 Government Drivers

One of important globalization drivers is government regulations. Favorable trade policies, compatible technical standards, common marketing regulations, government-owned competitors and customers, and host government concerns are a number of governmental drivers.

The first one, favorable trade policy, has undoubtedly promoted international trade. For example, the WTO agreement has considerably pushed world trade. Agreements like this facilitate the worldwide cooperation and motivate companies to develop their domestic supply chain to new countries. Without the emergence of these policies, the globalization of business activities would not have occurred.

The compatibility of technical standards is of major importance as well. This applies to the transparency and compatibility of information systems which are essential components of every flow of goods. For instance, global trade item number is a part of a global item numbering scheme used in radio frequency identification technology to track products moving through supply chains that stretch all the way around the globe. This is a single international standard for information about the product and tracking so that people all over the world in different companies and countries be able to read the data easily and not have to translate it from one standard to another (see Hugos 2006).

3.1.4 Competitive Drivers

The last group of drivers is called competitive drivers. High exports and imports, competitors from different continents, interdependency of countries and competitors globalized can be considered in this category.

High exports and imports represent flows of goods across national borders, and thus are of critical importance for global SCM. The interdependencies of country activities reflect the increasing functional integration of economic activities across national boundaries. In globally configured supply chains, product components have to cross a multitude of national boundaries before a finished product can be handed over to the final customer.

3.2 Global Vs. Domestic Supply Chains

There are many differences between global and local SCs, where the global SCs are generally more advanced and complex. However, it does not necessarily mean that the global supply chains are always the best solution. We, at first, review these differences, and then talk about the best solution, global or domestic.

Nowadays you can find few sole domestic companies. Global sourcing is becoming a critical strategy for most of businesses or at least for their suppliers. Fewer and fewer companies are still selling their merchandises merely in domestic markets. Even if a company wants to stay totally domestic, competitors will come from every area of the world to its market. If domestic suppliers and customers are the only partners of a company, it needs to be analyzed whether it would be better to develop a global SC or not.

Although extension of companies to global marketplaces is a strategy almost accepted by everyone, the way it should be translated when it comes to managing global SCs is not that much clear. On the other hand, can the domestic features of a locally managed supply chain be easily considered as a part of a larger global supply chain? Before answering this question, we need to know the differences between the global and domestic SCs. MacDonald (2006) reviewed some of these differences.

3.2.1 Differences Between Global and Domestic SCs

Obviously, one of the main dissimilarities between global and domestic supply chain management is that the former involves company's worldwide suppliers and interests rather than just a local or national direction. Thus, global supply chains are more difficult to manage than domestic supply chains.

Large geographical distances in global context not only increase transportation costs, but also complicate other logistics decisions because of inventory cost tradeoffs due to increased lead time in the supply chain. Dissimilar local cultures, languages, laws and currencies lessen the effectiveness of supply chain processes such as demand forecasting, material planning, supplier relationship management, etc. Moreover, shortages of infrastructural resources especially in developing countries may hinder supply chain's operations. Lack of qualified personals, bureaucratic management, poor banking system, inadequate road network, system inflexibility, inability of suppliers to provide requested products in adequate quality and quantity, and deficiencies in logistics and telecommunications infrastructure are just some problems frequently encountered when operating on the global scale.

There are some elements that are required to manage any supply chain regardless of whether it is domestic or global. Visibility and flexibility are some of basic ingredients that need to be incorporated in order for a supply chain to function efficiently regardless of the length of the chain.

Visibility is a key element. Effective supply chain collaboration requires that the people be able to see accurate and timely data showing needed information at different stages in the supply chain. This is critical in order to allow companies to manage their supply chain strategically, identifying various points throughout the supply chain where goods can be held to reduce the risk of delays. The increased visibility makes it possible to operate supply chains more efficiently leading to lower costs.

Another element is flexibility, a critical factor to the success of the supply chain. Importance of flexibility in supply chains and logistics becomes so obvious when we understand that global supply chain works in a vague environment where markets and customers are dynamic. In the new millennium, time is becoming the strongest competitive tool for the supply chain managers. As the basis of competition expands to the supply chain and time becomes increasingly significant, an important issue will be the flexibility of the supply chain. A supply chain should then have enough flexibility in order to be able to compete efficiently.

Global supply chains seem to be less agile and flexible compared to domestic ones. In a sense, the very process of globalization has retarded agility. For instance, many companies in their search for lower production costs have outsourced much of their functions offshore. The main driver for such moves is lower related costs. However, in so doing they run the risk of extending their lead times considerably and thus generating the need for more safety stock. As a result, their agility is reduced.

As mentioned above, a great number of firms no longer deal with only their local customers; in contrast, they would ship their products to many different countries around the world. In addition, it is very common that a firm source their raw material from different countries with distance of thousands of miles from it. Thus, lead time in both inbound and outbound logistics has dramatically increased and would result in a more uncertainty through the logistics. Since then, if companies want to be successful in the global competition, it is necessary for them to achieve supply chain flexibility.

These two elements are tied with information, and thus information management will be an important area in supply chain management. In fact, many would argue that today, managing the supply chain is more about managing information than moving goods. Companies operating today are collecting tremendous amounts of data and the trend to move towards point of sale information is resulting in mountains of information being fed into a company's system. While this information ultimately will help businesses streamline their operations and reduce inventory, the trick right now is to take the raw data and translate it into a form that is useful for the customer.

Information visibility is absolutely critical for businesses that want to improve management of their global supply chain. Metrics relative to shipments and order and payment status will spotlight inefficiencies in the global supply chain and help companies drive these out through cost elimination.

Companies are looking at how to achieve efficiencies in a broad range of supply chain operations such as product design, demand forecasting, inventory management, and customer service. The key to realizing these efficiencies is information sharing between companies in a supply chain. Many current e-business developments are working on methods and standards to share information across multiple companies. Information sharing is the foundation, and then cross-company coordination is what will deliver the desired efficiencies.

Although these elements are critical to both global and domestic supply chain success, operational differences come into play when the supply chain extends beyond borders. They play out differently where international trade is just more complicated. First, the goods are traveling a far greater geographical distance. This usually requires different modes of transportation. Since, visibility is very complicated to achieve in an international supply chain compared to a local. Consequently, the skills and expertise needed to manage a global supply chain differ from the domestic requirements.

For global traders, the information flow in developing countries is not as well established or disciplined as it is in developed countries. Missing and unreliable information adds risk and decreases flexibility in the international supply chain. Often supply chain managers and the ultimate customer can't be sure what they will be receiving until the shipment actually arrives.

Achieving visibility is easier domestically than globally. In the domestic supply chain, you can contract a single carrier and will achieve high visibility. If you are going end-to-end, it is more complex, and there will be gaps in visibility. Langley is a big proponent of outsourcing the supply chain function to partners that have the ability to handle the complexities of global SCM. You need to have partners if you really want to play in the global supply chain. One of the reasons these partnerships are so important is because many of these logistics partners have developed operations and partnerships in countries overseas. For companies shipping globally, there are three main issues: getting the goods from origin to port in-country, shipping from port to port over the ocean, and then shipping from port to destination.

Extending a supply chain beyond countries borders clearly lengthens the chain, and thus results in exposure to greater variables. These variables can include border crossings, multiple modes of transportation and multiple hands-offs, different government systems, technology issues and security concerns. Every one of these variables presents opportunities for errors that can stall the entire supply chain. There is more risk in global trade, and you have to plan for and be aware of that. Thus, it can be concluded that managing the global supply chain is mostly about risk management. Domestic supply chains face less inherent risk; incidents are less likely to occur and the consequences will be less severe. Global supply chains are entirely different where the margin for accident and error is huge.

Companies that operate globally are under greater pressure than their domestic counterparts to actively manage their supply chain. It is such a dynamically charged situation with constant trade-offs. The risks inherent in managing a global supply chain mean that companies need to constantly be conducting cost-benefit analyses. Sourcing overseas may be less costly, but the risks could outweigh the benefits in the long run.

3.2.2 Selecting Global or Domestic Supply Chain?

A company's supply chain is an integral part of its approach to the markets it serves, regardless of whether the supply chain is domestic or international. There is no perfect supply chain formula that can be applied to every company. The supply chain should respond to the market necessities and do so in a way that supports the company's business strategy. Supply chains vary across industries and even within industries, according to the corporate goals. The business strategy a company employs starts with the needs of the customers that the company serves or will serve. Depending on the needs of its customers, a company's supply chain must deliver the appropriate mix of responsiveness and efficiency.

This means that there is no right answer about which one is the best. Companies need to understand how the supply chains result in the profitability of their business. Depending on the size and operational structure of a company, the domestic supply chain may be managed as part of a global whole. In many companies, their global supply chain is yet made up of a lot of smaller sections that operate separately and individually. In such cases, the domestic supply chain comprises one part, and the skills and knowledge necessary to manage it are different from those required to manage the global SC.

Based on the above discussion, it can be concluded that although supply chain is very important and crucial in nowadays business, it is at most a function of companies that helps them achieve their objectives. No matter which one you select, domestic and global supply chains should all be aligned with your business strategy.

3.3 Characteristics of Global Supply Chains

There are a number of characteristics, which add more difficulties to handling a global supply chain compared to a domestic (see Delfmann and Albers 2000). More important ones are: farness, forecasting complexities, economical and political worries, and infrastructural insufficiency.

3.3.1 Farness

No need to say, worldwide business are associated with larger geographic distances and more unpredictable disturbances, implying longer lead times. Longer lead times in a supply chain cause "the bullwhip effect". The bullwhip effect is a dynamic in supply chains. This phenomenon happens when small changes in product demand by the consumer is translated into wider swings in demand experienced by companies, going back in the supply chain. As a result, companies at different stages in the supply chain will have different pictures of final-customer's demand, and a breakdown in supply chain coordination will occur.

3.3.2 Forecasting Complexities

Another feature of global supply chains that increases the bullwhip effect is forecasting inaccuracy. Increased geographical distances and communication difficulties result in forecasting complexities. Moreover, in a global SC, different cultures with different languages and mentalities should be included into the demand forecasting models. As the exactitude of demand forecast has considerable impact on the safety stock level, operating in the global context tends to raise inventories.

On the other hand, demand forecasting based on orders received instead of end user demand data will become more and more inexact as it moves up the supply chain. In global supply chains, companies are usually removed from contact with the end user, and thus they lose touch with actual market demand. Therefore, each company just sees the orders that come to it, and when it uses this order data to do demand forecasts, it adds more distortion to the demand picture and passes this distortion along in the form of orders that it places with its suppliers.

3.3.3 Economical and Political Worries

Global SCs carry unique risks, including variability and doubt in currency exchange rates, economic and political instability, tariffs and duties changeability, non-tariff trade barriers, individual income tax, etc. Although macroeconomic uncertainties arise in the national setting, in the international context, the problem is magnified as the company deals with a number of national macroeconomic settings. Since then, risk management has to be seen as an essential part of global SCM, where practitioners should factor these risks into their decisions when dealing with global supply chains. For example, currency exchange rate affects the price of goods purchased in the supplier's currency, and so influences the financial performance of the supply chain. Thus, its changes should be traced in order to continuously make decisions about the time and quantity of purchasing.

3.3.4 Infrastructural Insufficiency

Infrastructural shortages in developing countries in transportation and telecommunications as well as inadequate worker skills, supplier availability, supplier quality, equipment and technology provide challenges normally not experienced in developed countries. These difficulties reduce the degree to which a global supply chain provides a competitive advantage. For example, intra-country links are usually sparse in the third world countries, making access to new inland markets more difficult and costly.

3.4 Global Sourcing

One of the most important activities of global SCM is global sourcing. Global sourcing occurs when buyers purchase goods and services from sellers located anywhere in the world. Global sourcing is used as a proactive strategy to reap economic advantage. As developing countries continue to implement free market reforms, educate workforces and develop expertise and knowledge, these emerging economies can be considered as a cost-effective alternative compared to more expensive, domestic resources.

Global sourcing is a sourcing strategy which involves identifying, assessment and negotiating supply across multiple countries in order to minimize costs, make the most of performance and lessen related risks. Global sourcing related factors that must be controlled can be summarized as follows (see Tim Minahan 2003):

– *Material costs.* Price, tooling, transaction, and other costs related to the actual product or service delivered.
– *Transportation costs.* Transportation, freight charge, consolidation, transfer fee, pickup and delivery.
– *Inventory holding costs.* Warehousing, taxes, insurance, depreciation, shrinkage, obsolescence, and other costs associated with maintaining inventories, including the cost of money or opportunity costs.
– *Cross-border taxes, tariffs, and duty costs.* The sum of duties, shipping, insurance and other fees and taxes for door-to-door delivery.
– *Supply and operational performance.* The cost of noncompliance or underperformance, which, if not managed properly, can offset any price variance gains attained by shifting to an offshore source.
– *Supply and operational risks.* including geopolitical factors, such as changes in country leadership; tariff and policy changes; and instability caused by war and/or terrorism or natural disasters (e.g., typhoons, earthquakes) all of which may disrupt supply lines.

Such variables give global sourcing attributes that are similar to financial and risk management, requiring companies to determine performance targets and to develop a balanced supply portfolio that includes the appropriate mix of cost, risk and performance.

3.4.1 Global Sourcing Challenges

Although the use of foreign suppliers has an increasing trend, the transition to global sourcing seems not to be easy for most companies. Few companies have the required infrastructure to effectively make this transition. On the other hand, although sourcing from low cost markets may offer significant cost advantages, it also means larger geographical distances, extended lead times and increased risk. Left unaddressed, these challenges result in critical supply chain performance issues that can severely undermine any sourcing initiative. Some of global sourcing challenges are as follows (also see Yip, 2005).

3.4.1.1 Low Visibility

As mentioned before, global sourcing processes introduce distance, time zone, cultural and language barriers that combine to reduce visibility into offshore operations. With no visibility into international shipments, companies are forced to maintain safety stock that handle the risk of obsolescence each time a decision is made to launch new products, extensions or discontinuations. Furthermore, with no access to complete and up-to-date information, supply chain executives struggle to assess the cost of making these decisions. In this environment, making the right sourcing decisions quickly turns into a guessing game.

One of the greatest problems for executives in GSCM is lack of visibility. If people have visibility into where an item is within the global supply chain, they are able to make optimal supply and demand decisions based on the information. Without context it is impossible for individuals responsible for managing products across complex global supply chains to make decisions that are optimal for the organization. To get context the organization requires cross-functional execution, information and financial visibility. Therefore, more emphasis and investment are needed by organizations to insure that they have the required visibility and are enable to operate efficiently.

Critical global supply chain visibility is not just about the location of an item in the supply chain, but it includes the ability to see virtually all aspects that affect the item. Critical supply chain visibility includes views into where an item is anywhere in the cash-to-cash cycle and the views into all of financial and compliance issues that accompany the item.

3.4.1.2 Difficult Communication

Diverse cross border business practices and customs often create a challenging communication environment. Suppliers, logistics providers, manufacturers and other members of the chain may have different expectations on how, where and when to communicate information, and at what level of detail. Manual methods of communication such as phone, fax and email combined with language, cultural, and time-zone differences result in higher order-taking and order fulfillment error rates, high days sales outstanding rates, etc. Since then, these problems may even outweigh the benefits of employing an international low-prices supplier.

3.4.1.3 Security Issues

On top of sourcing and logistics complexities, companies are now increasingly concerned with security issues in the global sourcing process. To avoid these pitfalls, brand owners must develop greater visibility into order and logistics related processes across their extended supply chain.

3.4.2 Global Sourcing Dimensions

There are a number of different dimensions of global sourcing that should be considered selecting the sourcing strategy. Dominick (2007) mentioned what a global sourcing strategy should address as follows:

3.4.2.1 Costs

One of the main reasons of global sourcing is to benefit from lower costs abroad such as labor; raw material, etc. However, there are other costs such as multi-modal freight charges, broker fees, taxes, and insurance in global sourcing that are not part of domestic transactions. Since then, one should employ a cost/benefit analysis in order to make decision between global or domestic sourcing strategy.

Today's supply chains exist in an extremely dynamic global environment. Product customization, rising energy, commodity, labor costs, and new markets located in emerging economies have driven many manufacturers to source and produce goods in globally dispersed regions of the world. The uncertainties and risks associated with increasingly extended supply chains are resulting in bloated inventories to hedge against the unanticipated disruptions in delivery times and supply.

3.4.2.2 Laws

Laws applied in global contracts between buyers and suppliers can be chosen from the law of the buyer's country, the law of the supplier's country, or one applicable under an agreement accepted by both countries. Therefore, it should be clearly defined which one of these three category of laws are going to be used through buyer–supplier transactions.

3.4.2.3 Currency

Supply chain members should agree on a currency to use. If the buyer's currency strengthens relative to the supplier's currency, careful decisions consider use of the supplier's currency.

3.4.2.4 Lead Time

As mentioned before, large geographical distances in global context make lead time to be longer than for domestic ones. This is also due to slower transportations modes such as shipment which is not usually involved in domestic sourcing. Whether ultimate customers expect all products to be available for immediate delivery or they will accept longer lead times will have a significant effect on company sourcing strategy. Also, longer lead times require a longer time horizon over which forecasts must be made.

3.4.2.5 Language and Culture

Being unfamiliar with the supplier's language and culture, you increase the risk of communication challenges, misunderstandings, and uncomfortable encounters. On the other hand, sourcing processes such as supplier selection, supplier assessment, supplier involvement, and so on in global SCs need to consider more sophisticated factors such as culture and civilization which may be insignificant in domestic sourcing.

3.4.2.6 Transportation

While domestic sourcing usually involves one shipping mode, global sourcing involves multi-modal transportation, combined air, water, and ground transportation to get goods from initial suppliers to the ultimate consumers. Deciding about optimal shipment modes combination is another global sourcing attribute which can be worked out using operations research techniques.

3.4.2.7 Payment Methods

Global sourcing often involves payment using international letter of credits which requires the involvement of both the buyer's and supplier's banks. Managing credit risk can be accomplished by creating some credit programs that are tailored to suppliers in foreign countries. Credit risks can be lowered by the use of credit insurance and government loan guarantees for exports.

3.5 Demand Management

One of the other main activities in global SCM is known as demand management. Mentzer et al. (2006) point out that demand management in a global SC includes three activities: demand management, demand planning, and sales forecasting management. Although any purchasing order from a buyer to a supplier in a global supply chain can be considered as a demand, all of them are dependent to each other except the first one – the amount of product demanded by the end-use customer of the supply chain. On the other hand, the ultimate customers create the demand that will flow through the supply chain. These ultimate customers may be final consumers shopping from a retailer or online, or a business buying products for consumption in their business operations.

Only the frontline company in the supply chain that directly serves these ultimate customers can experience the actual independent demand. All companies in the other levels of traditional supply chains just experience an inexact demand that is tempered by the order fulfillment policies of their immediate customers which they procure products for them. The second type of demand is not the independent demand of the ultimate customer.

It is important to note that only one company in front of a supply chain is directly affected by independent demand. The rest are affected by dependent demand. It should be mentioned that the techniques, systems, and processes needed to deal with dependent demand are somewhat different from those of independent demand. In order to improve the global SC's performance targets such as logistics and supply chain costs or customer service levels, we need to know the differences between these independent and dependent demand and identify which type of demand affects companies in different levels of a chain. Moreover, developing techniques, systems, and processes to deal with each company's type of demand can have a deep impact on global supply chain performance targets.

Demand management includes the marketing functions, along with the coordination of marketing activities with other functions in the company and the supply chain. However, the traditional demand creation role of marketing is tempered in demand management by a desire to coordinate the flow of demand across the supply chain and to create incentives for supply chain partners to help manage these flows. Demand planning is concerned with the coordination across the global supply chain of derived and dependent demand. Sales forecasting management is concerned with the independent demand that occurs in any global supply chain.

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Chapter 4
National Logistics Costs

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In today's world, economic climate changes more quickly, and countries realize that globalization has made the world smaller and more competitive. Also, customers seek products and services that can respond to their specific needs and firms make effort to create competitive advantages to keep their profit and market share. All of the above trends lead firms and countries to focus on supply chain and integrated logistics (Fig. 4.1).

Making supply chain activities more effective and efficient is a sustainable competitive advantage for countries. One of the important parts of these activities is logistics activities, which can make a significant reduction in costs. Efficient management of logistics activities is a perfect source for creating competitive advantages. Besides, it allows firms to respond to their customers' specific needs, which in turn, results in customer satisfaction.

4.1 Importance of Logistics Costs

Lack of information about logistics costs is a significant barrier to understanding integrated logistics. Optimizing the flow and integrating resources are important objectives in integrated logistics, so managers need transparent information about logistics costs in all stages of product flow. Without this information, it is impossible to measure the impact of decisions on costs through supply chain (Themido et al. 2000). This issue has been cited in the literature by researchers as follows.

"The distribution of products and services from the point of origin to point of consumption is a very important part of any country's gross national product, and indicates how much "money" the country has produced or made. Logistics activities thus mean money to a country." (Voortman 2004 cited in The First State of Logistics Survey for South Africa 2004).

"As the logistics functions become more integrated, they are able to achieve much efficiency. But, a barrier to fully implementing an integrated logistics function is the

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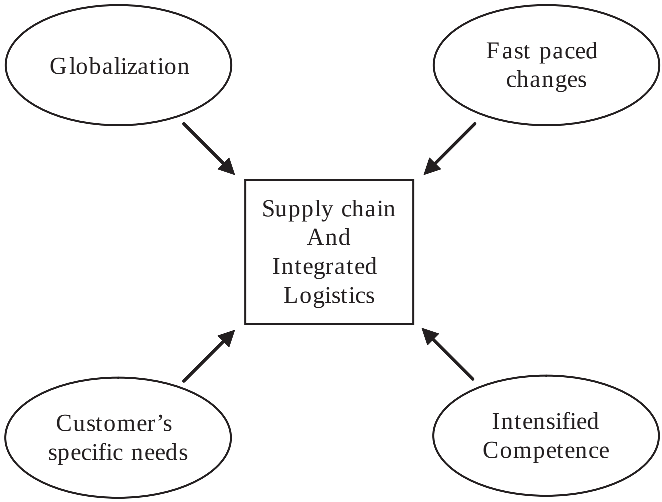

Fig. 4.1 Trends lead to supply chain and integrated logistics

lack of accurate information about costs." (Fredendall and Hill 2001 cited in The First State of Logistics Survey for South Africa 2004).

Logistics costs measurement is a proper indicator for past and future. As a lead indicator, Logistics costs measurement would support national policy making and the targeted deployment of operational and capital resources (transport infrastructure investment). As a lag indicator, it would enable measurement of performance and pave the way for corrective actions.

As a result, measuring logistics cost is not a goal but it is a proper indicator for monitoring and evaluating national logistics. Importance of logistics costs increases when you know that efficiency of logistics activities is an important infrastructure for economic growth.

Researches show that first world countries have achieved a significant reduction in their transportation and inventory costs as most important parts of logistics costs in last five decades (The First State of Logistics Survey for South Africa 2004).

For example logistics costs in 1981 in USA were 16.2% of GDP[1] whereas in 2003 they are only 8.5% of the GDP. We know that USA gross domestic production in 2003 was approximately 12,400 billion $, so this reduction in logistics costs results in 954.8 billion $ saving (17th Annual State of Logistics Report of USA 2006).

Another important issue is logistics costs proportion of product price. We know that low price for the same product is a competitive advantage that could result in more market share. So because logistics costs are a substantial proportion of product prices (Fig. 4.2), calculating logistics costs and trying to reduce them is very important. Also, because logistics costs proportion of product prices is not

[1] Gross Domestic Product.

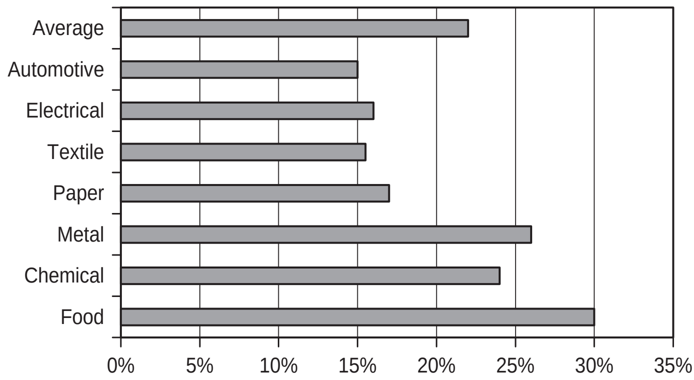

Fig. 4.2 Logistics costs as a proportion of product prices (European Logistics Association cited by Amos 2007)

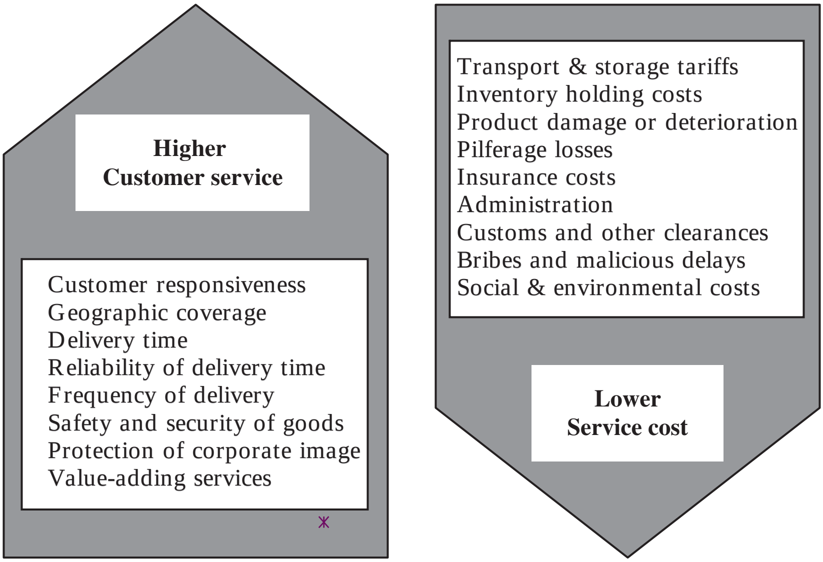

Fig. 4.3 National logistics strategies (Amos 2007)

equal for different products (Fig. 4.2), calculating logistics costs is a good indicator to prioritize investments on reducing logistics costs in different products.

Different countries use different strategies to improve their national logistics systems and to be able to respond to logistical needs of different industry sectors. We can categorize these strategies into two categories: Lower service costs and higher customer service (Fig. 4.3). It seems that making successes in national logistics systems needs improvement in both categories, and neglecting each one of them leads to failure. Therefore, measuring logistics costs makes a proper index for strategic control (evaluating strategies), especially in lower service costs strategy.

We can see a global effort for calculating logistics costs in different countries and significant numbers of first world countries calculate their logistics costs yearly. But in spite of high importance of national logistics costs, this issue does not find appropriate place in literature.

4.2 Complexity of Calculating Logistics Costs

Calculating logistics costs in national level has more complexity than calculating these costs in a firm, although calculating logistics costs in a firm is complex too. Two significant complexities in calculating logistics costs are as follow:

(a) *Complexity in the process* surface means costs of whole flows of materials and information within the enterprise. This shows the complexity of calculating material and information flow in all stages in processes (Wajszczuk 2005).
(b) *Complexity of calculating depreciation* that means calculating the value reduction of all property and equipments involve in logistics activities (Wajszczuk 2005).

With respect to these complexities, calculating logistics costs exactly in national level is very hard or impossible. What we can achieve is the estimation of national logistics costs; and efforts should focus on reducing the error of this estimation. To estimate national logistics costs, countries should have reliable statistics in transportation and inventory parts. Without this information, estimating logistics costs is very hard and results are unreliable.

Another important issue is the point of origin and point of consumption in national logistics chain. As we know "Logistics management is... the planning, implementation and control of the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customer requirements" (CSCMP 2006). So, selecting the point of origin and the point of consumption could play an important role in complexity of calculating national logistics costs. For example, if we put the point of consumption on end consumer(s) (customers), we should calculate costs of transportation for each person from origin to destination in all parts of country, that is very hard. But if we put the point of consumption on retailers, we can calculate the costs with less complexity.

4.3 Components of National Logistics Costs

Before we describe the components of national logistics costs, let's talk about logistics main components. There is no standard for this issue, so we describe logistics components based on Rushton et al. (2006). Storage and warehousing, packaging and unitization, transport, inventory, information and control are the main components of logistics activities.

Different methods use different components for calculating logistics costs with a little disparity. Nevertheless, most of these methods consider transport, inventory and administration costs as their components. In coming sections, when we introduce the methods of calculation, we describe the components covered by related method too. In the present section, for better understanding based on Zeng and Rossetti's (2003) work, we define logistics costs component as: transportation, inventory holding, administration, customs, risk and damage, handling and packaging. Table 4.1 shows each part with related subparts and a brief description.

However methods used for estimating national logistics costs in countries usually divide logistics costs into more general components that almost include transportation, inventory and administration costs.

Table 4.1 Components of logistics costs (Zeng and Rossetti 2003)

Logistics cost category	Description
Transportation	• *Freight charge*. Cost incurred during delivery using various transportation modes • *Consolidation*. The fee for combining small shipments to form larger shipments • *Transfer fee*. Cost incurred during the transfer of goods between different modes of transportation • *Pickup and delivery*. Transportation charges incurred between shipper's warehouse and air, rail consolidator's terminal
Inventory holding	• *Pipeline holding*. Holding cost during the transfer • *Safety stock*. Holding cost of safety stock
Administration	• *Order processing*. Salaries of employees responsible for purchasing and order management • *Communication*. Telephone, fax and information transfer related costs associated with international logistics • *Overhead*. Rent paid by the international logistics group
Customs	• *Customs clearance*. Fee imposed by local customs to clear goods • *Brokerage fee*. Charge levied by an agent acting on behalf of the shipper or the receiver depending on the delivery terms • *Allocation fee*. Per house-bill
Risk and damage	• *Damage/loss/delay*. Percentage of the value of each unit shipped that will be lost, damaged or delayed • *Insurance*. Min $25 or $0.50 per $100.00 insured value
Handling and packaging	• *Terminal handling*. Material handling fee charged by the transportation company • *Material handling*. Cost of labor and equipment used to move goods within the shipper's or receiver's warehouse • *In/out handling*. Material handling charge levied by the freight forwarder for use of its facilities • *Disposal charge*. Fee for taking away an empty container from the receiver's warehouse • *Packaging/supplies materials*. Cost of preparing goods for shipment • *Storage*. Rental fee of the warehouse space

Table 4.2 Taxonomy of logistics costs (Logistics survey 2006)

Overhead costs		
	• Stock keeping • Cost of time • IT-maintenance	• Lost sales • Customer service level • Non-marketable products • IT maintenance/purchases
Functional costs		
	• Transportation • Goods handling • Warehousing • Fairway • Documentation • Communication	• Packing • Capital costs of equipment and facilities • Administration
	Direct logistics costs	*Indirect logistics costs*

If we wish to divide logistics cost with respect to taxonomy of costs, logistics costs include four types of costs: Direct costs, indirect costs, functional costs and overhead or alternative costs. Table 4.2 shows these parts with related subparts.

This taxonomy is important because each type of these costs has a different behavior, and we should consider this behavior in cost analysis and corrective actions.

4.4 Factors Affecting National Logistics Costs

Quality and performance of logistics systems are different among countries. For example, In Namibia the costs of all trade-related transactions for a 20-ft full container, load container, including inland transport from the ocean vessel to the factory gate, amount to slightly more than $3,000; and in Georgia, to slightly less than $3,000. In Germany, these costs amount to only $813; and in Sweden, to a little more than $500 (Hausman et al. 2005). These disparities originate from factors that affect logistics costs. We introduce important factors affecting logistics costs below:

– *Geographical situation.* Logistics costs could increase or decrease in relation to geographical situation. Usually, countries that are close to ports, airports, economic hubs and logistically developed countries have better logistics systems with lower logistics costs. This is because of competition and adoption with environment. For example, logistics costs for importing and exporting the products are about 50% higher for land locked countries (Radelet and Sachs 1998).
– *Logistics infrastructures.* This area is about the development and maintenance of Logistics infrastructures to support full range of logistics services and transport modes. Distribution network and communication network are important components of this part. Singapore is a good example for this issue. in past

decades Singapore makes good investments on its logistics infrastructure that results in logistics excellence and costs reduction (Bookbinder and Tan 2003).

– *Human resource.* Availability of skilled labor as a strategic source can play an important role in promoting logistics activities and reducing logistics costs. This issue is more important in developing countries. It is interesting to know that one of the factors which led to increasing logistics costs in USA in 2005 was lack of vehicle driver (Cooke 2006).
– *Administration.* In most methods for estimating national logistics costs, share of administration costs is assumed to be 4% of total costs. But actually, this 4% has a significant effect on the remaining 96%. In fact for making logistics activities more effective and efficient that lead to cost reduction, we should use administrative tools. Correct administration prevents squandering resources and leads to saving. For example, executing petrol sharing policy in Iran, results in a daily saving of 20 million liters and an annual 3.7 billion $ cost reduction.
– *Technology.* Technology is an important factor in all parts of logistics. Sometimes, Technological development makes fundamental changes in logistics activities. In this area information and communications technologies (ICT) are more effective on logistics activities. In some cases, ICT omit the whole physical distribution network and make significant savings. Researchers believe that development in ICT is one of the reasons for reducing trend of logistics costs in past decades. They also believe that there is still greater potentiality in technology to further reduce cost in future.
– *Political and economical stability.* This factor can reduce or increase the risks and affect the insurance costs. So with respect to high number of logistics activities in national level, it can have a significant effect on logistics costs. In addition, political and economical stability can play an important role in attracting investment in national logistics activities. Moreover, instability in this area may result in industrial disputes and work stoppage that both result in an increase in logistics costs.
– *Business legal rules.* Customs, taxes and insurance laws are components of this part. Compatibility of these rules with logistics processes and activities could affect logistics costs.
– *Rate of interest.* One of the important macro economic indicators that can play an important role in logistics costs is rate of interest. This factor is more important in inventory costs because of direct relation between them. One of the factors that led to inventory costs increase in USA in 2005 of 71 billion $ over 2004, is growth of interest rate (Cooke 2006).
– *Energy price.* Global trend of increasing energy prices is another important factor that affects logistics costs. This increase especially in fuel prices that is used in logistics activities makes inflation in logistics costs, especially in transportation because of nature of its related activities. One of the factors that played an important role in transportation costs increase in USA in 2005 of 92 billion $ over 2004, was rise of fuel prices (Cooke 2006).

4.5 Logistics Costs in Agriculture

Agriculture is an important part of GDP in many countries. So, calculating logistics costs in agriculture is prominent. Also, Results of calculating agricultural logistics costs (Sect. 4.5.2) show this importance obviously. In this section we study logistics costs in agriculture based on Wajszczuk's (2005) paper.

4.5.1 Logistics Costs Components Including in Method

Wajszczuk defines components of logistics cost as physical flow of material cost, inventory cost and information process costs. Table 4.3 shows these parts with related subparts.

We can calculate logistics costs as follows:

$$C_{\mathrm{L}} = C_{\mathrm{pfm}} + C_{\mathrm{inv}} + C_{\mathrm{inf}}. \tag{4.1}$$

Table 4.3 Components of logistics costs in agricultural (Wajszczuk 2005)

Costs of physical flow of material (C_{pfm})	Costs of inventory (C_{inv})	Costs of information processes (C_{inf})
Labor costs (also material and energy costs)	Costs of inventory leasing	Depreciation costs of property which is involved in logistical processes
Depreciation of information equipment	Labor costs	Leasing costs (lease for square, garages, internal ways)
Costs of telecommunication services	Costs of stock losses (losses during evaporation, going stale of stock, diseases, pests)	Labor costs
	Other costs (insurance, energy, cost of inventory capital)	Use costs of oil, materials and energy
		Costs of transport external services
		Other costs of flow (taxes and insurance of transport means, repairs and preservation of equipment)

Table 4.4 Comparison of logistics costs in agricultural vs. non-agricultural enterprises (Wajszczuk 2005; Skowroneki and Sarjusz-Wolski 1999)

Elements of logistics costs	Share of basic elements in total logistics costs (%)	
	Investigated enterprises	Non-agricultural enterprises
Costs of physical flow of material	86.5	40–50
Inventory costs	12.2	30–40
Costs of information processes	1.3	15–20

4.5.2 Result Analysis

This method was used to calculate logistics costs in four great area rural enterprises located in Poland in 2003. Table 4.4 shows the achieved results in comparison with non-agricultural enterprises.

Wajszczuk (2005) compares his results with results of past researches on non-agricultural enterprises:

(a) The results of this research showed high share of logistics costs in total costs in comparison with non-agricultural enterprises. The index of share was 42.2%, whereas in non-agricultural enterprises it fluctuates between 20 and 30%.
(b) The results of this research showed high share of logistics costs in total selling and services value in comparison with non-agricultural enterprises. The index of share was 27.5%, whereas in non-agricultural enterprises it fluctuates between 12.1 and 5.8%.
(c) Share of physical flow of material costs in total logistics costs in agricultural enterprises was 86.5%, whereas in non-agricultural enterprises it fluctuates between 40 and 50%. The reason for this disparity could be explained with respect to high diversity and volume of agricultural products. Moreover, the selected enterprises have several branches with significant distance between them. we should consider that in agricultural environment we have small distances transportation on bad quality roads (mostly dirt roads).
(d) Share of inventory costs in total logistics costs in agricultural enterprises was 12.2% whereas in non-agricultural enterprises it fluctuates between 30 and 40%. That is to say inventory costs in agricultural enterprises is around three to five times smaller in comparison with nonagricultural enterprises. This can be a result of several circumstances. Firstly, in researched enterprises, majority of fabricated agricultural products can be characterized as raw materials for farthest processing and short period of freshness. Secondly, the enterprises want to get back their engaged capital very quickly in order to start the next productive cycle again. So, most of agricultural enterprises sell their products immediately. Based on this fact, one may hypothesize that an enterprise which is located in the supply chain "near the final receiver", has higher inventory costs because it must keep certain level of stock for assurance of liquid service of clients. Analyzed enterprises are placed at the beginning of such supply chain. Thirdly, currently, contrary to the past years, the agricultural enterprises purchase means

of production just before their use for production. In this way, the enterprise is limiting costs of engaged capital to minimum. This fact has caused that in analyzed enterprises some store surface not to be used fully. Such a situation is also a result of rules of the past economic system. Before 1990, the agricultural enterprises had to buy the means of production too early due to the general lack of such supplies and consequently store them for a long time. So, it considerably increased cost of storage.

(e) Information processes costs in agricultural enterprises are around 13 times smaller in comparison with nonagricultural enterprises. This is because of lack of investment in information processes in researched enterprises.

Based on above facts, we can say “there is a direct relation between volume and weight of products with logistics costs”. Therefore, if the volume and weight of products increase, it results in a growth in logistics costs. As a result, in agriculture, mining and similar industries logistics costs are higher than information and service provider industries. The following figure shows this relation with respect to producer countries (Fig. 4.4).

These results show that logistics costs are more important in industries that produce heavy and bulky products (e.g. agriculture, mining and similar industries). They also show that investments in logistics activities in such industries could lead to more significant savings. This is an important issue that countries should consider.

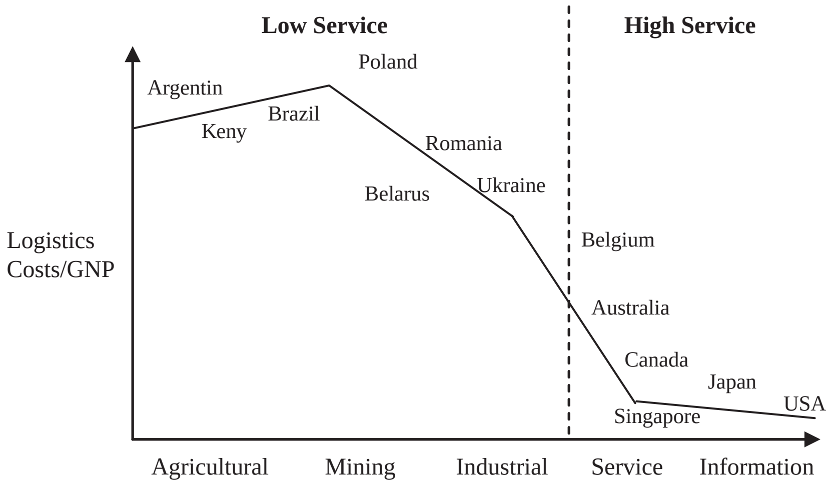

Fig. 4.4 logistics costs with relation to industries and countries

4.6 State of Logistics in America

In this section, we describe the method used in USA for calculating national logistics costs.

4.6.1 Literature Review

As noted in previous sections, calculation of logistics costs is a multidimensional issue. So, we see many improvements in the literature review of this subject. In the following, we will review this literature briefly.

The first published methodology for logistical cost assessment was presented by Heskett et al. (1973). They applied their methodology, estimating total logistics cost, to estimate USA market size. They introduced four types of commercial activities (Bowersox et al. 2003):

1. Transportation
2. Inventory
3. Warehousing
4. Order processing

Their methodology is summarized in the Table 4.5.

Table 4.5 Estimation methodology proposed by Heskett et al. 1973; (cited by Bowersox et al. 2003)

Transportation	Air carrier	Equipment	Highway
	Commercial[a]	Manufacturers	Automobile[b]
	General[b]	Motor vehicles and equipment[b]	Truck and trailer[c]
	• Oil pipeline[c]	• Other than motor vehicles[c]	Bus[b]
	• Water carrier	• Transit	Dealers, service stations[a]
	Inland[c]	Rail & trolley[b]	Repairs, garages, etc.[a]
	Ocean[c]	Repairs, garages, etc.[a]	• Railroad[a]
	Great lakes[c]		
Inventory	• Farm[c]	• Manufacturers[c]	
	• Wholesalers[c]	• Retailers[c]	
Warehousing	• Public[c]	• Private[c]	
Order processing[d]			

[a]Costs split between the two
[b]Costs related to just passenger
[c]Costs related to just freight
[d]Costs not available

Information concerning transportation costs were obtained from the Transportation Association of America and the Bureau of Labor Statistics. Inventory cost was estimated as the ratio of cost of the average value of inventory over 1 year. Public warehousing cost was estimated using the average valuation of $2 per square foot for basic warehouse space plus $0.25 per cubic foot for refrigeration space. Private space owned by retailers and manufacturers was estimated based on inventory value/space occupied ratio for wholesalers. The order processing cost, although proposed by the authors, was not estimated. Annual logistic cost was estimated as the sum of the noted cost components (Bowersox et al. 2003).

Then, Robert Delaney, based on this methodology, has estimated annual logistical expenditure, under the sponsorship of Cass Information Systems and ProLogis. His annual report, called "The State of Business Logistics in the United States" is the only long-running attempt to quantify logistics expenditure in the United States (Delaney and Wilson 2003). Which we will use them for our work in this chapter at the conclusion section.

Delaney uses three key components to estimate logistics expenditures (Bowersox et al. 2003):

(a) Inventory carrying cost
(b) Transportation cost
(c) Administrative cost

Delaney's methodology is summarized in Fig. 4.5.

The challenge in estimating global logistics expenditures is that a direct measurement or roll-up summation methodology is not applicable. Such a methodology requires detailed data on all logistical components. Although the data are available to varying degrees in most developed nations, they are not available in many other

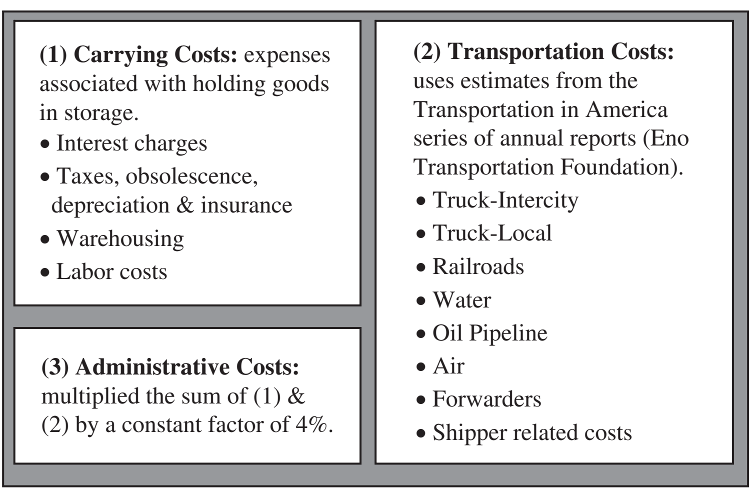

Fig. 4.5 Estimation methodology proposed by Robert Delaney (Bowersox et al. 2003)

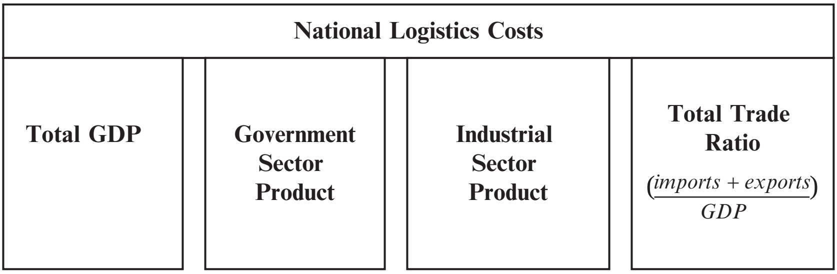

Fig. 4.6 Estimation methodology proposed by Bowersox in 1992; (cited by Bowersox et al. 2003)

countries. A country-by-country estimation requires the use of available aggregate data across countries (Bowersox et al. 2003).

The first study to frame global logistics requirements was conducted by Bowersox (1992). He presented an estimation of global logistics costs based on four components (Bowersox et al. 2003):

(a) Total gross domestic production (GDP)
(b) Government sector product
(c) Industrial sector product
(d) Total trade ratio

The first and the fourth ones were included to size individual economies. And the rest of components were included to capture expenditures related to the logistics activities of transportation, inventory, and warehousing. Figure 4.6 depicts the methodology in a snapshot (Bowersox et al. 2003).

In this assessment, analyses were conducted aggregating the countries in seven regions (Bowersox et al. 2003):

– Europe (EC 1992)
– Pacific Rim (AFTA)[2]
– North America (NAFTA)[3]
– Eastern Europe and Middle East
– China and Southeast Asia
– Central/South America and Caribbean Basin
– African Nations

In a later study, Bowersox and Calantone (1998) refined the estimation method by introducing an artificial neural network model, Fig. 4.7.

This methodology expanded the scope of the previous approach by including infrastructure variables related to cost and information systems (Bowersox et al. 2003).

[2] Australian Federation of Travel Agents.

[3] North America Free Trade Agreement.

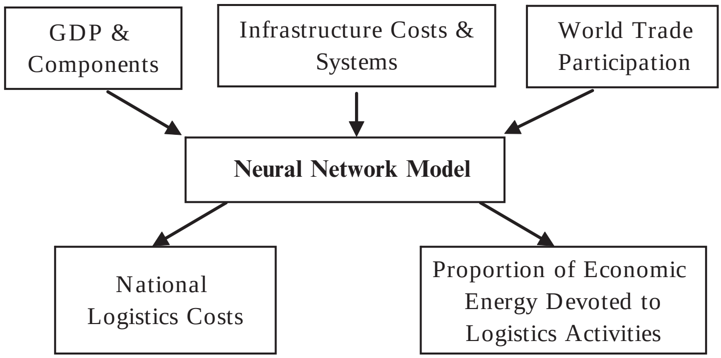

Fig. 4.7 Estimation methodology proposed by Bowersox and Calantone in 1998; (cited by Bowersox et al. 2003)

4.6.2 CASS Methodology

Now, let's go through a notable methodology which has been used in USA since 1973, called CASS.

In the remainder, we are going to explain several basic conceptual issues concerning the measurement of logistics activity, description of CASS methodology and Eno Transportation Foundation methodology for calculating transportation costs, as the CASS methodology relies entirely on this cost estimation methodology.

In the end, we suggest some potential improvements to the current procedures used to calculate logistics costs.

First, it must be mentioned that the name of this methodology, CASS, was derived from the name of a company which established the methodology: Cass Information System Inc. (formerly CASS logistics Inc.).

However, the sponsorship of execution of this methodology has recently moved from CASS to CSCMP[4], but the CASS methodology is unlikely to be changed.

Since comparison between logistics and GDP is the output of CASS, let's remind the concept of GDP.

Simply stated, GDP, is the total value of final goods and services produced for consumption within a country's boundaries in a given time period (usually a year).

$$\begin{aligned}\text{GDP} = {} & \text{private consumption} + \text{government consumption} + \text{investment}\\ & + \text{exports} - \text{imports}. \end{aligned} \tag{4.2}$$

The considerable point in the definition is that, GDP does not include intermediate goods and services. And this is an important point that we will refer to in the following sections.

[4] Council of Supply Chain Management Professionals.

On the other hand, estimation of logistics costs is not inherently related to GDP because it is neither a measure of how much of GDP is consumed by logistics nor is it a measure of how much logistics contributes to GDP.

Therefore, assuming the most commonly cited estimate of logistics costs:

– It is incorrect to say that logistics costs account for X% of GDP.
– It is incorrect to say that logistics contributes X% to GDP.
– To say that logistics costs are equal to X% of GDP is acceptable, but it is simply a statement of their relative sizes, not a statement of how much one is dependent on the other.

But somebody may ask "Why we compare logistics costs with GDP?" in other words, "What is the property of GDP which we choose for this comparison?"

Or another question may be "Why preceding interpretations were incorrect?" and "Isn't it necessary to have comparisons in these ways?"

To answer these elegant questions, notice that the difficulty in comparing logistics with GDP is in the way "logistics" is classified and calculated. Which elements are included in the estimation of "logistics" can significantly change the meaning of any comparison.

In our CASS methodology we focus on the concept of macroeconomic logistics costs, which is more useful for national decision-makers. So, we should choose a macro-economical indicator. But there are so many other macro-economical indicators other than GDP, such as GNP[5], PPP[6], etc. Why don't we use them? Because GDP is more common and governments prefer to estimate it more precisely for different purposes.

About other questions we say that: One way to evaluate logistics relative to GDP is to determine how much of GDP is consumed by the logistics activities or the total final demand for logistics by all user categories (consumer, government, business, and net export). This comparison says nothing about the contribution of the industry to GDP rather than to determine the level of final demand that logistics requirements generate. This calculation of logistics must only include purchases that are not consumed by the production of services that ultimately contribute to GDP. This measure of logistics is not currently available. Furthermore, the usefulness of such a measure is not readily apparent (MacroSys Research and Technology 2005).

Another way to evaluate logistics relative to GDP is to determine how much the logistics industry contributes to GDP. To make this comparison, one must determine the level of added value generated by the industry. Such a metric would be desirable because it would be a statement of logistics' contribution to GDP. Importantly, intermediate goods are not included in GDP. As a result, this is a difficult comparison to make. One must determine which of the many goods and services purchased by logistics firms are consumed in the production of the goods and services produced by the firms. The difference between the two equals the industry's contribution to GDP. The required calculation is a two-step process. The first is to develop a clear

[5] Gross National Production.

[6] Purchasing Power Parity.

boundary separating logistics activities from other business activities. Within the established boundary (as drawn in this report or as employed in the CASS methodology) the second challenge is to estimate value-added from both outsourced logistics activities (i.e., transportation and warehousing industries) and from in-house logistics activities. The transportation element of logistics is measured in this manner by the TSA[7]. However, there is currently no comparable measure of other logistics activities. As such, there is currently no means of calculating the contribution of logistics activities to GDP from a value-added perspective (MacroSys Research and Technology 2005).

Finally, one can calculate the amount firms spend on logistics activities fairly easily (as CASS does) and compare that number with GDP. The problem is that this cost calculation contains (a) intermediate goods and services, and (b) internal business operating costs unrelated to logistics. When firms outsource logistics activities, they purchase not only the services produced by the logistics providers, but also the intermediate inputs used in the production of the services. When firms run in-house logistics operations, their “logistics costs” also include internal business activities and purchases that are not strictly logistics functions.

Furthermore, logistics costs include inventory-carrying costs, which include opportunity cost of capital, which is not a component of GDP (MacroSys Research and Technology 2005).

Now we turn to the description of CASS methodology.

As mentioned before, CSCMP define logistics as “that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers’ requirements.”

Remember that Heskett first introduced the concept of macroeconomic logistics costs and developed a methodology to measure them which becomes a base for CASS methodology. However, CASS’ estimates, published in its “Annual State of Logistics Report”, have been most frequently cited by government agencies and trade associations. As one United Nation’s document states, the CASS report “has taken on oracle status in the profession and statistics in it are often cited in federal government reports (MacroSys Research and Technology 2005).”

Based on MacroSys Research and Technology (2005), according to this definition, logistics includes all activities concerning the movement and storage of goods between the point of origin and the point of consumption of the goods. Furthermore, logistics includes freight movement and excludes people movement, although it must be recognized that the overall logistics does involve passenger movement, which will be discussed more lately.

Where is the “point of consumption?” Should the point of consumption be extended to households? In other words, should the movement of goods such as that from a grocery store to a private kitchen be part of the logistics chain? Obviously, such movements require the same kind of inputs, individually at a much smaller

[7] Transportation Satellite Account and the U.S. Transportation Satellite Account was designed to produce estimates of all transportation operations for all modes.

scale of course, as those between wholesalers and the grocery store. Both require loading, transporting, and unloading the goods. However, since much of the goods movement to households is carried out by households, and household activities are not treated as part of the national production process in official economic accounting systems such as the US National Income and Products Accounts and the US Input–output accounts, treating household logistics activities as part of the overall logistics chain expands the production boundary and causes problems of consistency and comparability with official economic statistics.

One way to avoid this difficulty is to limit the measurement of logistics to business logistics only. And in fact, CASS' methodology includes only the logistics costs for the US business system. Furthermore, the CSCMP definition may be interpreted to cover only business logistics because it refers to the supply chain, which normally does not include household activities. Clearly, the final stopping point of goods movement in business logistics is not always consumption. The inbound movement of goods to retailers is often the last leg of goods movement for business logistics, yet retailers are not the ultimate consumer of the goods. Although the movement of goods from retailers to the final point of consumption by households creates real value to consumers, this kind of value creation is not counted in current economic accounting methodologies. Instead, it is treated as consumption. In other words, value-addition in current economic accounting only happens in the business sector. Therefore, to achieve clarity, the definition for business freight logistics should refer to the last point of value-addition rather than the point of consumption.

Whereas consumer transportation of goods from market to household is properly excluded from logistics activities, merchandise home-delivery on behalf of sellers is part of the production and logistics chain. To exclude the former and include the latter, business logistics may be better defined on the basis of who performs certain activities rather than where those activities are performed. To the extent that supply chain management refers to business activities only, the CSCMP definition of logistics on the basis of supply chain management is sufficiently clear for delimitating where business logistics starts and ends.

As cited in previous sections, cost items according to our purpose of calculation, vary from one definition to another. So, based on the aim of CASS methodology which focused on comparison of logistics costs with GDP in macroeconomical level, it defines three broad cost components comprising the business logistics system. They are inventory-carrying costs, transportation costs, and logistics administration costs.

Measuring inventory-carrying costs and transportation costs, however, is not straightforward because both involve substantial amount of in-house operations.

In-house operations refer to those business operations that a company conducts to provide services for its own use. In contrast to the services from for-hire operations that are bought and sold in market-places, in-house operations are provided and consumed internally without market mediation. Some internal operations should be included because they are either the same kind of activities as external logistics or the natural and immediate extensions of external logistics.

It is a well-known fact that much of the trucking and warehousing operations in the US are in-house operations. Therefore, measures of transportation and warehousing costs should cover services from both for-hire and in-house operations. It is important to note that the for-hire cost should be the total price charged to the service users, not the cost to the carriers providing the services. The full cost of in-house services should include an imputed return to capital as well as the costs of intermediate inputs, labor compensation, and capital consumption.

While the cost of transportation measures the cost of goods movement, the cost of warehousing does not fully capture the cost of goods storage. Clearly, warehoused goods tie up capital, and capital is costly. Moreover, businesses may suffer losses as materials in storage may experience obsolescence, physical deterioration, and loss in value. Also, businesses have to spend money to insure goods in storage against accidental losses such as those due to natural disasters and fire hazards. Based on these considerations, an inventory-carrying cost is often measured to include costs of interest, taxes, obsolescence, depreciation, insurance, and warehousing.

While how much of a certain material a business decides to keep in warehouses may heavily depend on transportation system performance, inventory-carrying costs may change independently for reasons completely unrelated to transportation. Costs of interest change in response to fluctuations in interest rate. Insurance costs depend on the level of insurance premium. Even the level of inventory itself may be determined by factors outside transportation and logistics management such as business cycles.

A business may experience an unexpected increase in inventory due to an economic slowdown, no matter how well it manages its logistics operations. Factors such as these do not constitute a valid argument against the inclusion of inventory-carrying costs in total logistics costs, but they do indicate that certain price and business cycle variables need to be controlled if the resulting logistics cost measure is utilized for trend analyses.

There are internal business operations that are immediate extensions of transportation and warehousing and therefore should also be counted. These include industrial traffic management, loading and unloading by shippers, inventory planning and analysis, and support by central distribution staff.

Yet another problem in defining logistics, is the question of how much intra-plant activity should be included as logistics activity. For example, goods are moved around within the business establishment where the goods are to be retailed. This is relevant, because extensive intra-plant movement of materials may cause a significant increase in the estimate of total logistics costs, depending if the activities are included as logistics. In some literature on business logistics management, production scheduling, materials handling, purchasing, order processing, and market forecasting are included as business logistics activities, where materials handling is basically intra-plant material movement. Although these activities affect the movement of goods and level of inventory, they are not themselves intrinsic to goods movement and inventory management. The literature and practice of macroeconomic costing of logistics seems to indicate that the costs associated with these functions should not be counted as logistics costs. For example, the Heskett approach and the CASS methodology both exclude many of those internal business activities. For Heskett, such exclusion may be because his approach was originally developed to measure the macroeconomic costs of physical distribution.

The reason for the exclusion of these cost categories from the calculation of logistics costs relates to the purpose for which logistics costs are being defined, measured, and analyzed. Within an individual firm, for the purpose of planning and managing business operations, logistics may well be defined to include everything that is involved in physical supply, physical distribution, and intra-plant materials movement. For a manufacturing company, for example, anything that is not general administration and direct manufacturing operations may be counted as part of the company's logistics operations. It is certainly useful and necessary for the firm's management to know how much it costs the company to move things in and out and get them to the right spot in right quantity at right time. However, this cost information is less useful outside the firm (other than to its competitors.) Specifically, the cost information based on this broad concept of logistics is of little consequence to public decision-makers because it contains many elements on which public decisions have no effect. For instance, an inefficient plant layout that hampers intra-plant material movements will cause the firm to incur costs, no matter how efficient the highway system or trucking operations are. Therefore, information on the internal logistics costs of a business enterprise is largely irrelevant to public decision-makers.

Of course, cost measurement or any other measurement efforts by the government sector are not necessarily all for the purpose of public decision-making. A logistics cost measure that includes all intra-plant material movement may be useful for some purposes, but the logistics cost measure exclusive of intra-plant material movement has its own value, and is perhaps more valuable to decision-makers in transportation.

The questions and discussion above define in theory the proper boundary of business freight logistics for the purpose of calculating national logistics costs. As determined, many internal business activities should be excluded from the calculation. However, the boundary must be cast to include specific cost items. Unfortunately, the exclusion of certain internal business operations is easier said than done. A certain level of arbitrariness in drawing the cut-off line is unavoidable. However, the consequence of this arbitrariness to the final estimates of overall logistics costs is likely to be inconsequential so long as the list of internal operations included does not get too long.

Now, let's explain more about each component of logistics costs in CASS methodology. The main components are: inventory-carrying costs, transportation costs, and logistics administration costs.

4.6.2.1 Inventory Carrying Costs

Inventory carrying costs include the cost of money (opportunity or interest), ad valorem taxes, insurance and shrinkage. Inventory carrying costs vary with the level of inventory stored. They can be categorized into the following four groups: (1) capital costs, (2) inventory service costs, (3) storage space costs, and (4) inventory risk costs.

- *Capital costs for inventory investment.* Holding inventory ties up money that could be used for other types of investments. Consequently, a company's opportunity cost of capital should be used to reflect accurately the true cost involved. All inventory carrying cost components must be stated in before-tax numbers, since all the other costs in the trade-off analysis, such as transportation and warehousing, are reported in before-tax dollars.
- *Inventory service costs.* Inventory service costs consist of taxes and insurance paid as a result of holding inventory. In general, taxes vary directly with inventory levels. Insurance rates are not strictly proportional to inventory levels, but are related to the value of inventory over a specified time period.
- *Storage space costs.* Storage space costs can be incurred at four types of facilities:
  - Plant warehouses
  - Public warehouses
  - Rented (leased) warehouses
  - Company-owned (private) warehouses
- *Inventory risk costs.* Although inventory risk costs vary depending on the company, in general, they include charges for: obsolescence, damages, pilferage and relocation. The cost of taxes, and obsolescence, depreciation and insurance are estimated according to the Alford-Bangs Production Handbook formula. In this formula obsolescence accounts for nearly 40% of total inventory carrying costs, thus demonstrating the challenges facing inventory managers in the world of fast cycles and just-in-time procurement. Total warehousing cost estimates encompass both public warehouses and private warehouses operated by manufacturing and distribution companies. Public warehousing costs are obtained from the public warehousing services data reported by the Commerce Department's Census Bureau. Private warehousing costs are independently obtained by CASS. Relocation costs are incurred at the transshipment of inventory from one warehouse location to another to avoid obsolescence.

4.6.2.2 Transportation Costs

Transportation costs include carriers' charges for all modes, including trucking, rail transport, water and oil pipeline, and both international and domestic airfreight transport, as well as freight forwarding and shipper-related costs. The freight transportation costs in the CASS report account for the largest portion of logistics costs. These estimates are based on the annual Transportation in America report published by the Eno Transportation Foundation. Of total transportation costs, trucking costs dominate the United States business logistics system, accounting for more than 80% of the nation's freight bill. Shipping related costs include the loading and unloading of transportation equipment, as well as traffic department operations.

Total transportation costs include costs for both primary and secondary transportation. Primary transportation is the movement of finished goods from plants and vendors to warehouses. Primary transportation costs include costs for replenishment movement from plants or distribution centers to other plants or distribution centers, and inbound freight on purchased finished goods movement to plants or distribution centers for resale. Secondary transportation is the delivery of finished goods to customers. Secondary transportation costs include payments to carriers, pickup allowances, truck or rail equipment and operations costs, and freight allowed. Freight may originate in plants, distribution centers or terminals.

Anyhow, eight items which Eno methodology calculates are (MacroSys Research and Technology 2005):

- Intercity truck
- Local truck
- Railroads
- Water
- Oil pipelines
- Air
- Forwarders
- Shipper related costs

Each item will be estimated based on spread statistics of formal organizations such as Federal Highway Administration for intercity truck's statistics.

4.6.2.3 Logistics Administration Costs

Logistics administration costs include indirect management and support staff, which comprises central distribution staff, planning and analysis staff, and the traffic department staff. Computer software and hardware cost allocations are another important distribution expenses. Such costs are included in the appropriate cost categories; with any remainder, considered as part of administration costs.

Logistics administration costs are set at 4% of sum of the inventory-carrying costs and transportation costs, in line with the methodology that has been consistently employed since the data series was first published in 1973.

However, we shouldn't forget that unless Administration costs are only 4% of total logistics costs, but improving the methods of doing them would result in deep effects on total logistics costs.

The details of these cost components and the CASS methods for measurement are included in Table 4.6.

At last and in order to improve measure of logistics costs we suggest three recommendations (MacroSys Research and Technology 2005):

1. The prices of the goods in inventory should be held constant to allow inventory levels to be estimated in constant dollars. This is a standard practice applicable to all other logistics cost items. Without controlling price effects, inventory level fluctuates even if the real inventory level does not change.

Table 4.6 Cost components and CASS methods of measurement (MacroSys Research and Technology 2005)

Cost components	CASS methods of measurement
Inventory carrying costs	
Interest	Annualized commercial paper rate
Taxes, obsolescence, depreciation, insurance	Alford-Bangs production handbook formula
Warehousing	Expenditure on public warehousing from census
Transportation	
Intercity truck	Eno estimates
Local truck	Eno estimates
Railroads	Eno estimates
Water	Eno estimates
Oil pipelines	Eno estimates
Air	Eno estimates
Forwarders	Eno estimates
Shipper related costs	Eno estimates
Logistics administration costs	Imputed at 4% of total logistics cost

2. The level of inventory can be smoothed over time to lessen the effect of cyclical changes. An unexpected economic slowdown usually pushes up business inventory causing an increase in inventory carrying cost, other things being equal. Likewise, an unexpected economic upturn causes inventory to go down. While the resulting level of inventory carrying costs can still be usefully measured, its changes are not good indicators of whether the underlying logistics system is working better or worse. A moving-average or some other time-series processes may be applied to the inventory data so that a more persistent trend can be identified.
3. The interest rate used to estimate the inventory capital costs should be held constant. While the tax rates and the insurance premiums can both change, the CASS estimation does not individually utilize tax rate and insurance premium data. Interest rates are also relatively more volatile. Fluctuations in interest rates directly result in changes in the inventory-carrying cost even if the underlying logistics system stays unchanged. For a trend analysis, interest rates should be held constant.

4.6.2.4 Conclusion of State of Logistics Survey in America

In order to see the use of CASS methodology practically, we will review the state of logistics in US, mainly reports of year of 2006, according to 17th Annual Report of State of Logistics reported by CSCMP.

Total business inventories rose dramatically in 2005, which could have happened because of two reasons:

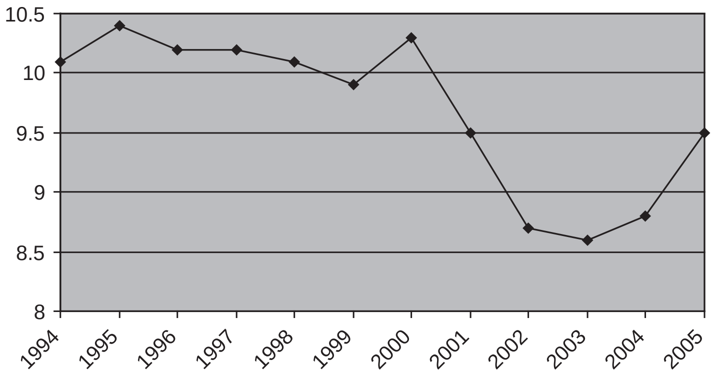

Fig. 4.8 Logistics costs as a percentage of GDP (Cooke 2006)

1. Raising trend of interest rate in order to control inflation caused by energy costs. (It's obvious that many factors motivate energy costs to increase in recent years, such as war of Iraq, internal changes of Iran which have deep effects on global decisions).
2. Storing more goods by companies in order to response to longer, often unpredictable transit times.

Interest rates have begun to climb back up and this, also combined with bigger inventories, pushed inventory carrying costs to new highs. It has two main reasons:

1. Increase of fuel cost
2. Shortage of labor, especially driver

Figure 4.8 depicted that US business logistics costs were equal to 9.5% of nominal GDP in 2005. By the way, comparing the statistics of 2004–2005 illustrates that transportation costs rose 14.1% in 2005, the single largest rise and now account for 6% of nominal GDP. Costs were up for virtually every component of business logistics costs. In the beginning of 1980s, legal barriers of transportation industry have diminished and caused decrease in costs which result in a decisive competition between rival companies. In this way, we see a declining trend since 1980s–2003. But economical growth in 2003 locked in to rising demand for transportation industries then cumulating in inventory stocks and high interest rates causing a rising trend since 2003.

So we can conclude that the economy is still growing and freight shipments are forecast to increase at double digit levels. We are hampered by inadequate and aging infrastructure and in need of strong national leadership to focus on solving the tough capacity problems facing out transportation network. Embracing security as a core business function will enable firms to gain measurable bottom line benefits while mitigating the need for a plethora of invasive government practices (Cooke 2006).

4.7 State of Logistics in South Africa

After becoming familiar with CASS methodology which is used to calculate the US logistics costs, now it's time we studied methods of determining the costs in under developed countries.

We chose South Africa for this purpose, because we have two formal reports on state of logistics survey for South Africa at hand for years of 2004 and 2005.

4.7.1 South Africa's Methodology

The multiple perspectives considered by the state of logistics survey include established areas of research, such as cost-modeling, transport economics and supply-chain analysis, as well as emerging research areas, such as the role of logistics in economic development. The research methodology reflects this holistic approach and the relative maturity of these research areas. A more formal and quantitative approach is adopted for the development of the cost of logistics, while a more qualitative and exploratory approach is applied to the small business and economic development perspective.

For the purposes of model development, logistics is considered to be that part of the supply-chain process that deals with the transportation, warehousing, inventory carrying, administration and management of physical products between the primary point of production and the point of delivery to the final consumer (or last customer in the supply chain whenever products are not delivered to consumers). Per definition this excludes the cost of passenger transport and the cost of transport, storage, packaging, handling, etc. of mail and luggage, as well as the storage and movement tasks that occur during the production process (The second annual state of logistics survey for South Africa 2005).

4.7.2 Conclusion of State of Logistics Survey in South Africa

Based on annual reports on state of logistics survey for South Africa, 2005, in the first State of Logistics Survey in 2004, the need for measurement and revitalization of basic infrastructure in South Africa's dual economy was accentuated. The process of addressing these needs has started with the release of the National Freight Logistics Strategy, which delineates a comprehensive development framework, as well as Spoor net's growth plans for recapitalization.

The global context – the case for developmental logistics. Currently, the world's focus on logistics issues is divided with the first world caught in a three-way paradox, i.e. to:

– Continue the efficient development of their economies and therefore logistics systems
– Contribute to sustainable development globally and stimulate global growth, poverty alleviation and open access, which require a different approach to global logistics

– Provide homeland security against perceived terror threats, which will tax logistics systems even more and bring new and unexpected inefficiencies into the system

These paradoxical themes are all related to developmental logistics. The global village made competition difficult for the third world, but at the same time, enabled it to catch up with the first world in new and important ways.

These issues point towards a need for structural change to existing logistics systems that will improve efficiencies, while also enabling international access between the developed and developing world and between first and second economies locally (The second annual state of logistics survey for South Africa 2005).

A macro-economic perspective. South Africa's 2004 production and imports increased by 7.4% on the 2003 volumes. While transport costs increased by 11%, the overall logistics cost remained flat at 15.2% of the GDP. In absolute terms, the biggest cost driver is transportation, rising by about R13[8] billion in the freight sector. The gap between road and rail corridor freight transport has widened even further during the past year, compounding the structural inefficiency in the economy. The good news is that the declines experienced by rail between 1997 and 2003 have been halted, with rail maintaining similar tonnage levels over the past 2 years. However, the challenge facing the economy remains: while rail focuses on reversing historic trends, growth in tonnage available for transport is still captured by road. The structural changes required and indicated for developmental logistics are still South Africa's biggest challenge. Efficient long-haul corridors are required, Alongside a focus on greater access for the second economy through focused investments (The second annual state of logistics survey for South Africa 2005).

Industry innovation. The surveys in South Africa reflect the supply-chain challenges and innovations of the chemicals, processed foods and logistics service provider industries. The nature of supply-chain innovation reflects the varying levels of supply-chain maturity across the industries, as well as the fundamental challenges experienced by these industries. The high level of supply-chain maturity of the bulk chemical industry is reflected in the move to cross-industry collaboration to improve the utilization of the national logistics infrastructure. In the highly competitive cost-sensitive industries, such as processed foods, firm-level innovation to reduce costs dominates, sometimes at the expense of channel-level innovation (The second annual state of logistics survey for South Africa 2005).

Government service delivery. The supply challenges faced by government in delivering services to its citizens are illustrated in an overview of the National Health Care System, where the need for inventory management is identified as the key challenge (The second annual state of logistics survey for South Africa 2005).

The need for expanding small business support initiatives to include all the aspects involved in establishing channels to market and in developing supply chains is obvious. A comprehensive range of SMME[9] networking and logistics interventions is required on a large scale. Innovative solutions to the integration of small and large businesses in a supply-chain context are emerging (The second annual state of logistics survey for South Africa 2005).

[8] South Africa currency is Rand. 1 South Africa rand = 0.140313 US dollars.

[9] Small, medium and micro enterprises.

4.8 Conclusion

As noted before, global trends show that all the countries all over the world, especially developed countries are going forward to implement and also improve their methodologies calculating logistics costs. Results of these calculations show that logistics costs comprise proportion of GDP (Table 4.7). So efficiency and effectiveness of logistics activities could be an important competitive advantage and also a strong infrastructure for economical growth.

In other words, logistics costs measurement is a proper indicator for the past and future states of logistics. One should never forget that measuring logistics costs is not a goal but it is a proper indicator for monitoring and evaluating national logistics.

Another remarkable point is that current methodologies are needed to improve more, calculating more precisely in today's complicated and competitive world. So countries should invest more on this issue according to different countries experiments.

Finally, we could summarize our suggestions in some research priorities:

The improvements made in the performance of the national logistics system needs to be rooted in multiple-perspectives research, ranging from a macro-economic view to the reduction of the logistics divides between the first and second economies. This requires a research agenda to be developed to continuously provide quality information that can be integrated to support both strategic and operational decision-making with respect to these varying perspectives. To this end, it is proposed that research is focused on the following areas (The second annual state of logistics survey for South Africa 2005):

– Structural inefficiencies in the logistics system
– Logistics modeling with both a macro-economic and industry focus
– Strategies for improved supply-chain efficiency

Table 4.7 Logistics costs as a percentage of GDP (Transport & Logistics in the Internet Age: International Summit 2001 cited by Amos 2007)

Country	GDP in US$ million	Logistics in US$ million	% of GDP
Mexico	334,729	49,753	14.9
Ireland	67,392	9,611	14.2
Singapore	94,063	13,074	13.9
Hong Kong	153,068	20,992	13.7
Germany	2,352,472	306,264	13.0
Taiwan	273,440	35,686	13.0
Denmark	174,237	22,440	12.8
Portugal	101,182	12,871	12.7
Canada	585,105	70,191	12.0
Japan	4,599,706	522,982	11.3
Netherlands	392,550	44,495	11.3
Italy	1,214,272	137,027	11.2
UK	1,151,348	122,344	10.6
US	7,576,100	795,265	10.5

– Strategies for reducing the logistics divide
– Logistics for improved government service delivery.

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Chapter 5
Spatial Analysis and Land-Use Planning

Elnaz Miandoabchi and Nasrin Asgari

In today's global economy, logistics and supply chain management has become the back-bone that supports national economic growth. Logistics is definitely becoming a key issue of the economic development.

One of the key parts of the development planning for the economic sectors is planning for the geographical and spatial development of the economic activities which is crucial in achieving balanced and sustainable development. Spatial planning contains methods which the public sector employees to control and direct the future distribution of the activities in the space. Public sector as the leader of the direction of the whole development of the economic sectors has the responsibility of planning and regulation for the spatial development of the logistics sector, considering the socio-economic and environmental consequences of the plans.

In this chapter, we will discuss spatial planning and analysis for the logistics industry. After a brief definition of the concept, we examine the geographic concepts of logistics. Then, we proceed to describe the role of public sector in planning for the logistics sector, especially from spatial planning aspect, and then we proceed to present some real world examples of spatial planning and spatial analysis for logistics activities.

5.1 Spatial Planning and Development

There are numerous definitions of spatial planning. One of the earliest definitions comes from the European Regional/Spatial Planning Charter (often called the "Torremolinos Charter"), adopted in 1983 by the European Conference of Ministers responsible for regional planning: "Regional/spatial planning gives geographical expression to the economic, social, cultural and ecological policies of society. It is, at the same time, a scientific discipline, an administrative technique and a policy developed as an interdisciplinary and comprehensive approach directed towards a

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balanced regional development and the physical organization of space according to an overall strategy."

"Spatial planning supports the guidelines and regulations for *spatial or regional development* by which the distribution and quality of physical features and human activities across the territory is maintained or altered. There is increasing attention to the use of space and territory and its contribution to environmental sustainability, economic competitiveness and social cohesion." (Nadin 2003).

According to the compendium of European spatial planning systems, "spatial planning refers to the methods used largely by the public sector to influence the future distribution of activities in space. It is undertaken with the aims of creating a more rational territorial organization of land uses and the linkages between them, to balance demands for development with the need to protect the environment, and to achieve social and economic objectives. Spatial planning embraces measures to co-ordinate the spatial impacts of other sector policies, to achieve a more even distribution of economic development between regions than would otherwise be created by market forces, and to regulate the conversion of land and property uses" (see http://www.espon.org.uk).

Spatial planning includes urban, regional, national or transnational spatial planning. The concept of spatial planning is not native to English-speaking countries. It originates from terms such as "aménagement du territoire" from France and "Raumplanung" from Germany.

One of the closely related issues of the development to the concept of spatial planning is sustainable development. Sustainable development is a socio-ecological process characterized by the fulfillment of human needs while maintaining the quality of the natural environment indefinitely. The linkage between environment and development was globally recognized in 1980, when the International Union for the Conservation of Nature published the World Conservation Strategy and used the term "sustainable development."

The concept came into usage after the Brundtland Commission (formally the World Commission on Environment) published a report in 1987. The commission was set up by the United Nations General Assembly. The definition proposed by the Brundtland Commission became the most referred definition of sustainable development: a development that "meets the needs of the present generation without compromising the ability of future generations to meet their own needs."

Many times, and with some force, the connection between spatial planning and sustainable development, has been created. Many institutions including the World Commission on Environment and Development and the European Union have called for more effective use of spatial planning for more sustainable development.

Spatial planning addresses sustainability to the extent that is adopts and implements core sustainability principles. These include (Nadin 2003):

– Environmental limits – apply the precautionary principle so as not to exceed carrying capacities

- Demand management rather than planning to simply meet demands
- Environmental efficiency – reducing our use of natural resources
- Welfare efficiency – obtaining the most human benefit from economic activity
- Equity – social cohesion and an equitable distribution of wealth.

Having presented a brief description of spatial planning and its related issues, we will discuss about the geographic and spatial aspects of logistics industry.

5.2 Logistics, Space and Geography

When speaking about the spatial aspects of logistics activities, we are concerned with the geographical and locational characteristics of the logistics industry and the consequences of those locations. This issue can be covered by a more general topic of science called "economic geography".

Economic geography is a multidisciplinary subject in which the locational, organizational and behavioral principles and processes associated with the spatial allocation of scarce resources such as human, man-made and natural resources, and the spatial patterns, direct and indirect, environmental, economic, and social consequences resulting from such allocations, are studied. Or economic geographers, simply, study the principles governing the spatial allocation of resources and the resulting consequences.

Based on the above definitions, major perspectives and explanations in economic geography can be summarized as follows (see http://faculty.washington.edu):

- Location and spatial distribution of economic activities, including questions of "place", "locality", "site and situation" and land use;
  - Typical dependent variables:
    - Location (retail, industrial, residential etc.)
    - Relative location and spatial access
    - Density
    - Degree of concentration (clustering) or dispersion
    - Size (of cities or facilities)
    - Internal structures (e.g. product mix, organizational setup, etc.)
    - Place attributes; locality characteristics
  - Important independent explanatory variables:
    - Classical, primary and geographic forces, including frictions of space (economic distance: communication and transport costs, incl. cost of time). Dependence on land (land-intensiveness of residential, agricultural, recreational, industrial and service activities), and internal and external economies of scale & scope.

    - Others: post-classical, derived, secondary and institutional forces, including uncertainty (instability and complexity), power relations, technology, Entrepreneurship, organization, distribution of man-made and human resources (including "investment inertia" and "Infrastructure"), cultural, "personal", and "subjective" factors such as values, "conventions", habits, beliefs, biases and preferences, etc.

- Spatial interaction and economic dependence and interdependence such as communications, transpiration, and migration:
  - Typical dependent variables:
    - Flows (of messages, goods and people)
    - Distances and direction
    - Routing in networks
    - Origins and destinations
    - Regional and interregional inter-industry transactions (input–output analysis)
  - Important independent explanatory variables:
    - Factors related to "transferability"
    - Factors related to "complementarity"; sufficient similarities and required differentiation including absolute and "comparative (relative) advantage".
    - Relative accessibility and lack of intervening opportunities

- Economic change in a spatial context (regional growth or decline, technological innovation, processes of structural change (i.e. long-run compositional and interdependence changes in the economy) regional economic development, etc.):
  - Typical dependent variables:
    - Change in spatial structures: such as change in spatial distribution, e.g. population densities, change in spatial interaction pattern, e.g. migration patterns
    - Regional economic development: e.g. Changes in income, employment, human welfare, quality of life
  - Important independent explanatory variables:
    - Factors related to locational (dis-) advantages and locational change
    - Spatial interaction stimuli
    - Economic development conditions and events: e.g. natural resource endowment, human resources (skills, education), employment structure, organizational, institutional and political factors, access to capital, technology and entrepreneurship, Trade, migration

Studies in economic geography and related subjects have revealed the important role of logistics functions in the economy. Novel production concepts such as flexible manufacturing, just-in-time production, increased outsourcing, and off-shoring, rely on efficient logistical activities. The application of the economic geography in analyzing logistics, have been investigated in a number of studies. But it has not been gained adequate consideration in this area of research (Aoyama et al. 2006).

In economic geography, transport has been viewed as an area related to other areas of research, such as urban and/or transport geography. However, the organizational dynamics of the logistics industry has not been among the interests of those areas. For example, mobility and accessibility are studied in urban geography, and transport geographers are interested in the flow of commodities and people or the operations of facilities. Transport geography, as a discipline, emerged from economic geography in the second half of the twentieth century. Traditionally, transportation has been an important factor behind the economic representations of the geographic space, namely in terms of the location of economic activities and the costs of distance. It tries to link spatial constraints and attributes with the origin, the destination, the extent, the nature and the purpose of movements.

Transport geography became a distinct field of study as the consequence of contradictions between economic geographers and transport geographers. Economic geographers assumed that industrial location decisions are unrelated to the transport costs, while transport geographer did not. Solving transportation, routing, and distribution problems and the analysis of flows of goods and services between regions, has been investigated by the operations research and regional science researchers. But the theoretical implications of logistics functions have traditionally excluded from the scope of their research. The importance of the logistics is beginning to be accepted by some economic geographers (Aoyama et al. 2006).

In the following section we will discuss some of the most important geographical dimensions of the logistics in the logistics industry, presented by Hesse and Rodrigue (2004).

5.3 Core Geographical Dimensions of Logistics

This section is based on Hesse and Rodrigue (2004).

As it is investigated in by transport geography, the structural change in distribution and logistics can be viewed from various geographical dimensions. These dimensions are presented in terms of flows (i.e. information, freight, transportation, and vehicles), nodes and networks within the supply chain. An increasing interest in hubs, flows and networks in the broader sense has been noted recently. Logistics and physical distribution provide mobility for people, goods, and information, which interact with space and also with time (Fig. 5.1).

The concept of space/time convergence is already known in transport geography, where time is considered as the amount of space that can be traded with a specific amount of time, including travel and transshipment. This concept has been expanded by logistics to contain activities that were not previously considered fully in space/time relationships. They imply an organization and synchronization of flows through nodes and network strategies. The expansion of a distribution system involves a trade-off between marginal improvements of spatial coverage (ΔS) and

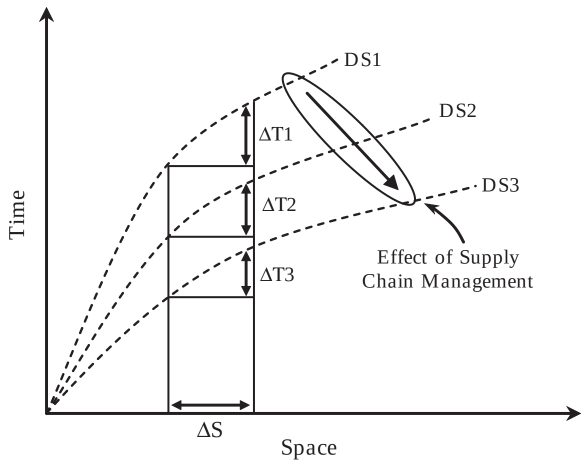

Fig. 5.1 Geographical dimensions of logistics (Hesse and Rodrigue 2004)

the related marginal time change (ΔT). Supply chain management enables a more efficient space/time convergence since the marginal differences are larger for space (ΔS) than for time ($\Delta T1$). In this paradigm, also includes the notion of time as a management constraint of transportation, in the space/time convergence. Time is a component of flows, synchronized at nodes and the expression of a network structure, while it is a factor of distance/friction/impedance. Thus, the expansion and improvement of a distribution system from DS1 to DS3 could either imply an extended spatial coverage with the same amount of time or same spatial coverage with a reduction of time, or a combination of both. The distribution system is not only supports the constant flow of commodities, but ensures that they are available and accessible synchronized-timely.

5.3.1 Flows

This section is based on Hesse and Rodrigue (2004).

The amount of freight transport is rising as the result of the growth of geographical areas of interaction and the temporal flexibilization of freight. Traditionally the flow of goods started by processing of raw materials to manufacturers, and it continued via wholesaler and/or shipper to retailer, ending at the end user. The occurrence of delays was very common in this chain, causing accumulated inventories, and there was a limited flow of information from the consumer to the supply chain. An important physical outcome of supply chain management is the concentration of storage in one facility, instead of several. This facility is increasingly becoming a flow and throughput oriented distribution centre (DC), instead of a warehouse holding cost intensive large inventories.

Now, the freight flows has lower volumes, higher frequency, and occur in longer distances. These flows have been associated with modal adaptation. The degree of change can be attributed by the growth of geographical areas of interaction, and the temporal flexibilization of freight flows, both resulting in a rising amount of freight transport. The DC, thus, becomes on of the main components of such a distribution system.

5.3.2 Nodes and Location

This section is based on Hesse and Rodrigue (2004).

The concentration of logistics functions in certain facilities at strategic locations is very common. Terminals provide major improvements in freight flows. Facilities are becoming larger and the particular connection of regional and long-distance relations characterize their location. Traditionally, freight distribution has been located at major places of production. But today, mostly large-scale goods flows are directed through major gateways and hubs, mainly large ports and major airports, and at highway intersections with access to a market. The changing geography of manufacturing and production has been concurrent by a changing geography of freight distribution.

The economics of scale which exist in utilizing nationally designed networks causes the distribution to be increasingly planned and operated on their basis. Favorite locations are either those gateways or transportation corridors with access both to traditional gateways of trade and to large consumer markets. Distribution companies expand the infrastructure and rationalize flows in order to meet the demand for timely and accurate delivery. As a result of increasing competition between distribution locations, all major freight hubs such as large ports, freight airports, inland hubs are currently expanding their infrastructure. The strategy of concentrating freight at hub locations is becoming restricted, due to density, land constraints, and traffic congestion in main roads and routes. Such limits to expansion and the scarce neighborhood connections of major hubs are becoming the most important barrier for the development of major hub locations.

“Inland Hubs” are becoming more and more important, where primarily road and air freight is consolidated as a consequence. These new DC areas are mainly associated with the interstate network and air cargo facilities. Warehousing, trucking, freight forwarding and air cargo activities are major indicators and drivers of this new distribution economy.

The current location of DCs is an outcome of high pressure on supply chains, caused by accelerated information transfers, changing consumer preferences and rising competition. As many parts of the supply chain are now globally integrated, DCs tend to provide the connections between global sourcing and regional distribution. Innovations such as containerization and particularly IT developments have integrated all components of the supply chain. As a result, container shipping lines, freight forwarders, warehousing firms, terminal operators, and other major players in the distribution business are trying to control as many parts of the logistics chain as possible. These firms are challenged by vertical and horizontal integrations, by mergers, takeovers and strategic alliances. Competitiveness for such firms means increasing the throughput and providing the demanded services at low rates. So the activity space of main ports is increasingly becoming relocated to low cost locations reaching and connecting more distant places of their neighborhoods.

Concerning the issue of location, decision makers must carefully evaluate the advantages and disadvantages of different candidate locations. Suburban sites offer larger and lower cost land resources, unrestricted transport access, a robust environment for round-the-clock operations, and the locational advantage of intersections, connecting local and long-distance flows, compared to the urban areas. Trade-offs between inventory and transport costs is also highly supportive for suburban locations, since freight transport and land use are closely related to each other. DC locations are chosen by companies as faraway as possible from expensive lands, taking into account the best balance between land price and distance. Proximity to the markets is important because of logistical and cost reasons. Most of recently constructed DCs and warehouses are located in urban regions, at the periphery or at the outer regions. Further, the function of nodes has become more complex with several DCs performing light manufacturing tasks such as assembly and especially packaging.

5.3.3 Networks

This section is based on Hesse and Rodrigue (2004).

The spatial structure of the distribution is affected by the spatial structure of the transportation networks. Network building leads to a shift towards larger DCs, often serving significant transnational catchments. However, national or regional DCs, with some goods still require a three-tier distribution system, with regional, national and international DCs. The structure of networks has also adapted to satisfy the requirements of an integrated freight transport demand, which can take many forms and operate at different scales. Freight network structures can be classified into five categories: point-to-point, corridor, hub-and-spoke, fixed routing and flexible routing.

When specialized and specific one-time orders have to be satisfied, point-to-point distribution is unavoidable. They often create less-than-full-load as well as empty return problems. Such structures imply minimum logistical requirements and less efficiency. Corridor structures of distribution often link high density areas with services such as the land bridge where container trains link seaboards. Traffic along the corridor can be loaded or unloaded at local or regional DCs. The Hub-and-spoke networks are mainly based on air freight distribution and efficient DCs. In such networks, the hub must have the capacity to handle large amounts of time-sensitive shipments. The logistical requirements of a hub-and-spoke structure are consequently extensive, as a result of the importance of efficiency at the hub's terminal. In routing networks often circular configurations are used in order to transship from one route to the other at some hubs. Pendulum networks with many container shipping services are instances of relatively fixed routing distribution networks. Achieving flexible routing requires a high level of logistical integration as routes and hubs are shifting depending on the anticipated variations of the integrated freight transport demand.

5.4 Role of Public Sector

In today's global economy, logistics and supply chain management has become the back-bone that supports national economic growth, and logistics is definitely emerging as a key theme of the economic development. Needless to say, the efficiency of the logistics services can contribute to the competitiveness of firms in global markets.

"Freight logistics is vital to the economy because of its enabling effect. It extends the market reach by giving manufacturers access to a wider range of raw materials and supplies from different sources. It also provides consumers with access to a wider range of domestic and international goods and services, while reducing waste in production, consumption and capital expenditure" (Industry Steering Committee of the Freight Transport Logistics Industry Action Agenda 2002).

Although the private sector (i.e. logistics companies and logistics actors) may plan and establish their own facilities to support the logistical needs, this undirected attempts may be very diverse with conflicting interests, which may not lead to a better level of logistics services and lower costs at the national scale. Besides, private sector doesn't have the authority in providing some of the very important requirements of the logistic services, such as infrastructures for various transportation modes and large regional logistical centres.

Because of the national importance of logistics sector to trade and development, public sector is responsible for planning and supporting logistics industry and its related infrastructures.

Public sector's role includes (Amos 2007):

– Determining the logistics policy principles including public policy objectives, roles of public and private sectors, role of markets and of regulation, roles of central and local governments, and principles of industry access or licensing.
– Auditing of current performance of logistic current performance including benchmarking of service performance, benchmarking of cost performance, benchmarking government functions, research into customer perceptions, and problems and bottlenecks.
– Planning for related legal and regulatory changes such as new legalization or legislations if necessary, amendments to existing legislation or regulations, changes to administrative structures to implement logistics strategy.
– Planning for participation process of private suppliers of customers and logistics services, private suppliers of logistics services, public infrastructure suppliers, governmental service suppliers, local government authorities, and key policy departments (trade, transport, etc.).
– Planning for public infrastructure framework such as finance and management, access rights to public infrastructure, pricing and cost recovery policies, public infrastructure investment priorities, and land-use planning (e.g. for transport corridors or logistics centres).
– Determining the monitoring and review mechanism for the industry including measurable objectives, timetables and milestones, clear responsibility and accountability, public transparency and reporting, and periodic updating.

Land-use planning and planning for spatial development of logistic activities basically include the determination of the geographical location and land-use allocation of logistical facilities and other related transportation infrastructures. Intervening and directing the spatial development of logistics activities, considering the socio-economic and environmental development consequences of their establishment and operation enable the public sectors to provide balanced and sustainable economic growth.

In section, we will present some of the real world examples of related practices to spatial planning and analysis for logistics industry.

5.5 Spatial Planning for Logistics

In this section, we will present a number of real world practices in the field of spatial analysis and planning for logistics industry. The subjects of the presented cases are somewhat diverse. The first two cases are related to the spatial planning of logistics terminals, one at the European transnational level and the other at the regional Japanese level. Both cases present mathematical decision making approaches to recommend desired solutions. The third case discusses the organizational and institutional aspects of the processes, rather than mathematical approaches. The purpose behind presenting such diverse examples was to provide some insight for the spatial development planning of logistics industry.

It should be mentioned that, from the public sectors point of view geographical and locational planning is different form what exists for private firms. For a single firm or even a group of cooperating firms, geographical decisions are based on organizational objective which can increase the profit or lower the related costs. Decision making for the public sector involves a wide spectrum of objectives, ranging from national income and expenditures to qualitative objectives such as equity, social welfare, etc. such a process requires complex assessments for the environmental and socio-economical consequences of the considered planning scenarios for the specific region and for the higher scales of the geography.

5.5.1 Spatial Planning for Logistics Terminals

This section is based on Nathanail and Gogas (2005), Ockwell (2001) and Nathanail (2007).

This case presents a transnational European project (IMONODE) which was initiated to support transnational co-operation to enhance balanced and sustainable development of the European territory. The focus of the project was directed towards chains along the transportation network of the Central European, Adriatic, Danubian, South Eastern European Space (CADSES) area and especially along the main routes (corridors) that cross the area of interest in order to shift cargo from road to rail or sea transport and to improve the accessibility and the connectivity of the regions towards an integrated, intermodal and interoperable freight transport network (Nathanail and Gogas 2005).

Project consisted of a number of work packages, one of which referred to spatial planning and development of intermodal nodal points in the area of CADSES. In particular, through a questionnaire survey the intermodal freight transport nodes to be included in the infrastructural network to be accomplished. Also, a survey on business, operation and administration issues concerning freight centres throughout Europe is elaborated in order to examine the function of the freight centres from an overall scope.

Nathanail (2007) studied and presented an analytical qualitative procedure which had been developed and implemented for assessment of the intermodal freight transport and logistics terminals (TLTs) in Europe. The research was carried out in a framework of the project, its main objective being the identification of TLTs, and their presentation using a set of common criteria which is used for their evaluation.

TLTs are considered those key nodes along a freight transport corridor which service the transshipment of cargo from one mode to the other and support at least two transportation modes. Activities that occur at TLTs are related to cargo consolidation (into unitized cargo, such as containers) or deconsolidation, and others facilitating the supply chain realization (Ockwell 2001).

The main objective of the TLTs is to support the intermodal transportation of cargo and at the same time to achieve minimization of total transportation cost, elimination of traffic congestion on the roadway network, and reduction of environmental pollution and deterioration.

TLTs are categorized into four major categories. Table 5.1 indicates these categories and their attributes.

First, a set of objectives, sub-objectives and criteria are needed to be fulfilled in order for a freight transport node to be considered as TLT and to be included in the analysis. The objectives were:

– *Improvement of the competitiveness.* Competitiveness of industry and transport sector

Table 5.1 TLTs categories and attributes (Nathanail 2007)

	Category			
Attribute	City terminal	Freight village	Industrial and logistics park	Special logistics area
Location	At urban area	At interurban area in or within regions	At interurban area in or within regions	At international transport node
Transportation modes	Road–road, road–rail	Road–rail	Road–road, road–rail	All modes
Transportation networks	Access to urban area	Direct connections to national networks	Direct connections to national networks	Direct connections to international networks
Stakeholders	Forwarder, retailer	Operating company, small companies, transport companies	Industrial companies, transport companies	Larger companies, transport companies

- *Development.* National and regional increase of attractiveness of region for installation of business socioeconomic development
- *Contribution to transport policy.* Improvement of competitiveness of intermodal transport, modernization of freight transport sector, exploitation of existing infrastructure
- *Cohesion.* Economic and territorial cohesion
- *Improvement of quality of life.* Reduction of environmental pollution due to traffic, improvement of life at urban areas, reduction of logistics costs

A set of multicriteria evaluation process was accomplished through a common methodology, applied to the selected freight nodes. In particular, several quantitative and qualitative indicators describing the attributes of the TLTs were used, in order to evaluate and prioritize them:

- Geostrategic (location of TLTs and connections to all transportation networks)
- Appropriateness of land
- Planning security

"Geostrategic" concerns the location of the TLT and the types and quality of its connections to several transportation networks. From the locational aspect, the distance of each terminal from major industrial zones, important ports or hub-airports, transport and transshipment companies and form urban, commercial or agricultural centres should be defined. Also, the flows (long haulage and/or distribution – tons per year generated in the catchment area of the selected TLT) and the international flows passing through the site per year, are to be identified in other fields. Finally, the type of connection (good, very good – direct or indirect – to be realized within the next 10 years or not) to the national and international motorway and railway networks, as well as to maritime terminals and/or hub-airports are considered.

"Appropriateness of land" is the present and the anticipated saturation ratio – i.e. the fraction or the percentage of the present and the anticipated flows serviced by the TLT/its capacity. Also, the size and the expandability of the terminal are examined, which is the percentage of the anticipated demand that may be accommodated by the site (this constitutes an indicator of the market share) and the percentage of the ability to expand the available size in the near future. Furthermore, the topography (flat or mountains – major infrastructure development is required) of the wider areas where the freight stations are located is examined. Finally, the availability and sufficiency of the superstructure, the utility networks and the equipment is considered, in combination with the provision of some special secondary activities by the operators of each TLT to its users and customers.

Several environmental issues are taken into account in detail. The existence of an environmentally protected area in the vicinity of the selected site or in the wider area is examined, in combination with the visual impact that is entailed by the development of the TLT, as per the harmonization of the TLT's activities with the regional landscape identity.

"Planning security" is concerned with the available land and land use planning issues are stressed. Not only is the property status and availability of each terminal (public, private, P.P.P., one or more owners or in expropriation) analyzed, also, as per the planning, it is declared whether the TLT's future plans (e.g. for further development) are approved for implementation and are in accordance with the national and regional planning (e.g. whether the land is established or not).

Based on the above criteria, a performance matrix was produced for each TLT concerning each one of the main criteria and the overall performance. The qualified TLTs then are evaluated and prioritized based on calculated performances.

5.5.2 Spatial Planning for Public Logistics Terminals

This section is based on Taniguchi et al. (1999).

This case is about planning for the optimal size and location planning of the public logistics terminals (Taniguchi et al. 1999). The study focuses on optimization in designing public logistics terminals, explicitly taking into account environmental impacts of the solution alternatives (traffic conditions on the road network). A mathematical model was developed using queuing theory and nonlinear programming. The model deals with the minimization of the transportation and facility costs at terminals. In order to determine truck and passenger car traffic on the road network of any location pattern of candidate sites of public logistics terminals, the user equilibrium assignment procedure is applied within the model. Figure 5.2 indicates the structures of the bilevel mathematical model.

The developed model is solved by the genetic algorithm metaheuristic solution procedure. It is assumed that the movement of goods is divided into two parts: line-haul, which is long-distance transportation by large trucks on expressways, and

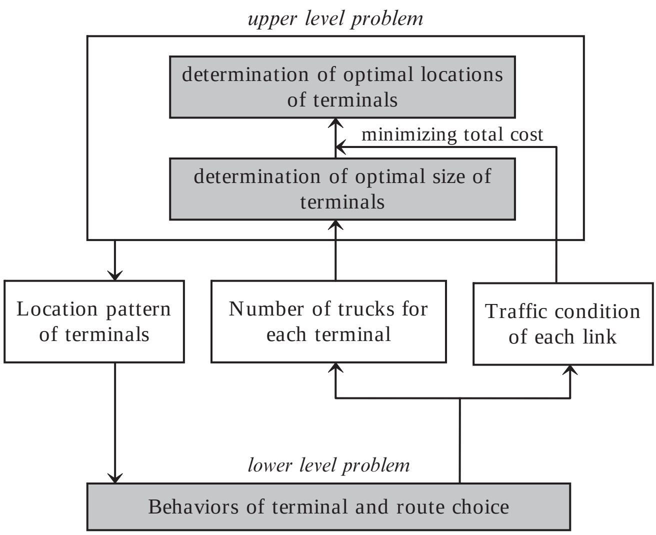

Fig. 5.2 Structure of the bilevel mathematical model (Taniguchi et al. 1999)

local pickup/delivery, which is transportation over short distances by small trucks on urban roads. Logistics terminals are the connection points between the line-haul and pickup/delivery of goods where transshipments are usually performed. Goods may be stored at terminals, but no inventory is considered. The origin and destination points of freight are set for line-haul and pickup/delivery trucks within the road network. These points are referred to as centroids. The model has four features:

– Determining the optimal location of logistics terminals from candidate nodes;
– Taking into account trade-offs between transportation costs and facility costs (such as construction, maintenance, land and truck operation costs in the terminals);
– Assuming that the distribution and assignment of truck traffic can not be controlled;
– Determining the distribution of the movement of goods for each pair of centroids for line-haul trucks and pickup/delivery trucks;
– Assuming that each truck tries to minimize its costs by choosing a logistics terminal from candidate nodes.

The model was applied to an actual road network in the Kyoto-Osaka area, to determine the optimal size and location of logistics terminals. The network is planned for the year 2010, and 16 candidates for logistics terminals are specified along with several planned expressways. It has two centroids for line-haul trucks in East and West Japan and 36 centroids for pickup/delivery trucks and passenger cars within the Kyoto-Osaka area. Six nodes outside the area are included for passenger cars. Predicted matrix of O–D traffic volume in 2010 existed for passenger and freight traffic, and these were used in all calculations.

Because of the absence of predicted goods movements between centroids in East/West Japan and those within the Kyoto-Osaka area in 2010, the present amount of goods was used in case 1, and the amount of 1.5 times was used in case 2. In case 3, the capacity of ordinary roads between some nodes was increased, the other conditions being the same as that of case 1. The land price is high for some candidate nodes close to large cities and thus the construction costs of logistics terminals in these areas are higher, but the transportation costs are lower for pickup/delivery trucks between logistics terminals and customers. So the trade-offs can be taken into account between terminal costs and transportation costs.

Genetic algorithms were found to be effective in obtaining an optimal solution for the size and location of logistics terminals. The optimal location of logistics terminals were generally at junctions of expressways and close to large cities, because of the heavy congestion on many ordinary roads which generates an increase in transportation costs.

It was found that improvements in the road network significantly affect the location of logistics terminals, even if the improvements were not near the terminals because improvements alleviate traffic congestion, which leads to decreased transportation cost of the pickup/delivery trucks.

5.5.3 Spatial Planning and Logistics Centres

This section is based on Leppänen (2007).

The present case is related to a project named Integrating logistics centre networks in the Baltic Sea Region (InLoC), which aims at improving the competitiveness and attractiveness of the Baltic Sea region in relation to other European regions. This is achieved by transnational co-operation on spatial planning and improvement of transport and communication links. InLoC stimulates the business sector of the area by creating better conditions for logistics operations. Furthermore, the project will result in innovative co-operation networks of all actors in transport chains, as well as networks of the logistics centre (LC) related actors (Leppänen 2007).

The InLoC project creates better conditions for logistics operations in the Baltic Sea region by enhancing networking between logistics centres and their interest groups. The project is divided into four work packages. The objectives include:

- Improving the networking and operation of ports, logistics centres and other logistics operators.
- Creating conditions for the spatial integration of logistics operations, analyzing spatial and environmental consequences of logistics centre development and removing bottlenecks in port-hinterland–logistics centre connections.
- Enhancing co-operation of logistics companies by improving the compatibility of different ICT-based networks.
- Educating public on logistics centres and disseminating knowledge of them and their potential, as well as logistics in general.

Each objective was related to a work package. The emphasis of the second work package was on the relationship between spatial planning and logistics, the territorial and environmental impacts of logistics and the transport connections of logistics centres and other logistic nodal points. Even though logistics centres were the primary focus, in many cases along the project, it was useful to consider logistics centres in a broader sense as agglomeration points of logistic operations in contrast to seeing them as strictly defined logistic centres. The activities aimed at supporting the idea of creating favorable conditions for spatial integration of logistics operations, and thus the overall objectives of the InLoC project. Having said that, in many cases spatial integration of logistics leads to more efficient and sustainable logistics. For example, through combining transport flows and centralizing volumes, it is possible to build transport links with higher frequencies and better use of capacity. This in turn results in more efficient transport and cargo handling. At the same time, it is possible to promote efficient land use, decrease congestion and lower the level of emissions, as well as to promote more sustainable transport modes. Four types of studies are conducted (Leppänen 2007).

5.5.3.1 Case Studies on Spatial Planning and Logistics Centres

This section is based on Leppänen (2007).

The case study on spatial planning and logistics centres focused on the relationship between spatial planning function and logistics operators (logistics centres in particular) in Finland, Denmark, Poland, Latvia. The idea was to study both the spatial planning systems in each country from the logistics development perspective, and research areas that would serve as case examples in providing information from real life situations. The research questions were as follows: what are the needs of logistics centres in relation to spatial planning (and vice versa) and what kind of problems and conflicts occur in real life situations.

Spatial planning authorities see that it would be important for logistics operators to participate more actively in the planning processes. It is found that logistics actors should be more involved in transport planning. From the point of view of logistics actors, continuous co-operation with spatial planning authorities leads to more effective spatial planning, land use planning and building practices. In the early stages of planning, flow of information into both directions between the spatial planners and logistics actors is required. It is important that spatial planning prepares all alterations that logistics actors need in their operation beforehand.

It is required that logistics companies and actors be more familiar with the planning process in general. Also, logistics actors should be aware on how they can influence the spatial planning process and they should be more willing to make themselves known for spatial planners, as well as for the decision makers on a national level. They are also looking forward to more persistent spatial planning, in some cases in order to avoid the situation in which the plans change after a short time of approval.

Logistics companies should be able to gather the information themselves, as well as get professional help from the authorities in the interpretation, if needed. Logistics companies should also aim at making their own plans for land use more persistent in the near future. It takes a lot of time to amend the land use plan to correspond to the needs of logistics companies afterwards. As important is to take into account the uncertainties in spatial planning.

The development of regional logistics strategies is important. But it was suggested that instead of focusing on particular regions, the emphasis on development efforts should be on the operation of entire networks and competences within these networks. For example, it is more reasonable from the added value point of view to develop the co-operation of logistics companies within and with logistics centres, than merely to work to allure transport flows to pass through a certain region.

It is suggested that the further development and integration of the existing logistics nodal points, should be focused on the areas where the infrastructure is more developed. On the other hand, areas with insufficient infrastructure for the demand of transport and other logistics services require new logistics centres. Ports, in fact appearing more or less as logistics centres, were still considered to have significant potential in providing the logistics chains with more value adding services.

5.5.3.2 Territorial Impact Assessment of Logistics Centres

This section is based on Leppänen (2007).

The territorial impact assessments examined the relationship between a logistic nodal point and a defined focal area in Poland, Lithuania, Estonia and Finland. A strategic environmental impact assessment of a logistics investment in Poland was also produced.

The case studies showed that the type of interrelationships between logistic nodal points and the surrounding territories or regions can be very different. However, the territorial impacts are common, which generally fall into the following categories: the impacts on traffic, local or regional economies, spatial planning and the environment.

The main consequence of spatial integration of logistics operations is the concentration of traffic flows. This can occur in actual logistics centres, ports or other agglomeration points of logistics operations. On the one hand, it can cause the goods traffic to be concentrated to certain routes that can be optimized for heavy traffic and possibly even separated from the other types of traffic. On the other hand, the increase of heavy traffic does not have desirable effects on routes with inadequate capacity or other inappropriate qualities. Even still, intensified volumes on links between logistics centres support the shifting of cargos into more sustainable and efficient modes of transportation.

The impacts of logistics on local or regional economies vary greatly depending on the type of industrial production, the type of trade of a particular region and on the basic logistics position of the region. The case studies showed that logistics can have various positive effects on the logistics sector economy and on the other businesses established in the target areas. Measures of improving logistics competitiveness of a region are justified by the increase of investment attractiveness, new businesses and new jobs. On the other hand, Establishing or expanding logistics service areas normally faces competition from other forms of land use such as housing, recreation, nature conservation, which may result in various types of conflicts. A typical example of this is the situation in many ports that are situated in the neighborhood of a city centre. The ports face with lack of space for their development, and their locations are usually not good in terms of the requirements of heavy traffic either. There is a high pressure to put the areas into other use, for example for housing or offices. When logistics is integrated into spatial planning processes well enough, the development projects of infrastructure act as an essential part of the sustainable development.

A wide rage of environmental impacts should be considered when evaluating the consequences of logistics centres and logistics operations in general, ranging from the impacts of the building of logistics infrastructure, to all the long term impacts of logistics operations of a fully functioning logistics centre. The legal framework for such an impact assessment defines the issues that have to be assessed. According to this framework, the direct and indirect impacts on human health, soil, water and air, community structure and other issues should be considered. For the logistics and or infrastructure projects close to nature conservation areas, special challenges may arise. Planning logistics in a way that minimizes the environmental impacts is a demanding task in general.

The extreme complexity of the territorial and environmental impacts related to logistics and infrastructure development underlines the necessity of excellent planning. It is very important to apply proper and suitable systems of planning and impact assessments, but do not delay the development projects unnecessarily.

5.5.3.3 Hinterland Connections of Ports/LCs

This section is based on Leppänen (2007).

The studies on hinterland connections of logistics centres and ports were conducted in Finland, Lithuania, Latvia, Poland and Denmark.

The way in which a logistics centre or other logistic nodal point is linked with a transport network is a critical factor in its functionality. The needs for improving this linkage become concrete in the physical transportation infrastructure, the road and rail networks. The most critical connections are the local ones, but a non local connection such as a missing link of a railway network, can be equally critical and influence the long distance connections.

The result of surveys showed that a wide variety of bottlenecks and deficiencies exist in the hinterland connections of ports and logistics centres. Specifically, the deficiencies in the rail network included missing links, both the ones connecting the nodal point to the network, and links further away in the network. Improvements in the condition of tracks are required to support the use of heavier axel loads and trains of higher speed. The needs for improvements in the road networks are even more diverse. The local connections and the linkage between the logistics nodal point and national road network are the most problematic connections. In many cases exits and junctions were reported to be bottlenecks and obstacles in utilizing the whole capacity of the road network, even in the regions with otherwise well developed infrastructure. It is suggested that the awareness of the importance of transport connections and the profitability of the investments that provide accessibility and efficient cargo flows should be increased.

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Chapter 6
Supply Network Design

Hoda Davarzani and Shabnam Rezapour

A well-structured supply chain is of key importance in achieving efficient operations among the suppliers, producers, distribution facilities (DCs), and retailers that constitute the supply chain. The changing environment (economic and political conditions) makes industries to redesign their existing production and distribution network to meet customer service levels at lowest cost (Dullaert et al. 2007).

Man power costs, governmental regulations, taxes, and duties change rapidly in the international environment which alters the attractiveness of locations (Tong and Walter 1980).

The literature usually assumes that the physical network structure of the supply chain is given, and the objective is to minimize (maximize) the system-wide cost (profit) by the best-planned movement of goods through the chain. However, the physical network structure of a supply chain can usually influence its performance, and hence a firm's competitiveness.

The supply chain network design phase includes strategic decisions, such as facility location decisions and technology selection decisions. Once the supply chain physical configuration is determined, the focus shifts to the tactical and operational levels decisions such as inventory management decisions and distribution decisions within the chain. Failure to consider the related inventory and shipment costs when deciding on the locations of facilities in the supply chain's networks can lead to sub-optimality of the chain's structure. Works that have considered the integration of location, inventory, and distribution coordination issues in supply chain network design include Erlebacher and Meller (2000), Daskin et al. (2002), and Shen et al. (2003).

Some major supply chain network design decisions include (Shen 2007):

– Which producers should we use?
– How many DCs should there be and where should they be located?
– How do we set the DC capacity at each location?
– What products should each factory produce?

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Given locations and capacities, supply chain decisions will then try to answer questions such as the following:

– What quantities should we produce and store at these locations?
– How many goods and when should be moved from location to location?

In this chapter we will have a general overview of distribution networks and some of their models as well; finally this chapter concludes with national and international aspects of this issue and some related case studies.

6.1 Classification of Network Design Problems

Dullaert et al. (2007) mentions some classification criteria for network design problems. These criteria are briefly discussed below:

– *Objective function*: minimizing costs, maximizing profits or a multiple objective function;
– *Number of layers in the production-distribution system*: 2, 3, or multiple layers to model supply chain interactions in order to better support managerial decisions;
– Number of layers to be located;
– *Number of commodities*: single versus multiple commodities;
– *Capacity limitations on facilities*: to model the limited availability of production and distribution resources at alternative sites;
– *Nature of demand*: deterministic or stochastic;
– *Number of time periods*: single or multiple time periods;
– Other side-constraints;
– *Capacity or technology acquisition*: different facility configurations (e.g. size) are no longer modeled in at the input stage of the problem as "different" facilities based on their predetermined configuration, but can be endogenously determined;
– *International features*: impact of price and exchange rate uncertainties, tariffs and duties are taken into account for production-distribution decisions.

Also by investigating many different kinds of network design problems in the literature, we can mention some other classification criteria for supply chain network design problems as follows:

– *Feasible locating space for the facilities*: this feasible space sometimes defines as a plane and sometimes defines as a set of feasible discrete points.
– *Physical flows of the network*: sometimes in designing the supply chain network only forward flows considered, sometimes only reverse flows, and both of them can also be considered.

We summarized the characteristics of problems investigated in some of the recent works about the supply chain competition in Tables 6.1 and 6.2.

Table 6.1 Recent works about supply chain network design (forward)

References	Fixed components				Flow direction			Objectives								Uncertainty						
									Cost													
	Number of tiers	Producers locations	DCs locations	Retailers locations	Open/close loop	Reverse	Forward	Service level	Operational	Local distribution	Transportation	Ordering	Safety stock	Working inventory	Locating	Parameters	Demand side	Supply side	Finite capacities of facilities	No. of products	No. of periods	Solution methods
Daskin et al. (2002)	3	√	?	√			√			√	√	√	√	√	√		√			1	1	Lagrangian relaxation
Shen et al. (2003)	3	√	?	√			√			√	√	√	√	√	√		√			1	1	Column generation method
Ozsen et al. (2006)	3	√	?	√			√			√	√	√	√	√	√		√		√	1	1	Lagrangian relaxation
Shu et al. (2004)	3	√	?	√			√			√	√		√	√	√		√			1	1	Column generation method & variable fixing
Shen and Qi (in press)	3	√	?	?			√			√	√	√	√	√	√		√			1	1	Lagrangian relaxation
Shen and Daskin (2005)	3	√	?	√			√	√		√	√	√	√	√	√		√			1	1	Weighing method & genetic algorithm
Shen (2005)	3	√	?	√			√			√	√	√		√	√					*n*	1	Lagrangian relaxation & branch and bound
Qi and Shen (2005)	3	√	?	√			√			√	√	√		√	√		√	√		1	1	Bisection search & outer approximation algorithm
Snyder et al. (2007)	3	√	?	√			√				√	√	√	√	√	√	√			1	1	Lagrangian relaxation
Shen (2006)	3	√	?	√			√			√	√	√		√	√				√	1	1	Branch and price

?: isn't predetermined in problem definition and is determined in the article

Table 6.2 Recent works about supply chain network design (reverse/close & open loop networks)

	Fixed components				Flow direction		Objectives							Uncertainty					
							Minimization of costs												
References	Number of tiers	Location of collection centers	Location of reprocessing centers	Location of consumer markets/ factories	Open/close loop	Reverse	Operational	Local distribution	Transportation	Incomplete waste collection	Shortage	Working inventory	Locating	Demand side	Supply side	Finite capacities of facilities	No. of products	No. of periods	Solution methods
Lieckens and Vandaele (2007) (Stochastic optimization)	3	√	?	√		√	√		√	√	√	√	√			√	1	*s*	Differential evolution
Jayaraman et al. (2003) Heuristic method	3	?	?	√		√			√				√			√	1	*s*	(MILP)
Listes (2007)	3	√	?	?	√		√		√	√			√	√	√	√	1	*s*	Two stage stochastic programming
Ko and Evants (2007)	3	√	?	√	√				√				√			√	*m*	*m*	Genetic algorithm
Salema et al. (2007)	4	√	?	?	√		√		√	√	√		√	√	√	√	*m*	*s*	(MILP)
Uster et al. (2007)	5	?	?	√	√		√		√				√				*m*	*s*	Bender decomposition
Hammond and Beullens (2007)	2	√	√	√	√		√		√								1	*s*	Game theory/ Variational inequality
Sirivastava (2008)	3	?	?	√		√	√		√			√	√			√	*m*	*m*	Hieratical optimization

s: Single-period?: isn't predetermined in problem definition and is determined in the article. *m*: multi-period/multi-product

6.2 Network Design Models

In this section we briefly investigate some of the simple and basic models proposed in the literature for supply chain network design problems. For more details about these models reader can refer to their references.

6.2.1 Basic Model

Shen (2007) designs a three-tiered supply chain system consisting of one or more suppliers, DCs, and retailers as a basic model for supply chain network design problem. Each retailer has uncertain demand. The model wants to determine how many DCs needs to be located, where to locate them, which retailers to assign to each DC, how often to reorder at the DC and what level of safety stock to maintain, so as to minimize total location, shipment, and inventory costs, while ensuring a specified level of service.

They assume that location costs are incurred when DCs are established. Line-haul transportation costs are incurred for shipments from a supplier to the DCs. Local transportation costs are also incurred in moving the goods from the DCs to the retailers. Inventory costs are incurred at each DC and consist of the carrying cost for the average inventory used over a period of time and safety stock inventory carried to protect against stock outs that might result from uncertain retailer demand.
Inputs and parameters

I: set of retailers
J: set of candidate DC locations
μ_i: mean (daily) demand at retailer i, for each $i \in I$
δ_i^2: variance of (daily) demand at retailer i, for each $i \in I$
f_j: fixed (annual) cost of locating a DC at j, for each $j \in J$
d_{ij}: cost of shipping a unit from DC j to retailer i, for each $i \in I$ and $j \in J$
α: desired percentage of retailer orders satisfied (fill rate)
β: weight factor associated with the shipment cost
θ: weight factor associated with the inventory cost
z_α: standard normal deviate such that $P(z \leq z_\alpha) = \alpha$
h: inventory holding cost per unit of product per year
F_j: fixed administrative and handling cost of placing an order at DC j, for each $j \in J$
L: DC order lead time in days
g_j: fixed shipment cost per shipment from the supplier to DC j
$\overline{a}_j$: cost per unit of a shipment from the supplier to DC j
χ: a constant used to convert daily demand into annual demand (e.g., 365 if demands occur every day of the year)

Variables

$x_j = 1$, if retailer j is selected as a DC location, and 0 otherwise, for each $j \in J$
$y_{ij} = 1$, if retailer i is served by a DC based at location$j$, and 0 otherwise, for each $I \in I$ and each $j \in J$.

Here, calculating the working inventory cost and the safety stock cost is explained. *Working inventory cost*: A DC orders inventory from the supplier using a (r,Q) policy with service level constraints. Let S_j denote the set of retailers served by j, D_j denote the total annual (expected) demand going through DC j, and n be the number of shipments per year from the supplier. Then the average shipment size in one shipment from the supplier to DC j is D_j/n, and the average working inventory cost at DC j is $\theta h D_j/(2n)$. Assuming the delivery cost from the supplier to DC j can be calculated as: $g_j + \overline{a}_j D_j/n$, where g_j is the fixed cost of placing an order, then the total annual cost of ordering inventory from the supplier to DC j is given by

$$F_j n + \beta(\mathrm{g}_j + \overline{a}_j D_j/n)n + \theta h D_j/(2n).$$

It is easy to show that the optimal value of n that minimizes the above function is equal to $\sqrt{\theta h D_j/(2(F_j + \beta q_j))}$. The corresponding total annual working inventory cost associated with DC j can be expressed as:

$$\sqrt{2\theta h D_j/(2(F_j + \beta q_j))} + \beta \overline{a}_j D_j.$$

Safety Stock Cost: Using Eppen's risk-pooling result, the amount of safety stock required to ensure that stockouts occur with a probability of α or less is: $z_\alpha \sqrt{L \sum_{i \in s_j} \sigma_i^2}$. The corresponding holding cost for the safety stock at DC j is:

$$\theta h z_\alpha \sqrt{L \sum_{i \in s_j} \sigma_i^2} = \theta h z_\alpha \sqrt{L \sum_{i \in I} \sigma_i^2 Y_{ij}}.$$

Model:

$$\mathrm{Max} \sum_J \left\{ f_j x_j + \left[\sum_I (\beta \mu_i d_{ij} + \beta a_j \mu_i) \chi y_{ij} \right] + \sqrt{2\theta h (F_j + \beta q_j)} \sqrt{\sum_I \mu_i \chi\, y_{ij}} + \theta h z_\alpha \right.$$
$$\left. \sqrt{\sum_I \widehat{\sigma}_i^2 y_{ij}} \right\} = \sum_J \left\{ f_j X_j + (\sum_I \widehat{d}_{ij} y_{ij}) + K_j \sqrt{\sum_I \mu_i y_{ij}} + q \sqrt{\sum_I \widehat{\sigma}_i^2 y_{ij}} \right\}, \quad (6.1)$$

Subject to

$$\sum_{j \in J} Y_{ij} = 1 \qquad (\forall i \in I), \quad (6.2)$$
$$Y_{ij} - X_j \le 0 \quad (\forall i \in I) \quad \text{and} \quad (\forall j \in J), \quad (6.3)$$
$$Y_{ij} \in \{0,1\} \quad (\forall i \in I) \quad \text{and} \quad (\forall j \in J), \quad (6.4)$$
$$X_j \in \{0,1\} \quad (\forall j \in J), \quad (6.5)$$

where

$$\widehat{d}_{ij} = \beta\chi\mu_i(d_{ij} + a_j),$$
$$K_j = \sqrt{2\theta h\chi(F_j + \beta q_j)},$$
$$q = \theta h z_\alpha,$$
$$\widehat{\sigma}_i^2 = L\sigma_i^2.$$

The first two terms of the objective function location include the fixed cost of locating facilities, and the delivery costs from the DCs to the retailers as well as the marginal cost of shipping a unit from a supplier to a DC. The last two terms are related to inventory costs, which are nonlinear in the assignment variables. K_j captures the inventory effects due to the fixed ordering costs at the DC as well as the fixed transport costs from a supplier to a DC. Finally, q captures the safety stock costs at the DCs. The value of q depends on the desired service level.

Constraint (6.2) stipulates that each retailer is assigned to exactly one DC. Constraint (6.3) states that retailers can only be assigned to candidate sites that are selected as DCs. Constraints (6.4) and (6.5) are standard integrality constraints.

Shen (2000) and Shen et al. (2003) use a column generation method to minimize the above objective function and Daskin et al. (2001) proposes a Lagrangian relaxation method for this problem.

6.2.2 Model with Capacitated DCs

This section is based on Ozsen et al. (2006).

Ozsen et al. (2006) introduce a capacitated version of the basic model. They assume that the DCs have capacity restrictions. The capacity constraints are defined based on how the inventory is managed.

Their model evaluates the tradeoff between having more DCs to ensure sufficient system capacity versus ordering more frequently through the definition of capacity. If we assume the inventory is managed by a (r, Q) model with a type-I service level constraint at each DC. By defining C_j as the capacity of DC j, r_j as the reorder point at DC j, and Q_j as the reorder quantity at DC j.

The inventory at DC j reaches its maximum when there isn't any demand during the lead time. Thus, the maximal accumulation at DC j equals $Q_j + r_j$ where $r_j =$ safety stock $+E$ [demand during lead time]. Let D_j be the expected annual demand of retailers served by DC j. They write the capacity constraint for DC j as:

$$Q_j + r_j \leq C_j,$$

or

$$Q_j + z_\alpha\sqrt{LD_j/\chi} + LD_j/\chi \leq C_j. \tag{6.6}$$

By adding this constraint to basic problem model in Sect. 6.2.1, they obtain a new model with nonlinear terms in both the objective function and the constraints. They apply a Lagrangian relaxation solution algorithm to solve this problem.

6.2.3 Model with Service Considerations

This section is based on Shen and Daskin (2005).

Basic model in Sect. 6.2.1 captures important facility location, transportation and inventory costs. In this model some retailers may be served very well, in the sense that they are located very close to the DCs to which they are assigned, while others may be served poorly. The maximal covering location problem try to maximize the number of customers that are covered by a fixed number of facilities (customer i is covered if node i is assigned to a facility that is within d_c of node i, where d_c is the coverage distance). Shen and Daskin (2005) instead of maximizing covered demand volume, for fixed total demand, minimize the uncovered demand volume. By this way they formulate a model that simultaneously minimizes the fixed costs of the facilities and a weighted sum of the uncovered demand volume as follows:

$$\mathrm{Min} \sum_J f_j x_j + W \sum_J \sum_I \hat{d}_{ij}\, y_{ij}, \tag{6.7}$$

subject to (6.2)–(6.5), where W is the weight on the uncovered demand volume and

$$\widetilde{d}_{ij} = \begin{cases} \chi \mu_i & \text{if } d_{ij} > d_\mathrm{c} \\ 0 & \text{if not.} \end{cases}$$

This model is structurally identical to basic model. The only difference is that we penalize all assignments of demand nodes to DCs that are more than d_c away from the DC.

Shen and Daskin (2005) propose two solving methods, one based on the weighting method and the other based on genetic algorithms, to solve this multi-objective model. The genetic algorithm performs very well compared to the weighting method, and it is the only feasible approach for large-sized problem instances.

6.2.4 Model with Parameter Uncertainty – Scenario Based Approach

This section is based on Snyder et al. (2007).

Snyder et al. (2007) present a stochastic version of the basic model that explicitly handles parameter uncertainty by allowing parameters to be described by discrete scenarios, each with a specified probability of occurrence. The goal is to choose DC locations, assign retailers to DCs, and set inventory levels at DCs to minimize the total system wide cost. To model this problem, we need to define the following additional notation:

Set
S: set of scenarios, indexed by s.

Parameters

- μ_{is}: mean daily demand at retailer i in scenario s, for $i \in I$, $s \in S$
- δ_{is}^2: variance of daily demand at retailer i in scenario s, for $i \in I$, $s \in S$
- d_{ijs}: per-unit cost to ship from DC j to retailer i in scenario s, for $i \in I$, $s \in S$, $j \in J$
- q_s: probability that scenario s occurs, for $s \in S$

Decision variables

$x_j = 1$, if j is selected as a facility location, and 0 otherwise, for each $j \in J$
$y_{ijs} = 1$, if retailer $i \in I$ is served by DC $j \in J$ in scenario $s \in S$, and 0 otherwise

Model:

$$\text{Min} \sum_S \sum_J \left\{ f_j x_j + \left(\sum_I \hat{d}_{ijs} y_{ijs} \right) + K_j \sqrt{\sum_I \mu_{is} y_{ijs}} + q \sqrt{\sum_I L_j \delta_{is}^2 y_{ijs}} \right\}. \tag{6.8}$$

Subject to

$$\sum_J y_{ijs} = 1 \qquad (\forall i \in I), (\forall s \in S), \tag{6.9}$$

$$y_{ijs} - x_j \leq 0 \quad (\forall i \in I), (\forall j \in J), (\forall s \in S), \tag{6.10}$$

$$y_{ij} \in \{0,1\} \qquad (\forall i \in I), (\forall j \in J), (\forall s \in S), \tag{6.11}$$

$$x_j \in \{0,1\} \qquad (\forall j \in J), \tag{6.12}$$

where

$$\hat{d}_{ijs} = \beta \chi \mu_{is} (d_{ijs} + a_j),$$
$$q = \theta h z_\alpha.$$

Snyder et al. (2007) present a Lagrangian-relaxation based solution algorithm for the above model. They show the Lagrangian subproblem is a non-linear integer program, but it can be solved by a low-order polynomial algorithm.

6.2.5 Theory in Application: Distribution Network for Fresh/Dry and Frozen Food (Ambrosino and Sciomachen 2007)

Let us consider a food distribution network consisting of a depot δ, a set C of n customers that in this case are markets located on the highway, and a fleet V of m homogeneous vehicles; and the customer demand is known.

In particular, since any time some frozen product is unloaded from a vehicle, a variation of the temperature may occur, it is assumed that a maximum number of stops, U, of the vehicles is allowed; therefore, each vehicle $\upsilon \in V$ can visit at most U customers when supplying frozen products.

A vehicle starting from δ can visit the customers according to two different paths:

1. A sequential path: a vehicle goes on the highway, visits all customers along the same one-way direction and when the last one is visited, it leaves the highway, changes direction, goes to all customers located along the opposite side and finally returns to the depot;
2. An alternate path: a vehicle enters and leaves the highway several times for visiting customers located at opposite sides of the highway.

We can now formally define a weighted digraph $G = (N,E)$, representing the distribution network under consideration, where $N = \{0,1,\ldots,n\}$ is the set of nodes (customers are indexed $i = 1,\ldots,n$ and node $i = 0$ refers to depot δ) and $E = A \cup P \cup B$ is the arc set such that:

– A gives the oriented connections between customers and customers and the depot that are on the same side of the highway;
– P represents the set of oriented arcs that connect customers and the depot on the opposite side of the highway;
– B is the set of "bridge arcs": for each pair of customers $i, j \in N$ that are connected by a bridge, we have two "bridge arcs", namely, (i, j) and (j,i).

6.2.5.1 Problem Definition and Modeling

Additional notation:

f: fixed cost of the vehicles;
z: capacity of the vehicles.

We use as decision variables:
$x_{ijk} = 1$, if vehicle k visits customer j immediately after customer i,
$x_{ijk} = 0$, Otherwise, $\forall (i, j) \in A \cup P \cup B, \forall k \in V$,
$u_{ik} = 1$, if vehicle k supplies frozen products to node i,
$u_{ik} = 0$, Otherwise, $\forall i \in N \backslash \{0\}, \forall k \in V$.

Moreover, since a customer can be visited more than once, Ambrosino and Sciomachen (2007) have introduced the following variables:
$q^d_{ik} \geq 0$, quantity of fresh/dry products supplied to customer i by vehicle k,

$$\forall i \in N \backslash \{0\}, \forall k \in V$$

$q^f_{ik} \geq 0$, quantity of frozen products supplied to customer i by vehicle k,

$$\forall i \in N \backslash \{0\}, \forall k \in V.$$

Finally, the flow variables:

$f_{ijk} \geq 0$, that represents the quantity of flow shipped from node i to node j by vehicle k, $\forall(i,j) \in A \cup P \cup B$, $\forall k \in V$.

Note that, for formulation convenience, variables x_{ijk} and f_{ijk} are used for those pairs of customers who are connected by a bridge, i.e. customer j is served with customer i without any routing of vehicle k.

The resulted model is given by (6.1)–(6.11):

$$\text{Min} \sum_{(i,j)\in E} c_{ij} \sum_{k\in V} x_{ijk} + \sum_{i\in N\setminus\{0\}} \sum_{k\in V} f x_{0ik}. \tag{6.13}$$

Subject to:

$$\sum_{(i,j)\in E} \sum_{k\in V} x_{jik} \geq 1 \quad \forall i \in N\setminus\{0\}, \tag{6.14}$$

$$\sum_{(i,j)\in E} x_{ijk} = \sum_{(j,i)\in E} x_{jik} \quad \forall i \in N, \forall k \in V, \tag{6.15}$$

$$f_{ijk} \leq x_{ijk} z \quad \forall(i,j) \in E, \forall k \in V, \tag{6.16}$$

$$\sum_{(j,i)\in E} f_{jik} - \sum_{(i,j)\in E} f_{ijk} = q^f_{ik} + q^d_{ik} \quad \forall i \in N\setminus\{0\}, \forall k \in V, \tag{6.17}$$

$$\sum_{k\in V} q^d_{ik} = D^d_i \quad \forall i \in N\setminus\{0\}, \tag{6.18}$$

$$\sum_{k\in V} q^f_{ik} = D^f_i \quad \forall i \in N\setminus\{0\}, \tag{6.19}$$

$$q^f_{ik} - z u_{ik} \leq 0 \quad \forall i \in N\setminus\{0\}, \forall k \in V, \tag{6.20}$$

$$\sum_{i\in N\setminus\{0\}} u_{ik} \leq U \quad \forall k \in V, \tag{6.21}$$

$$x_{ijk} + x_{jik} = 2x_{ijk} \; \forall(i,j) \in B, \forall k \in V, \tag{6.22}$$

$$\begin{aligned} & q^f_{ik} \geq 0 \quad \forall i \in N\setminus\{0\}, \forall k \in V, \\ & q^d_{ik} \geq 0 \quad \forall i \in N\setminus\{0\}, \forall k \in V, \\ & f_{ijk} \geq 0 \quad \forall i \in N\setminus\{0\}, \forall k \in V, \\ & x_{ijk} \in \{0,1\} \quad \forall i \in N\setminus\{0\}, \forall k \in V, \\ & u_{ik} \in \{0,1\} \quad \forall i \in N\setminus\{0\}, \forall k \in V. \end{aligned} \tag{6.23}$$

6.3 Closed-loop Network Design

Recovery of used products is receiving much attention recently due to growing environmental concern (Salema et al. 2007). In order to achieve an effcient implementation of such networks, there is an essential need to appropriate closed-loop network design for the arising goods flow from users to producers. This issue will be discussed in chapter nine completely but in this part we investigate the design of such logistics networks mathematically.

We review the study done by Shih (2001) who employs the mixed integer programming method to optimize the infrastructure design and the reverse network flow for end-of-life computers and home appliances. The proposed model attempts to minimize the total cost, which consists of transportation cost, operating cost, fixed cost for new facilities, final disposal cost and landfill cost, as well as the sale revenue of reclaimed materials. Integer variables are incorporated for site selection for storage and treatment facilities. The optimal physical flow of products going through collection points, storage sites, recycling plants, and the final disposition sites are obtained. The model includes flow conservation constraints, facility capacity constraints, a number limit for new facilities, and non-negative constraints. The model can solve for the optimal reverse network flow and also determine the number and the location of new facilities. The following discussion of this section is based on Shih (2001).

Parameters:

i: subscript for collecting points
j: subscript for four major home appliances and computers
s: subscript for storage sites
p: subscript for disassembly:recycling plants
r: subscript for final disposition facilities
g: subscript for materials from recycling plants
n: number of existing storage sites
m: number of existing recycling plants
d: number of existing final disposition plants
h_1: number limit of new storage sites
h_2: number limit of new recycling plants
h_3: number limit of candidate re-processing plants
L_g: weight of the material g
Xisj: quantity of product j transported from collecting point i to storage s
Yspj: quantity of product j transported from storage site s to disassembly plant p
Hipj: quantity of product j transported from collecting point i to disassembly plant p
Zprg: quantity of material g transported from disassembly plant p to final disposition facility r
Wsj: total quantity of product j going through storage site s
Vpj: total quantity of product j going through disassembly plant p
Ts: total units of EOL products going through storage site s
Qp: total units of EOL products going in the plant p
Urg: total quantity of material g sent to final disposition facility r
Ss: $\{0,1\}$ variable for selection of storage site
P_p: $\{0,1\}$ variable for selection of disassembly:recycle plant
R_{rg}: $\{0,1\}$ variable for selection of final disposition facility Other parameters
$B1$: a set denoting the profitable reclaimed materials
$B2$: a set denoting the materials that incur cost

B_g: unit revenue of selling material g
C_g: unit cost of treating material g
M_{1j}: unit subsidy for collecting product j at collecting points from the fund
M_{2j}: unit subsidy for storing product j at storage sites from the fund
M_{3j}: unit subsidy for recycling product j at disassembly:recycle plants from the fund
TCIS_j: unit transportation cost for a product j (per km) from collecting point to storage site
TCSP_j: unit transportation cost for a product j (per km) from storage site to disassembly plant
TCPR_g: transportation cost of material g (per kg km) from disassembly plant to final disposition
TCIP_j: unit transportation cost for a product j (per km) from collecting point to disassembly plant
D_{is}: distance from collecting point i to storage site s
D_{sp}: distance from storage site s to recycling plant p
D_{ip}: distance from collecting point i to recycling plant p
D_{pr}: distance from recycling plant p to disposition plant r
f: fixed cost for setting a storage site S
f_p: fixed cost for setting a disassembly:recycle plant
f_r: fixed cost for setting a final disposition facility
CC_{1j}: unit operation cost of collecting product j at collecting point
CC_{2j}: unit operation cost of storing product j at storage site
CC_{3j}: unit operation cost of recycling product j at disassembly:recycle plant
A_{ij}: estimated number of product j that can be collected at collection point i
G_{jg}: weight percentage of material g in product j
MINS: lower limit for the annual capacity of the storage site s
MAXS: upper limit for the annual capacity of the storage site s
MINP: lower limit for the annual capacity of the disassembly:recycle plant p
MAXP: upper limit for the annual capacity of the disassembly:recycle plant p
MINR_{rg}: lower limit for the annual capacity of the final disposition facility r for material g
MAXR_{rg}: upper limit for the annual capacity of the final disposition facility r for material g

Mathematical model:

$$\begin{aligned}
&\mathrm{Max} \sum_{g\in B1} B_g \times L_g - \sum_{g\in B2} C_g \times L_g + \sum_i\sum_j M_{1j} \times A_{ij} + \\
&\sum_i\sum_s\sum_j M_{2j} \times X_{isj} + \sum_s\sum_p\sum_j M_{3j} \times (Y_{spj} + H_{ipj}) - \\
&\sum_i\sum_s\sum_j (\mathrm{TCIS}_j \times D_{is} \times X_{isj}) + \sum_s\sum_p\sum_j (\mathrm{TCSP}_j \times D_{sp} \times Y_{spj}) - \\
&\sum_i\sum_p\sum_j (\mathrm{TCIP}_j \times D_{ip} \times H_{ipj}) + \sum_p\sum_r\sum_l (\mathrm{TCPR}_g \times D_{pr} \times Z_{prg}) - \\
&\sum_{s=n+1}^{q} f_s \times S_s - \sum_{p=m+1}^{k} f_p \times P_p - \sum_{r=d+1}^{v} f_r \times R_{rg} - \sum_i\sum_j CC_{1j} \times A_{ij} - \\
&\sum_i\sum_s\sum_j CC_{2j} \times X_{isj} - \sum_s\sum_p\sum_j CC_{3j} \times Y_{spj} + \sum_i\sum_p\sum_j CC_{3j} \times H_{ipj}.
\end{aligned} \tag{6.24}$$

Subject to:

$$\sum_s X_{isj} + \sum_p H_{ipj} = A_{ij} \quad \text{for all } i, j, \tag{6.25}$$

$$\sum_i X_{isj} = W_{sj} \quad \text{for all } s, j, \tag{6.26}$$

$$\sum_p Y_{spj} = W_{sj} \quad \text{for all } s, j, \tag{6.27}$$

$$\sum_s Y_{spj} + \sum_i H_{ipj} = V_{pj} \quad \text{for all } p, j, \tag{6.28}$$

$$\sum_j V_{pj} \times G_{jg} = \sum_r Z_{prg} \quad \text{for all } p, g, \tag{6.29}$$

$$\sum_p Z_{prg} = U_{rg} \quad \text{for all } r, g, \tag{6.30}$$

$$\sum_r U_{rg} = L_g \quad \text{for all } r, g, \tag{6.31}$$

$$\sum_j W_{sj} \geq \text{MINS} \times S_s \quad \text{for all } s, \tag{6.32}$$

$$\sum_j W_{sj} \leq \text{MAXS} \times S_s \quad \text{for all } s, \tag{6.33}$$

$$\sum_j W_{sj} = T_s \quad \text{for all } s, \tag{6.34}$$

$$\sum_j V_{pj} \geq \text{MINP} \times P_p \quad \text{for all } p, \tag{6.35}$$

$$\sum_j V_{pj} \leq \text{MAXP} \times P_p \quad \text{for all } p, \tag{6.36}$$

$$\sum_j V_{pj} = Q_p \quad \text{for all } p, \tag{6.37}$$

$$U_{rg} \geq \text{MINR}_{rg} \times R_{rg} \quad \text{for all } r, g, \tag{6.38}$$

$$U_{rg} \leq \text{MAXR}_{rg} \times R_{rg} \quad \text{for all } r, g, \tag{6.39}$$

$$\sum_{s=n+1}^{q} S_s \leq h1, \tag{6.40}$$

$$\sum_{p=m+1}^{k} P_p \leq h2, \tag{6.41}$$

$$\sum_{r=d+1}^{v} R_{rg} \leq h3. \tag{6.42}$$

where: non-negative decision variables and $\{0,1\}$ integer variables: S_s, P_p, R_{rg}.

Table 6.3 Description of model constraints

No.	Description
(6.25)	Flow conservation at the collection point *I*
(6.26), (6.27)	Flow conservation at the storage site *s*, and record the total amount passing through the storage site
(6.28)	Mass conservation at the disassembly:recycle plant *p*
(6.29)	The *g*th material that leaves the plant *p*
(6.30), (6.31)	Material going to the final disposition sites. The material can go to a secondary material market, landfill or treatment plants if they are hazardous
(6.32), (6.33), (6.34)	Capacity limits of storage sites
(6.35), (6.36), (6.37)	Capacity limits of disassembly:recycling plants
(6.38), (6.39)	Capacity constraints for the final disposition site
(6.40), (6.41), (6.42)	Upper limits for the number of new facilities

In order to achieve better understanding of different constraints, Table 6.3 provides the description of the constraints in the model.

6.4 International Distribution Network Design

An international distribution network could be seen as a network of factories and material sourcing on a world wide basis. It performs its work through the processing activities and their corresponding linkages with suppliers and buyers. As these activities, nodes and linkages spread out around the world, it becomes essential to carefully coordinate the operations.

There are some different factors that should be considered in "international distribution network design".

Researchers developing mathematical models and conducting simulation studies need to be aware of factors affecting the international distribution network design.

6.4.1 Influential Factors in International Distribution Network Design

In an international distribution network design, activities and sourcing decisions should be adapted to countries conditions. So, it can lead to gains in cost, quality, lead times, etc.

In the remainder of this part we will demonstrate the role of country, industry type and multi-national networks strategies in an international distribution network design.

6.4.1.1 Country

We can divide this factor (conditions of different countries) into some more detailed factors. Endowment factors, cultural variations, arbitrage and leverage opportunities, government incentives and regulations.

In the following, these factors will be discussed more:

– *Endowment factor*. Any country around the world has its own characteristics. So, there are many differences among them.

  - There are three levels of endowment factors; primary, secondary and tertiary endowment factors (Porter 1986).
  - Primary factors include access to low-cost labor or perhaps proximity to raw materials (Kogut 1985). Companies like Toyota, in order to take advantage of low wages, locate part of their labor intensive productions in countries with this characteristic. Natural resources, such as access to special kind of stone, large logs, etc. make you choose some specific countries to locate your operations.
  - Secondary endowment factors include the quality of infrastructure (Porter 1986). For example, accessibility of e-communications, roads, transportation stations such as airports or railways and the quality of the mentioned items. We can add skilled labor and scientific personnel to the list above, as secondary endowment factors.
  - Note that the primary and secondary endowment factors may not occur simultaneously. For example, a country with low wages may have very poor infrastructure.
  - Tertiary endowment factors relate to the country demand and operation conditions (Porter 1986). For example locating in a populated country like China.

– *Cultural variations*. Cultural variations can cause misunderstandings or faults in the communications between the different nodes in an international distribution network (Murphyand and Dalenberg 1989). Differences in languages and definitions add to the complexity of an international distribution network design.

– *Arbitrage and leverage*. In international distribution network design it is essential to leverage and arbitrage the movement of material and location of activities.

  - By having excess to capacity or a number of suppliers spread across the world, the exchange rate should be leveraged by sourcing from countries with weak currencies and limiting production in countries with strength currencies.
  - No harmonized tax structures between different countries have made good opportunities to arbitrage tax regimes. For instance, in countries with a low tax rate, items with higher value are noticed.
  - Finally, it should be noticed that demand patterns vary according to buyer behavior variations and seasonality.

– *Government incentives and regulations*. Governments have understood the advantage of being a part of an international distribution network, so they provide a series of incentives to multi-nationals. Some of the countries have set up export processing zones which have eliminated or at least minimized most of international distribution networks problems. An example of this could be free trade zones in many countries like China, Mexico, Iran and etc.

- An important factor in this part is regulations which are different from one country to another. Items like shop floor control, tariffs, export requirements, import substitution impositions, customs duties, quotas, customs procedure, standards and labor requirements are very essential in an international distribution network design.

6.4.1.2 Industry

The type of industry can influence the design of distribution networks. Factors such as amount of raw materials and the relative scarcity, value and cost of components, perishability of products and the characteristics of the processes employed (Prasad and Sounderpandian 2003) are very important in an international distribution network design.

6.4.1.3 Multi-National Networks Strategies

From the international point of view, we need to have responsive and flexible networks to be able to adapt ourselves to shifts in the relative changes in the endowment factors (Doz 1986).

6.5 National and Governmental Distribution Networks

National and governmental distribution networks are very similar to each other. Both of them are within the same geography borders and the government is usually responsible for both of them.

It is noticeable that there is a slight difference between national and governmental distribution networks. The later is much more regional than the former. In other words, when we talk about national distribution networks we emphasize geographical borders of that network. Although governmental distribution networks could be regional networks, our stress is on the possession of them. For example, in some countries we can see the national distribution network of flour or in one country the government in some regions has made governmental distribution networks of fruit and so on.

6.5.1 Comparison Between International and National-Governmental Distribution Networks Design

In this part, we want to go back to Sect. 6.4.1 and review the influential factors once more and see which of those factors could be mentioned in national and governmental distribution network design.

Among country related factors; cultural variations and endowment factors are some of the factors which can be discussed here.

In endowment factors, it is possible to have more access to low-cost labor in an especial region of a country or to be close to raw materials. The quality of infrastructure like the quality of roads or accessibility to airports, etc. are considered in this part.

We can see the factor of cultural variations in this issue (national and governmental distribution network design) as well, because in each country different people with different cultures live in different regions. So, these differences should be noticed in national and governmental distribution network design.

Among industry factors, we should consider how much raw materials do we need? Or whether our products are perishable or not? It is also important in design of national and governmental distribution networks to notice the value and cost of components and the characteristics of the processes employed.

Again, transportation is a keyword here that should be considered as an essential factor in national and governmental distribution network design.

All in all, there are many factors influencing the design of international, national and governmental distribution networks, that we mentioned some of the most important here.

In the following, you will go over a related case study which clarifies the introduced parameters.

6.6 Distribution and Logistics Development in China (Jiang and Prater 2002)

Today, there are three main forces that are changing and modernizing China's distribution and logistics system. These are the booming economy, entering the WTO and e-commerce. While great changes have been made, China's distribution system still lies somewhere between socialism and free market capitalism.

6.6.1 China's Traditional Distribution System

In the pre-reform era, prior to the mid-1980s, china's both production and distribution were conducted solely according to the dictates of the State Plan; the production and how much of the product were determined by the state; distribution channels within China were strictly controlled by the three-tier system.

China's distribution networks during this period were organized along rigid, vertical lines. Tier-1 distributers were located in Beijing, Shanghai, Tianjin, and Guangzhou; Tier-2 consisted of wholesalers in the provincial capitals and medium-sized cities; and Tier-3 wholesalers operated in smaller cities and towns (Chen 2001). State-owned distributors shipped products for each industry from Tier-1 facilities to province and cities, then to local retailers. With no marker forces at work, this extended distribution center increased the prices as each layer added additional operating margins ranging from 5 to 17%.

As China grew more interested in trading with all over the world, leaders recognized the need to liberalize this system. With the introduction of reforms in the mid-1980s, control gradually shifted away from central government control to the provinces and municipalities, which gained the right to establish their own trading companies.

6.6.2 China's Current Distribution System

One of the biggest current changes in China's business environment is the opening of distribution rights. There can be no true market access without distribution rights.

Today, China's distribution systems lie somewhere between a rigid planned structure and a free market system. The nationwide State system still exists, but the rigid demarcations between each level, and between different parts of the system, have broken down. Manufacturers may now bypass wholesalers and sell directly to retailers. Moreover, the three traditional tiers now compete against each other as well as against new, privately owned companies.

6.6.3 Chinese Company Perspective

Today, china's market has many virtual "Great Walls." Three types of "bricks": Unbalanced economic development, the need for guanxi and regional protectionism, has built these walls.

6.6.3.1 Unbalanced Economic Development

With a population of more than 1.3 billion, China is the largest potential market in the world. However, it is wrong to view China as one homogenous market. In reality it has at least two "countries" contained within it. The first is a coastal urban megalopolis with almost 30% of population with a per capita income in the neighborhood of $1,000 (the magic number above which Chinese can start buying luxuries) and a highly educated populace (Powell 2002). The second country is a vast Third World interior of nearly 70% of population, where incomes can be as low as $200 a year.

With China's geographic size (almost the same as USA) and a wide range of per capita GDP and disposable income, most Chinese distributors are small and specialized in limited types of goods. Large-scale distributors and wholesalers are few. Suppliers have to deal with many different distributors or wholesalers to achieve national coverage.

6.6.3.2 The Need for Guanxi

Chinese culture is distinguished from the Western culture in many ways, including how business is conducted. A key difference is that Chinese prefer to deal with people they know and trust. On the surface, this may seem similar to Western business procedures; however what this really means is that Western companies as well as Chinese from different regions have to make themselves known to Chinese companies before any business can take place. This is known as guanxi, which literally means relationships.

Guanxi can also be viewed as "friendship with implications of continued exchange of favors" (Pye 1992).

In China, the right guanxi or connections will increase the odds or business success. While Western businesses may not see this as necessarily cost effective, it does have advantages. By making the right connections an organization minimizes the risks, frustrations and disappointments of doing business in China.

If a company (or individual) has always delivered on their promises, then they are being trustworthy and Chinese business people are open to working with them again. However, failure to follow the rules of reciprocity and equity in a guanxi-based relationship results in loss of face and being labeled as untrustworthy (Luo and Chen 1966).

6.6.3.3 Regional Protectionism

Beyond the geographic size and unbalanced development, the political/legal barriers are the most powerful forces that separate China's distribution market. Government interference on economic activities increases the risk to private investment and affects the extent of participation of private sector in the supplying and distribution of goods.

Provinces and municipalities have erected tariff and non-tariff barriers to keep out one another's products. As soon as you move across provincial borders in China, there are barriers. Thus each province or city built its own steel mill, chemical plant, brewery and so forth. Tight state control over distribution was aimed at maximum employment, not efficient use of resources.

Since the 1980s, with the decline of central planning, economic authority has devolved to local governments. In some ways decentralization has worsened protectionism. Most state-owned enterprises are controlled by local governments. Local authorities are obsessed with local economic growth, employment, social stability, and tax revenues.

6.6.4 Future Prospects of China's Distribution/Logistics

To determine where China's distribution industry is going, one must understand the forces that are causing the change. There are three main forces that are changing and modernizing China's distribution and logistics system. These are the booming economy, entering the WTO and e-commerce. All these forces have a common characteristic: they are tearing down the walls facing distribution logistics. Booming economy results in more export-oriented foreign firms, China's entrance into the WTO is tearing down the regulation walls since the Chinese government must phase out most restrictions affecting the sales, services, and distribution sectors to foreign firms. Finally, the advent of e-commerce is tearing down the bricks and mortar walls of physical distribution. As a result of these efforts distribution is widely regarded as one of the most critical determinants of business success in China today. The government of China has been trying to overcome difficulties in logistics system including China's overburdened, underdeveloped physical infrastructure; inexpert, underfunded state-owned distribution companies; unbalanced economy development; enormous, fragmented distribution and logistics sector; and regional protectionism.

6.6.5 Distribution and Logistics Development in Japan

Distribution system in Japan is typically complex, multilayered and highly unique. Japan is a country with huge but gradual reformation in its logistics system. Before 1990s, distribution system in Japan was inefficient; a product changed hand from manufacturer to general distributor to special distributor to special sub-distributor to retailer to consumer; sometimes the product never physically changed hand merely the paperwork. Primary, secondary, and tertiary wholesalers in Japan existed with each group performing different functions in the physical and financial aspects of distribution. Often, goods were trucked from one warehouse to another in the same block (Martin et al. 1998). But after a while this system was changed, some corporation like toyota as a leader in scm concept and sony changed dramatically and after them the other organizations transformed.

If we want to review the history of logistics and distribution system in Japan we may face with following eras (Kajita 2000):

- 1970s – Unclear markets enlarge
  - Use of IT for collaboration begins

- 1980 – Transpotation deregulation
- 1981 – Telecommunication deregulation
- Mid 19880s – IT in strategic use
  - Study of Japanese firms collaborations
  - Quick response
  - Standardizing EDI
  - Transportation deregulation partially begins
  - Several leading firm start to adapt to market change
  - Supply chain management born
- 1992 – Movement from physical distribution to logistics.

The intense rivalry between wholesalers and retailers used to put pressure on manufacturers to continually bring out new products. However, the lengthy Japanese distribution channel made it difficult for manufacturers to keep their finger on the pulse of the market. To overcome this obstacle, manufacturers used two techniques (Martin et al. 1998):

1. Many manufactures opened and operated "antenna" stores which were designed to broadcast ideas and receive ideas and feedback from consumers.
2. Another technique used by many manufacturers was having their own distribution channels; Matsushita sold through 56,000 retail outlets half of which sold only Matsushita products and were therefore solely dependent on Matsushita.

Japanese executives themselves give four reasons why distribution is a problem in Japan (Martin et al. 1998):

1. Limited space and crowded conditions cause low inventories and many small deliveries
2. Slow transportation because of congestion on an inadequate roadway system
3. Government regulations that protect small distributors and small retailers
4. Tradition-bound commitments and longstanding trading relationships among distributors, some of which have existed for generations

Because of mentioned problem, there is an essential need to an accurate and appropriate plan to overcome existence obstacles. Japanese tried different solutions to achieve success, they employed lean supply chain, continuous improvement thechniques and intelligently use of IT. In the past, logistics and logistics departments used to be regarded as "cost centers that just cost money". In order to change these industry views on logistics, improvements to change logistics to profit centers with high value and thorough implementation of compliance that is the premise for improvements are necessary. In the future, Japanese Industries will continue to promote optimal logistics solutions.

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Chapter 7
Privatization

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Supply chain consists of different entities with various responsibilities, but all of them follow one purpose: reaching to high satisfaction of their customers to maximize their profit individually and supply chain profit as a whole. Each entity in each echelon has an ownership, whether governmental or private. Whether the ownership affects supply chain performance, its profit and other things are subjects that are discussed in this chapter by introducing privatization and its effects and challenges.

Regarding living in a changing and competitive world, governments tend to reduce size of fiscal deficit, improve efficiency, and develop capital market to be viable and powerful in such world but, most of them are affected by weak performance of public or state-owned enterprises. State-owned enterprises domination was an obstacle for reaching these situations for most countries, so they approached to divest government of state-owned enterprises domination. Concerning "Open doors" policy, liberalization and commercialization, the doors were really opened slowly to private sectors for privatization. Nowadays, the main question is "How we should privatize our tasks rather than whether privatization or not?"

Privatization has faced worldwide acceptance in the past decade. During 1990–2000 the compound annual average growth rate was around 10%. It denoted that global privatization revenues jumped from \$25 billion in 1990 to \$200 billion in 2000. In addition to increased growth rates and revenues, the number of countries that have implemented privatization policies exceeded 110. In short, we can say that private participation and privatization influenced a variety of aspects of economic activities. The most important yield is that, after two decades of applying privatization, there is not any country that has started privatization and reversed gear or stopped halfway. Privatization progressed from the time it covered all sectors of economic activity, with majority of telecommunications, transportation and energy. For example, telecommunications alone has accounted for an average of 30% of total privatization proceeds in 1994–1997 and around 50% in 1998–1999.

Figure 7.1 shows the value of global privatization revenues from 1990 to 2000.

Although developing countries started privatization after developed countries, they had much attention to it. You can see this in Fig. 7.2.

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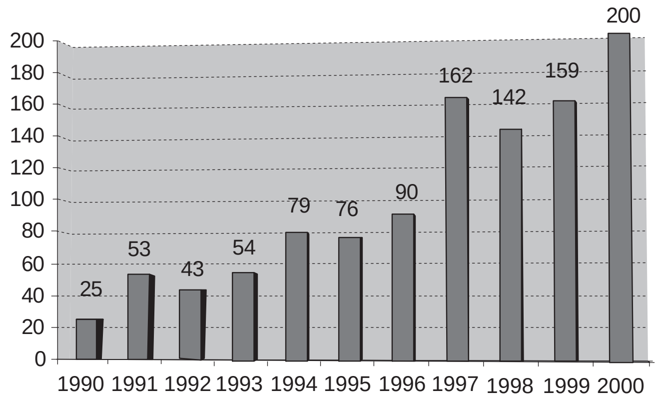

Fig. 7.1 Global revenues of privatization (Shehadi 2002)

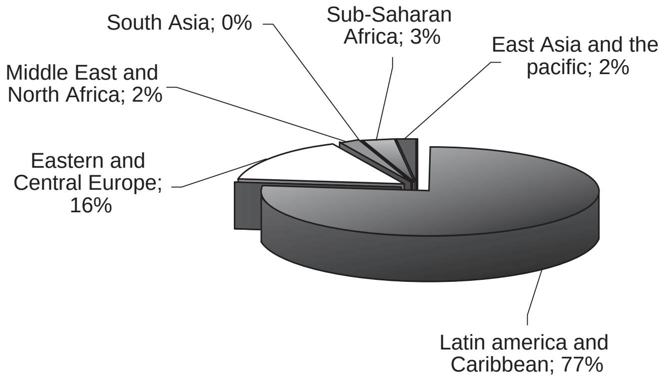

Fig. 7.2 Revenues of privatization in developing countries in 1998 (Shehadi 2002)

This chapter is composed of the following sections:

– A literature review on privatization and its definition
– Steps to privatization
– Privatization methods
– Selecting appropriate method
– Impact of privatization
– Obstacles and challenges in the progress of privatization
– Managing privatization program
– New opportunities
– Challenges
– Related case studies

7.1 A Literature Review on Privatization and its Definition

Ownership has its cost and benefit economical considerations in contracting out. Ownership has a two side factor with one pulse and one negative. On pulse side it can facilitate reaching profitable sales, reduces long-term cost, and provides a capital basis for efficient enterprise operation. But on the negative side, ownership often involves ongoing maintenance costs, costs related to transforming capital assets into liquid assets and need for some political will to provide for long-term capital replacement when it is politically more expedient to provide tax relief or new services to citizens (Johnson and Walzer 2000).

Traditional ideology of Anglo-Saxon economists before the 1970s was based on the idea that ownership did not matter when it came to efficiency; it depends on market structure within which supplier and providers operate i.e., market structure is the determinant of behavior. The question is where public ownership may be desirable? Public ownership can be desirable when there are public good elements in supply and other alternatives, such as subsidies, are difficult, for the reasons of leakages and transactions costs, to apply, but in these cases it was a matter of practical expediency rather than criteria.

In other cases, when there are some externalities that cannot be easily eternalized by property rights allocations, again public ownership can be justified. When the output is a merit good, again there may be a rational for public ownership. For a variety of reasons, the notion of the state-supply model has come under security in recent years. The major effect of privatization and liberalization of markets have brought this question again that "ownership doesn't matter." It was clearly of increased efficiency through establishing principal-agent relationship by variety of private sectors. Privatization has also resulted in divesting of supply through outsourcing and this again leads to enhancing efficiency. The final aim of less government involvement in supplying is known generally as injecting "commercialization" into the system.

Commercialization can involve full privatization but it is not as just this means. It can mean outsourcing when the ownership does not change but tasks, works and responsibilities are shifted to a private sector. The government and private sectors can cooperate with each other. Generally, greater commercialization and particularly privatization was introduced into many sectors in the 1980s and 1990s. It was realized that many of the outputs, products or services of state enterprises do not need public provision. New vision of competition is that open market permitting potential entry can curtail some of the power of monopolies, at least some private sector input would allow more flexibility in investment financing, and they have more incentives to grow for competition. At a more macro level, some governments also saw the opportunity to use funds raised by privatization as ways for smoothing transition to lower tax regimes as national deficits were reduced. In other cases, the motivation was more ideological rather than economic. For example, in UK, the notion of a "Share-owning Democracy" underlined much of the privatization process in the 1980s and 1990s (Kulkurni and Sharma, 2004).

Privatization has been a major reform issue in the developing countries since the mid-1980s, with different names-“*desincorporaciÓn*” in Mexico, “*capitalization*” in Bolivia, “*divestment*” in India and “*peoplisation*” in Sri Lanka. With these different labels we can understand that privatization had various ways in each country. Some states have moved rapidly to divest themselves of their public enterprises, while others have progressed at little more snails’ pace, selling only a few strategically unimportant state assets, such as state- run hotels or bottling companies (Hakan 2005).

Morocco was first Arab country that formally implemented privatization as a policy, after that Tunisia, Jordan and Egypt followed it quickly. Latin America started privatization in 1990s. We can not just say that privatization reached worldwide acceptance but it is a measure of maturation in these days.

Now, it is necessary to exactly define privatization policy. The most complete definition that we can say is the first definition in our chapter of privatization.

Privatization is a compound policy based on six empirically supported hypotheses; First, that “ownership matters” i.e., when the firm has a private owner, the economic performance is optimized. Second, the “management matters” i.e., for private manager, his own interests and shareholders are important. So, he tries to attract and satisfy himself and shareholders with delivering much better economic performance than do politicians or bureaucrats. Third, the “market matters” i.e., the business decisions should be driven by demand in competitive markets, rather than dictated exogenously by politics or other forces. Forth, the “competition matters” i.e., we should not forget the effect of competition as an invisible hand in economy that injects incentives and motivation to growth. Fifth, the “freedom of fail matters” denoted to possibility of a bankrupt firm exiting the market is a necessary part of a competitive and healthy market. Finally, the “regulation matters” denoted to the role of effective regulation in balancing the interests of firms and customers in market with no competition (Shehadi 2002).

Privatization is “any process aimed at shifting functions and responsibilities, in whole or in part, from the government to the private sector” (see http://www.gao.gov).

Privatization in its most traditional form refers to “public sector divestiture of assets and service responsibilities, allowing the private sector to take over all aspects of service and service delivery.” (Johnson and Walzer 2000)

Privatization is the abolition of barriers to private sectors’ provision of services or the infrastructure necessary for their delivery (Shehadi 2002).

7.2 Steps to Privatization (Shehadi 2002)

Governments that have succeeded in privatization should try to follow the best appropriate strategy for implementation of it. Privatization can be implemented in following steps.

7.2.1 First Phase: Getting Ready

Step 1. Identification of privatization candidates: The first major step in this process is to define the objectives of privatization in general and of the specific transaction in particular.
Step 2. Feasibility study: The second major step is to determine the necessity of company or sector restructuring.

By reviewing of the candidates and after recognizing the preparations required for each transaction to go forward, governments should then define their overall privatization strategy.

However, the existence of a strategy that addresses a number of issues seems to be necessary:

– The candidates for privatization. An approach, which provides flexibility and predictability, would be to have annual or biennial programs, with identified privatization transactions.
– The timeframe for each privatization.
– The priorities for the overall program. Even when the political will exists, when there is no opposition, and when the enterprise is cooperating, the capacity of a government to manage a transaction in most developing countries is restricted. To be effective, governments have to make choices and set priorities. In any situation, before setting of priorities, a careful assessment of both the importance of the transaction to the economy, and the feasibility of the transaction within the given timeframe should be done.

Once the overall privatization strategy and the individual transaction strategies have been selected, the government can then proceed to the next phase.

7.2.2 Second Phase: Moving to Sale

Step 3. Privatization plan
Step 4. Legislation or executive order
Step 5. Sale

In this phase, government should provide a vision on the future role of the state, the roles and responsibilities of the various participants (government departments, civil society and the private sector) in the privatization process, the guidelines for each infrastructure privatization (market structure, regulatory design, etc.), the use of proceeds, social and labor concerns, and how they will be addressed. Within this context, the government can then define the appropriate privatization method.

7.3 Privatization Methods

– Asset sale or long-term lease
– Contracting out (outsourcing)
– Corporatization
– Franchise
– Internal markets
– Joint venture
– Management contracts
– Private infrastructure
– Partnership
– Public–private-partnership
– Anchor investor sale
– Performance-based contracts
– Self-help
– Volunteer
– Vouchers

These forms of privatization are the most important forms that are partially different from each other in terms of structure. Our main aim is to know these forms best in order to be able to choose the most appropriate structure in various cases. We now illustrate their definition and some examples where needed.

7.3.1 Asset Sale or Long Term Lease

The government sells assets or leases them for long term to private firms with the aim of turning physical capital to financial capital. These assets are such as airports, gas utilities or real estate (Johnson and Walzer 2000). In other word, asset sale is the transfer of ownership of government assets, commercial-type enterprises, or functions to the private sector. In general, the government has no role in financial support, management, or oversight of a sold asset. However, if the asset is sold to a company in an industry with monopolistic characteristics, the government may regulate certain aspect of business, such as utility rates (see http://www.gao.gov).

There are two other forms that are counted as subsets of asset sale. These are *Sale-Leaseback* and *Employee buyout*.

Sale-Leaseback, as its name implies, means that a government agency sells the asset to a private sector and then leases it back. But in Employee buyout an exiting public manager and employee take the public unit privately, typically purchasing the company through an employee stock ownership program (ESOP) or employee stock association (ESA) (Johnson and Walzer 2000). If you are eager to know more about ESOP refer to http://www.gao.gov.

7.3.2 Contracting Out (Outsourcing)

Contracting out is the selecting and hiring of private firms or non-profit organizations to provide goods or services for the government. In this form of privatization, government remains financier and it can select or reject the private firms because of their quality, performance, economic considerations, etc. but they contract and act according to it. (Johnson and Walzer, 2000; http://www.gao.gov)

"Outsourcing is defined as the contracting of one or more of a company's business processes to an outside service provider to help increase value, by primarily reducing operating cost and focusing on core competencies."

Outsourcing, according to Coopers & Lybrand's Breakpoint: Business Process Redesign, is "the practice of contracting out for services once run by an organization's employees and managers." (Kulkurni and Sharma 2004)

7.3.3 Corporatization

Government corporations are entities that are separate and created by Congress. The general aim of creating such corporation is, conducting revenue-producing commercial-type activities. They are often freed from certain governmental restrictions related to personnel and procurement. (Johnson and Walzer 2000; http://www.gao.gov)

7.3.4 Franchise

Government gives an exclusive right to provide a service within a specified geographical area. Franchise is divided to two subsets:

– ***Franchising of external services.*** It is the same as the statement above.
– ***Franchising of internal services.*** Under the franchising of internal services, government agencies provide administrative services to other government agencies on a reimbursable basis. In this way, new opportunities are created to obtain administrative services from another governmental entity instead of providing them for themselves (http://www.gao.gov).

7.3.5 Internal Market

In this case, departments are allowed to purchase support services from in-house provider or outside supplier. In-house provider needs to be an independent unit to compete with outside supplier. Some advantages of this system are bringing market forces to bear within an organization. Internal customer can reject the service of in-house provider if they can't satisfy their expectations (Johnson and Walzer 2000).

7.3.6 Joint Venture

In order to control asset management and service delivery, government and private sectors join together and share their responsibilities for policy and management decision. In this case, asset may be owned by the government or by a new private firm. Also, operation and service delivery may be contracted to the private partner or it may be jointly provided (Johnson and Walzer, 2000).

This state can be accounted as one form of public–private-partnership.

7.3.7 Management Contracts

In this type of privatization, just operation of a facility is contracted out to a private sector. This can be used for places such as airports, wastewater plants, arenas, cinemas. (Johnson and Walzer 2000)

7.3.8 Private Infrastructure Development and Operation

The private sector builds finances and operates public infrastructure such as airports and roads, recovering costs through user charges. Two general techniques are used in this case:

– *Build- Operate- Transfer (BOT)*. The private sector does every work for the related project but at the end of complication period, ownership reverts to the government. It is usually applied for public constructions.
– *Build-Own-Operate (BOO)*. The private sector is the owner, too. (Johnson and Walzer 2000)

7.3.9 Partnership

Partnership usually provides opportunities to improve access to new technologies and tools, new research expertise and infrastructure, private equity markets, new product markets, new customers and new marketing and distribution networks. Thus, the *synergies* through knowledge sharing, joint learning, scale economies, resource pooling and cost sharing can be obtained.

Partnerships can help to maximize the efficiency and effectiveness of sustainable development orientated *supply chain management* strategies. Examples of partnerships are discussed below:

– Partnerships among groups of companies working with the same suppliers enable partners to develop common standards and share the costs of monitoring and verification (e.g., the work done by the Hudson Bay Company with other department store chains internationally).

– Partnerships which build private sector capacity in developing countries enable companies to start sourcing products and services from local suppliers, thereby increasing their economic contribution to host countries and reducing operating costs (e.g., the work done by Chevron Texaco and UNDP in Kazakhstan and Angola). (Braun 2005)

7.3.10 Public–Private-Partnership (PPP)

Public–private-Partnership is a contraction conformed between public and private sectors that can include a variety of activities such as development, financing, ownership, and operation of a public facility or service. It is usually related to infrastructure projects or facilities. Through such a partnership, we can improve our ability, skills and strength and also decrease weakness. It occurs by dividing responsibilities and sharing income resulting from the partnership in direct proportion to the partner's investment.

From this partnership, public sector reaches new revenue or service delivery capacity without having to pay the private-sector partner (Johnson and Walzer 2000). In this way, the roles of *public partners* can be defined in terms of core competencies (including identification of public needs, arbitrage between needs and managing contracts for maximal social value creation), time horizon and incentives. Also, there are some roles for *private partners* in terms of core competencies (including technology use and development, economies of scale and scope, development and export of know- how) and reputation building (dynamic incentives and opportunism) (Braun 2005).

7.3.11 Anchor Investor Sales

There is no clear definition of anchor investor sales. So, we explain it with an example; in Egypt the only private company (Cement Misr) tends to buy Abu Zaabal for Fertilizers, but this company was allowed lease Abu Zaabal for a period of 3 years before buying. Cement Misr is committed to paying LE 182.8 million for the company under an installment plan against collateral over a 3-year period. This was an anchor investor sale with a value of LE 128.8 million (CARANA Corporation 2002).

7.3.12 Performance Based Contract

Without considering the *Performance* parameter and trying to improve it, all of the outsourcing, contracting, privatizing and partnering won't work effectively. Some of the most important motivators for outsourcing projects are flexibility and speed, cost containment/certainty, improved quality, access to personnel or skills, innovation and enhancing focus on core mission.

Following considerations will result in a *"Performance-based" contract*:

1. Soliciting bids on the basis of what results you want to achieve rather than what activities you want to conduct.
2. Defining clear performance expectations and measures (baseline vs. expected results).
3. Clearly defining due dates and milestones.
4. Providing incentives for performance.
5. Granting flexibility in exchange for accountability for results.
6. Monitoring to ensure that performance is being achieved.

There are critical factors for *managing* a performance-based contract successfully including:

- Monitoring Performance with regular reporting
- Adjusting:
  - Identifying changes in external factors that will impact performance
  - Devising corrective action plans for deviations
  - Benchmarking and comparing! Analyze for next steps
  - Revise performance targets to continue the push for gains
- Providing comparative performance data to contractors: create a "race to the top" culture
- Communicating and rewarding success (see http://www.knownet.hhs.gov)

7.3.13 Self-Help

Self-Help case generally occurs in community groups or neighborhood organizations to take over a service or government asset such as a local park. The main difference is that the service providers are the service users too. Service providers are non-profit organizations. Such cases are suitable for zoos, museums, fairs, remote parks (Johnson and Walzer 2000).

7.3.14 Volunteers

Volunteers are used to provide all or part of a government service and are conducted through a government volunteer program or non-profit organization and it can be a kind of outsourcing (Johnson and Walzer 2000).

7.3.15 Vouchers

Government pays for the services. These payments subsidize the consumer of the service, yet services are provided by the private sector. In addition to providing

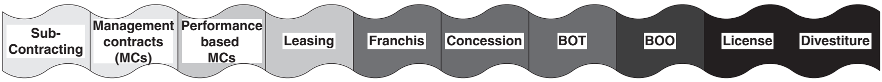

Fig. 7.3 Risk allocation in contract design (Johnson and Walzer 2000)

greater freedom of choice, voucher brings consumer pressure to bear, creating incentive for consumer to shop around service. For service providers to supply high-quality, low-cost services (Johnson and Walzer 2000).

The choice of the privatization method is dependent upon company or sector that decided to be privatized. Therefore, we should identify various methods and the application thereof. Each method has different ranges of risks, commercial between the state and private investor to which we briefly refer in the next section (Fig. 7.3).

7.4 Selecting the Appropriate Method (Shehadi 2002)

There are many methods for privatization or Private Participation in Infrastructure (PPI), but there is no option that fits all. One of the most important determinants of the transaction success is the selection of method and strategy of privatization that has to be made with respect to sector or SOE attributes, the government's policy goals, and the state of the international market.

The method of privatization should carefully trade off between the concerns of investors and consumers to optimize the benefits of privatization.

It is evident that the choice among PPI options results in a different distribution of responsibilities between the private and the public sectors. Anyway, Irrespective of the option for PPI, the state will be responsible for regulation or contract monitoring.

7.5 Impact of Privatization (Shehadi 2002)

The experience of the past two decades of privatization shows that privatization can work effectively. Privatization has had, for the most part, a positive impact on the countries that have implemented it.

In a landmark study, Galal et al. (1994) find that there was a net welfare gain from privatization.

According to their study, the positive welfare effect of privatization resulted from productivity improvements, optimizing investments, efficiency pricing, and increased flexibility in hiring. The study also suggests that the main determinants of the success of privatization are competition in the marketplace into which the enterprise is being divested, effective regulation of non-competitive sectors, the credibility of government commitments, efficient capital markets, the relinquishing of control to the private sector, and transparency in the privatization process.

Here, the impact of privatization on company performance, on fiscal adjustment, on foreign investment, on capital market development, on employment and on poverty is reviewed:

7.5.1 Company Performance

It is agreed that privatization has lead to improvements in financial and operational performance of company. The impact of privatization on the performance of privatized firms can be measured with regard to some of the firm's indicators such as profitability, efficiency or labor productivity, investments, output, dividends, exports and financial leverage.

Governments can make sure that privatization improves company performance through a number of ways including: Divesting into competitive markets; putting in place commercial and corporate legislation that provides for good corporate governance mechanisms such as transparency, accountability of managers to owners, protection of the rights of minority shareholders, etc.; selecting a method for privatization that gives a core of private owners management control of the enterprise; giving the new management the flexibility to hire and fire; and imposing a hard budget constraint on the new enterprise.

7.5.2 Fiscal Adjustment

Governments often implement privatization to overcome serious fiscal pressures, either to decrease the burden of loss-making enterprises on public funds or to increase additional revenues to fill a financing gap.

The fiscal impact of privatization depends on the volume of proceeds and how they are directed.

Privatization itself can generate recurring revenues to the state treasury. First, privatization raises the tax base. Privatized SOEs are subjected to corporate taxation. In the field of privatizing infrastructure sectors, introduction of competition can result in further tax base expansion. Second, the privatization of infrastructure sectors also earns recurring revenues in the form of license fees, radio spectrum fees, right-of-way fees, and other revenues associated with commercial management of the public domain. Third, by removing infrastructure bottlenecks in the medium term and absorbing new investments, privatization can be seen as a catalyst for the expansion of economic activity and the consequent rise in tax revenues.

Governments have to join privatization with parallel measures to manage the public debt efficiently and to reduce the budget deficit. If they decide to use part of the funds to finance development projects, they should put safeguards in place to prevent politically motivated and wasteful government disbursement.

7.5.3 Foreign Investments

Privatization is one of the most effective policies that governments can use to attract foreign investments, both Foreign Direct Investments (FDI) and foreign portfolio investments.

Privatization has increased foreign investments in most countries. However, until governments don't eliminate constraints on foreign investments and don't simplify associated administrative procedures, they can't use privatization as an effective instrument to attract foreign investments. Moreover, they have to improve the legal and judiciary environment for business and bring it up to international "best practice" standards.

7.5.4 Capital Market Development

Privatization has been the main agent in development of capital markets. It has lead to the growth (in terms of market capitalization) and deepening (in terms of numbers of shareholders) of financial markets, as well as increasing their liquidity.

Governments have to upgrade the capital markets legislation and set up an effective financial regulatory authority. They also have to design their privatization transactions in an appropriate way to promote broad share ownership. Social security legislation often has to be revised to support the establishment of private pension funds that will result in liquidity to the market.

7.5.5 Employment

Moving toward privatization is not without its own pitfalls. Still, an issue that continues to plague privatization initiatives is how these strategies affect public employees.

The assessment of the impact of privatization on employment is complex and has different dimensions.

In order to seriously pursuing employment concerns, governments should devise labor strategies, so they would be able to mitigate the adverse results of privatization.

Though the impact of privatization on labor is vague, it has been observed that privatization can have a neutral or even positive effect on employment. In general, since government links privatization with adequate labor policy and social safety nets, beside the implementation of Employee Stock Ownership Plans (ESOPs), privatization leads to a positive effect on labor.

Labor cost is approximately three-fourth of most municipal budgets. When some issues such as performance of government and cost- saving are important, inevitably personnel costs appear more than past.

The opposition from public employee unions and anxiety of the employees themselves can pose a formidable obstacle to privatization. Employees are anxious about loss of job, reduced fees, lower earning, and they don't know about future working conditions. There are five areas of potential impact and ways they will need assistance that should interest public officials:

– Loss of jobs
– Wages and earning
– Building trust
– Coping whit changes
– Enabling leadership (Johnson and Walzer 2000)

7.5.6 Poverty

Privatization and PPI can result in a determinable improvement in overall welfare. If governments design the privatization process regarding objectives, private provision of infrastructure services can be more affordable and provide greater access to the poor than public provision. Governments can comprise service obligations in the contract or devise subsidy schemes to yield a greater share of the benefits to the poor.

7.6 Managing Privatization Program

Privatization is a demanding process that is not without pitfalls. Since we decide to privatize until we achieve results, we should confront with different ranges of pitfalls and obstacle. It's so clear that without any perfect and right management, we fail at the beginning of process. It is necessary to know all aspects of challenges and after that plan the program to manage it in the best way. However, there is no exact and right way to implement privatization program but some necessities may be helpful to manage it in a right way. These are as following:

7.6.1 Political Commitment from the Top Political Leadership

In the first definition of privatization we noted that it is a "policy" so a political power is required to overcome the types of obstacles to a successful transaction: opposition, bureaucratic inertia, and lack of coordination. SOEs and ministries are often not equipped for such vast transformation. And they can not meet privations, their data are not sufficient and there are many other problems. Government can overcome the most important obstacles of privatization mainly by providing political commitment to the process. The ways that government can help to facilitate privatization process depend on circumstance of each country. But international experience suggests these ways:

– Supporting privatization by having the highest executive authority in the country oversee the privatization process, arrange with privatization opponents;
– Mobilizing protection for privatization by the people who are most likely to benefit from it;
– Pursuing a transparent and fair privatization process to eliminate possible corruptions;
– Establishing a labor strategy that consider labors for job and social security;
– Hiring technical expertise as needed: legal, financial, regulatory, etc. in addition to hiring qualified professionals to prepare privatization transactions (Shehadi 2002).

7.6.2 Transparency and Fairness of the Privatization Process

Transparency is an inseparable factor in successful privatization programs, because lack of Transparency leads to misperception about fairness of process, especially for public. The need to existence of transparency can be illustrated in four levels:

First, laws and regulations should direct publicity and openness in the implementation of the program. Second, the advisors should be selected according to pre-announced terms of reference and selection criteria, the selection process itself should be public and competitive. Third, procedures in selecting individuals, purchase prices and selecting criteria in evaluation bidders should be opened, since more investors are encouraged in participating.

In short, transparency has a value and price, in terms of the speed with which transactions can be implemented (Shehadi 2002).

7.6.3 A Desirable Legal Environment

Without supporting legal environment, privatization process will stop at the beginning. Government should provide supporting legal environment before privatization. In such environment, investors (internal or external) are persuaded to invest or sale SOE. Some more important key legalizations are brought in the Table 7.1 (but they are some not all).

7.6.4 Liberalization and Competition before Privatization

The benefits of privatization are not optimized without liberalization and competition. Undoubtedly, one of the main effects of privatization is injecting competition in market, but if we do not liberalize market and follow “open doors” policy, how

Table 7.1 Key legalization on privatization (Shehadi 2002)

Legislation	Relevant features
Bankruptcy law	Condition and procedures for liquidation, bankrupty, and insolvency
Contract law	Considerations about form of contracts
Company law	Restrictions to ownership forms (for example, with or without limited liability, and joint stock company)
	Supporting the establishment of companies
	Providing for minimum capital requirements in case of sale or transfer shares and on protection of minority shareholders
Financial law	Possibility of getting finance from local banks, pension funds, and other financing
Foreign investment law	Identification that whether laws show favoritism between local and foreign ownership and amount of harmony between them
Import/Export law	Rules for importing materials and liabilities for import duties
	Submission to export Control
Tax law	Application of corporate income tax, real estate tax, value-added tax
Labor law	Contractual rights on employees and obligations on employer
	Flexibility in hiring and firing
	Retraining jobs
	ESOP
Civil service law	Civil service benefits
	Price of civil services
Social security law	Voluntary retirement packages
	ESOPs
	Transfer from public to private ownership

can we compete? And on what thing do we want compete when all doors are closed and only monopolies act? Of course, we obtain best results of privatization when it acts in a competitive environment. It is so important that we can say competition and privatization are two inseparable elements for a policy that government decides. Bringing competition into infrastructure services often needs the vertical or horizontal unbundling of a sector.

Horizontal disclosing separates the sector into competing entities in the same market segment (e.g., the break-up of AT&T into regional “Baby Bells”).

Vertical disclosing separates the sector into various components, each at different stage of value chain (e.g., the separation of electricity production, transmission, and distribution). This process takes long time and cost but it has proven to be worth the time and effort spends on it. Table 7.2 brings examples of unbundling sectors into their component activities (Shehadi 2002).

7.6.5 Establish Strategies for Employees

In the discussion on the impact of privatization on labors section, it was noted that opposition and reaction of labors is a hard obstacle in front of progressing privatization, especially in SOEs. Some strategies can help private sectors to solve

Table 7.2 Unbundling sectors into their component activities adapted (Shehadi 2002)

	Horizontal unbundling (Competitive component)	Vertical unbundling (Monopolistic component)
Service	Telecommunication services	Traffic safety
	Passengers and freight transportation	Port or river dredging
	Equipment supply	
Physical Infrastructure	Warehouse	Power transmission and distribution
	Terminals	Roads, rail track
	Power station	Water transport and distribution
	Wireless and long-distance networks	

this dilemma. Reports and studies indicated that communication, employee involvement, and training are crucial in managing a privatization initiative. So, involving employee in the decision making process is an important strategy in reducing negative feedback of employee and minimizing the potential conflict over workforce changes such as privatization. We should provide programs for them. The programs should be aimed to minimize employee opposition and effect of privatization on public employees.

We should train employees about contracting, evaluating contracts.

Here, some of the international experiences with privatization have been listed:

– Governments can and should plan appropriate labor strategies to mitigate the adverse impact of privatization on employment;
– Governments should involve employees and their delegates in early design stages of labor strategies. The particular form of engagement will have to fit the political, social, and economic system of the country;
– Governments should communicate the government's labor strategy to employees and to the public at large;
– Time is valuable and delays in restructuring are costly;
– Governments should implement minimal company restructuring and let the private sector restructure consistently with existing policies and legislation;
– Governments can handle large-scale redundancies better than the private sector. They can minimize labor resistance and set the parameters for subsequent restructuring;
– Governments should beware of setting unsustainable compensation precedents or social safety nets;
– Voluntary programs, such as early retirement schemes, and Employee Stock Ownership Plans (ESOPs) help overcome labor opposition to privatization;
– Governments should reform labor legislation to make labor markets flexible. This will alleviate the adverse consequences of privatization and stimulate faster job creation.

7.6.6 Establish Regulatory Framework

The most important issue in establishing regulatory framework is providing stable, clear and reasonable rules. Establishing such rules is a difficult process, because it should balance the interests of the private partner and citizen or user. The main role of a regulator is to promote competition and bring a clear definition of it. To reach this aim, the regulator should be so powerful that can avoid anti-competitive practices and can license new entrants. Governments can facilitate the establishment of regulatory institutions. One way for facilitating the establishment of regulatory institutions is designing independent and financially autonomous regulatory institutions that are not subject to arbitrary political intervention. This is a very effective way; however, governments are reluctant to use it.

Another factor that governments should consider is the scope of the regulatory authority. For example, some countries have opted for the single-industry regulator, establishing a separate regulator for telecommunications, one for electricity, and so on.

7.6.7 Evaluation and Monitoring

Interest in privatization and competitive government moved beyond ideological and political boundaries to become two of the more popular and successful management practices, but without an established decision making process, several pitfalls can occur.

For example, Indianapolis and Philadelphia have developed systematic approaches to evaluate both privatization and competition for services.

A commission in Indianapolis consists of both public and private sector that have representatives for analyzing costs, competitiveness, and performance evaluation. The Indianapolis model of managed competition allows public employees to bid for contracts.

Philadelphia provides a 19-point checklist to be used by city employees in evaluating contracting for services.

Violent factor which causes a revision of privatization is the change in political climate. Accurate and complete cost data for public services are essential for an effective competitive process.

We can benefit some simple sources such as citizens. Outside and inside sources or customer and citizen involvement can help:

– Shield against potential opposition
– Build a political case for privatization
– Ensure against a charge of favoritism or corruption in privatization decision-making process.

Well-developed privatization or competitive initiatives involve many technical, financial, and legal issues that need variety of expertise sources. They also require citizen and employee input to help in providing accurate information and encourages an open process.

Monitoring and performance evaluation play the main role in continuing the privatization process successfully. Following the lead of the private sector, many public agencies are measuring performance of services to ensure cost-effectiveness and quality. Because, turning a service over to a private firm without any oversight and evaluation can result in lower quality services and higher cost. Especially for services involving environmental regulations, such as solid waste disposal and water and wastewater treatment, monitoring contractor performance has a greater importance. There are some issues that should be evaluated such as, cost, quality and customer satisfaction.

Cost factors are important for city officials to monitor because cost pressure is usually a driving force in the promotion of privatization in the first place. It shouldn't be forgotten why we privatize? One of aims was saving more money, provision of services for people with lower price. Another considerable factor is quality. Cities can assure that contractors meet quality and performance standards by enumerating specific tasks or performance measures in the contract. Citizen satisfaction with contracted services is vital to the long-run success of privatization. There are some simple techniques to evaluate private sectors systematically for municipal officials.

– Monitoring citizen complaints
– Analyzing data and records
– Conducting field inspection
– Conducting citizen survey

It is wise for cities to use a variety of techniques. A single approach may not provide a proper overall picture of performance.

The content of this section is based on Johnson and Walzer (2000).

7.7 New Opportunities

The major area to profit from privatization is government-owned enterprises, infrastructure, and social insurance. These areas consist of three subjects that are radically different with each other, so the ways to reach privatization are different.

These three issues are made clear by some examples in each case. Government-owned enterprises among the world are being privatized. Some examples of government-owned enterprises that are being privatized in united state are:

– Export-Import bank of United States, Federal prison industries, United States postal service, National railroad, Legal Services Corporation, Rural telephone bank, Corporation for public broadcasting.
– Some appropriate infrastructures for contracting are water supply, wastewater treatment, transportation, prisons.

– Social insurance privatization can be applied in social security (for retirement system), social service (child care, job training, administering social programs under government contract).

It is noticeable that vouchers are emerging as the preferred privatization method for some social welfare services for two reasons (Johnson and Walzer 2000, Chap. 3):

– Social services have been monopolistic, and vouchers introduce competition which destroys monopolies and improve services.
– It is difficult to specify quality standards in social services contracts, but vouchers offer a solution because standards do not have to be articulated.

Privatization/contracting would lead to some *progresses*, such as improving legislative framework governing procurement, acquisition, contracting and outsourcing, simplification of procurement and contracting processes and expanding use of Business- oriented acquisition models and information technology, expanding Performance- based contracting and other results- oriented procurement vehicles, substantial decrease in the number of formal bid protest cases as a result of agency efforts to proactively manage contract disputes and where applied effectively, this process stimulates government to be more competitive.

7.8 Challenges (See http://www.knownet.hhs.gov)

It is evident that some *challenges* arise in this way. Some of them are as following:

– Additional efforts are needed within each agency to simplify and streamline procurement and contracting in government.
– Agencies continue to struggle to implement Performance-based contracting and effective contract monitoring systems and implementation of this process is uneven across government.
– The quality of cost data and financial information used in the procurement and outsourcing processes needs to be improved.
– Significant problems surround the implementation of the privatization and greater efforts are needed to involve and protect public employees during the outsourcing process.
– Tension between program staff and contract staff exists, with a need for greater collaboration between the two communities on improving the procurement and contracting processes.
– Some contract officers and program managers lack the skills that are needed as government increasingly turns towards contracted services and outsourcing.

In confronting with these challenges, the following *recommendations* would be helpful: Develop an aggressive champion to lead efforts to improve contracting, procurement and outsourcing in the government, aggressively implement performance-based contracting and provide incentives to contractors for improved results, launch a process to Re-Engineer this process government-wide, continue the trend towards simplification, flexibility and streamlining in government procurement, develop specific proposals to remedy the shortcomings identified in this process, examine alternatives to this process, invest in training contract officers and line managers for managing government programs in a highly contracted and outsourced environment, emphasizing its use as a tool for creating a data base rather than merely a privatization vehicle, collaborate with employees and their unions during outsourcing initiatives and develop pension and benefit portability solutions.

7.9 Case Studies

In this section we investigate some case studies. The main aim is to reach a more sense and understanding about privatization results. The first case is about port privatization, which has logistic approach. The second case discusses rice milling and textile industries in Egypt. The third one discusses institutional and structure changes in air navigation service-providing organizations in different countries. And finally, bank privatization in Argentina is investigated.

The cases are presented briefly in order to make the reader familiar with privatization applications in reality. The cases are introduced in the order mentioned above.

7.9.1 Port Privatization, Efficiency and Competitiveness (Heng 2005)

Today, one of the most obvious phenomena in port industry is port privatization, since ports form a vital link in the overall trading chain and efficiency is an important factor for a nation to achieve internationally competitive advantages.

Based on the principal-agent theory, private ownership should be more efficient than the public one (Hartley et al. 1991; Parker 1994). The transformation from public to private ownership, even without change in the competition, will be associated with improved efficiency (Hartley et al. 1991; Parker 1994).

Many studies have been conducted on the relationship between port ownership structure and its operation efficiency, and the effect of port size on port efficiency. We summarize the result of the past studies about these three fields in Table 7.3.

Since the environment in which ports operate has changed dramatically, ports are affected by various new forces driving global competition, including the far reaching unitization of general cargo, the rise of mega-carriers, the development of inland transport networks, the creation of network linkage among port operators, the market entry of logistics integrators and so on. The eight key determinants of port competitiveness are presented in Heng (2005).

Table 7.3 Result of past studies

Deny	Confirm	Subject
Van Den Broeck et al. (1994)	Liu (1995)	Relation between port ownership structure and port operation efficiency
Baird (2000)	Coto-Milla et al. (2000)	
	Cullinane et al. (2002)	
	Estache et al. (2002)	
	Cullinane et al. (2002)	
Coto-Millan (2000)	Martinez-Budria et al. (1999)	The effect of port size on port efficiency
Tongzon (2001)	Notteboom et al. (2000)	
	Cullinane et al. (2002)	

7.9.1.1 Methodology

This study uses *stochastic Frontier production model* of Battese and Coelli (1995) to investigate the relationship between port ownership structure, port size and technical efficiency. The technical inefficiency effects are specialized as a function of firm specific variables, and the parameters of an inefficiency model are simultaneously estimated with those of stochastic frontier production model. To avoid more complexity and focus on main subject, we don't enter to detail about variables and models. We just show the result of the model:

The result of regression model was as below:

– -0.639: indicated that Ports with larger size are more efficient than port with smaller ones.
– -0.666: said that Positive relationship between technical efficiency and privatization in port industry.
– $+0.415$: denoted that an inverted U-shape relationship between technical efficiency and privatization.

According to this model following ports are known with highest competitiveness Index (Fig. 7.4).

7.9.1.2 Conclusions

– Private sector participation in the port industry is useful for improving port operation efficiency.
– This study shows that the best extent of private participation in container ports/terminal is between the private public and the private mode.
– It is better for port authorities to limit the private sector participation within the "landowner and operator" function and take over the regulatory function.
– Port authorities should introduce private finance, operational & management instead of state funds and administration while they remain in place as regulators.

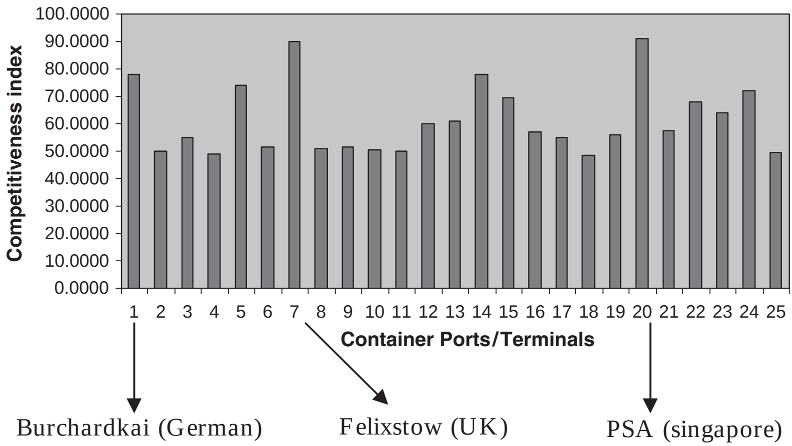

Fig. 7.4 Container port/competitiveness index (Heng 2005)

– Implying partial privatization is as a quite effective way to help port authorities to win in the competition.
– Another most important factor is adaptability to the customer's demand.

7.9.2 Rice Milling and Textile Industry in Egypt after Privatization

Privatization program in Egypt was started in late 1980s and early 1990s. It was promoted by government through establishing law 203. Law 203 denoted to privatize 203 SOE because of the existence of violent crisis in Egypt's economic. After persuading privatization program, substantial changes happened in Egyptian rice milling sectors. Rice became one of the candidate agricultural products to liberalize. Before liberalization of rice market during early 1990s, public sector took 88.2% of market capacity in its hands. Liberalization of mills attracted new entrants and private sector started their growth in this environment. By 1997, private mills overtook public mils in milling capacity. Public castor milling companies lost their market share to the private sectors quickly such that by 1998/1999, the private sector firms obtained 78.6% of the total milling capacity of the sector. In 1998, 7 out of 8 public sector of rice milling was sold by ESA. And final company was sold in 2001 by ESA, too. Competition was the consequence of this privatization. Rice milling in Egypt is now highly dynamic and competitive.

7.9.3 Textile and Garments

The spinning and weaving (textiles) industry plays main role in the economy of Egypt by employing 30% of total industrial workforce in that country and revenue of LE 8 billion, LE 3 billion of exporting. There are 42 public enterprises and 2,356 private enterprises engaged in the textiles industry in Egypt. However, there was private company in this sector together with a public monopoly until the last few years on all the "upstream" stages in the supply chain for cotton textiles. Internal trade, supply of cotton, cotton ginning and spinning of yarn and weaving and dyeing of fabric, all depends on that "upstream" stage with state-owned ownership. These policies have negative impact on competitiveness and dynamism of a sector that could be a much larger exporter and source of job creation. Fortunately, in the past few years, the combination of privatizations and policy liberalization has allowed increasing private sector participation. For example, in cotton ginning, there are seven main gins: two state-owned, two privatized and two new private. The result is to achieve greater degree of choice of suppliers for downstream producers.

7.9.4 Institutional and Structure Changes in Air Navigation Service-Providing Organizations (Button and McDougall 2006)

Major changes are happening in the ways in which ANSs (air navigation service) are provided. They aim is to be single Europe skies, to pay attention to importance of financial factors, to reach new technology, to change ownership structure and economic regulation.

In past years, ANSPs (air navigation service providers) have been paid less attention, why?

1. ANSPs are largely natural monopolies whereby economies of scale, scope, and density, beside transaction cost issues, make competition untenable.
2. ANSPs become distant from the political process, so they tend to focus on a fairly tight community of aviation customers and users.

7.9.4.1 The Air Transportation Value Chain

ATC (air traffic controller) is one element in a longer value chain that ultimately provides air transportation services to customers. One reason to recent pressures to review the nature of ANSs is that many airline markets have been found to be financially unstable, whereas the overall air transportation industry, including navigation services has enjoyed stability. In following figure (Fig. 7.5), you can see the supply chain of air service provision. It shows that Airlines have less return than others.

7.9.4.2 Toward Privatization

– We discussed about commercialization in literature review on privatization. Commercialization is a general word in this context, it includes a variety of different

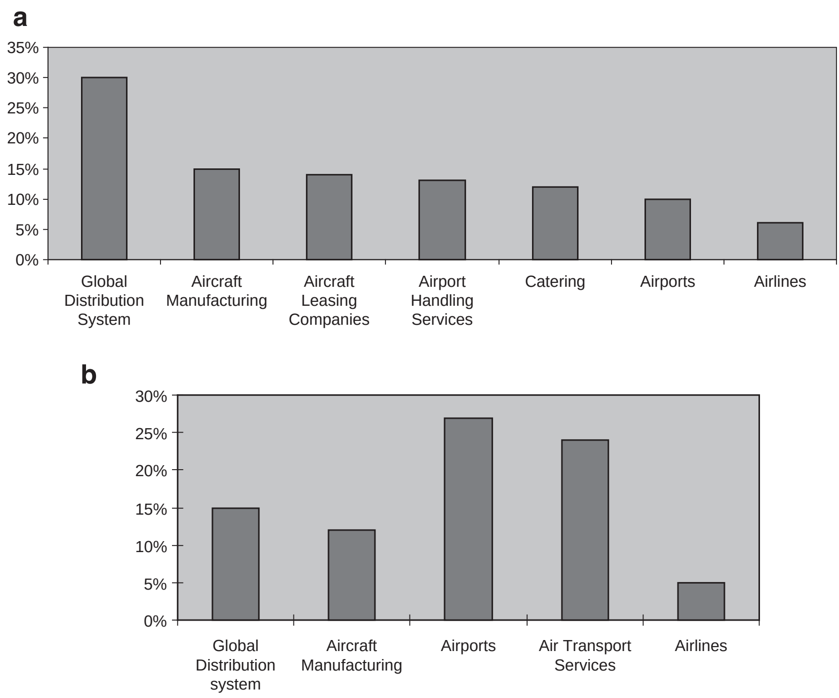

Fig. 7.5 Economic margins of industries within the air transportation sector (**a**) Calculation of return on investment globally (1992–1996) using *McKinsey* data. (**b**) Calculation of operating margins globally (2000–2001) using *Airline Business* data. (Button and McDougall 2006)

measures to bring private sector style incentives into the provision of ATC. The trends related to privatization led to increase in the scale of economies that ANSPs can enjoy and put pressure on more cross-boundary coordination and investment. Domestically, they can profit by labor saving in shadow of this approach. After arriving privatization into air navigation institutes, major changes have accrued. These are represented in form of some graphs. In this case six air navigation institutes are investigated. The first figures i.e., Fig. 7.6 indicate:

- “Commercialization has allowed the ANSPs to implement modernization projects more effectively”
- Any *discernable pattern* for smaller ANSPs because their investment tend to be discrete and irregular.

But data didn’t show all things including followings:

- The nature of the investment.
- Commercialization and access to private finance market pushes their organizations toward the maximum production possibility frontier but there are clear problems of self-interest involved in these insights.
- Investment program are dependent on the capital base.

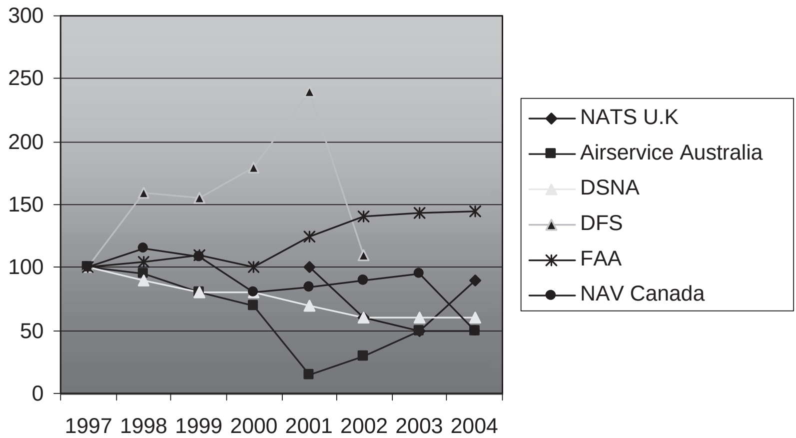

Fig. 7.6 Annual capital expenditures of larger ANSPs (in 2004 prices)

Table 7.4 Returns and saving

Air service Australia	$70 million in standby/money market facilities
	$4 million in overdraft arrangement
NATS UK	$38.6 million liquidity reserve
	$4 million debt-service reserve for 6 month
NAV Canada	$170 million operation and maintenance reserve
	$125 million debt-service reserve
	$520 million as unallocated credit facility balance

– Effect of event such as 11 September 2001.
– Government guarantees help, but moral hazard problems abound.
– Table 7.4 is appropriate for see more details.

Other changes and results under privatization were reducing in delay that is accounted as critical factor. Labor and staff costs are more than 50% costs in air navigation systems. By reducing number of labors and staff and improving their remaining productivity costs come lower and benefits go higher.

7.9.5 Bank Privatization in Argentina (Clarke and Cull 2005)

Clarke and Robert Cull (2005) offered a simple model of the tradeoffs governments and buyers face during provincial bank privatizations of the 1990s in Argentina. In addition to price, the buyer is concerned with solvency and profitability following privatization and politicians are concerned with layoffs and service coverage. This is the first theoretical model that tries to show how political incentives affect the features of bank privatization contracts and to test whether the outcomes meet the model's predictions.

At the beginning of the 1990s, the public provincial banks had poor performance in terms of portfolio quality, the efficiency with which they generated income, and their return on assets. The provincial governments could borrow from the public provincial banks, which would then discount the loans to the Central Bank of Argentina. Moreover, if the provincial banks became insolvent, the Central Bank bailed them out. As a result, provincial governments had little motivation to monitor management closely and could use the banks to finance desired programs at a relatively low cost.

This arrangement finished in the early 1990s, when the newly elected Menem administration implemented the Convertibility Plan. The Convertibility Law, and the new 1992 Charter of the Central Bank that advocated it, vastly affected the provincial banks, by preventing the Central Bank from rediscounting loans and from guaranteeing bank deposits.

Taking advantage of the Tequila Crisis in December 1994, the Federal Government, with the assistance of the World Bank and the Inter-American Development Bank, established the Fondo Fiduciario to further encourage privatization. This federal agency extended loans to the provinces to help them privatize their provincial banks.

Under this program, the provinces separate the public provincial banks into two sections- a healthy bank to be privatized and a residual entity containing non-viable assets.

The basic strategy was to transfer the most attractive assets to the privatized bank and then to match those assets with liabilities up to the point that the privatized bank's net worth met Argentina's prudential standards. The provinces used the loans from the Fondo Fiduciario converting short-term obligations to long-term loans.

To pass a substantial share of low-quality assets onto a private purchaser while imposing branching and labor constraints would have been difficult, if not impossible, without concessions on other dimensions. The most attractive of these were the service contracts that were awarded to purchasers to provide banking services to the provinces and guarantees as to the quality of the acquired assets. Instead of verifying the quality of individual assets, which would have been time-intensive, many provinces guaranteed a substantial share of the assets transferred to the privatized bank.

7.10 Conclusion

Argentina's provincial bank privatizations of the 1990s offer a unique opportunity to study these issues. During this privatization, different provincial politicians, who faced different constraints, agreed with private purchasers for the sale of their loss-making public banks. Since the privatization contracts differed significantly in some regards, it can be investigated how the different incentives and constraints facing different decision makers affected contract design.

Although their sample is quite small, the empirical evidence supports a number of the theoretical predictions. For example, politicians in provinces with poor fiscal health were able to protect jobs for fewer bank employees and received higher payments for their banks. Additionally, the evidence suggests that the Tequila Crisis indicated that politicians could protect fewer jobs and had to assume a higher share of their public banks' assets.

Their model predicted that when buyers had less expertise in managing a loan portfolio, smaller portions of the loan portfolio would be transferred to the privatized bank.

In practice, due to the relatively short post-privatization experience for most banks and because the banks are still going through a balancing process, the complete assessment of bank privatization in Argentina is difficult. However, there is some evidence that banks privatized after the Tequila Crisis have performed better than those privatized before the crisis. This suggests that the Crisis may have wrought some unforeseen benefits by tying politicians' hands.

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Chapter 8
Export Clusters

Seyed Vahid Moosavi and Mahdi Noorizadegan

Industrial clusters, specially export-oriented clusters are rather new and emerging strategies for companies and countries to achieve export development throughout the world. According to Porter (1998) in his well known paper, clusters and the new economics of competition, "paradoxically, the enduring competitive advantages in a global economy lie increasingly in local things – knowledge, relationships, and motivation that distant rivals cannot match". These clusters have been considered as competitive advantage of nations.

The experience of several developed economies including United States (in, for instance, Silicon Valley, California; Research Triangle, North Carolina; etc.) and other regions of the world (e.g. Ireland, Scotland, Singapore, New Zealand, and Australia) has demonstrated that strong clusters ensure sustainable competitive advantage within a region. Examples for developing countries are clusters in India, Pakistan, Turkey, Chile, and Brazil to name a few.

In this chapter, we will discuss different aspects of clusters and export oriented clusters, and attempt to highlight key issues in developing successful clusters.

8.1 Cluster Definition

There is no precise definition for clusters and almost all of the existing definitions are based on the description of clusters. The following definitions are the most acceptable ones among the researchers and practitioners. According to Porter (1998), "a cluster is a geographically proximate group of interconnected companies and associated institutions in a particular field linked by commonalities and complementarities. Clusters encompass an array of linked industries and other entities important to competition... including governmental organizations and other institutions – such as universities, standard setting agencies, think tanks, vocational training providers and trade associations." UNIDO[1] also defines clusters as

[1] United Nations Industrial Development Organization.

R. Zanjirani Farahani et al., *Supply Chain and Logistics in National, International and Governmental Environment.* Contributions to Management Science.
DOI 10.1007/978-3-7908-2156-7_8,

sectoral and geographical concentrations of enterprises that produce and sell a range of related or complementary products and thus, face common challenges and opportunities (UNIDO 2001). Another definition points out that an industry cluster is "a group of business enterprises and non-business organizations for whom membership within the group is an important element of each member firm's individual competitiveness. Binding the cluster together are buyer–supplier relationships, or common technologies, common buyers or distribution channels, or common labor pools" (Bergman and Feser 1999).

Rosenfeld (1997) indicates that an industry cluster is "a geographically bounded concentration of similar, related or complementary businesses, with active channels for business transactions, communications and dialog that share specialized infrastructure, labor markets and services, and that are faced with common opportunities and threats." Most of the above definitions focus on the geographic scope of clusters. Based on this feature, clusters can be divided into two categories of "deep" and "shallow" clusters. A cluster's depth refers to the number of firms in a specific geographic area. Where there is a large concentration of firms in a particular area, the cluster is said to be "deep" and, conversely, where there is a low concentration of firms, the cluster is said to be "shallow".

And finally, clusters are inter-related industries and institutions that mutually reinforce and enhance competitive advantage by acting as each other's consumers, competitors, partners, suppliers and sources of research and development, relying on collaboration and cooperation between public and private sectors, breaking down barriers and promoting the intangible assets of synergy, trust and social capital. Clusters give an industry a stronger collective voice on R&D funding, skill development, legislation and regulations.

Cluster-based economical policies are nowadays considered as an essential component of SME[2]s development in many countries. Many of the constraints facing SMEs are related to SMEs isolation rather than their limited size. Clustering and closer cooperation among SMEs can, therefore, be a solution. SMEs in a cluster could benefit from the cluster's advertisement impact and the possibility of meeting the requirements of large-scale orders through networking. Moreover, cluster members benefit from collective actions such as joint marketing, purchasing, and technology management, training, facilities, testing, etc. which are all factors that lead to achieving economies of scale. Therefore, the key feature of this type of SME grouping is cluster dynamics which lead to SMEs growth. As companies spin-off and compete with each other to expand their production capabilities, technological variation occurs within the cluster. More specialization increases/intensifies the need for cooperation and horizontal integration between partners offers new business opportunities within the cluster. More integration leads to the overall specialization of the cluster and increases its dynamics and competitiveness.

Before further detail, it is necessary to distinguish between clusters and networks. Networks are groups of firms that cooperate on a joint development project, complementing each other and specializing in order to overcome common problems, and

[2] Small and Medium Sized Enterprises.

achieve collective efficiency and penetrate markets beyond their individual reach. But as networking intensifies and more and more enterprises get involved, the territorial, or *cluster*, dimension starts to emerge with the involvement of business development service providers, associations of enterprises and government institutions. Therefore, a larger number of different institutions are required to be involved to construct a cluster.

8.2 Export Oriented Clusters

In Sect. 8.1, we completely discussed the definition of clusters; however, our focus in this chapter is on clusters with export orientation, or clustering as a strategy for development of export. Here, the main questions are "Do cluster based firms perform better internationally?" and "Is export development a common priority for cluster initiatives?"

According to a recent study (Solvell et al. 2003), 84% of the studied cluster initiatives had a strong component of export promotion as part of their commercial objectives. The opportunities clusters offer firms to significantly increase the quantity and quality of export has been well established through experiences, such as in Tirupur textile cluster in India. The textile entrepreneurs in Tirupur believe that the formation of the Tirupur Exporters' Association (TEA) in 1990 and the activities pursued within the cluster strategy played a major role in upgrading the clusters' capabilities and, ultimately, lead to a tenfold increase of exports in 10 years.

Particularly, in smaller and developing countries, export promotion tends to be a primary focus of cluster initiatives. Establishing a successful presence in foreign markets is considerably more difficult for an SME than for a large enterprise, particularly in developing countries. Minimum volume requirements, quality controls, complex export processes, and limited financial resources are the main barriers for a less experienced and smaller enterprise.

Here again there are success stories. Costa Rica's Electronics and Information Technology cluster, a partnership between the government and the private sector, resulted in advanced manufacturing operations leading to the export of $44M (USD) of medical equipment and $36M (USD) of communication equipment (Singh 2003).

It can be inferred from the successful export clusters in the world that there are two approaches for developing export clusters, which can be referred to as backward and forward development of clusters, similar to the well-known backward and forward integration strategy of firms. The basic definition of cluster dictates the geographic proximity of the cluster's entities; however, as global supply chains increasingly become more integrated, there are more and more examples where this integration has led to additional investments and activities that ultimately strengthened the exporting cluster. For example, in Caldas, Colombia, Nespresso has established relationships with local cooperatives to produce "specialty coffee" as a buyer. This initiative includes joint activities in areas such as specialized technical education, tasting, quality control, infrastructure upgrading, logistics, and traceability. This has contributed to the Colombia's ability to compete successfully in the "specialty and gourmet" coffee segment, where increased and consistent quality strongly influence the market price of the product. This type of cluster development can be called backward development in which the international buyers cooperate with local (usually small) producer due to some regional advantages of producers. In the other type of cluster development, forward approach, which is a common industrial cluster initiative; firms cooperate with each other to take advantage from collective actions. A successful example is the evolution of the Tirupur knitted garment cluster. The creation of the Tirupur Exporters' Association (TEA) in 1990 was the first real step in creating the cluster. By the end of 2004, the value of exports had risen from the level of $100 million in 1990 to $1.2 billion. Growth in garment making also triggered a parallel expansion within supply and service industries (e.g. yarn spinning, bleaching, dyeing, compacting, mercerizing and printing). Local spinning and dyeing capacity increased by 5 and 20 times, respectively, as garment-makers invested in their own facilities and specialized facilities were set up.

Finally, to conclude, we can consider the advantages of clustering as follows:

– Collective efficiency (creating synergy),
– Opportunities to *access market information* more expeditiously,
– Ability to obtain specialized inputs and technical support more easily and cost-effectively,
– Ability to participate in '*consortiums*' to fulfill large orders,
– Ability to leverage market development and promotional expenses,
– *Group shipments* to minimize transportation costs.

In the next sections, we will discuss some important issues and insights regarding the successful development of clusters and export promotion strategies. These issues are as follows:

– The "Four Gears" model of a National Export Strategy
– Cluster life cycle
– Different structures for different clusters
– Infrastructure development, financing and public–private-partnership (government regulations)
– Cluster success factors and assessment measures

8.3 The Four Gears Model of a National Export Strategy

In 2003, the International Trade Centre (ITC) introduced an "Export Strategy Template"[3] process guideline to help export strategy makers with their efforts to build a comprehensive and effective export strategy.

[3] For details of this guideline see http://www.intracen.org/wedf/ef2006/Strategy-Tools.htm

This model consists of four key focus areas on which export strategy makers must focus to evaluate their current competitive position and to establish an export strategy agenda. The model has been illustrated in the Fig. 8.1. As shown in the figure, each gear drives the other gears. This characteristic shows the effect of different areas on each other and the importance of driving all gears in the same direction. This means that the success of an area can lead to the success of the other areas and vise versa.

It has been discussed in ITC 2005 that effective cluster initiatives must address all of the competitiveness and developmental "gears" of a national export strategy.

Three of the gears deal directly with cluster competitiveness. The fourth gear, the development gear, is concerned with the contribution the cluster makes to socio-economic growth in the cluster's geographic area. In each of these gears, strategy makers have to consider the following issues:

– *Border-in issues.* Services in this area include enhancing existing supply capacities, capacity diversification, and inter-firm collaboration and networking, technology transfer and information exchange, collaborative production arrangements and competency development in export management.
– *Border issues.* Address bottlenecks in trade-related infrastructure, administrative procedures and documentation such as transportation, trade facilitation, company registration, cost and availability of pre-shipment and post-shipment finance and guarantees as well as non-tradable costs such as the cost of acquiring ISO certification.
– *Border-out issues.* Support exporters in dealing with opportunity identification, markets development and national promotion issues.

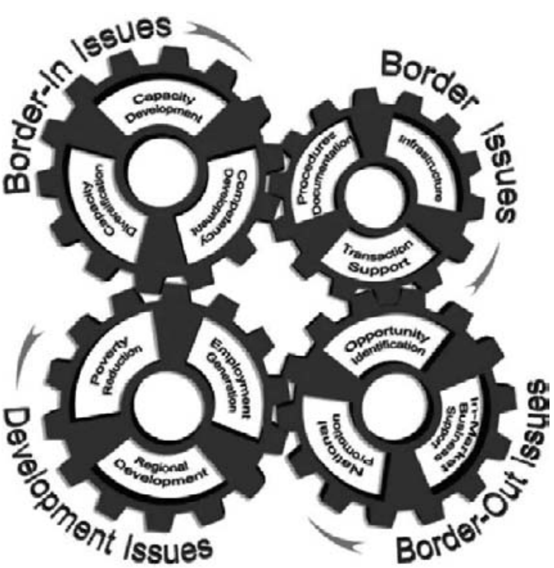

Fig. 8.1 The four gears model of national export strategy (ITC 2005)

– *Development issues.* Export strategies must also address the outcomes in terms of employment generation, poverty reduction and regional development.

Here, one may wonder what the differences, or similarities, between export consortia, as a strategic approach among firms, and export oriented clusters are. According to UNIDO guide on export consortia (UNIDO 2003), "An export consortium is a voluntary alliance of firms with the objective of promoting the goods and services of its members abroad and facilitating the export of these products through joint actions." Bangalore Machine tool cluster can be considered as a successful consortium (ITC 2005): where 56 SMEs were organized into nine marketing consortiums. So far one of its main achievements, in terms of export-related activities, has been the entry of one consortium into the Chinese market, which would have been impossible for any single firm to achieve. In general, the achievements of consortiums include:

– Alignment of efforts among firms and between firms and providers of business development services
– Elaboration of common brochures
– Establishment of joint marketing offices across the country
– Appointment of common sales agents
– Creation of common websites
– Joint advertising campaigns
– Common warehouses
– Collective participation in more international exhibitions

A key finding related to the role of export consortia and clustering in Brazil (Netto 2005) is that export consortia can be established inside a clustering system. However, it is still difficult to measure the impact of a cluster on the internationalization process of an export consortia or vice-versa. Indeed, analyzing the evolution of the collective approach strategies for SMEs, makes it clear that the export consortium is one step behind from the clustering system.

The clustering strategy offers unique aspects which strengthen the sustainability of this model. These aspects include the presence of high levels of cooperation and integration, collective learning and the presence of different actors. The export consortia can be a helpful tool which can leverage and accelerate the cluster's internationalization process, but clustering allows exploring and acting over the three dimensions of competitiveness: the structural (macroeconomic), the systemic (territory) and the enterprise level (inside firms).

8.4 Cluster Life Cycle

Clusters, just like any other live/dynamic system, have life cycles, but a main difference is that clusters are never created from scratch. According to Porter (1998), "Cluster development can be enhanced by conscious private and public action". However, there have been numerous cases following an "unrealistic dream" approach to cluster identification, as was the case for several countries that embarked on extravagant projects centered on information and communication technology clusters. These initiatives were based on hopes rather than on a thorough analysis of potential and local conditions. ITC 2005 indicates a number of conditions which is required for potential clusters to be successful, such as confirmed production capacity within the target geographic area based on SMEs (and possibly one or more larger, prospective lead producers), some form of actual or potential competitive advantage (defined in terms of process, product, location or cost), latent readiness among producers to cooperate, and more importantly international demand for the product.

Clusters are dynamic and have a recognizable life cycle. The interventions that are appropriate at an early stage in the lifecycle of a cluster are likely to differ from those appropriate at later stages. The lifecycle is often described in different ways. Here, we describe the DTI model (DTI 2003) of cluster life cycle which can be represented simply as a cyclical process composed of four stages as Fig. 8.2:

As we can see the life cycle has been separated to four stages as follows:

– *Embryonic clusters.* Those at the early stages of growth.
– *Established clusters.* Those perceived as having room for further growth.
– *Mature clusters.* Those that are stable or will find further growth difficult.
– *Declining clusters.* Those which have reached their peak and are failing or declining clusters at this stage are sometimes able to reinvent themselves and enter the cycle again.

An important note here is how the public sector or leader(s) of clusters intervene in different stages of cluster life cycle. In embryonic clusters, government and intermediary brokers can be important in encouraging collaboration and acting as

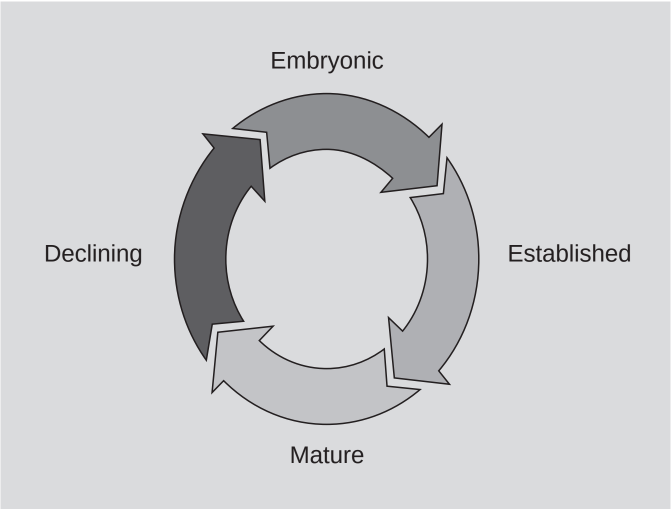

Fig. 8.2 The stages of the cluster lifecycle (DTI 2003)

information brokers, a role that may not be needed at a later stage. In embryonic clusters, for example, the prerequisite local conditions exist, but further development of the cluster requires a catalyst – the opening of an industrial park, or the building of specifically needed infrastructure – or a combination of catalytic inputs (including, for example, the emergence of entrepreneurial leadership such as Tirupur Exporter Association).

In the maturity stage, risks of stagnation and lack of competitiveness may lead the cluster to enter its decline phase. In this stage, firms and strategy makers should transform the cluster to earlier stages, such as embryonic or established phases. This can be best achieved through *product diversification*, *market repositioning* and/or *technology acquisition*.

8.5 Structure of Clusters

The main question in this section may be: "what is the right organization mechanism to support cluster development?" The organizational structure of a cluster can vary based on two factors: firstly, the degree of cluster specialization and cluster depth, and, secondly, the life cycle stage of the cluster. Even though these two factors are relevant, organizational structure of cluster changes between informal and formal structures. Awareness of strategy and policy makers of these conditions is very critical to sustain a successful cluster over time. In general, it appears that as clusters upgrade their capabilities and become more sophisticated, they tend to add formal organizational structures. This is certainly the case when a cluster becomes involved in infrastructure development or other initiatives involving a significant financial component. Nevertheless, it is important to know that there is no "best practice". According to (ITC 2005), although TEA, as a formal structure, was clearly instrumental in the success of the knitwear cluster, two other equally successful Indian examples – the hosiery cluster in Ludhiana and the ICT cluster in Bangalore – do not have a cluster "organization" per se. Clusters in northern Italy have been traditionally based on interpersonal relationships and old commercial relationships that built "social capital" in the form of strong "trust" between players. Existence of trust in clusters with informal structures is an essentially important factor. Schmitz (1999) has extensively emphasized the role of trust in export clusters in Brazilian shoes export clusters and Pakistan surgical instrument export. In *leather* shoes, the Sinos Valley in Southern Brazil accounted for about 10% of world exports in 1990; having started from near zero in 1970, and the cluster of Sialkot is estimated to account for over 20% of world exports in surgical instruments, making Pakistan the second largest exporter after Germany. According to his paper, "The Valley was rich in social capital but poor in financial capital. The latter was to some extent overcome by pooling financial resources." Finally, Schmitz (1999) concludes that, there are two distinguished types of trust (Fig. 8.3): one is based on family, ethnic or other attributes (which are called "ascribed"), and the other is based on not old socio-cultural ties but on conscious investment in inter-firm relationships (earned trust).

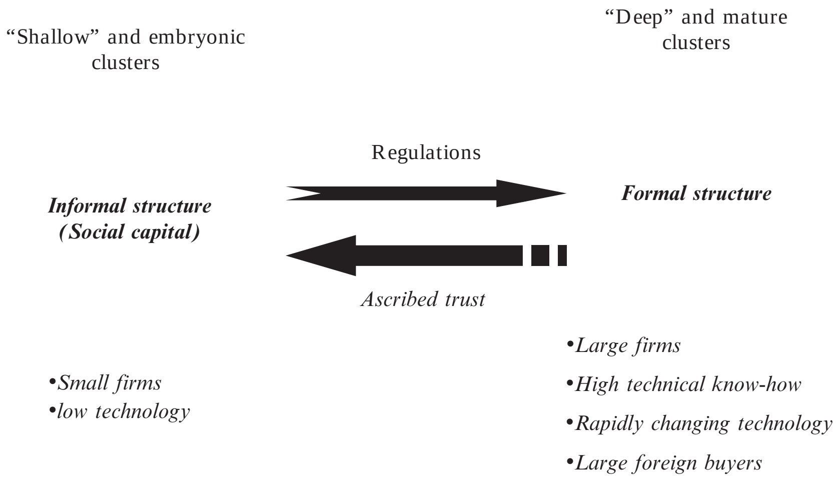

Fig. 8.3 Transforming structures of clusters (Schmitz 1999)

The former usually exists in earlier stages of clusters and gradually transforms to the latter. Also, there are three categories of trust in the Pakistani cluster called: caste or "biradari", family ties, and social networks based on being "local".

8.6 The Role of Public Sector and Financing in Clusters

To develop a successful cluster, the existence of a catalyst, a coordinator and a leader is almost essential. However, in developing or developed countries this catalyst can be a public or private entity or a mixture of both. Furthermore, there is also a growing consensus about the importance of the role played by other key cluster actors, such as educational and research institutions, financial institutions, suppliers, and integration with the global operations and firms relevant to the sector.

In this section, we will discuss the impact of government on clusters, and financing support institutes in different types of clusters.

Before providing further details, it is necessary to distinguish conditions in developing economies and developed ones. According to studies examining clusters in different places of the world, there are important differences in the dominant basis of cluster competitiveness in developing nations. In general, SMEs in transitional economies can operate under severe financial constraints and heavy distortions. Many other conditions are also generally weaker in developing countries. Deficient physical infrastructure, rigid labor laws, and weaker justice systems generally hinder the development of a strong and internationally competitive cluster. Many transition economies also have a legacy of public ownership and public dominance over resource allocation and central planning.

Singh (2003) has investigated the government's role as a cluster catalyst and indicated the key government functions, actions and impact on selected clusters along with areas for governments to support clusters with several examples of government's intervention in different parts of the world.

In addition to the three basic roles of government in providing suitable macro economic conditions, improving microeconomic capacity and, establishing a supportive and progressive regulatory environment, Porter (1998) argues that the government's role should also include facilitating and upgrading cluster development and creating opportunities for productive dialogue to bring cluster participants together. Some key government functions, as Singh (2003) indicated, are as follows:

– Play the role of a "broker", "facilitator", "initiator", "participant" and "listener" to engage partners in a productive dialogue and create a sense of urgency to cause action.
– Conduct ongoing cluster assessments to determine its viability and relative strength to ensure global competitiveness.
– Institutionalize cluster upgrading (e.g. restructuring government programs and services, diffusing new knowledge, and collecting and disseminating data/information by clusters).
– Directly invest in and provide investment incentives for technical, physical and knowledge infrastructure.
– Sponsor cluster conferences and forums to promote "social capital" (Porter 2000) opportunities for participants.

Some successful interventions of government in clusters are as follows in (Singh 2003):

8.6.1 Ottawa's Silicon Valley North

The early success at the Silicon Valley North's telecommunication cluster can be attributed to the Government of Canada's unprecedented R&D spending levels, tax credits and start-up support for companies. If Ottawa had not been blessed with government laboratories, such as the NRC and the Defense Research Board, at the end of WW2, firms like Computing Devices of Canada and Leigh Instruments would not have been created.

8.6.2 India's Bangalore Software Cluster

This is an example of a deliberate public policy to support moving from application software to systems design cluster. In 1991, the government initiated 15 Software Technology Parks instrumental in creating a critical mass of 180 companies with 20,000 skilled professional workers. It exported 85% of its software products as merchant exports accounting for 350 M$ (USD) in 96/97, growing with a 64% rate in 2002. While Information Technology Cluster growth worldwide has waned, the Bangalore Cluster continues to grow. Bangalore attracts talented ex-patriots, foreign investment and major corporations. Oracle, Microsoft and GE have opened offices in Bangalore.

The US Department of Commerce, Economic Development Administration, sponsored a major project to identify America's industry clusters. The project identified 380 leading clusters accounting for 78% of the nation's exports.

Finally, Singh (2003) suggests that government as a facilitator, not a master strategist, creates opportunities for cluster participants to organize, identify and solve common problems, then the private sector leadership will emerge to drive the process.

Singh (2006) addresses the key issue associated with the *financing* of cluster development. Financing of cluster development is one of the major issues and constraints that serve as a hindrance in developing countries to the successful performance and development of especially export-oriented clusters. It is important to note that several of the existing financing arrangements or options that are available in developed countries do not necessarily work for growth of clusters in developing countries. Some of these financing sources in developed countries are as follows:

– Venture capitals
– Angel investors[4]
– Insurance companies
– Public pension funds
– Foreign direct investment

But in many developing countries these sources are not available and, in stead, in several developing countries government agencies (and sometimes development agencies such as UNIDO, World Bank, etc.) seek to provide access to capital.

However, these options are few and far in between and also have led to several initiatives failing to sustain after their initial promotion. In that paper, the new emerging PPP[5] model, which has shown good results after being implemented in Indian clusters, has been presented. In this model, a consultancy institute as PPP manager has the responsibility to assist the Government and the Industry with the development and commissioning of the cluster parks on a *Concept to Commissioning* basis. To do so, it created an exclusive Business Unit, namely Cluster Development Initiative (CDI), and deployed a multi-disciplinary professional team, under the leadership of a carefully chosen CEO, to execute the program. In addition, various other technical services (e.g. architectural design and planning, financial analysis, technical selection of machinery, etc.) are outsourced when required.

In order to undertake these tasks, this professional intermediary organization should have the competencies related to capacity building, project development, financing, implementation and O&M of infrastructure projects on a PPP basis. The relationships between cluster stakeholders have been shown in Fig. 8.4. This project

[4] Angel investors are risk financiers who typically provide the first level of outside investment to small start-ups to take them to the next level.

[5] Private–public-partnership.

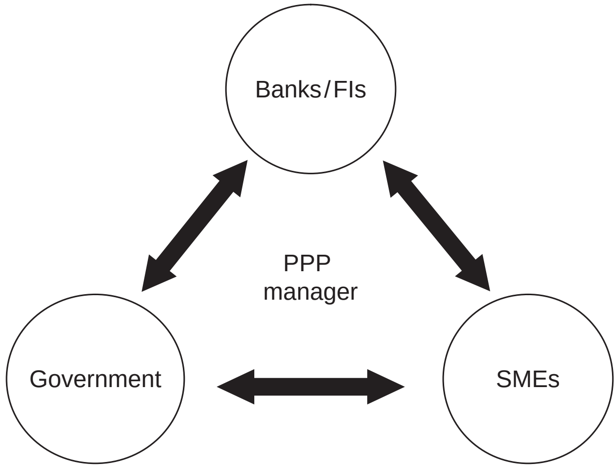

Fig. 8.4 The structure of PPP model (Singh 2006)

finance structure results in a win–win situation for all of the three major stakeholders of the process:

– The Government; since its financial support actually results in financial closure of the project and thereby achieving the purpose for which the assistance is provided.
– The financial institutions; in view of better off-take of loans at minimum transaction costs with appropriate security coverage ensuring better repayments.
– The SME enterprises; whose schemes become bankable and can access institutional finance, which otherwise would be difficult on an individual basis.

Finally, it is important to note that many cluster objectives – for example networking, lobbying, and commercial cooperation – do not require large budgets. There are, however, other objectives that have more significant funding requirements, including infrastructure improvement, cluster expansion and technical training. The results of a research conducted by UNIDO (Nadvi 1995) confirms that the absence of adequate infrastructure, which undoubtedly reflects the absence of financing for infrastructure, represents the single greatest constraint to the growth and competitiveness of most of the clusters assessed.

8.7 Cluster Success Factors

There are different descriptions of success factors for export cluster. In this section, we will present the results of two studies.

8.7.1 DTI Report

Department of trade and industry (DTI 2003) of England in a report as “a practical guide to Cluster Development”, expresses these factors as follows:

The evidence suggests three critical success factors which form the basis of cluster success:

1. Networks and partnerships
2. Strong skills base
3. Innovation and R&D capacity

8.7.1.1 Networks and Partnerships

Some networks generate formal and informal flows of knowledge and information throughout a cluster. These networks are the basement for success over time. Collective learning and more competitive performance could be carried by the access to tacit knowledge. Many cluster evolution activities are delivered by the networks way.

Prosperous clusters are prone to have powerful embedded networks and relationship systems. Trust and inter-personal relationships are favorably progressed, supplying the cluster with a high rate of social capital. The improvement of these relationships and connections needs time. Networks may be supported through strong organizational structures, or through shared cultural values and a common purpose.

Face-to-face links or remote technologies such as the web could be the tools to sharing knowledge through networks and partnerships. Technology has advanced considerably in this field and cluster practitioners are using interactive cluster portals to aid networking, share information about the cluster as well as using them for actual business to business interactions. The key is that a flow of knowledge occurs in more complex networks in which active collaboration is encouraged.

8.7.1.2 The Presence of a Strong Skill Base

There is a consensus across the literature that successful clusters are those that have a great base of skills, in higher levels and in management skills, and also have an appropriate and qualified labour force in general. For drawing the companies toward a cluster and keep them with a cluster, and also to keep on with a prosperous development of companies in a cluster, this element (labour force) should be taken highly into consideration. So, considering all of these factors and as a reasonable comment we could say that the quantity and quality of the labour force is a highly vital element in the development of successful clusters.

A range of adequate skills and abilities are required for successful clusters. The kinds of business skills that are pursued in successful clusters are those associated with global businesses such as strategic management skills for business leaders, entrepreneurship for graduates, management and production techniques, leadership skills, mentoring/coaching and personal development skills, etc.

The quality and availability of training can also be a factor contributing to the progress of successful clusters. This can apply to the existing workforce as well as to the new and potential entrants to the labor market. The capacity of the available training infrastructure to respond to employer needs and provide relevant training is a key factor. The cluster can have an influence on the provider side in terms of encouraging appropriate provision that is flexible and meets the needs of employers.

8.7.1.3 Innovation and R&D Capacity

The evidence shows that product evolvement and well-developed research structures, with other forms of innovation, are essential for a dynamic cluster. Innovation keeps the cluster at the head of the market whilst a strong R&D base would be able to give the ideas and products for future development. The advancement of innovation and R&D are two separate but inter-related activities. Innovation in general applies to product or process development, but what is meant by R&D is the development of new knowledge. In the best cases successful innovation is the outcome of the R&D process. Innovation can be incremental so that existing products and processes are built upon little by little, or may be more radical by introducing a completely new product or approach. Successful clusters are inherently innovative and practitioners can support the innovation process through encouraging networking and the sharing of ideas. The development of networks outside the cluster could also be beneficial as often innovative ideas are the ones that work well in one setting and are being applied for the first time to another area. The benefits of information and intelligence services in this area are often worth exploring.

Constitutions based on research activities, as for universities, non-profit foundations and for-profit R&D could function greatly as catalysts for research and innovation. They are able to provide the foundation for developing new ideas and applications, besides that, they could also play an essential and critical role in nurturing high technology entrepreneurialism. Looking from this point of view it could be said that, public and private research tools and resources are the key drivers for the cluster.

8.7.2 The Cluster Initiative

A survey (Solvell et al. 2003) of over 200 cluster initiatives (most of them in developed countries), pointed out three common elements that, have some kind of effect on raising the desire of new corporations and companies to join the cluster and/or increasing the cluster's international competitiveness:

– *Having the right resources*. A budget that provides a cluster initiative with enough fund so that it would be able accomplish important projects without the need of additional funds is highly connected to the attraction of new firms.
– *Having a strong and respected facilitator*. He or she is ought to have a great knowledge of clustering, a powerful network of contacts and enjoy the respect of cluster members.
– *Building a common framework.* A framework based on strengths, where efforts and time are dedicated to sharing the framework among cluster members, developing an explicit vision collectively and specifying quantitative targets.

There are some other factors that are often mentioned and talked about. These other factors include, a reliable and proper infrastructure, having some sort of entrepreneurial and risk taking characteristic and venture capital, as well as having a high potential of making and designing complete backward and forward linkages. But also in sectors like ICT, another favorably relevant factor is the educational and professional institutions taking part. A stable business environment, suitable policy intervention, and large firms acting as catalysts are also some factors that have introduced themselves as significant and extremely relevant factors, in certain contexts, particularly in developing countries.

According to Rosenberg (2002), many success factors in the original California's Silicon Valley have been identified by researchers over the years some of which are presented here: low taxes, venture capital, risk taking start-up culture, business webs, physical infrastructure, IT-savvy local population, local "living laboratories," good local markets, networking skills, activities and organizations for communities of interest, collocation of companies in various stages of development, flexible organizational structure, legal/accounting services, M&A activity for flow of skilled labour and intellectual property, local academic and research institutes, commercial partnerships between academia and industry, activist government policy via research funding and small business debt assistance, speed of business activity, presence of role models, and human talent in innovators, serial entrepreneurs, marketers, and managers.

Above all, success is in fact the mixture, combination, arrangement and order in which the ingredients come into play, and how the factors settle beside each other, the environment – both local and global, the opportunities and the timing. (Singh 2005)

8.8 Measuring Cluster Development

This section is based on DTI (2003).

Having favorable and measurable feedback is an essential part of the strategy review process, and also is a considerable help to the development quality of the strategy itself. However, from the work undertaken, and reported in the accompanying evidence paper, there is little evidence of the use of consistent indicators by which to measure the development of clusters. In this part, an approach to indicator selection is proposed. At first, indicators are assumed and used as a decision support tool and further in the approach a potential monitoring framework is considered.

Different cluster initiatives have developed their own measures of success. They depend on the objectives that the initiative had set for itself.

It is clear that establishing a set of metrics that are capable of tracking the performance of a cluster over time and space is important for:

– Assessing the impact of cluster measures
– Benchmarking performance

Understanding the different elements of clusters and their respective performance is an important step in identifying where clusters might be strong or weak and where subsequent intervention might be appropriate. This involves quantitative and qualitative analysis. Quantitative analysis might include statistical or numerical analysis on variables such as employment or output. Qualitative analysis might include discussion with businesses in the cluster on the innovative content of projects, or an assessment of the "softer" dimensions of the cluster.

Some of the principal factors promoting clusters as identified in studies focusing on ICTs include:

– The presence of educational institutions which produce a stream of engineers
– Technicians and scientists
– State support in the form of tax incentives and subsidies
– Salubrious living conditions which enhance the quality of life, especially in university towns
– Availability of venture capital
– And generation of forward and backward linkages

8.8.1 Measuring the Success of Interventions

Policy makers are willing to know if their intended goals have been achieved by the interventions adopted for the enhancement of the cluster performance. Also, they want to know why interventions have not leaded to success. This information will help to identify the effectiveness and efficiency of a certain policy approach and whether it is appropriate or not. Measuring success can be performed in an actual sense, i.e. has the intervention achieved the aims it has set itself, but might also be considered relative to other possible actions, or similar approaches adopted in other locations. Regular monitoring will also help to ensure that the intervention is being implemented as planned and is having the intended effects, acting as an early warning of any potential difficulties.

Measuring the success of diverse interventions contributes to the monitoring and evaluation of cluster development policies as a whole. It is important to understand whether success or failure is due to the interventions adopted or to outside factors beyond the control of policy makers.

Cluster measurement may seek to identify three key things:

– *The appropriateness of interventions.* To estimate the relevance of the policy or intervention with regard to the technical, social or economic problems it is meant to solve.
– *The effectiveness of interventions.* The fact that expected effects and objectives has been acquired. Calculated by relating an output, result or impact indicator to a quantified objective.
– *The efficiency of interventions.* The fact that the effects were obtained at conservative cost and were worthwhile. To calculate this factor an efficiency indicator is usually obtained by dividing the budgetary inputs by the quantity of effects obtained.

Ideally, a measurement procedure should capture both the effects of the interventions being undertaken and the development of the cluster in general. For the development part it should take into consideration the several aspects of cluster development and try to understand how each element is progressing over time. Clusters are multi-faceted and measurement should recognize this. There is little point in measuring one or two dimensions of a cluster, as this will lose important aspects of performance. In practice, those aspects that are cited as the most important in cluster development, such as networks and the development of social capital, are currently not being measured on a regular or consistent basis. Most measures have the economic performance of the cluster as the main measurement. This captures the outcomes but cannot provide information on what is happening to the drivers of cluster success. The different dimensions of clusters can be broadly classified under one of four headings which broadly encapsulate the following three "drivers":

– Networks and partnerships – the extent of social capital.
– Innovation and R&D – the extent of innovation and R&D capacity.
– Skills – the availability and quality of the workforce within the cluster.
– Economy and enterprise – the level of employment, number of firms and their performance and the outcomes.

As a principle the success of a certain intervention should be assessed on the basis of what it is planned to achieve, and the assessment of how this helps the overall performance of the cluster itself. Measuring the performance of clusters is based upon improvements in the performance of the constituent parts of the cluster, and establishing the effect of cluster policies upon this. It is common practice to seek to:

– Identify the outcomes of any intervention
– The results achieved by this; and potentially
– The impact that this has had on the development of the cluster as a whole

For the purpose of deciding which indicators to use, not only should we take into consideration their relevance to the action in hand, but should also consider whether they have a wider relevance or not. Indicators that are confined to a certain context or cluster would not always be useful for measuring the relative efficiency, in respect to comparable clusters in other places in UK or foreign countries. Definite increase

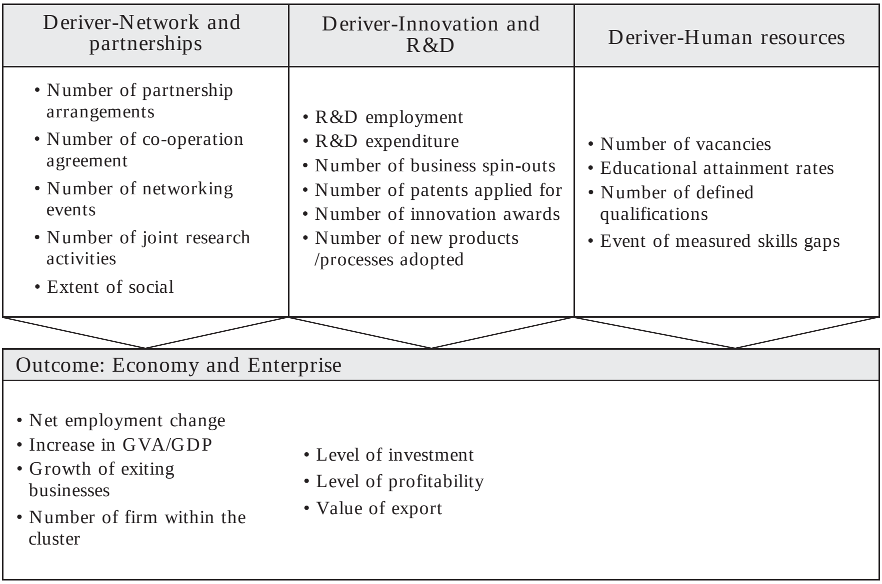

Fig. 8.5 An illustrative monitoring framework (DTI 2003)

in research funds which are received by an individual university are samples of unique indicators. A preferable measurement could be an overall measurement of the research cost in the cluster as a whole.

The science of measurement of clusters will hold on to its infancy. So measuring the efficiency of a certain cluster in a definite way would be out of reach. However, it is possible to aim for an understanding of the results of particular interventions on the identified cluster and its component firms.

The choice of what indicators to use is dependent on:

– The nature of the cluster
– The nature of the interventions adopted
– The overall policy objective

We have formerly suggested that for measuring the enhancement and growth of clusters we should differentiate the diverse dimensions of clusters. The selection of indicators should illustrate this approach. Some indicators with the probability of success are depicted in Fig. 8.5 below. These are not definitive and exhaustive, but give a picture of the potential indicators that could calculate the development of clusters.

8.8.2 Establishing Targets

Determining targets for certain indicators is an important aspect of cluster development initiatives. In addition to knowing the direction we wish to head, it is important

Table 8.1 Cluster policy vs. industrial policy (Ketels 2003)

Industrial Policy	*Cluster-based Policy*
• Target desirable industries / sectors • Focus on domestic companies • Intervene in competition (e.g., protection, industry promotion, subsidies) • Centralizes decisions at the national level	• **All** clusters can contribute to prosperity • Domestic and foreign companies both enhance productivity • Relax impediments and constraints to productivity • Emphasize cross-industry linkages / complementarities • Encourage initiative at the state and local level
Distort competition	*Enhance competition*

to know the distance and the time that it may take. Targets should be:

– *Specific* to the initiative in hand
– *Measurable* using identified data sets
– *Achievable* by the initiative in question with the resources available
– *Realistic*, given the existing state of play
– *Time-bound*, in that there is an agreed data by which they will be achieved

8.9 Cluster Policy Vs. Industrial Policy

Following table (Table 8.1) innuendo cluster policy vs. industrial policy.

8.10 Cluster Initiatives Require a Catalyst

This section is based on ITC (2005).

A cluster can develop, grow and be competitive without its members ever embarking on aligned "joint" initiatives. Silicon Valley in California is an example of a very prosperous cluster that happened by the natural gathering of related businesses in a geographic area. But, for the majority of instances, and definitely in the vast majority of clusters in developing countries, a catalyst is needed. This catalyst is normally an institution (as evidenced by KNIDGRO's activities in Ludhiana). In Tirupur's case, TEA assumed the role of both cluster catalyst and cluster leader.

In fact, if in addition to growing, a cluster wants to evolve, coordination and management should complement the catalyst and leadership roles. Formal or informal associations may provide the necessary management input, through a formalized approach, such as that followed, although flexibly, by TEA would seem to be the best option. And a solid public–private sector partnership is an essential precursor to coordination. Industry clusters now play a major role in public debate, economic policy and research.

Beyond research and debate, however, there has been growing recognition that the effective management of clusters can have an important impact on competitiveness and economic performance. A recent study pointed out 719 clusters in over 49 countries, from which 23 of them were developing nations. A 2003 survey of over 200 cluster initiatives revealed that over 80% of the respondents believed that the initiative had improved the cluster competitiveness, and over 60% were confident that the initiative had improved the cluster international competitiveness.

Because of this growing interest, at the request of the Executive Forum network, ITC is arranging a cycle of specific consultations over the first half of 2005. The several negotiations focus on the important issue relating to the theme of "Competitiveness through Public–Private-Partnership".

A report as consultation on "Competitiveness through Export Clustering: Strategic Considerations" was being arranged by the ITC Executive Forum Team, UNIDO and the Tirupur Export Association. The purpose of this consultation is to provide a forum and vehicle for public and private policy makers to review insights not only from research, but also from the growing experience base of countries around the world who have undertaken initiatives to enhance cluster performance (Table 8.2).

This section is an overview of various aspects which are related to cluster constitution and growth, drawing on the experience of a number of cluster initiatives and in fact is the first level to set off this consultation. This discussion paper also proposes general frameworks and language that is used to construct the ten specific questions given by the consultation:

1. Why clusters?
2. Can clusters boost the quality and quantity of exports?
3. Why do clusters succeed? When do clusters fail?
4. Do clusters just happen or can they be made?
5. Does the public sector have a role in creating/building clusters? Or is this mainly a private sector initiative? Who else should be included?
6. Does a developing country cluster differ from a developed country cluster?
7. Do clusters require a formal structure? Or is an informal network enough? What is the role of trust?
8. Should buyers be included in an "Export oriented Cluster"?
9. What is the role of financing? Who pays for what?
10. Are benefits measurable? Are the theoretical benefits borne out in reality? Are the benefits equally distributed?

Measuring the answers of these questions requires the reference to this conclusion.

Table 8.2 Private sector and government potential contributions (ITC 2005)

Government potential contributions to cluster development	Private sector potential contributions to cluster development
Support cluster-specific information gathering and compilation	Jointly develop mechanisms to collect and disseminate cluster information
Organize its services around clusters	Develop specialized education
Foster linkages between universities and clusters	Collaborate with local universities and institutions on cluster-related research
Improve infrastructure requirements for clusters	Market jointly through trade fairs and delegations
Streamline regulations that affect clusters' ability to compete	Collaborate on international market research
Focus export promotion activities around clusters	Find a balance between cooperation in some activities and competition in others
Act as a sophisticated buyer for clusters' products and services	Establish cluster-based trade associations
Establish cluster-oriented free trade zones or industrial parks	Establish cluster linkages with suppliers, customers and related businesses
Focus efforts on attracting financing options around clusters	Cooperate with government to streamline regulations
Sponsor forums to bring together cluster participants	Take the lead on infrastructure projects, involving financial institutions and governments
Act as a catalyst for artisan clusters or clusters that need initial organizational support	Foster trust among its members
Incorporate interests of clusters in trade negotiations and international agreements	Start with small projects. Advertise early successes to gain support for cluster activities

8.11 Case Studies

We provide three case studies in this section. These case studies include some experiences in Turkey, Pakistan and finally, one of the most well known export clusters, Tirupur, India as successful clusters in developing countries and Boston export cluster as an example of successful ones in developed countries.

8.11.1 Turkey

This section is based on Yilmaz et al. (2005).

In Turkey, industries are dispersed all over the country; furthermore, another important point is that 99% of all enterprises are placed in SME category. Along the same lines, according to Yilmaz et al. (2005): "At present, there exist neither comprehensive strategies nor policies by public sector for clusters in Turkey", while many of enterprises belong to SMEs set. However, they had planned several programs for promotion of SMEs such as "SME strategy and action plan" in 2003.

According to this plan, they developed local and regional clusters which were formed within organized industrial zones, industrial zones and small-scale industrial states. Major traditional clusters that are scattered in Turkey can be listed below (Yilmaz 2005):

- Textile yarns and carpets: Gaziantep
- Ceramics: Kütahya, Bilecik and Eskisehir (They are in the same geographical Region)
- Automotive: Bursa, Kocaeli (They are at the same geographical Region)
- Machinery: Konya, Ankara (They are at the same geographical Region)
- Furniture: Kayseri, Inegöl (a town of Bursa), Ankara (Ankara and Kayseri are in the same geographical Region)
- Leather and leather products: Istanbul, Izmir and Çorlu (Çorlu (a town of Tekirdag) and Istanbul are close to each other geographically)
- Towels and bath robes: Denizli
- Clothing: Istanbul
- Gold jewellery: Istanbul
- Truck dressing: Beypazari (a town of Ankara)
- Rose oil: Isparta, Burdur, Denizli, Afyon.

The analysis of the existing conditions was required to be done with support of organization of small industrial estates (SIEs).

Today, different organizations are responsible for determination and implementation of SMEs policies. They have created a group as “SME Study Group”. This group consists of Ministry of Industry and Trade, the State Planning Organization, undersecretaries of Treasury and Foreign Trade, State Institute of Statistics, Small and Medium Industry Development Organization, Union of Chambers of Commerce, Industry, Maritime Trade and Commodity Exchanges (TOBB), and Confederation of Tradesmen and Artisans of Turkey (TESK).

Some of organizations and companies that play important role are listed below:

- Private sector organizations. The associations/Unions cover many clusters. Export clusters owe these sectors for the economic growth in recent years. The private sector organizations consist of the umbrella organizations of producers, chambers of industry and commerce and their upper organization, “Union of Chambers of Commerce, Industry, Maritime Trade and Commodity Exchanges” (TOBB). They have been successfully active both in creating new clusters and developing clustering networks for the existing ones in their own areas.

  They export and do some activity to promote their members to invest, they also have close relationship to public organizations, private organizations and international organizations, etc.
- Public sector organizations: Turkey government established export associations as branches of undersecretaries for foreign trade, but government transfers their management to private sector. Therefore they have dual structure in term of management. They offer services like trade information, training, etc. furthermore, some of the mentioned associations are connected to many public and private organizations such as universities and manufacturers’ associations/unions.

The other key public actors in the export clusters are as follows:

- Small and medium sized industrial development organization (KOSGEB)
- Technology development centers in universities and enterprise development centers

• Sectoral Foreign Trade Companies and Foreign Trade Capital Companies: Within the liberalization policy, large company model (Foreign Trade Capital Companies) was introduced to promote export products. As a result of increasing export, role of these companies become more highlight and they export some of SMEs' products. They lead clusters in many aspects such as cluster activities on export marketing and technology.
  To develop foreign trade, another organization was established as Sectoral Foreign Trade Companies (SFTCs) in 1994. The main functions of SFTCs are export marketing and implementation of export procedure.
• NGOs initiatives: since 1999, a process has been started as "competitive advantage of Turkey" (CAT) in order to develop clusters. The project is directed by the Center for Middle East Competitive Strategy Center which Michael Porter chairs. The team work for CAT includes both foreigner and Turks and also private companies and commercial banks sponsor it.

8.11.2 Pakistan

This section is based on Fayyaz (2005).

In 2003, SME cluster development has been introduced as principal element of Pakistan trade policy and in order to adapt UNIDO's services, Export Promotion Bureau (EPB) determined phased approach (Fayyaz 2005). As a result of mentioned approach, five pilot clusters have been developed in different places in Pakistan as follows:

- Leather and leather products in Korangi, Karachi
- Gems and jewellery in Saddar, Karachi
- Ready-made garments in Lahore
- Electric fans in Gujrat
- Cutlery in Wazirabad

The government of Punjab as a Pakistan province governor, also, has started such cluster development approach based on UNIDO program for seven SME clusters in the province. In preliminary stage, in the 2004–2005 financial year, this project was supported with more than US$ 200,000.

We could list main related agencies to this project as follows:

- Federal and Provincial Agencies
- Ministry of Commerce (MOC)
- Export Promotion Bureau (EPB)
- Ministry of Industry & Production (MOI & P)

MOC and EPB have been selected as the mandate for development of export clusters. Small and Medium Enterprise Development Authority (SMEDA) is one of the major departments of MOI&P. They work on training, feasibility studies, business plans to add value to the export oriented clusters, at the same time, working on the supply side.

- Ministry of Commerce (MOC):

  Objectives that MOC should meet are announced as followings:

  – Developing and modernizing Pakistan trading system
  – Eliminating bottle-neck and developing liberalism in flow of trade
  – Creating opportunities for entrepreneurs

  In order to achieve these objectives, several departments at MOC are working together. Some of the major departments are as follows:

  – Export Promotion Bureau (EPB)
  – National Tariff Commission (NTC)
  – Foreign Trade Institute of Pakistan (FTIP)
  – Trade Marks Registry (TMR)
  – Trading Corporation of Pakistan (TCP)

- EPB as primary agency working under MOC is trying to promote export through the following initiatives:

  – Marketing (Market Research, Fairs and Exhibitions - local and international, Trade Delegations and . . .)
  – Communication (Publication of Trade inquiries/opportunities, Library, Export intelligence Bulletin and . . .)
  – Human Resource Development (Training Institutes, Seminars on ISO 9000 and 14000, TQM and . . .)
  – Service to exporters (Export Facilitation committee, Resolving problems in exports, Simplification of procedures, Export procedures handbook and . . .)
  – Regulatory (Formulation of proposals for the Trade Policy, Implementation of Trade Policy, Textile Quota Management, Registration of Importers/Exporters and . . .)
  – Special incentives (Scheme for freight subsidy on exports, Management Consultancy firms, Marketing & Brand development for Export Promotion and . . .)

- Ministry of Industries & Production (MOI&P):

  MOI&P prepares information and analytical insight to create a competitive price in a globalized economy. Some of the main activities of this ministry are as follow:

  – Marketing support to SMEs (for example to identify new opportunities, new markets, increasing their competitiveness, identify new opportunities in global markets, Branding Support.)

– Packaging Support (Factors affecting the type of packaging, Technical specifications required, Information sources on the packaging requirements of particular countries.)
– Advertisement & Media Support

As a result of review on Pakistan cluster program, we can find that government of Pakistan has played the major role in development of country export through export clusters. Moreover UNDIO in its published documents clearly considers the role of Pakistan's Government in the success of export clusters.

8.11.3 Tirupur

Indian industrial clusters have acted as nucleus that develops surrounding urban societies. One of these clusters is centered in Tirupur city in southern India and works on hosiery exports. In 1999, this cluster was accountable for more than 90% of Indian's knitwear exports to Western Europe, USA and Japan. This export was equal to annual production of 145,000 tonnes of fabrics, especially in the form of T-shirts and sweaters, which is equivalent to about 1,000 million USD and 10% annual growth is expected.

During the last decade, pressures of local and international standards in textile wet processing, forced dyestuff manufacturers and hosiery clusters to act under eco-textile standards, both in individual and industry group activities.

8.11.3.1 Context and Framework for Sustainable Development of a Hosiery Cluster

The main characteristic of India's industrial states is their clusters of small and medium size industries that drive local economic development process. Clusters in some zones are homogenous and in some others are heterogeneous. A map of some major industrial clusters is shown in Fig. 8.6.

Each cluster has created its own urban centers, which are penetrated in traditional rural areas. These rural ecosystems are expected to share their natural resources with industrial and urban areas, and accept industrial wastes. But, rapid growth of industrial and urban areas, is eradicating rural parts. Figure 8.7 shows a model that is depicting such phenomena. Tirupur is a classic example of this model and its statistic is summarized in Table 8.3. In general, ineffective resource conservation policies in industrial clusters, has inhabited faster technological adaptation to curb water and solid waste pollution.

Individual units within these clusters have been traditionally competing mainly on the grounds of cheap unskilled labor and low overheads due to minimal expenditure on technological safeguards for the environment; although in some cases the situation has been recently changing towards a better direction.

Fig. 8.6 Location of major industrial clusters in India (Narayanaswamy and Scott 2001)

Because of the rapid and unplanned migration of population from rural areas to urban areas and negligence in proper town planning, sanitation and other basic amenities are inadequate in these new urban areas. To move toward a sustainable developing state, Tirupur should develop a cohesive strategy in which both the hosiery cluster and rural areas should be taken into account. This strategy should be based on the availability of local knowledge and skills. In this strategy, clusters and urban areas should be thought as resource productive centers, especially with shared natural resources like water, land and energy. This ensures a sustainable resource from rural environment for a long time. Some pricing policies must be taken into account to persuade industries to use resources more productively. An appropriate GIS on clusters and rural–urban interdependencies would be helpful in zoning clusters to achieve sustainability.

The leaders of Tirupur Exporters Association (TEA) discovered the potential impact of globalization in the early 1990s, when the association was formed. As TEA's focus was on exports, its approach was global. India decided to welcome open market economic policies, but TEA decided as well beforehand. Like founding any other clusters, the first step in developing an export cluster is to evaluate any internal and external developments that is probable to influence the performance of the cluster.

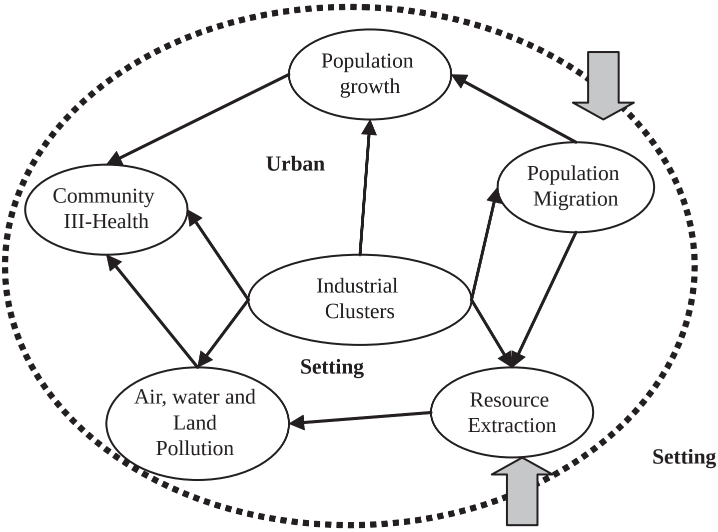

Fig. 8.7 Interdependency between industrial clusters and the rural environs (Narayanaswamy and Scott 2001)

Table 8.3 Major environmental indicators of the history cluster and urban Tirupur (Narayanaswamy and Scott 2001)

Housing	Around 150,000 houses, of which more than 70% lack a toilet facility and safe drinking water. 23% of the houses do not have electricity connections and 10% do not have all the three basic amenities
Water resource	The water table, on an average, is 65 m below the ground level, has a TDS of around 1,000 mg l^{-1}. 150 borewells are currently in operation. The river Bhavani, a monsoon driven, non-perennial river, located 55 km southwest of Tirupur is another major water source. Ten villages located at a distance of 2–37 km from the city provide water to industries. Private vendors abstract water from these villages and sell it to industry @ US$0.7 per m^3. These vendors cater to 90% of industrial needs and 10% of domestic water requirement
Energy consumption	The city consumes 115 M kWh pa of electricity, of which industry consumes 56%; commercial facilities 13%; public use 2% and residential 2%. Most firms and commercial units have diesel generators to help cope with erratic supply. Bleaching and dyeing units consume about 500,000 tonnes pa of fuel wood chopped from the nearby rain forest of the Nilgri hills in Western Ghats
Health effects	There are poor health facilities in the city, with only 1,000 beds (inclusive of government and private hospitals) for 400,000 people. Cardiac arrest causes 38%; respiratory failure 17%; and dysentery, diarrhea and fever 2% of total deaths annually

TEA members set TEA's objective during different brain storming sessions in 1990. These objectives were as follows:

- Multilateral growth of knitwear industry and exports
- Developing infrastructure needs of industry and community of Tirupur
- Promoting industrial harmony and peace by offering the workers fair wages and benefits, healthy working conditions and sharing of profits
- Fostering the growth of harmonious relationship with all sectors of the industry
- Forging meaningful relationship and constructive co-operation with other associations
- Sharing experiences and information with those who approach the association
- Help the foreign buyers:
  - In locating suitable suppliers
  - Resolving commercial disputes amicably through informal arbitration

In order to reach these objectives, TEA identified areas that needed attention both in short term and long term. Preliminary studies indicated the fact that there were serious deficiencies in the infrastructure and that some of these deficiencies were extremely critical not merely for growth but for the survival of the cluster itself. So, further attempts were made in several areas, such as:

- Infrastructure
- Production capacities and technology
- Marketing
- Manpower development
- Logistics
- Quality assurance
- Industrial peace
- Finance
- Fair business practices
- Community orientation of projects

Finally the gaps were identified and a holistic approach was developed:

- Industry required huge quantities of water. There was no perennial source of water supply anywhere in the vicinity of the cluster. Ground water available in and around the cluster was inadequate quantitatively and qualitatively. Unless water was made available for industrial use in adequate quantities and required qualities the survival of the industry, leave alone growth would be at peril. Besides industrial supply, the industry has a moral responsibility to improve supply of water for domestic use, as the entire population of Tirupur is dependent on knitwear industry and vice-versa, since public cannot bear the high cost of water proposed to be brought from a distance of 55 km. From a perennial source, the cost for domestic use may cross subsidized.
- Supply of huge quantities of water for domestic and industrial use must be matched by a scheme to evacuate the waste water. Hence an underground sewerage system may be put in place simultaneously.

– The roads were congested and badly maintained. Good roads for internal transportation of goods would be necessary.
– Production capacities need to be expanded, modernized and technologically upgraded.
– Marketing skills of exporters need to be honed up.
– The industry was already facing shortage of skilled manpower. Institutions need to be developed to train manpower tailored to the requirements of the industry.
– Problems of logistics should be addressed.
– Members should be motivated to introduce and practice quality, environment and management systems to enhance their credibility and competitive capacities in international markets.
– The burgeoning work force should be managed carefully to maintain industrial peace and harmony.
– Availability of finance for term loans for creating assets and working capital to run the operations should be ensured.
– Increase in the number of players would result in commercial disputes. A mechanism needs to be devised and put in place to settle commercial disputes amicably.
– Community development projects should be an integral part of industrial development.

TEA is trying to fulfill the specified objectives independently and jointly with other associations, and is currently executing some improvement projects (list of projects and its objectives have been introduced by Subramaniam 2005).

8.11.4 Greater Boston

This section is based on Swift (2002).

Nowadays, Greater Boston is known as economic engine of Massachusetts and also as one of the most developed and innovative regions in the world. This region includes all of Suffolk County, a large share of Middlesex and Norfolk counties, and portions of Plymouth and Essex Counties.

Based on the Bureau of economic analysis, the personal income of Suffolk, Norfolk and Middlesex Counties is more than 50% of the total state’s income.

Six large export industry clusters are known as the component of export sectors. These clusters could be divided into two types: knowledge-based clusters and clusters that are less knowledge intensive. The first type of these clusters includes Information Technology, Health Care, Financial Services and Knowledge Creation. The other type, itself is divided into two main categories of clusters: “Travel and Tourism” and Traditional Manufacturing (such as paper, plastics and rubber and metal working companies).

Figures 8.8 and 8.9, show export clusters’ growth in different themes, comparing the Greater Boston Region, West Sub-Region and Massachusetts. Gains and employment are two important factors in this comparison.

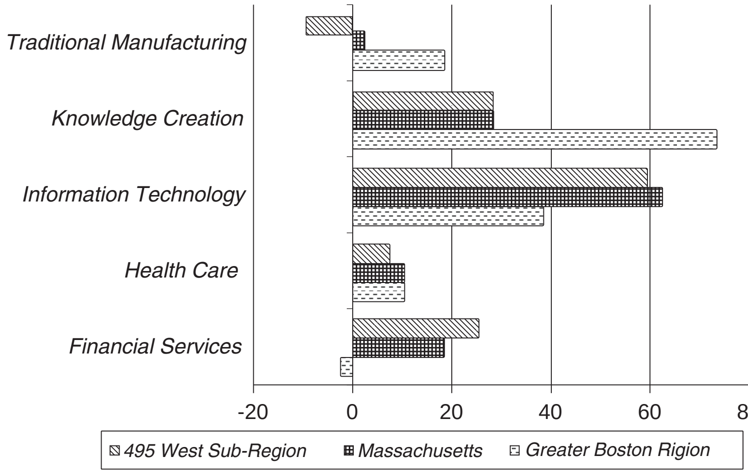

Fig. 8.8 Employment change in the Commonwealth's Export Clusters: Greater Boston Region, 1993–2000 (Swift 2002)

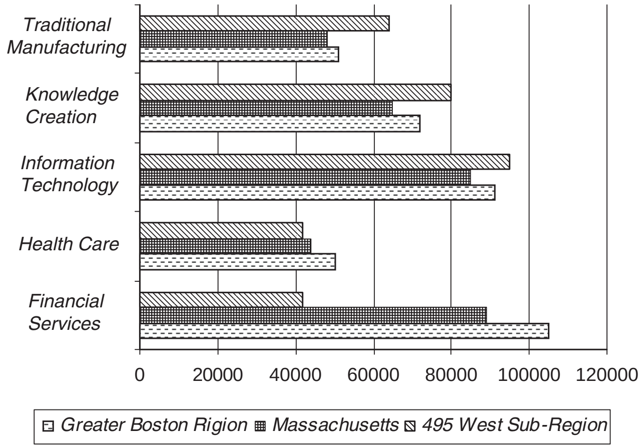

Fig. 8.9 Change in average pay in the Commonwealth's Export Clusters: Greater Boston Region, 2000 (Swift 2002)

The region's economic growth includes several factors. One of them is educated workers, so that many workers without a college education didn't share in this progress.

Another important point can be considered as the price of housing. The price of housing has increased even faster than income growth. By increasing this gap throughout the decade, the region's growth ability will be decreased.

8.11.5 Economic Over View

- *Employment*:

Figure 8.10 shows that unemployment rate in Greater Boston has been under the unemployment rate in the state, over the past decade (it reached to 2.2% in 2000). The distribution of unemployment rate is not the same all over the Greater Boston. For example, the unemployment rate of the west sub-region (I-495) was around 2%.

- *Income*:

Wages in the Greater Boston are much better than wages in the rest of the state. The gap of wages between Greater Boston and rest of the state was 9.5% and it increased to 13% in 2001. In Fig. 8.9, we can see wages in I-495 are even higher than wages in Greater Boston. In addition to growth of income in this region, housing price has more growth so that it creates an estimated affordability gap $31,460 in 1999.

- *Employment by major industry*:

The major activities in term of employment in this region are whole sale and retail trade, manufacturing, Financial, Insurance and Real State (FIRE). Employment grew by 20.7% between 1993 and 2000. Also services have grown by 30.7%, trade (whole sale and retail) by 15.4% and construction by 67.5%. The I-495 west sub-region with a growth equal to 62% was forerunner.

Figure 8.11 shows that the growth of employment in construction and agriculture surpasses the other activities. Most of the large increase in construction can be attributed to the Central Artery Project, increasing demand for home building services and commercial space. On the other hand, spread of home yard service companies boosted growth in the agriculture sector. This figure also shows day-off in manufacturing. It is because of down sizing of regional manufacturing. Between

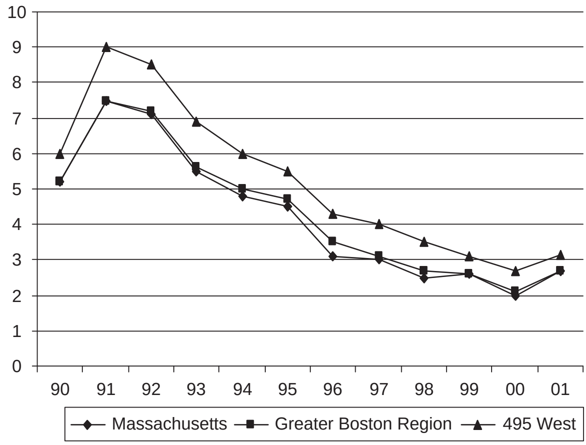

Fig. 8.10 Unemployment rate: Greater Boston Region (Swift 2002)

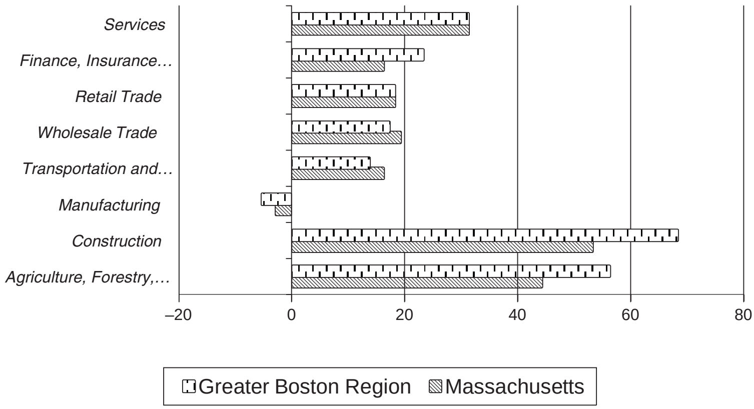

Fig. 8.11 Change in employment, by major industry, Greater Boston Region: 1993–2000 (Swift 2002)

1993 and 1998, 50% of jobs are lost due to plant closing or permanent layoffs in the Metropolitan Area Planning Commission Region (which is slightly larger than the Greater Boston Region) were from the manufacturing sector. Also in 2001, 35.5% of Greater Boston layoffs were in manufacturing, over three times its share of total employment.

8.11.5.1 Export Clusters

The knowledge-intensive export clusters that drive the larger economy of the State are concentrated in Greater Boston. These export clusters are: knowledge creation, information technology, financial services, care health, traditional manufacturing and travel and tourism:

– *Knowledge creation.* The gains that were achieved in this group of clusters include gains of research and testing, engineering and architectural services, and the management, public relations, advertising, and accounting industries. The most balanced growth of clusters belongs to knowledge creation and also most of clusters in knowledge creation grew close to their state wide. By leading the gains appropriately, growth of export industries drives demand for professional business services like management, public relations, advertising and accounting services (see Fig. 8.12).
– *Information technology.* The most effective export cluster in term of employment in this region is the Information Technology export cluster, in a way that growth of it was more faster than average (60% vs. 21%). Two major sectors of IT that absorbed main gains, could be introduced as “computer software development” and “other computer services” (Fig. 8.13). More than 50,000 jobs were created by these sectors between 1993 and 2000.

Over 9% of whole jobs in this region are associated to IT export cluster. The growth of this cluster in the I-495 west sub-region was much faster than its state or region counterparts (see Fig. 8.9). Some of factors that caused this rate of growth in the I-495, could be listed as the availability of land for development, immediate access to major roads, ready access to professional services firms, the cultural amenities their employees desired.

- *Financial services.* This cluster includes three important sectors as follows:
  1. Securities and exchange services
  2. Insurance carries
  3. Banking and services

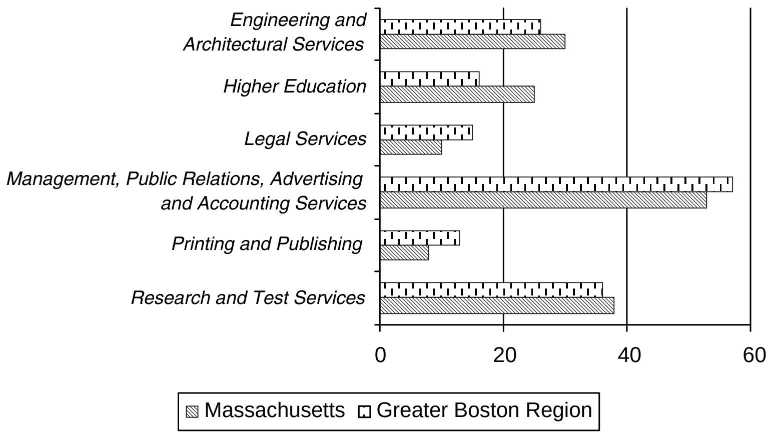

Fig. 8.12 Knowledge creation: change in employment, Greater Boston Region: 1993–2000 (Swift 2002)

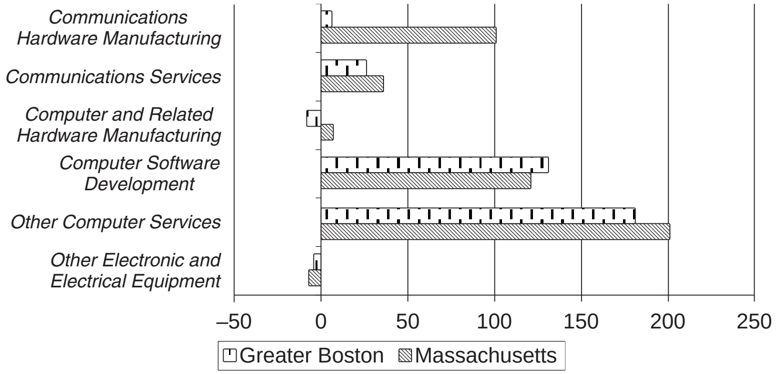

Fig. 8.13 Information technology: change in employment, Greater Boston Region: 1993–2000 (Swift 2002)

The growth of employment in this cluster was close to average of this region (25% vs. 21%) between 1993 and 2000. Employment for securities and exchange services grew dramatically. It is because of rapid rise of stock market during 1990s (see Fig. 8.14).

But financial services employment faced to decrease in the I-495 west sub-region (see Fig. 8.8).

- *Health care.* This cluster where includes teaching hospital and academic research centers, attracts out-state patients and research funds and also causes development of the related medical device and biotechnology sectors. The growth of employment in the Health Care export cluster was less than average of growth of employment in the region (7% during 1993 and 2000). While the drugs and pharmaceuticals sector grew 173%, it still represents less than 3% of total cluster employment in 2000 (Fig. 8.15).
- *Traditional manufacturing.* Share of the traditional manufacturing export cluster in employment after decreasing about 9%, has now been reduced to 3% of Greater Boston employment. Reasons of this reduction have been discussed "economic overview". Figure 8.16 shows changes in traditional Manufacturing sector. The same pattern exists for I-495 sub-region.
- *Travel & tourism.* We can study growth of the Travel and Tourism cluster in Greater Boston by surveying the hotel industries. The gross income in room sale grew about 42% between year ending Jun 1997 and year ending Jun 2000, so that at the end of this period it was about \$1.3 billion[6]. Travelers spend usually on meals, retail purchases and accommodations.
- Room sales in Greater Boston exceeded the statewide gains of 37%, and propelled an expansion of the industry.

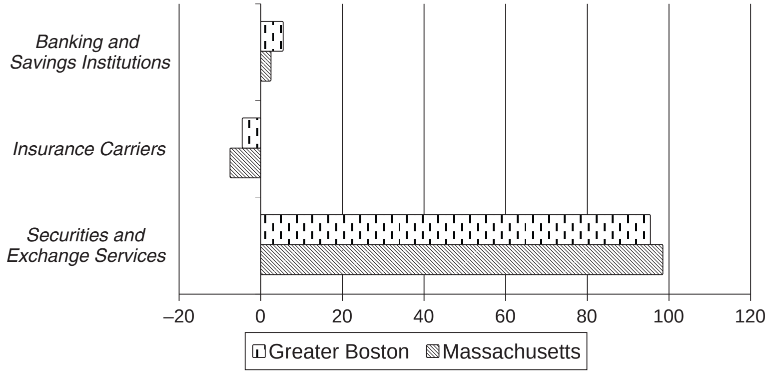

Fig. 8.14 Financial services: change in employment, Greater Boston Region: 1993–2000 (Swift 2002)

[6] This growth was observed in Suffolk, Middlesex, and Norfolk Counties.

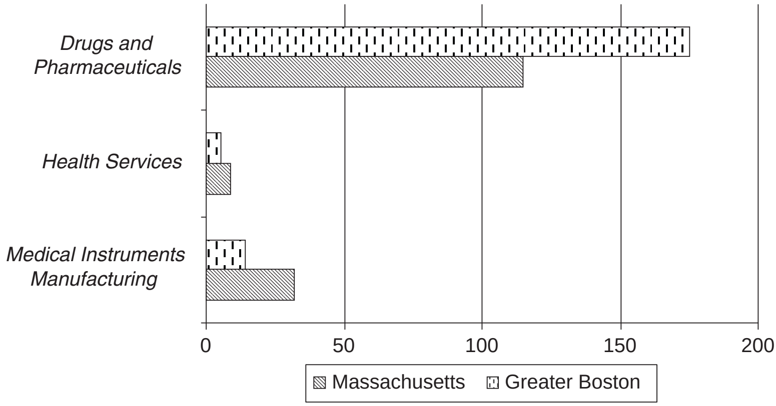

Fig. 8.15 Healthcare, change in employment, Greater Boston Region: 1993–2000 (Swift 2002)

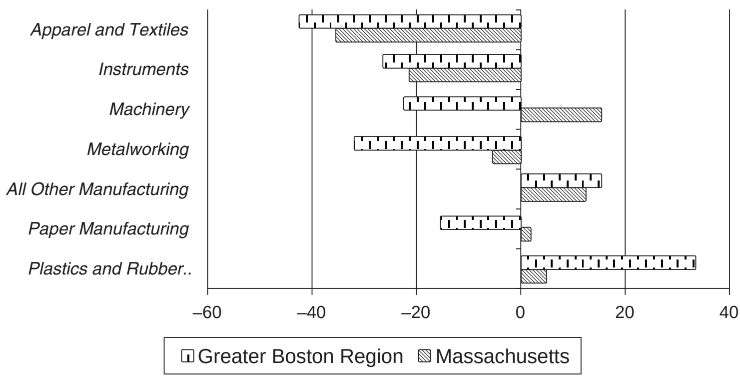

Fig. 8.16 Traditional manufacturing: change in employment, Greater Boston Region: 1993–2000 (Swift 2002)

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Chapter 9
Green Supply Chain Management

Ehsan Nikbakhsh

Nowadays along with the fast growth of industrialization in the world, the environmental and ecological impacts of products have become a major issue. Considering merely the economical impacts of industrial decisions, and excluding their ecological impacts, make the human beings and animals more vulnerable to various threats such as global warming, toxic environments, ozone layer depletion, and natural resources depletion. Therefore, considering environmental impacts of industrial decisions plays an important role in preserving our environment.

The first and most important step in this endeavor is to analyze products impacts on environment with a holistic approach. This holism includes the analysis of the product life cycle from the very beginning up to the very end of it. Using this approach, ecological impacts of every little decision in various product stages such as product conceptualization, design, raw materials processing, manufacturing, assembly, warehousing, packaging, transportation, reusing, and refurbishing is measured and considered in designing the product and the required operations.

Sustainability and environmental management require closing the loop of material and product flows. Serious concerns about local, regional and international impacts on environment and increased risk to health and safety of human beings and animals from industrial activities have led to significant increase in green and sustainable supply chain management research. In addition to environmental awareness, increased national and international legislation has made organizations more responsible for environmental issues. However, smart companies have also understood that returned products often contain lots of value to be recovered.

In this chapter, we will discuss some of the fundamental aspects of Green Supply Chain Management (GrSCM). First, GrSCM, its origins, advantages, barriers, and initiatives will be discussed. Next, we will review green design, green operations, green procurement, and GrSCM frameworks. Finally, the role of governments

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DOI 10.1007/978-3-7908-2156-7_9,

and international organizations in promoting and developing green supply chain practices will be analyzed and discussed.

9.1 GrSCM Origins

In order to discover the origins of Green Supply Chain Management, we must first review Supply Chain Management and Environmental Management as the two bases of GrSCM.

9.1.1 Supply Chain Management

Supply Chain (SC) and Supply Chain Management (SCM) concepts have become one of the most important managerial trends within the last two decades. One of the main reasons contributing to this importance is the large share of logistics costs in the finished product costs. Customer-orientation, intense competition, shrinking product life cycles, and improvement of interorganizational communication tools are among the many reasons contributing to the growing importance of SCM.

The Supply Chain and Supply Chain Management terms were introduced for the first time in the middle of 1980s (Jones and Riley 1985) and later became more widespread in the 1990s. Prior to that time, terms such as "*Logistics*" and "*Operations Management*" were used instead. Chopra and Meindl (2001) defined SC as follows:

> "*A supply chain consists of all stages involved, directly or indirectly, in fulfilling a customer request. The supply chain not only includes the manufacturer and suppliers, but also transporters, warehouses, retailers, and customers themselves.*"

SCM can be known as set of processes which an organization performs in order to control its SC behaviors and achieve its predefined goals. Supply Chain Council[1] (2007) defined SCM as a process which "*encompasses every effort involving producing and delivering a final product or service, from the supplier's supplier to the customer's customer. Supply Chain Management includes managing supply and demand, sourcing raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order management, distribution across all channels, and delivery to the customer.*"

9.1.2 Environmental Management

Environmental management can be defined as the management of human's interactions with environment and their impacts on environment. Environmental

[1] www.supply-chain.org.

management has developed significantly from its early stages in the late 1960s and early 1970s. Early environmental efforts were based on controlling pollution emerging from individual sources. However, environmental management evolved into a systematic attempt to prevent pollution at the source and manage entire ecosystems in the 1990s.

Industrial ecology is one of the subfields of environmental management which considers industrial systems as part of the earth ecosystem. It tries to minimize the environmental impacts of industrial systems by closing the material and products flow loop and change the waste of each industry into the input of another. The term Industrial Ecology was first coined by Harry Zvi Evan in 1973. Evan defined his idea of industrial ecology as a "*systematic analysis of industrial operations including factors like technology, environment, natural resources, bio-medical aspects, institutional and legal matters as well as the socio-economic aspects*" (Evan 1974). Later, industrial ecology received more attention by efforts of Frosch and Gallopoulos (1989).

Companies pursue environmental management and industrial ecology practices based on different motivations. The main reason is environmental laws and regulations which make companies obliged to environmental issues. On the other hand, some companies pursue these practices for the sake of their own profitability and/or customers' requirements.

9.1.3 Green Supply Chain Management

Traditional definitions of SC and SCM have very little to do with what the product is going through after its delivery to customers. But during recent years, SC managers tend more to consider environmental aspects in their decision making process. GrSCM is not just about considering environment in SC decision making processes, but also about productivity and making more profit.

Green supply chain (GrSC) concepts manage environmental impacts where they occur, ideally before they occur. GrSCM tries to minimize the undesirable environmental impacts of supply chain processes within the participating organizations and the whole supply chain as well. Srivastava (2007) defined GrSCM as "*integrating environmental thinking into supply-chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life*."

GrSCM has emerged from two origins. First, environmental managers started to use life cycle assessment (LCA) approach for assessing products environmental impacts. In addition to usual product design and manufacturing processes, this approach considers many logistical activities such as material handling, packaging, distribution, and disposal. Similarly, creative supply chain managers and analyzers tried to improve and optimize supply chain processes by integrating environmental issues with SCM practices.

GrSCM has many financial and operational advantages in addition to its environmental importance and necessity. Porter and van der Linnder (1995a, b) debated that waste elimination, resource saving, and productivity improving aspects of green practices can lead to competitive advantages for green companies. Also, Rao and Holt (2005) discussed that greening different phases of the supply chain leads to an integrated GrSC, which ultimately leads to competitiveness and better economical and operational performance.

9.1.4 A Note on Sustainable Supply Chain Management

Sustainable Supply Chain Management (SSCM) origin dates back to the late 1980s when World Commission on Environment and Development (WCED) put forth the "*sustainable use*" and "*sustainable development*" concepts. WCED pointed out the threats of deteriorating natural resources to human beings, animals, and environment. WCED (1987) has defined sustainable development as "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*." Sustainable development has three main dimensions known as economical, social, and environmental (Fig. 9.1). These dimensions are highly rooted in political and social scenes, but they are also related to industrial fields (Preschey 2005).

In recent years, sustainability concept has been introduced to many fields, including economics, technology, agriculture, and SCM. According to Schmidt (2005), SSCM is concerned with internal and external management of supply chain, integrating the dimensions of sustainable development. Therefore, SSCM approach can be defined as considering environmental, economical and social issues in supply chain management.

Although GrSCM and SSCM are usually being used interchangeably in SCM literature; one must note that these two concepts are slightly different. SSCM includes economical and social sustainability issues as well as environmental sustainability

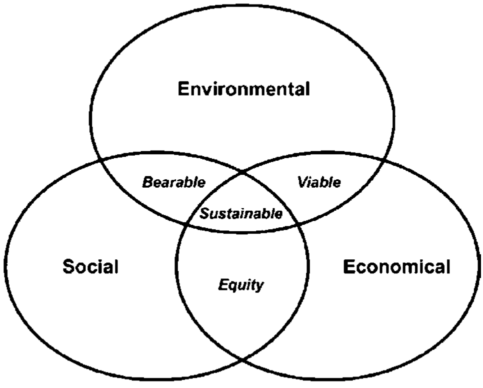

Fig. 9.1 Sustainable development dimensions (Wikipedia Contributors 2007)

issues. Therefore, SSCM is a broader field which includes GrSCM as a part of it. For the sake of clarity, we will use the term GrSCM through this chapter.

9.2 GrSCM Advantages and Barriers

Although environmental management imposes higher initial costs and restrictions on design and manufacturing practices, implementing GrSCM practices will lead to many advantages. GrSCM advantages can be categorized based on *costs*, *risk*, *productivity*, *property value*, and *environment*. Some examples of these advantages are summarized in Table 9.1.

GrSCM has also direct effects on SCM practices itself too. Integrating environmental and supply chain management can increase SC efficiency and flexibility. Also, it makes SC lean due to minimization of the amount of waste generated in SC. Other effects include (Wilkerson 2005):

– *Improving Agility:* GrSCM helps mitigate risks and speed innovations.
– *Increasing Adaptability*: GrSC analysis often leads to innovative processes and continuous improvements.
– *Promoting Alignment*: GrSCM involves negotiating policies with suppliers and customers, which results in better alignment of business processes and principles.

From a macro-level perspective, GrSCM leads to green products, which in turn creates new markets for these products and their required material and inputs. This gives the green companies a great competitive advantage. Also, GrSCM creates incentives for SMEs to adopt better green practices.

The main barriers of GrSCM can be divided into four main groups including environmental requirement costs, lack of green awareness, technological barriers, and lack of environmental information, knowledge and trainings. Concerning GrSCM barriers, different organizations and institutions are responsible for eliminating these barriers.

Table 9.1 Organizational advantages of GrSCM practices

GrSCM practices advantage	Sample advantage
Reducing costs	Raw material and energy costs, insurance costs
Reducing risk	Waste bills and pollution fines, water and/or energy shortages
Improving productivity	Using natural light and ventilation
Increasing property value	Lowering operating costs
Improving public image	Increasing sales, better public perception and community support, proving the company seriousness
Creating healthier environments	Less toxins and cleaner air, less hazardous production processes

Min and Galle (2001) debated that environmental requirement costs and investments is the main obstacle to green purchasing programs. Customers/suppliers partnership in green project and governmental loans can initiate many projects which in turn will be profitable. Lack of green awareness leads to other barriers such as lack of government involvement and participation, and lack of top-level management support to name a few. Therefore, it is everybody's responsibility to promote GrSCM, especially governments and final customers. Breaking technological barriers can only be achieved via interorganizational cooperation and investment from both governments and large influential companies. Finally, lack of environmental information, knowledge, and training can resolved through environmental information databases, knowledge transfer networks and providing more training classes for government and organizations personnel.

9.3 GrSCM Initiatives

Many factors can initiate the adoption of GrSCM by companies. GrSCM initiatives can be divided into four main groups as follows:

1. *Customer Requirement*: Customer requirements play an important role in SC design and specifications, and suppliers usually comply with these requirements. Green thinking lets the customers, especially major customers, use their influence on suppliers to adopt green practices. This demand has cascade effect and goes through the entire supply chain. Also, major customers should help suppliers achieve this goal by partnering in product and process design.
2. *Governmental and International Laws and Regulations*: Governments, national standard institutes, industrial development bureaus, and local authorities have a great impact on industries by passing laws and regulations and controlling the industries to implement these regulations. International unions, such as UN and EU, also pass laws and regulations which make countries conform to GrSCM practices.
3. *Organizational Green Awareness*: The economical impacts of using old and worn products for purposes such as repairing, reusing, reassembly, refurbishing and recycling on organizational productivity and cost reduction is another important initiative for companies to develop GrSCM practices. For example, in 2005 and 2006, Texas Instruments (TI) initiated 223 new resource preservation projects. The initial \$9.7 million investment led to a \$7.7 million annual savings for a simple payback of just 15 months. These projects help TI use natural resources such as water and fossil fuels, more efficiently and reduce the company's environmental impacts (Texas Instruments 2007).
4. *Environmental Activists and NonGovernmental Organizations (NGOs)*: These groups can create green awareness within both societies and industries as well. First, they can encourage people to buy green products instead of their nongreen counterparts. Despite the lack of expertise in technical fields, environmental activists, and NGOs can still have impact on industries by promoting green

awareness among people and requiring industries to adopt green practices. Kong et al. (2002) examined how NGOs could create green awareness in industries as their partners. They debated that consumers need to feel empowered to make a difference through their behavior; and they should also be able to improve their quality of life.

9.4 Green Design

There are many facets of the supply chain that could be improved via GrSCM. LCA Studies have shown that up to 70% of opportunities for mitigating environmental impacts and resource demand reduction are determined by the product design (Johannson 2001). Therefore, the first issue that green companies focus on is the design and production of the product. One must note that these efforts cannot be done for the whole products and each product should be analyzed separately. Companies in similar industries may produce vastly different products, in a number of different ways. Therefore, such an approach cannot be generic.

Green design concepts have been used extensively in the GrSCM literature for designing products with certain environmental considerations. Fiksel (1996) has defined green design as the systematic consideration of design issues related to environmental health and safety over the product life cycle during new product design and production process design. Green design is a multidisciplinary field and requires different areas of expertise such as environmental risk management, product safety, pollution prevention, resource conservation, and waste management (Srivastava 2007). Currently, green design literature seems to be mature and numerous works exist. This literature can be categorized based on two main environmental approaches, life cycle assessment and environmental conscious design.

9.4.1 Life Cycle Assessment

When addressing the environmental impacts of products, one cannot just consider the product design and production stages, but s/he must consider the product from its combining raw materials to end of its life. The approach considering this fact is life cycle assessment. The main idea of LCA is that designers and companies must not only look at their own direct environmental burdens, but also look at the indirect burdens as well.

LCA can be described as an objective process for evaluating the environmental burdens associated with a product, process, or activity through its lifespan. It identifies and quantifies the materials and energy used and wasted. Also, LCA assesses and implements different plans for improving environmental aspects. This assessment covers the entire life cycle of the product, process or activity, including extracting and processing raw materials; manufacturing, transportation and distribution; reuse and maintenance; recycling and final disposal (Guinée 2002).

There are four main types of LCA methods for different situations. Cradle-to-Grave is the most common LCA and is used for the analysis of materials used in making a product. This analysis covers the entire product life cycle. Wheel-to-Wheel determines the efficiency of transportation system fuel consumption. Cradle-to-Gate calculates the efficiency of product until it is delivered to the customers. Finally, Cradle-to-Cradle is a new way of thinking which tries to make the grave of a product, another product cradle. For example, many companies recycle used high quality paper in order to make newspapers paper or cardboard which have lower quality but they still can be used.

9.4.1.1 LCA in ISO 14040:2004

The main procedure for LCA is ISO 14040:2006 part of the ISO 14000 environmental management standards. Direct applications of this model are product development and improvement, strategic planning, public policy planning, and marketing. The guidelines for each phase are provided in ISO 14040:2006. The conceptual framework of ISO 14040 LCA model has four main processes (Fig. 9.2) as follows (ISO 2006):

1. *Goal and Scope Definition*: In this phase, the goal of LCA study, its intended application, the reasons for carrying out the study, the intended audience, the boundaries of study, and the study methodology are stated.
2. *Life Cycle Inventory*: The second phase involves product system modeling, data collection, data description, and data verification. Collected data includes

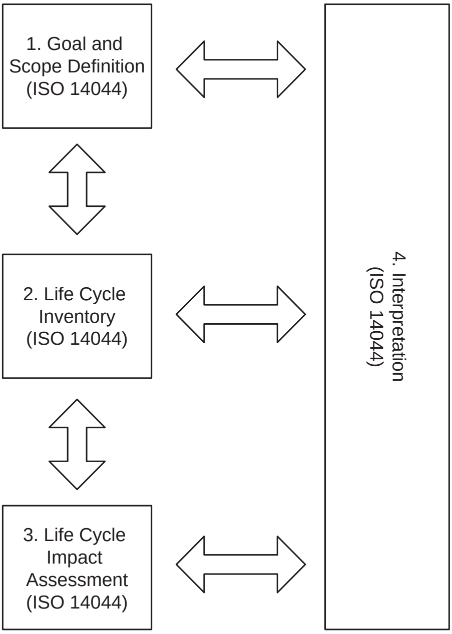

Fig. 9.2 Four phases of LCA proposed by ISO 14040:2006 (ISO 2006)

quantified inputs (e.g., raw material and energy) and outputs (e.g., air emission, water pollution, and solid wastes) of processes of the product system.

3. *Life Cycle Impact Assessment*: In this phase, the impacts of the system processes on human health and the environment are assessed. Every impact is associated with the corresponding raw material and energy inputs and environmental outputs quantified by the inventory.
4. *Interpretation*: This phase is the most important phase. In this phase, different opportunities to reduce energy, material inputs, or environmental impacts at each stage of the product life cycle are evaluated and implemented. The results of this phase are dependent on the other three phases; therefore, interpretation must be done with feedback from other phases. If necessary, outcomes of each phase must be reviewed and corrected.

9.4.1.2 LCA and SCM

One must note that designing a supply chain concurrently with its corresponding products is a SCM best practice. LCA seems to be a useful tool for this approach because of its generality and also covering the entire life cycle of product which leads to analysis of logistical activities.

Currently, many researchers are using LCA in their green SC analysis approaches. Hagelaar and van der Vorst (2002) debated that the integration of different types of LCA results in different SC structures to meet the specific specifications of each LCA type. Sanchez et al. (2004) have tried to develop operational models to help companies understand, monitor, and assess their products life cycles. Matos and Hall (2007) argued that sustainable development pressures have increased complexities and presented ambiguous challenges that many current environmental management techniques cannot adequately address.

Hugo and Pistikopoulos (2005) presented a multiobjective OR-based methodology for explicit inclusion of LCA in the process of supply chain network design. At the strategic level, the model selects the sites, allocate demands, determine capacity expansion, and assign distribution links required to satisfy the demands in the markets. Also, at the operational level, the model determines optimal production profiles and material flows between various components within the supply chain. The authors have incorporated the LCA via considering a set of life cycle stages and appropriate LCA method.

Puigjaner and Guillén-Gosálbez (2008) have presented a framework for SCM in batch chemical process industry considering SC dynamics, environmental issues, novel business aspects, and KPIs. They have considered the ISO 14000 LCA model as the basis of their environmental analysis and constructed their model based on the first three phases.

9.4.2 Environmentally Conscious Design

Environmentally conscious design (ECD) tries to consider environmental issues during the product and process design and design the product as sustainable as possible. The benefits of ECD include improved product quality at lower costs, cleaner plants, reduced disposal costs, reduced environment and health risks, better public image, and higher productivity (Zhang et al. 1997). The main goal of ECD is to design the product and its production processes in way that recovery rate of green operations such as reducing, reusing, and recycling increase significantly.

Tukker et al. (2001) have highlighted three ECD best practices by analyzing six leading EU institutes in the field of sustainable product design. The findings were as follows:

- Method development occurs within a well-coordinated structure
- This structure ensures communication between participants, and feedback loops between different phases
- The toolbox available consists at least of the following elements:
  - Up to date, databases and easy-to-use software tools for product analysis
  - Manuals with clear and comprehensive schemes and procedures
  - Simplified tools (checklists, design rules, protocols) that are specifically made to cope with environmental bottlenecks related to particular product groups and/or industrial sectors

ECD approaches can be classified into several categories (Srivastava 2007) such as material/product recovery (Ferrer 2001; Guide and van Wassenhove 2001), design for recycling (Bellmann and Khare 2000; Masanet and Masanet 2007), design for disassembly (Krikke et al. 1999, 2003; Moore et al. 2001), design for waste minimization (He et al. 2004), design for remanufacturing (Bras and McIntosh 1999), design under legislations (Bellmann and Khare 2000), and design for better material choices (Krikke et al. 1999).

Ijomah et al. (2007) have developed guidelines for design for manufacturing to facilitate remanufacturing and support sustainable manufacturing. Also, Zhang and Gershenson (2002) discussed the benefits of modular design in ECD and the possibility of decreasing the green operations costs. Masui et al. (2003) incorporated environmental issues into QFD to manage environmental requirements during early stages of product design. Zhang et al. (1997) and Srivastava (2007) have presented a comprehensive review on environmentally conscious design approaches. Also, Gungor and Gupta (1999) have reviewed environmentally conscious manufacturing and product recovery.

9.4.2.1 Hierarchic Framework for Environmentally Conscious Design

Madu et al. (2002) presented a systematic customer-oriented hierarchic framework for environmentally conscious design. This framework integrates green design issues into the product design using a LCA approach for evaluating the product environmental impacts. Also, it is shown how to integrate customers in the initial stages of product design. The authors have used AHP and QFD for developing customer requirements priorities and translating them into the design requirements. Finally, the authors have implemented their methodology in a paper recycling system. The proposed model has four main stages as follows (Madu et al. 2002):

1. *Prioritizing customer requirements*: First, the customers' requirements information is surveyed through one of the popular market survey methods, e.g., focus group. The gathered data will be statistically analyzed for finding requirements with significant importance. Then, these factors are prioritized through AHP.
2. *Translating customer requirements into technical specification*: In this phase, high-priority customers' requirements are aligned with technical design specifications using QFD.
3. *Developing design plans*: The impact of the most important design specifications on product performance is analyzed using Taguchi design of experiments method. Further assumptions on the level of most important design specification are tested using Taguchi loss function.
4. *Evaluating plans based on costs and environmental impacts*: In this stage, all of the manufacturing, environmental and social costs are assessed. For evaluating environmental impacts, a thorough input–output analysis and life cycle assessment is performed. Finally, the best plan with minimum cost is selected.

9.5 Green Operations

Green operations are intended to mitigate the environmental impacts of products once the design has been finalized. Therefore, the main application of green operations is improving an existing product or process. These operations include manufacturing and remanufacturing, reverse logistics and network design, and waste management.

9.5.1 Manufacturing and Remanufacturing

The main goal of green manufacturing is to reduce the product environmental impacts by using proper material and technologies, while green remanufacturing tries to restore worn-out products to like-new condition (Lund 1984). Green manufacturing includes activities such as reducing, and recycling; while remanufacturing includes reusing, and product/material recovery. Also, one must note that green manufacturing and remanufacturing requires inventory management, production planning, and scheduling besides usual planning due to varying and unknown amounts of returned products for recycling. Guide et al. (1999) have presented a review on production planning and control for remanufacturing.

Reducing is a technique in which the consumption rate of scarce materials and/or energy is minimized. Recycling refers to activities performed to recover material from products. Bellmann and Khare (1999) have considered recycling in automobiles; while, Krikke et al. (1999) have considered it in electronics industries. Pagell et al. (2007) have discussed supply chain implications for companies in recycling business; while Pati et al. (2008) considered a goal programming model for paper recycling system.

Reusing is the concept of using intact parts of used products for manufacturing activities (Krikke et al. 1999; Ferrer 2001; Fleischmann et al. 2001; Fernández and Kekäle 2005). Product/material recovery refers to activities performed to regain the product value at the end of its life cycle. These activities include repair/refurbish (Krikke et al. 1999; Ferrer 2001; Fernández and Kekäle 2005), and disassembly (Gungor and Gupta 1999; Tateno and Kondoh 2006; McGovern 2007).

9.5.2 Reverse Logistics and Network Design

Implementing GrSCM practices requires the flow of material from the final customers back to retailers, collection points, manufacturers, and/or disposal sites. Therefore, reverse logistical activities are different from traditional logistical activities in which the flows of materials and products are from the suppliers to the customers. Rogers ans Tibben-Limbke (1998) have defined reverse logistics (RL) as "*the process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal.*"

RL activities vary from product/industry to product/industry; but common activities are collection, transportation, inspection/sorting, storage, reprocessing (including recycling, reusing, repairing/refurbishing, etc.), and/or disposal. Based on the main recovery options categorized by Thierry et al. (1995) and the classification of return-objects by Fleischmann et al. (1997), Lu and Bostel (2007) proposed four kinds of basic RL network including directly reusable network (DRN), remanufacturing network (RMN), repair service network (RSN), and recycling network (RN).

RL literature is very extensive covering topics such as network design (Fleischmann et al. 2001; Min et al. 2006; Lu and Bostel 2007; Srivastava 2008), inventory (Mostard and Teunter 2006), location-inventory (Wang et al. 2007), return demand estimation (Srivastava and Srivastava 2006), SC asset management and investments (Sharma et al. 2007; Kocabasoglu et al. 2007), and managerial issues (Fernández and Kekäle 2005).

Successful adoption and implementation of RL depends on several intraorganizational factors, including commitment to environmental preservation, ethical standards, and the existence of supporters or policy makers with a commitment for the adoption of environmentally friendly policies (Murphy and Poist 2003; Richey et al. 2005). Beamon (2005) discussed ethical issues that SC engineers have to deal with. Beamon pointed out there is a gap about decision making and ethical issues in the SCM research. Manning et al. (2006) evaluated ethical modeling mechanisms for ranking an organization's ethical aspects and prioritizing the ethical impacts in food supply chains.

Krumwiede and Sheub (2002) discussed the issues and processes that an organization has to deal with to engage in the RL business. Tibben-Lembke (2002) discussed different challenges for RL that occur during each stage of a product life cycle. Comprehensive Surveys of RL are presented by Fleischmann et al. (1997) and Meade et al. (2007). Sbihi and Eglese (2007) have surveyed problems in the areas of reverse logistics, waste minimization, and vehicle routing which can be formulated as combinatorial optimization. Also, Fleischmann et al. (2000) have compared nine case studies on recovery networks.

9.5.3 Waste Management

Waste Management is the management of waste generation and its impacts through activities such as source reduction, pollution prevention, and disposal. Marguglio (1991) defines waste minimization as reducing hazardous waste generated during production and operations, or afterwards treating, storing, or disposing wastes. Source reduction and pollution prevention strategies try to hinder pollution at the generation source; while disposal is intended to dispose waste after its generation (Marguglio 1991).

Abou-Elala et al. (2008) discussed two pollution prevention scenarios in a broad paper mill. Chinh et al. (2007) analyzed the anthracite production in Vietnam using LCA and discussed pollution prevention options. Henningsson et al. (2004) discussed the value of resource efficiency in food industry and potential of source reduction for substantial saving.

Wey (2005) developed an integrated decision support system for the optimization of waste incinerator siting problems. Also, Erkut et al. (2008) considered a multicriteria facility location model for municipal solid waste management in north of Greece. Alumur and Kara (2007) considered a location-routing model for hazardous wastes.

In recent years, the researchers are focusing on environmental management system implementation effects as well as operational issues. White et al. (2003) discussed the management challenges of reverse manufacturing in computer industry. Kautto and Melanen (2004) analyzed the impacts of waste management policy on 14 Finnish companies.

9.6 Green Procurement

Procurement capabilities, responsiveness, and flexibility have major impacts on an organization's SC performance and its ability to satisfy customers' requirement on time and properly. Burt and Pinkerton (1996) defined procurement as the process of "*deciding what, when, and how much to purchase; the act of purchasing it; and the process of ensuring that what is required is received on time, in the quantity and quality specified*." Procurement activities include inventory management, identifying requirements, determining requirement specifications, finding appropriate supplier(s), contract negotiation and management (price, amount, quality, delivery schedules, etc.), receiving, quality inspection, storage, and inbound distribution.

Green procurement tries to minimize the environmental impacts of selected products and services. Unlike green design and green operations, green procurement refers to activities which most of them happen outside the organization boundaries. Hence, greening procurement processes and system is a major start point in greening SC, because procurement processes are usually the first place in which an organization and its suppliers encounter. Customers usually try to persuade their suppliers to meet their requirements during contract negotiation meetings. Therefore, incorporating green criteria in this process can lead to greening the whole SC.

Green procurement has received attention from academics and practitioners. For example, Min and Galle (2001) surveyed the US firms green purchasing practices. Humphreys et al. (2003a) used a cased-based reasoning approach for integrating environmental factors into the supplier selection process. Humphreys et al. (2003b) developed a framework and a decision support tool for integrating environmental criteria into supplier selection process. Finally, Chen (2005) proposed that green purchasing provides a positive effect on the implementation of ISO 14001 environmental management. He also presented a framework of guidelines for green purchasing and the related implementing procedures.

9.6.1 Green Public Procurement

Due to governments' large amount of purchases, government purchasing and procurement behavior is very important. In some industrial and service sectors such as computers, transportation, packaging, the impacts of government procurement behavior on industries behaviors can be significant. Governments can create strong incentives for industries to develop more green practices.

Bouwer et al. (2006) defined Green Public Procurement (GPP) as the approach by which public authorities incorporate environmental criteria into their procurement process, hence promoting environmental technologies and the development of environment friendly products, by looking for and choosing solutions that have the least possible impact on the environment throughout their whole life cycle.

GPP has been the main focus of some of SCM researches in public administration area. For example, Li and Geiser (2005) developed some product-related environmental policy instruments in governmental computer purchasing at state level in the United States. The instruments included eco-labeling, extended producer responsibility, and environmentally responsible public procurement. Swanson et al. (2005) developed a priority-setting tool for the State of California's procurement division to prioritize different classes of products and recommend better product brands. This tool considers purchase volume, environmental impacts, potential for improvement, and institutional factors such as existing state policies and upcoming contract renewals. Finally, Geng and Doberstein (2008) traced GPP concepts, its spread to China, and a number of approaches used to expand GGP adoption.

9.6.2 European Commission GPP Model

European Commission (EC) has issued a handbook on environmental public procurement consisting of six chapters on different aspects of greening the public procurement system. In this handbook, EC have proposed a GPP model to save money and protect environment at the same time. This model is designed to help public authorities adopt green purchasing practices. The proposed model consists of six steps as follows (EC 2004):

1. *Consider which products, services or works are the most suitable or implementing GPP* on the basis of factors such as their environmental impacts, costs, information available, technologies available, and market analysis
2. *Identify your needs and express them appropriately* to communicate your policies to your potential suppliers and citizens
3. *Draw up clear and precise technical specifications*
4. *Establish selection criteria* consisting of financial, technical, and environmental factors
5. *Establish award criteria* to give more weight to products or suppliers satisfying your environmental requirements more than others
6. Use contract performance clauses as a way of setting relevant extra environmental conditions including transportation

This handbook tries to cover various aspects of GPP in EU. It explains the possibilities offered by European Community law in a practical way, and presents simple, operational, and effective solutions that can be implemented in public procurement. Practical examples from public authorities in EU are provided as well.

9.7 GrSCM Framework

Although numerous articles on GrSCM exist, the numbers of proposed comprehensive frameworks for GrSCM are still few. Most of literature in GrSCM is addressing green design or operations issues. Very little articles exist which address GrSC analysis via generic models which could be applied to different products, processes, and industries. In this section, two generic models, EPA "Lean and Green Supply Chain Model" and GreenSCOR are reviewed and discussed.

9.7.1 EPA Lean and Green Supply Chain Model

The United States Environmental Protection Agency (EPA) has issued a guide entitled "The Lean and Green Supply Chain: A Practical Guide for Materials Managers and Supply Chain Managers to Reduce Costs and Improve Environmental Performance" (McDaniel et al. 2000). This guide provides a systematic approach to implementing a green SC. The proposed model is created through a collaboration program with US industry, trade associations, research institution, and government agencies (Fig. 9.3).

The proposed model has a four step decision making process. In the first step, environmental impacts within each process or facility are identified. This would later allow focusing on the significant improvement alternatives. Next, the opportunities, which would yield considerable cost savings and reduce environmental impact, are determined. The third step is to evaluate the quantitative and qualitative benefits of each alternative. Finally, the best alternative is selected, implemented, and its performance is monitored to control the behavior of the system.

9.7.2 GreenSCOR Model

GreenSCOR (LMI 2003), developed by Logistics Management Institute[2], is a model for focusing on the impacts of SCM on each stage of the product life cycle.

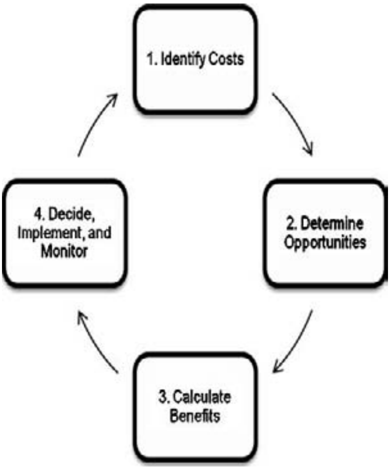

Fig. 9.3 EPA lean and green supply chain framework (McDaniel et al. 2000)

[2] www.lmi.org.

GreenSCOR modifies the SCOR 5.0 model structure to include environmental processes, metrics, and best practices. Most of these modifications have occurred in the SCOR model "best practices" part.

LMI developed GreenSCOR model through a structured approach. First, they researched for GrSC best practices and metrics. Then, environmental impacts of current SCOR model processes were evaluated (Table 9.2). Then, LMI incorporated environmental metrics and best practices into the SCOR model, and reported the changes in a way that specifies the reasons of each change and its the impact on SC operations (Wilkerson 2003).

The Supply Chain Operations Reference (SCOR) is a state-of-the-art SCM tool developed by Supply Chain Council. SCOR drives an end-to-end view of SC performance. This model incorporates best practices from a variety of industries, hence making it suitable for different kinds of organizations. Currently, SCOR model consists of five main processes including *Plan*, *Source*, *Make*, *Deliver*, and *Return*. For each process, suitable required inputs and outputs, enablers, and best practices are defined. The current version of SCOR is 9.0 as January 2009. Before version 9.0, SCOR did not explicitly consider GrSCM; although Return process does partially relate to GrSCM concepts.

Table 9.2 SCOR process environmental impact (Cash and Wilkerson 2003)

SCOR process	Potential environmental impact
Plan	Plan to minimize energy and perilous material consumption
	Plan the handling and storage of perilous materials
	Plan for the disposal of ordinary and perilous waste
	Plan conformity of all supply chain activities
Source	Select suppliers with positive environmental records
	Select materials with environmentally friendly content
	Specify packaging requirements
	Specify delivery requirements to minimize transportation and handling requirements
Make	Schedule production to minimize energy consumption
	Manage waste generated during the make process
	Manage emissions (air and water) from the make process
Deliver	Minimize use of packaging materials
	Schedule shipments to minimize fuel consumption
Return	Schedule transportation and aggregate shipments to minimize fuel consumption; prepare returns to prevent spills of perilous materials (oils, fuels, etc.) from damaged products

GreenSCOR is intended to be used by organizations that have already implemented the more advanced features of environmental management and SCM. For environmental management, this includes GrSCM practices and life cycle assessment. As for SCM, the organization must implement supply chain integration and SCOR model (Cash and Wilkerson 2003).

Supply Chain Council is still working on complete incorporation of GrSCM in SCOR. They are designing appropriate and efficient metrics and best practices for suitable incorporation of GrSCM concepts in SCOR.

9.7.2.1 GreenSCOR Findings

One of the main gaps in the SCOR model was lack of process for waste disposal during the production. Therefore, GreenSCOR added a new waste disposal process to every function of Make process. Also, as stated before, the return process does not completely account for many of GrSCM practices such as remanufacturing, refurbishing, reusing, recycling etc (Table 9.3).

Table 9.3 SCOR performance attributes environmental linkage(Cash and Wilkerson 2003)

Performance attribute	SCOR definition	Environmental definition
Reliability	Delivering correct product to correct customer, to correct place, at the correct time, in the correct condition and packaging and quantity, with correct documentation	Delivering the correct reduces waste, pollutions and fuel use from extra transportation for returned products; Proper documentation enables all of the supply chain entities to keep better track of perilous materials that are embedded in products; thus allowing to arrange for proper storage, handling, and disposal.
Responsiveness	The speed of providing products to the customers	The environmental impacts affecting the speed of material movement, including regulatory or pollution control steps within a process.
Flexibility	The agility in responding to market changes to gain or maintain competitive advantage	The extent to which a firm can meet the environmental demands of its customers. This refers to the products, their production, transportation and recyclability, etc.
Costs	Costs of operating supply chain	The costs of environmental conformity and cleanup as well as energy costs.
Asset management efficiency	Effectiveness of assets management in order to satisfy customers demand	Assets management in a way that mitigates environmental impacts and reduces internal costs.

LMI added new metrics to GreenSCOR to measure supply chain environmental performance. All of the metrics are supply chain oriented in order to improve customer service by implementing environmental practices. Finally, LMI added environmental best practices to the model. These environmental best practices are implementable regardless of industry.

9.8 Role of Governments and International Organizations

The role of governments and international organization in GrSCM is very complex. As stated in Sect. 9.3, governments and international organization are one of the most important initiatives in promoting GrSCM. This is mostly because governments themselves are very powerful customers in some national-level markets. For example, public authorities are major consumers in Europe, spending approximately 16% of the EU's GDP which is a sum equivalent to half of the Germany's GDP (EC 2004). Germany's GDP was about 2,760 billion Euros in fiscal year 2004 which makes the aforementioned saving as large as 1,380 billion Euros (DB 2007). Regarding the environmental impacts of governmental decisions and practices, consider another example form EU (EC 2004):

If all public authorities across the EU were to require more energy-efficient computers, and this led the whole market to move in that direction, this would result in a saving of 830,000 tones of CO_2.

The main activities of governments and international organization are as follows:

– Balancing between green criteria and guaranteeing purchases from SMEs
– Developing environmental standards, green products standards, and related regulations
– Supporting private sector in developing GrSCM practices
– Supporting scientific institutes and private sector in developing new green technologies

Other activities include creating green awareness through media, setting up official eco-labeling systems, and encouraging SMEs to adopt green practices through various incentives such as tax exemption and service discounts. Also, Bouwer et al. (2006) recommends policy makers to get GPP on the political agenda, define achievable goals, create a green information knowledge base, enable and stimulate training, and finally implement benchmarking in order to assess their current performance.

Besides governments' role, the roles of international organizations and treaties are very important. For example, the regulatory role of European Union in Europe and Supportive role of the International Organization for Standardization is significant. In addition, international treaties, such as the Kyoto Protocol for reducing greenhouse gases, can play an important role in forcing countries to adopt green practices.

9.8.1 European Union

European Union (EU) is a supranational community consisting of 27 European countries. Currently, Austria, Denmark, Finland, Germany, Netherlands, Sweden, and UK are more actively involved in adopting green practices in public sector (Bouwer et al. 2006). Some of environmental actions taken by EU are as follows:

– The Eco-Management and Audit Scheme[3] (EMAS) is the EU voluntary instrument which acknowledges organizations that improve their environmental performance on a continuous basis. EMAS is a management tool for organizations to assess, report, and improve their environmental performance. Also, legislation within the EU was introduced to encourage businesses to voluntarily adopt ISO 14000.
– EU have passed various environmental legislations including areas such as water protection and management, water pollution caused by nitrates from agricultural source, soil protection, climate change, sustainable development, protection of nature and biodiversity, waste management, noise pollution, and air pollution (EC 2007).
– EU tries to develop and promote key international environmental agreements and conventions as well (EC 2004). For example, regarding the Kyoto Protocol, EU committed itself to reduce its greenhouse gas emissions by 8% between 2008 and 2012 (compared with 1990 levels).
– EU has also passed legislation on specific substances consumption such as Restriction of Hazardous Substances directive (RoHS) law in 2003 (EU 2003). RoHS restricts the amount of specific substances in electrical and electronic equipments.
– Demonstrate and Assess New Tools for Environmental Sustainability[4] (DANTES) is a program initiated by EU to educate industries how to use sustainability tools to address environmental problems (Manuilova et al. 2005). Some of available tools are life cycle assessment, life cycle costing, environmental risk assessment, Environmental Product Declarations, and environmental performance indicators.

9.8.2 United States

The main authority for environmental issues in US is Environmental Protection Agency[5] (EPA). EPA is responsible for protecting human health and preserving the natural environment: air, water, and land. US government has passed several laws regarding environment (EPA 2007a) including National EnvironmentalPolicy Act

[3] http://ec.europa.eu/environment/emas/index_en.htm.
[4] www.dantes.info.
[5] www.epa.gov.

in 1969, The Clean Air Act in 1970, The Resource Conservation and Recovery Act and The Toxic Substances Control Act in 1976, The Clean Water Act in 1977, The Pollution Prevention Act and The Oil Pollution Act in 1990.

EPA has initiated many partnership projects with US industries (EPA 2007b) including Climate Leaders (greenhouse gas reduction), Design for Environment, Energy Star (energy efficiency and pollution reduction), Green Power (supporting industries interested in buying green power), and WasteWise (reducing municipal waste). EPA has developed a database of environmental information on its website for easy access to information, regulations, guideline, project, etc. EPA has also issued a guide named "The Lean and Green Supply Chain" for promoting GrSCM which was discussed in Sect. 9.7.1.

9.8.3 ISO 14000 Series

The International Organization for standardization (ISO) is a worldwide federation of national standard bodies, preparing international standards. Preparation of each standard is carried out through ISO technical committees. Draft standards adopted by technical committees are passed to member bodies for voting. Among notable management standard series are ISO 9000 series for quality management, and ISO 14000 series for environmental management.

The ISO 14000 series covers various aspects of environmental management systems (EMS). This standard series tries to minimize harmful effects on the environment caused by an organization's activities, and to achieve continual improvement of its environmental performance. The first two standards are ISO 14001:2004 (ISO 2004a) defining requirements for an EMS, and ISO 14004:2004 (ISO 2004b) providing general guidelines for EMS. Other notable standards in ISO 14000 series are shown in Table 9.4. An EMS meeting the requirements of ISO 14001:2004 is a management tool enabling an organization of any size or type to (ISO 2004c):

– Identify and control the environmental impact of its activities, products or services
– Improve its environmental performance continually
– Implement a systematic approach to setting environmental objectives and targets, to achieving these and to demonstrating that they have been achieved.

9.9 Conclusion

In this chapter we discussed some of the fundamental concepts of Green Supply Chain Management. GrSCM, its origins, advantages, barriers, and initiatives were introduced and discussed. Then, we reviewed green design, green operations, green procurement, and GrSCM frameworks. At the end, the role of governments

Table 9.4 Notable standards in environment management

ISO scope	ISO number
Environmental auditing	ISO 19011
Environmental assessment of sites and organizations (EASO)	ISO 14015
Environmental labeling	ISO 14020, ISO 14021, ISO 14022, ISO 14023, ISO 14024, and ISO 14025
Life cycle assessment	ISO 14040, and ISO 14044

and international organizations in promoting and developing GrSC practices was analyzed and discussed.

Nowadays, environmental issues are one of the most important issues concerning human beings' life. In order to preserve our environment and resources for future generations, we need to change the way we are managing and operating our supply chains. From a financial viewpoint, GrSCM is still advantageous. Along with the increase of awareness in environmental issues and environmental legislative constraints, SC managers are becoming more familiar with the advantages of GrSCM. Considerable improvements in supply chains can be achieved because environmental problems are mostly material-oriented. For industries with lower margins, GrSCM can lead to lower supply chain related costs. These cost reductions can be translated into significant competitive advantages and profit.

While many firms are working to integrate environmental issues and SCM, the integration is far from complete. First reason to this fact is cultural barriers between environmental and SC managers. Second reason is the lack of a holistic approach within green SC projects because common green SC projects usually tend to focus on discrete processes rather than entire system. Eventually, most green projects tend to focus on greening suppliers and upstream processes rather than focusing on the entire product life cycle. Companies must endeavor to leverage their competitive advantages across their entire supply chain.

Finally, considering the high share of logistical costs in a country's GDP, GrSCM is an important factor in developing national level sustainability strategies. Therefore, from a national viewpoint, GrSCM is a key piece in the puzzle of sustainability.

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Chapter 10
Logistics Management and SCM in Disasters

Marjan Aslanzadeh, Ehsan Ardestani Rostami, and Laleh Kardar

An understanding of supply chain management warrants a familiarity with basic definitions involved.

"A crisis results in extensive human suffering, property damage, and a disruption of society. This stretches the community's coping mechanism beyond the breaking point. Crisis not only refers to an unexpected catastrophe, but also to the slow build-up of environmental, political, or economic factors that act on a society's vulnerabilities" (Blaikie et al. 1994).

"The event becomes a disaster when the community's capacity to cope is overwhelmed and the status quo becomes untenable. The situation is then declared an emergency, and assistance is requested. Disasters happen when hazards meet exposure due to vulnerability" (Russell 2005).

A disaster can be defined as "an emergency of such severity and magnitude that the resultant combination of deaths, injuries, illnesses, and property damages cannot be effectively managed with routine procedures or resources. These events can be caused by nature, equipment malfunction, human error, or biological hazards and diseases" (Landesman 2005).

Also, UNDHA (1993) has defined disaster as "a serious disruption of the functioning of society, causing widespread human, material, or environmental losses that exceed the ability of affected society to cope using only its own resources".

In a research carried out for his Master's thesis, Akkihal (2006) has clearly shown that a natural disaster is born when fluctuations in geological and climate systems exceed the civilization's capacity to absorb such geological and climate fluctuations, as indicated in the following graph where "A" stands for the magnitude and frequency of fluctuations in geological and climate system at specific time and place, and "B" stands for vulnerability, or capacity of civilization at a given locality to absorb geological and climate shocks (see Fig. 10.1).

R. Zanjirani Farahani et al., *Supply Chain and Logistics in National, International and Governmental Environment.* Contributions to Management Science.
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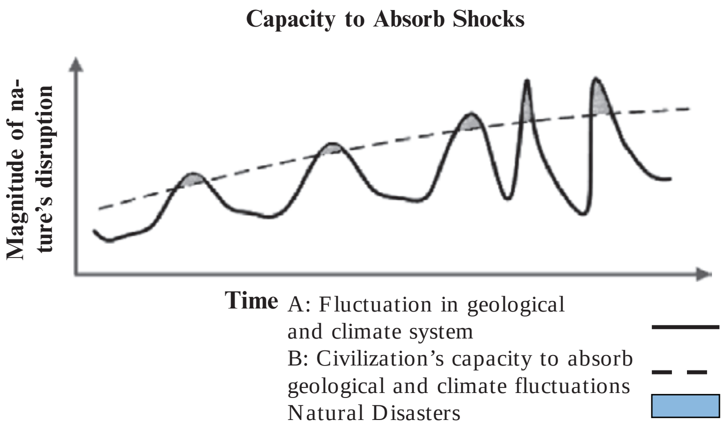

Fig. 10.1 Natural fluctuations and civilization's threshold (Akkihal 2006)

The above diagram also reveals that in spite of improvements in civilizations abilities to absorb the shocks due to the furtherance of the process of industrialization, events still occur with such strong magnitude to be identified as natural disasters.

10.1 Types of Disasters

There are a lot of categorizations for the disasters. Whybark (2007) divides disasters into natural and political/economic.

"Natural disasters can be categorized as "acute" or "slow" in their onset. They are predictable because they cluster in geographic areas. Natural hazards are unpreventable and, for the most part, uncontrollable. Even if quick recovery occurs, natural disasters can have long-term effects. Natural disasters with acute onsets include events such as earthquake, flood, hurricane or typhoon, tornado, fire, tsunami or storm surge, avalanche, volcanic eruption, extreme cold or blizzard, and heat wave. Natural hazards with a slow or gradual onset include drought, famine, desertification, deforestation, and pest infestation" (Landesman 2005).

"Political/economic disasters arise when people are displaced by war, genocide, political insurrection or other failures of government. These displacements can lead to large populations who are forced from their homes and even their countries. Natural and political disasters can strike almost anywhere" (Whybark 2007).

Another categorization has been introduced by International Federation of the Red Cross and Red Crescent (IFRC). IFRC divides all disasters into ten types as follows (see http://www.ifrc.org/what/disaster):

1. Hurricanes, cyclones and typhoons
2. Floods
3. Drought

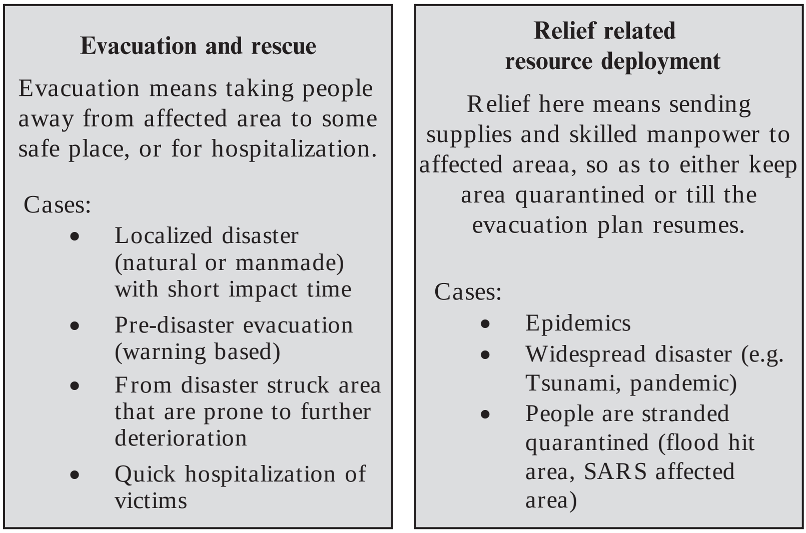

Fig. 10.2 Classification of disasters based on supply chain perspective (Siroya and Joshi 2005)

4. Earthquakes
5. Volcanic eruption
6. Epidemics
7. Famine and food insecurity
8. Man-made disaster
9. Population movement
10. Technological disaster

Included in technological disasters, item no. 10 above, are: nuclear accidents, bombings, and bioterrorism.

Talking about classification of disasters, one should consider the classification based on supply chain perspective (Siroya and Joshi 2005). Figure 10.2 shows such a classification.

10.2 Why Disasters Should be Given Closer Attention

Every year large numbers of people are affected by natural disasters of various types around the world. Large sums of money are spent to provide relief for affected population. In 2003, for example, an amount of $6 billion was spent on humanitarian relief around the world. In 2005, the amount has been considerably greater because of tsunami, so much so, that on March 22, 2005 an amount of $6.4 billion was allocated for tsunami response alone.

On the other hand, the number of people affected by natural disasters is also ever-increasing. Research shows that the number of victims has tripled in 1990s as compared with the number of victims in 1970s. This increment in number of victims is related to population growth on the one hand, and rise in the number of disasters during the mentioned decades on the other hand (Kreimer and Munasinghe 1991).

Research has also revealed that the greater part of destructions due to natural disasters occurs in the developing countries, where overpopulation and poverty prevail (Russell 2005).

Nevertheless, it should be kept in mind that a disaster's destructive effects do not confine to people and places where they happen, Rather, due to economic connectivity that there exists among the people and regions of the world, the unwanted condition once started, affects the people all over the world. A quick appropriate response to the needs of the affected population can, therefore, be inevitable in that it helps the victims return to their routine life to resume productivity and self-sufficiency.

10.3 Disaster Operations Life Cycle

Among the various approaches to categorize disaster management operations, there is a four-phase approach comprising mitigation, preparedness, response, and recovery (see Table 10.1).

By mitigation, it is meant the application of measures through which disaster is prevented or its impacts are diminished. "preparedness" refers to the activities whereby the community is sensitized to positively respond to a call for help when "need arises"; "response" as the application of resources and emergency procedures to protect the environment, people's lives and properties, as well as social, economic and political structure of the community; and "recovery" involves the measures that are taken, in the long run, to the effect that the community stabilizes and returns into normal functioning after the immediate impacts of the disaster have passed (Altay and Green 2006).

It should be mention that the above said phases repeat themselves in the form of a cycle.

Another categorization was done by Beamon (2004) who divided a relief mission into four phases: "(1) assessment – minimal resources are required to identify what is needed, based on disaster characteristics, (2) deployment – resource requirements ramp up to meet a need, (3) sustainment – operations are sustained for a period of time, and (4) reconfiguration – operations are reduced, then terminated. Figure 10.3 shows relief mission life cycle".

10.4 Humanitarian, Relief, or Emergency Logistics?

Relief logistics, in spite of the important role it plays in saving the lives of the victims, has not gained the due attention. For the same token, there is discrepancy among researchers as to the meanings and concepts thereof.

Table 10.1 Typical activities of disaster operations management (Altay and Green 2006)

Phase	Activity	Phase	Activity
Mitigation	Zoning and land use controls to prevent occupation of high hazard areas	Response	Activating the emergency operations plan
	Barrier construction to deflect disaster forces		Activating the emergency operations center
	Active preventive measures to control developing situations		Evacuation of threatened populations
	Building codes to improve disaster resistance of structures		Opening of shelters and provision of mass care
	Tax incentives or disincentives		Emergency rescue and medical care
	Controls on rebuilding after events		Fire fighting
	Risk analysis to measure the potential for extreme hazards		Urban search and rescue
	Insurance to reduce the financial impact of disasters		Emergency infrastructure protection and recovery of lifeline services
Preparedness	Recruiting personnel for the emergency services and for community volunteer groups		Fatality management
	Emergency planning	Recovery	Disaster debris cleanup
	Development of mutual aid agreements and		Financial assistance to individuals and governments
			Memorandums of understanding
	Training for both response personnel and concerned citizens		Rebuilding of roads and bridges and key facilities
	Threat based public education		Sustained mass care for displaced human and animal populations
	Budgeting for and acquiring vehicles and equipment		Reburial of displaced human remains
	Maintaining emergency supplies		Full restoration of lifeline services
	Construction of an emergency operations center		
	Development of communications systems		Mental health and pastoral care
	Conducting disaster exercises to train personnel and test capabilities		

Gupta and Mahadevan (2005) define humanitarian logistics as the process of planning, implementing and controlling the efficient, cost-effective flow and storage of goods and materials, as well as related information, from the point of origin to the point of consumption for the purpose of alleviating the suffering of vulnerable people.

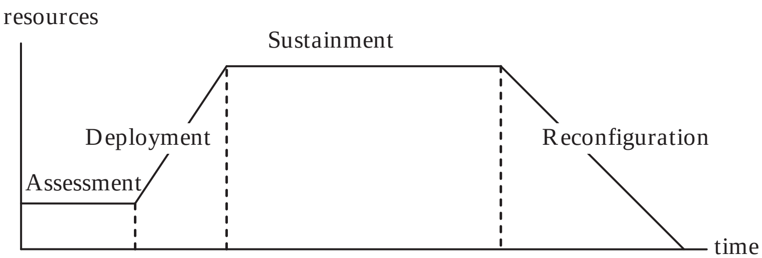

Fig. 10.3 Relief mission life cycle (Beamon 2004)

Some experts believe that different types of relief operations represent the various aspects of logistics activities. Others believe that relief missions have a number of "core activities" supported by relief logistics activities.

Federal emergency management agency has divided logistics activities into five tasks that include:

- Meet disaster victims' needs quickly.
- Provide assistance, services, materiel, transport and facility support to responders.
- Integrate into the Federal logistics system where the disaster occurs.
- Control and account for property.
- Maintain full logistics readiness during disaster and non-disaster periods.

Also Gupta and Mahadevan (2005) believe that logistics for disaster relief requires effective management of the followings:

- Demand for relief from the disaster struck areas
- Available supplies and donated relief material
  - Inventory levels
  - Location and perishability of supplies
- Logistics resource availability and response time
- Coordination of relief work – Government organizations, NGOs, foreign aid, etc.
- Costs vs. service levels

Generally, relief organizations have three main processes in their missions, namely search and save, medical care, and meeting primary needs of affected population. As shown in Fig. 10.4, in every one of the above mentioned processes, logistics plays a supportive role (PAHO 2001).

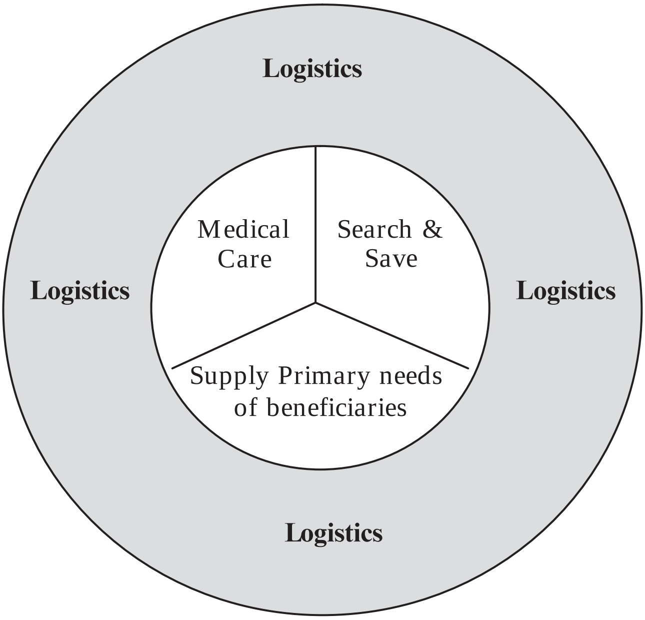

Fig. 10.4 Main processes of a relief organization

10.5 Humanitarian Relief Supply Chain Vs. Commercial Supply Chain

“Relief chains involve the supply of basic necessities to aid victims at the right place in the quickest possible time” (Chandra 2005).

As with relief logistics, relief chain has also received little attention in spite of magnificient role it plays in serving human life in times of disster.

Thomas (2003) distinguishes humanitarian relief chains of today from traditional commercial supply chains as followoing:

- They have highly uncertain demand pattern
- Usually there are alternate supply chains operating in parallel
- Highly responsive supply chains (almost zero lead time)
- Lack of existing supply chains/logistics systems to the affected areas
- Inadequate existing infrastructure at the affected areas
- Non-optimization of supply chain strategies due to insufficient information flow
- Non-coordination between Supply Chain participants
- Mutual existence of Multi-commodity supply chains
- Ad hoc and poorly structured operational setups
- Variable levels of technology availability

As it was discussed, the two types of chains differ in terms of the demand pattern. For many commercial supply chains, the external demand for product is relatively stable and predictable. In a commercial supply chain the demands seen from warehouses are stable in terms of location and frequency of occurrence. In a relief supply chain, the demands are supplies and people which are lumpy, i.e. they occur randomly and in an unpredictable way such that before the occurrence of the demand, the locations cannot be known (Beamon 2004).

A discussion of differences in commercial supply chain and relief chain should include differences in physical, financial, and information flows. The difference lies between the fact that in a corporate supply chain we have stockholders and customers, while in a humanitarian supply chain we have donors and beneficiaries. The direction of arrows gives an insight as to how the flow of materials and information takes place before and after disasters, respectively. As we can see in Fig. 10.5, there is no information flow between beneficiaries and the organization in relief chain. Also, we can see that donors provide financial and physical support to the humanitarian organization (Harjai and Abraham 2005).

Another difference between relief chain and commercial supply chain is that the former follows the shift from push to pull; a trend which is not familiar in commercial supply chain (Whybark 2007). Characteristics of commercial supply chains and humanitarian relief chains are compared in Table 10.2.

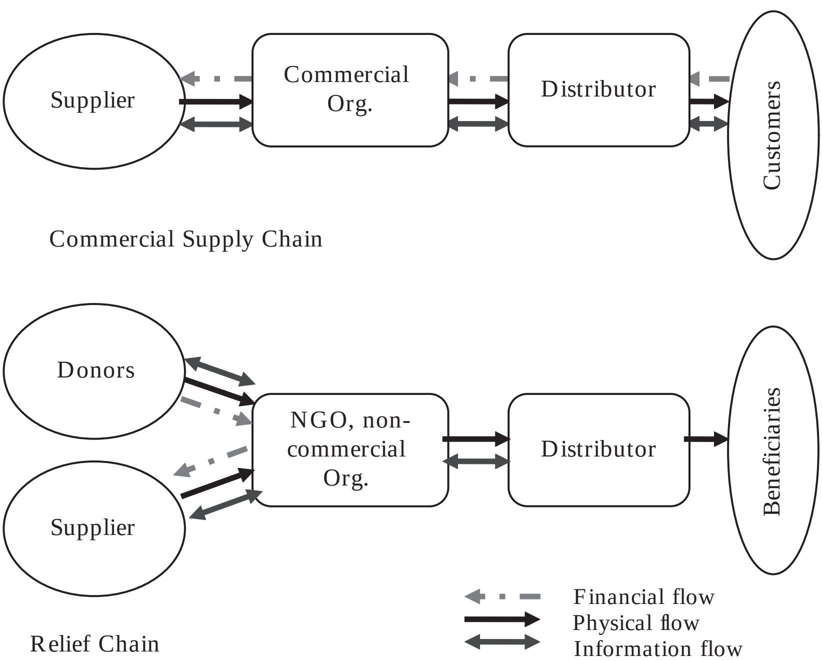

Fig. 10.5 Flows in a commercial supply chain and a relief chain (Chandra 2005)

Table 10.2 Commercial supply chains vs. humanitarian relief chains (Beamon 2004)

Supply chain parameter	Commercial supply chain	Relief supply chain
Demand pattern	Relatively stable, predictable demand patterns. Demands occur from fixed locations in set quantities	Demand is generated from random events that are unpredictable in terms of timing, location, type, and size. Demand requirements are estimated after they are needed, based on an assessment of disaster characteristics
Lead time	Lead time determined by the supplier-manufacturer-DC-retailer chain	Approximately zero lead times requirements (zero time between the occurrence of the demand and the need for the demand), but the actual lead time is still determined by the chain of material flow
Distribution network configuration	Well-defined methods for determining the number and locations of distribution centers	Challenging due to the nature of the unknowns (locations, type and size of events, politics, and culture), and "last mile" considerations
Inventory control	Utilizes well-defined methods for determining inventory levels based on lead time, demand and target customer service levels	Inventory control is challenging due to the high variations in lead times, demands, and demand locations
Information system	Generally well-defined, using advanced technology	Information is often unreliable, incomplete or non-existent
Strategic goals	Typically: to produce high quality products at low cost to maximize profitability and achieve high customer satisfaction	Minimize loss of life and alleviate suffering (Thomas 2003)
Performance measurement system	Traditionally: focused on resource performance measures, such as maximizing profit or minimizing costs	Primary focus on output performance measures, such as the time required to respond to a disaster (Thomas 2002) or ability to meet the needs of the disaster (customer satisfaction)
Distribution strategy	Varies depending on the products, customer requirements and manufacturer resources	Decentralized supply chain, Initially a push strategy followed by a pull strategy, use of 3PL for distribution of supplies
Demand type	Products	Supplies and people

10.6 Decision Flow for Disaster Management Supply Chain

Disaster management system aims at protecting the life and property of the population and restoring to the normal life at the earliest time possible. Uncertainty, available funding, time, interaction, political will, complexity and other sociological issues are among the factors that constrain disaster management system. In order to overcome the complexity on emergency environment, there is a need to the creativity resulted from rational design (see Fig. 10.6).

Supply chain decisions at various levels should follow a hierarchical approach as indicated in Fig. 10.7. Level 1 denotes typical strategic decisions about various locations, based on each hazard. At level 2, supply chain decisions are taken according to level 1 strategic framework and the results of risk assessment. Finally, at level 3, some improvised decisions are made at site after the occurrence of disaster.

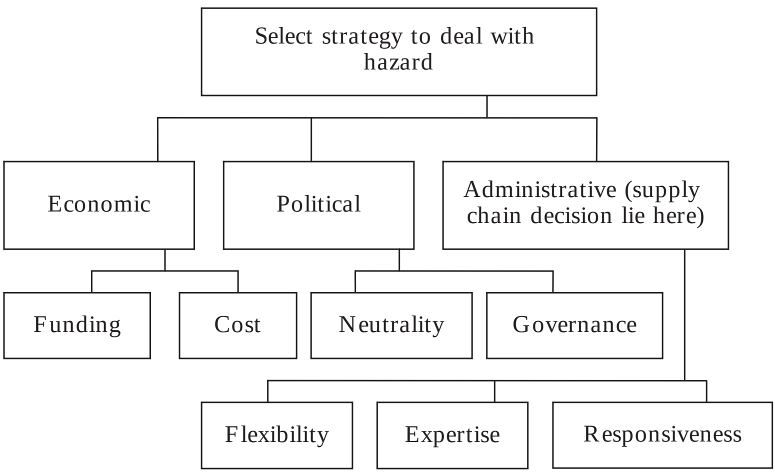

Fig. 10.6 Strategies to deal with hazard (Siroya and Joshi 2005)

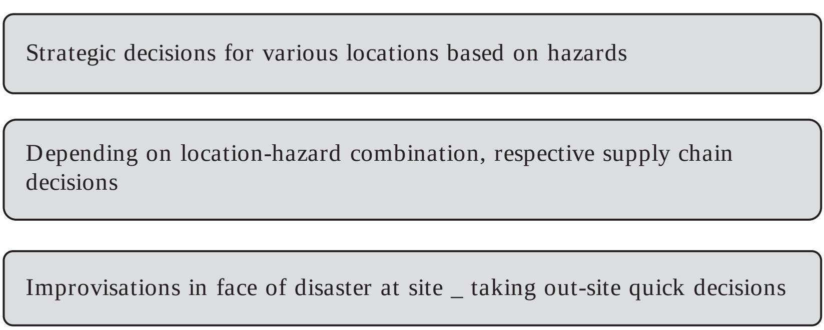

Fig. 10.7 A Hierarchical approach for relief chain decisions (Siroya and Joshi 2005)

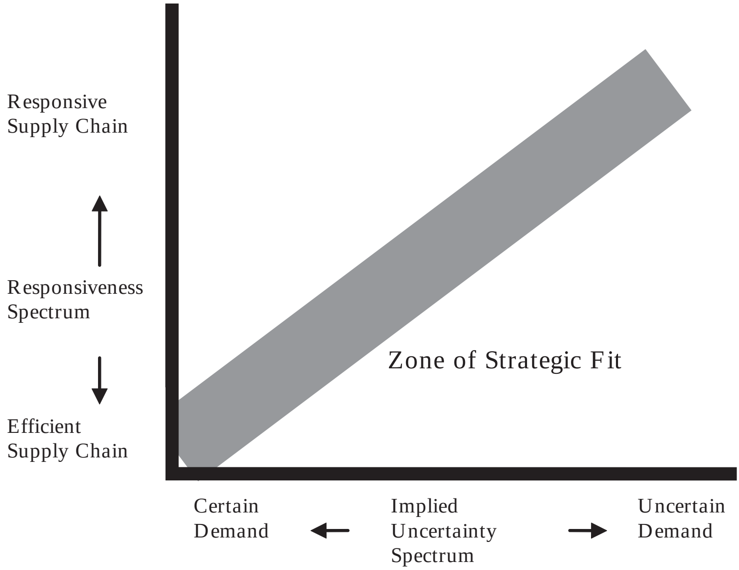

Fig. 10.8 Cross zone of strategic fit (Priyesh and Ramanan 2005)

10.7 Strategic Fit and Scope

The starting point in designing a supply chain is its evaluation on the basis of strategic fit and scope depending on the required circumstances. The criteria for the evaluation of the responsiveness and efficiency of a supply chain are the uncertainties in the demand. High uncertainty in demand requires responsive supply chains while stable demand patterns need highly efficient supply chains. The following diagram captures the idea behind strategic fit of the supply chain (see Fig. 10.8).

One unique characteristic of the demands in a disaster is their unpredictability. The demand calls for a prompt and quick response. This requires a more responsive supply chain rather than an efficient one (Priyesh and Ramanan 2005).

10.8 Challenges for Relief Chain Management

According to Beamon (2004), relief supply chains usually have problems regarding their structures, distribution network configuration, inventory control, disaster assessment, cooperation and coordination, procurement uncertainties and limitations, and performance measurement. In addition to above-mentioned challenges, one can consider the followings:

- Uncertainty in the number, location and presence of warehouses and distribution centers which pose problems for inventory storage, handling and logistics support.

- Lack of information flow upstream the supply chain, which is vital for an efficient supply chain.
- Destruction of/lack of basic and supporting infrastructure causing difficulty in setting up/supporting the relief supply chain.
- Uncertain demand raises issues such as how much inventory to hold, and how much to reorder.
- Bottlenecks can arise in the supply chain in terms of limited warehouse capacity, insufficient transport services.
- Lack of co-ordination in the supply chain and lack of central command which leads to waste of some resources, scarcity of some other resources, duplication of efforts from government and external aid agencies/NGOs.
- Presence of many relief agencies operating at the same time at the disaster location leads to competing and clogging of basic resources.
- Different commodities have different lifespan, different production times, but use the same distribution, logistics, and warehousing resources (Chandra 2005).
- Lack of planning and preparedness – even for disasters with forewarning, the government has no proactive measures planned with respect to evacuation of cities/towns.
- Lack of information systems – with a lot of manual procedures being involved, information regarding the relief work cannot be easily shared among the entities involved.
- Lack of tracking and tracing of supplies – due to the lack of effective tracking and tracing systems, it is difficult to determine whether the supplies are enough to meet the demand of relief materials. Without tracing of these supplies, it is also tough to predict the response times of the relief efforts.
- Lack of trained logisticians – the relief cannot reach the interior parts of the country due to the lack of trained logisticians as the government only attempts to get the aid to the district centers (Gupta and Mahadevan 2005).

In his article, Chandra (2005) has represented the following recommendations for the problems:

- Use of e-commerce, internet and other information technology tools to manage information and logistics flow through the relief chain;
- Better co-ordination between various relief supply chain participants
- Public–private-partnerships for increasing efficiency of operations
- Inventory reduction strategies to stop the low priority goods from reaching the disaster site
- Use of mathematical techniques for optimal routing thus reducing lead times
- Learning from the military supply chain
- Learning from past experiences for government, and NGOs above (Chandra 2005).

10.9 Relief Logistics as a System

According to Daftari and Bijan (2001), logistics can be analyzed into ten subsystems of:

- Planning subsystem
- Procurement subsystem
- Inventory subsystem
- Distribution subsystem
- Transportation subsystem
- Maintenance subsystem
- Control subsystem
- Human resource subsystem
- Information & Communication subsystem
- Administration subsystem

Subsystems more related to relief logistics are introduced in detail in the remainder of this chapter.

10.9.1 Planning Subsystem

The process of planning before the disaster is different from the process of planning after the event.

Before the disaster, i.e. in preparedness phase, we determine the tasks to be performed, the parts of an organization to carry the responsibilities, how to procure the resources required. Among such activities are:

- Zoning and land use controls to prevent occupation of high hazard areas
- Maintenance and preparing transportation system
- Logistical support in the area
- Having a national or regional plan based on the vulnerabilities of the infrastructure
- Risk analysis to measure the potential for extreme hazards
- Insurance to reduce the financial impact of disasters
- Recruiting personnel for the emergency services and for community volunteer groups
- Development of mutual aid agreements and memorandums of understanding
- Training for both response personnel and concerned citizens
- Budgeting for and acquiring vehicles and equipment and other goods
- Development of communications systems
- Threat based public education (Altay and Green 2006)

Other factors requiring attention in planning before the disaster are the sociocultural features of the affected population. These are:

- Identifying the population's dietary habits, including the types of food they will not consume for religious, cultural, or traditional reason.
- Identifying local and regional producers before asking for food assistance or negotiating the acquisition of food in other regions
- Finding out what type of clothes are used, and which ones are not worn due to cultural or environmental reasons.
- Identifying the most common types of housing and construction materials, including the cultural or environmental reasons.

After a disaster occurs, assessment gains the greater importance in planning subsystem in that it helps fulfill the role of demand planning in relief supply chain. Assessment helps find out:

- What is needed?
- How much is needed?
- When it is needed?
- Where it is needed? (PAHO 2001).

Assessments generally consist of several activities namely, survey and data collection, interpretation, forecasting, reporting and monitoring.

Various methods used in order to obtain data. These methods, range from observations and interviews by specialists, to statistical samplings and using checklists. The data and data analysis procedures are reported by an assessment team and ideas about future developments are presented to the interested parties. The information to be collected includes:

- The needs of the population
- The local infrastructure capacity
- The level of damage to the infrastructure
- The local resources available

In this connection, certain standardized procedures and tables to estimate the needs of the population are used (see Table 10.3). WHO has provided the following guidelines for categorizing the needs of affected population:

- Medicines
- Water and environmental health
- Health supplies/kits
- Food
- Shelter/electrical/construction
- Logistics/administration
- Personal needs/education
- Human resources
- Agriculture/livestock
- Unclassified

Table 10.3 Sample form for estimating required food quantities (PAHO 2001)

Daily average ration (gr)	Days	Total consumption per person during the period (kg)	Total required quantity (in metric tones)					Quantity of people who can be fed with			
			For 500 people	For 1,000 people	For 2,000 people	For 5,000 people	For 10,000 people	1 metric tons	50 metric tons	100 metric tons	200 metric tons
10	90	0.9	0.45	0.9	1.8	4.5	0.9	1,111	55,560		
	120	1.2	0.6	1.2	2.4	6.0	12.0	833	41,670		
	180	1.8	0.9	1.8	3.6	9.0	18.0	555	27,780		
20	90	1.8	0.9	1.8	3.6	9.0	18.0	555	27,780		
	120	2.4	1.2	2.4	4.8	12.0	24.0	417	20,830		
	180	3.6	1.8	3.6	7.2	18.0	36.0	278	13,890		
30	90	2.7	1.35	2.7	6.4	13.5	27.0	307	18,520		
	120	3.6	1.8	3.6	7.2	18.0	36.0	278	13,890		
	180	5.4	2.7	5.4	10.8	27.0	54.0	185	9,260		
40	90	3.6	1.8	3.6	7.2	18.0	36.0	278	13,890		
	120	4.8	2.4	4.8	9.6	24.0	48.0	208	10,420		
	180	7.2	3.6	7.2	14.4	36.0	72.0	139	6,940		
50	90	4.5	2.25	4.5	9.0	22.5	45.0	222	11,110		
	120	6.0	3.0	6.0	12.0	30.0	60.0	167	8,330		
	180	9.0	4.5	9.0	18.0	45.0	90.0	111	5,560		
60	90	5.4	2.7	5.4	10.8	27.0	54.0	185	9,260		
	120	7.2	3.6	7.2	14.4	36.0	72.0	139	7,140		
	180	10.8	5.4	10.8	21.6	54.0	108.0	92	4,630		
80	90	7.2	3.6	7.2	14.4	36.0	72.0	139	7,140		
	120	9.6	4.8	9.6	19.2	48.0	96.0	104	5,210		
	180	14.4	7.2	14.4	28.8	72.0	144.0	69	3,470		
100	90	9.0	4.5	9.0	18.0	96.0	90.0	111	5,560		
	120	12.0	6.0	12.0	24.0	144	120.0	83	4,170		
	180	18.0	9.0	18.0	36.0	90.0	180.0	56	2,780		

Other tasks related to the assessment include assessment of local capacity and local infrastructure capacity.

Local capacity involves not only the physical resources available at the site of an emergency, but also any factors that may help emergency supply management, such as local knowledge of the terrain or weather patterns, or social capital in the form of community organizations, formal and informal communications channels, and the like.

In local infrastructure capacity, assessment covers such areas as:

- The state of roads, waterways, and other transport infrastructure needed to guarantee the arrival of emergency supplies in the region or country that has been affected
- The existence and availability of supply storage facilities
- The existence and availability of means of transport
- The state and capacity of points of arrival (airports, ports, borders, and so on (PAHO 2001))

10.9.2 Procurement Subsystem

Goods and commodities to be distributed to victims of an act of God may be supplied from various sources and locations. They may be obtained in the form of donations, grants, gifts in kind. They may be provided as requested for or just unsolicited; they might be offered directly by a given government, or by multilateral institutions – governmental or nongovernmental.

Speaking of relief procurement, one should also bear in mind the "pre-sourcing" whereby materials such as blankets, tents, etc. are provided in advance by way of signing contracts with local and/or international suppliers. This has the advantage that not only the costs are reduced, but also better quality goods and commodities can be obtained (Sowinski 2003).

As was said above, aid may be obtained in number of different ways, each having its advantages and disadvantages. The Pan American Health Organization has contributed information quoted in Table 10.4.

10.9.3 Transportation Subsystem

Of great importance in getting the aid to the victims of hazards is the transportation system in its various forms: air, land, or waters; civil or military, commercial or noncommercial. Transportation may be carried out where necessary, even such animals as donkeys and mules may also be used.

Use of transportation for making the aid available to the victims has its own problems. Roads and other infrastructure, for example, may have been damaged due to earthquake or floods – necessitating the use of airplanes and helicopters

Table 10.4 Pros and cons of different kinds of acquisition (PAHO 2001)

Form of acquisition	Advantages	Disadvantages
Local purchase	Prompt delivery	Not always available in the quantity and quality needed
	Lower transport costs	Can generate competition between organizations for the purchase of a product
	Support for local economy	Can cause shortages in the local market
Imports	Possible to obtain better quality, large quantities	Longer delivery time
	Can order according to specifications	Higher transportation costs
		Do not support the local economy
Donations	Free or low-cost (bear in mind: every donation has a cost)	Frequently, items have not been asked for
	Promotes national and international solidarity	Supplies sent may not meet local needs
		If unusable, their handling leads to a waste of time and resources
		It is hard to reject them if they are useless
Loans	Sometimes, it is equipment or material that is hard to purchase	Depends on how long the items can be on loan
	Lowers operation costs	The loaned items must be cared for and must be replaced if damaged
		It is hard to demand responsibility, quality, or the meeting of deadlines and other commitments

which in turn creates overload and congestion of the airport facilities. All these make decision-making of great importance to choose the right type of transportation with due regard to the factors of time and transportation availability as the first priorities; and costs and compatibility as the second priorities (Russell 2005).

10.9.4 Inventory Subsystem

Inventories allocated for relief purposes are generally of social nature and in the service of social goals, where strategic and defense inventories are used in response to economic conditions or for defense purposes. In spite of the vast knowledge available due to research in management of commercial and industrial inventories, except for health issues, not much work has been done in relation to disaster relief inventories, though what has been carried out in industries and medical domain may serve as models for management of relief inventories, too. Nevertheless, because disaster relief inventories have their own typical characteristics which make them unique, especial care must be paid in using them as benchmark.

Researchers of inventory management agree on the fact that the fundamental issues in their area of studies are (a) when to purchase, (b) how much to purchase, and (c) where to store what is purchased. Yet, the above mentioned components have different values in each of the dichotomies of relief inventories and enterprise inventories. For instance, factor "c" above, i.e. where to store what is purchased, becomes significantly important in relief inventory management because of time and secure site location.

Whybark (2007) has designed a table in which he has compared the characteristics of disaster relief inventories as opposed to commercial and industrial, also referred to as enterprise inventories (see Table 10.5).

Table 10.5 Differences in characteristics between enterprise inventories and disaster relief inventories (Whybark 2007)

Characteristic	Enterprise inventories	Disaster relief inventories
Amount of research	*Extensive*	*Very limited*
Acquisition	Close relations with suppliers	Need supplier with capacity at time of need
	Few unknown peaks of demand	Future demand quantities highly uncertain
	Orders placed with uncertainty in mind	Demand uncertain in time and space
	Ownership is clearly defined	Ownership is diffuse and not always known
	Supplies can be used for entire enterprise	Some supplies could have restricted use
Storage	Location of storage is a business decision. Security is mostly an internal issue	Location of storage is a political decision
	Information available to manage expiry	Security can involve government corruption
	Market demand consumes oldest items	Information on inventory not integrated
	Obsolescence defined by business needs	Product expiry requires special attention
	Storage life not a major concern	Obsolescence defined by infrastructure
		Technology used for extending storage life
Distribution	Costs and benefits used for decisions	Cost may be real but benefits are social
	Theory available for quantification	Very little theory to guide decisions
	Enterprise decides what inventory to use	Inventory use decisions may be political
	Commercial transportation usually used	Transportation may require special carriers
	"Pull" systems can be used for inventory	Demand knowledge may not permit pull

10.9.5 Control Subsystem

Another subsystem of relief logistic system is control system, which deals with such issues as monitoring, evaluation, and reporting. By "monitoring" it is meant the regularly gathering of information, their analysis, and their application in relation to supply chain performance. By "evaluation" it is meant the assessment of relevance, efficiency, effectiveness, impact and sustainability of the supply chain carried out adjust the supply chain to prevailing conditions.

By "reporting" it is meant provision of summarized information whereby suggestions may be put forward for further operations.

What was said above in relation to control subsystem in connection with supply chain in general, is also applicable to relief chain.

However, what makes the scenario different is the costly expenses which make the provision of information technology required for gathering of related information unwelcome in the eyes of disaster managers and decision makers, so much so that they prefer to spend their budgets directly for purchasing of their material requirements rather than purchasing of information technology systems. This in turn results in lack of information about the outcome of their performance and, therefore, is a hindrance in correction of their points off failure and future improvements.

Proper response to any disaster requires a harmony between costs, speed, and accuracy in delivering of relief to the victims. In order for such a harmony to realize, we need to use some indicators to measure the performance of supply chain. In this connection, Davidson (2006) has proposed a framework comprising the following four indicators: appeal coverage, financial efficiency, donation-to-delivery time, and assessment accuracy (see Table 10.6).

10.9.6 Information and Communication Subsystem

ICT plays an important role in disaster management from two perspectives, namely, communication and information management. Regarding information management, there are various information tools and systems which can be used for different purposes, such as: inventory management software, project management software, tracking and tracing software. To these, barcodes, and RFID should also be added as new technologies. Most of the above said software and tools are provided by the market, but it is preferred to use software and tools which are specifically designed for disaster management.

Tracking and tracing is one of the major issues in relief supply chain which can be done through some logistics software. Russell (2005) defines tracking as "the process of building a history of shipment movements from origin to destination". He also defines tracing as "the process of retrospectively determining where a shipment was during the course of a move".

Table 10.6 A sample of scorecard – South Asia earthquake final scorecard (Davidson 2006)

South Asia Earthquake Appeal Date: October 9, 2005				
Status update: final date: March 18, 2006	Operation total (weighted)	Priority 1 Housing	Priority 2 Kits and sets	Total OP Target
Percent of appeal coverage 9 (in quantity of items)				
After 1 week	63%	61%	77%	
After 2 weeks	47%	45%	18%	
After 1 month	74%	73%	51%	
After 2 months	91%	92%	71%	
After 3 months	93%	99%	100%	
Percent of items Delivered (in quantity of items)				
After 1 week	6%	1%	4%	
After 2 weeks	9%	5%	2%	
After 1 month	33%	27%	8%	
After 2 months	48%	46%	19%	
After 3 months	67%	72%	47%	
Donation-to-delivery time				
Mean (#days)	33	35	29	33
Median (#days)	28	31	24	28
Financial efficiency				
(Donor cost – budget cost)/budget cost	−5%	−11%	30%	
Actual CHF spent – budget CHF	(3,510,849)	(5,209,538)	1,810,531	
Transportation cost/total product cost	10%	N/A	N/A	
Assessment accuracy: revised budget/original budget				
After 2 weeks	131%	118%	365%	
After 1 month	139%	123%	377%	
After 2 months	148%	127%	493%	
After 3 months	158%	127%	493%	

Both terms are used in conjunction as "tracking and tracing" to describe the process of gathering information about the current position or status of shipments.

According to Russell (2005) tracking and tracing is not well developed in the relief logistics. In fact, tracking is usually done in Excel. Tracing is not particularly beneficial for relief logistics. It is important to know what has been promised, what has been ordered, what is on the way, and what has already arrived. The resulting lack of visibility into inbound shipments impedes the task of receiving, clearing customs, shipping to intermediate warehouses, and distribution at each step of the supply chain.

This is an area where the software can contribute. For example, Humanitarian Logistics Software (HLS), developed by the Fritz Institute for use by the IFRC, is a web-based solution that provides visibility from the shipping origin to the destination. This allows both the donors and the organization to have overall pipeline visibility. The web-based nature of HLS speeds up information sharing and allows logisticians the opportunity to plan appropriately for customs, off-loading labor, and transportation requirements.

HLS consists of four main modules:

- Procurement
- Mobilization
- Reports
- Transportation and tracking

It connects to financial systems to provide real-time visibility for costs, purchases and in-kind donations in the relief pipeline. Table 10.7 compares different tracking systems used in disaster in connection with strength and weakness.

The next issue regarding ICT in disaster management is related to communication alternatives for the use of relief workers in tactical and strategic levels. Some of these communication alternatives are discussed in Table 10.8.

10.10 Case Studies

The remainder of this chapter is devoted to the presentation of two case studies. The first one, under the title of “The 1999 Marmar Earthquake Case Study”, is conducted by the Turkish Red Crescent Society (2006); and the second case study is “2005 Computerworld Honors Case Study”, conducted by Carrigan et al. (2005).

10.10.1 Case Study 1: Marmar Earthquake

This case study was prepared by an academician group specializing in disasters in Turkey in consultation and in coordination with the experienced and competent staff of the Turkish Red Crescent, in order to evaluate the 1999 Marmara earthquake from a critical point of view with respect to IDRL. It was essentially formulated in three parts, the first of which is an analysis of the legal framework of Turkey as applicable in the year 1999. The subsequent part of the study consists of a workshop conducted with all the parties involved in the 1999 disaster operation such as The Prime Ministry Crisis Management Center; as the supreme body of crisis management in the country, the Ministries, the Turkish Red Crescent’s experienced staff and others. The final part pertains to a survey the working group conducted with the purpose of practically assessing the operations, views and evaluations of the national and the international parties involved in the 1999 disaster operation, with the use of quantitative data for the aim of supporting and strengthening the case study.

Table 10.7 Strengths and weakness of commodity tracking systems (Lee 2004)

System	Strengths	Weaknesses
SUMA (PAHO)	Independent versions – central, pledges, and stock – for individual needs	Planning
	Elaborate process coverage	Inter-modular and inter-version workflow
Microsoft _ FACTS (Save the Children/Mercy Corps)	Project/program orientation	Logistics management
	Good process coverage	Workflow integration
	Suitable for food items, supports, ration definition	
Commodity Tracking Systems CTS 2000 (World Vision)	Numerous reports	Logistics management
	Good process coverage	Workflow
	Context sensitivity help at careen level	
CTS (Save the Children)	Simplicity	Planning Procurement Reporting needs Logistics management Insufficient business process coverage
Purchase Plus	Request for quote (RFQ) and bid registering	Planning
PALMAS (Oxfam/IRC)	Bill of material and kitting	Logistics and tracking
	Fixed assets	Humanitarian organization focus is absent
Log 6.5 (Medicine Sans Frontiers)	Report configuration	Installation process
	Project orientation	Planning
	Standard and non-standard item categorization	User help documentation for workflow details
	Auto-item code generation	
	Supports local procurement reasonably well	
	Reasonably good process coverage	
Humanitarian Logistics Software (Fritz Institute/IFRC)	Combines mobilization, procurement, tracking, and reporting	Enterprise software that requires significant investment and implementation
	Good interfaces and connectivity	Does not capture loss

Table 10.8 The most practical communication options (Cutts and Dingle 1998)

Short wave or HF radio	High frequency (HF) radio allows voice communication over medium to long range. It can connect to mobile phones and the international telephone network. Peripheral units connect with the international network via fixed short-wave radio stations. These systems can call other stations, link with Global Positioning Systems, provide FTP like data transfer, e-mail using true TCP/IP, and fax between stations. It is also possible to set up local radio-to-telephone links that in the medium to long term are cheaper to run than using the ground stations. Shortwave systems do require experienced installation and operation, antennas, and significant electric current – normally a local main, generator, or battery power supply
VHF radio	Very high frequency (VHF) is a short-range system for "line of sight" links, suitable for voice communication between mobile or hand portable transceivers over limited distances, and between mobiles and permanent sites. There is no access to international telecommunications networks. Setting up and operating a VHF system does not require prior knowledge. The transmitters use little power and can be operated from a vehicle battery
Cellular phones	Cellular phones are increasing prevalent the world over. If a disaster happens in an area with cell infrastructure, but does not damage it, cell phones can be the most cost effective means of communication. If an event damages cellular towers, temporary towers can be erected. They can also be placed in refugee camps. During the tsunami, Nortel installed a system such as this to enable cellular communications in a 10-mile radius of Banda Aceh
Satellite communications	The InMarSat constellation of four geostationary satellites is used to provide high-quality direct-dial voice, fax, and telex communications to and from the international public telecommunications networks. Mobile-to-mobile calls may also be made; but as this involves two satellite "hops", the quality will be reduced and the charges will be higher. Recently, InMarSat has offered a service called Regional Broadband Global Area Network, or RBGAN. This is a satellite terminal allowing internet access
	Iridium uses a constellation of 66 satellites in a near polar Low Earth Orbit (LEO) with cross-link architecture. Iridium services include worldwide voice, paging, Short Message Service (SMS), and data communications using lightweight, handheld phones and paging devices

With regard to the fatal Marmara earthquake itself, it struck the people of Turkey on 17th August 1999 during the early hours of the morning, with a magnitude of 7.4 affecting the whole of the Marmara region and its surrounding regions where 1/3 of the entire population; 65,000,000 people were resident. According to the official statistics declared by the State, seventeen thousand four hundred and eighty people died, 43,953 people were injured and 600,000 people were directly affected. Not only did victims lose their homes but many residential and commercial buildings were damaged to various extents by the Earthquake. The damage to the entire infrastructure in the region should also be borne in mind. Observers overwhelmingly agreed that this Earthquake was one of the most devastating disasters having taken place in the twentieth century.

In the context of the disaster operation, there were a great many obstacles and problems, especially operational challenges, alongside the actual problem of dealing and coping with the needs of the victims and the vulnerable groups. Millions of victims awaited relief and assistance and more than 200 agencies nationally and internationally with thousands of humanitarian workers responded to the disaster. Unfortunately, under the circumstances of the disaster, initial cross-matching the demand for relief and the supply for needs in a harmonious, efficient and effective way arose as a problem, which culminated in the serious structural and operational changes in the institutions responsible for disaster management in Turkey.

The workshop on the 1999 Earthquake was able to address the critical questions from the IDRL aspect. Five questions were gathered under the subject headings of; customs, service provision and freedom of movement, logistics and emergency shelter and coordination. The participants were then grouped according to these subject headings. The topics were determined by the moderators during the workshops and each group made their presentation with regard to these topics at the final plenary meeting at the end of the day.

The major operational challenges faced by international actors responding to the 1999 disaster become evident with the survey. In terms of concrete examples; the waste of valuable time due to the bureaucratic process for the entry of equipment from abroad, the process of customs for communication equipment, etc. the legal processes of other equipment and land vehicles caused a waste of time were given. There was no adequate needs assessment that could be used for correct and objective guidance by the international organizations, so as to avoid problems with the delivery of the relief materials. Apart from this, there were neither applicable response plans prepared in accordance with the current provisions of the legislation, nor were there educated personnel on the issue of disaster response. The inevitable result was that no liaison persons were specified for foreign relief teams. Relatively, efforts were made to learn the provisions of the legislation during the disaster.

Another problematic area was the coordination between all actors involved in the disaster response. The primary and crucial requirement for coordination; is communication. Unfortunately, efficient communication could not be ensured in the acute stage among the actors. Moreover, there was a lack of communication due to the limited number of personnel with knowledge of a foreign language, which would have facilitated the work of international workers.

There were problems with transit permits, visas, protective health measures, transportation and foreign language. Even though the international actors faced many challenges, they managed to avoid issues that may have arisen with concern to the nature, rules and religious beliefs of the national culture, as they were informed accordingly.

Significant challenges concerning the coordination and regulation of international response were common and applicable to both international and national actors as a whole. The first outstanding challenge, was the lack of knowledge on the legislation and regulations on disaster management in the country. Meanwhile, there were no guidelines stating the duties and authorizations and there was no process of sharing with coordinated persons and institutions (for further details and information, please refer to parts 3 and 4 of the case study). The biggest challenge for domestic actors in response to the disaster in its aftermath, was how to coordinate the initiate the response all the parties.

The legislative weaknesses in the Turkish legal system regarding disaster management, led to the creation of many complexities. During the acute stages, the absence of legal regulations regarding transactions concerning lodgings and consumption, authorization of response personnel and lack of legal regulations for legal responsibilities encompassing all kinds of activities arising from verbal instructions and initiatives, posed challenges for all actors. The issuance of a regulation regarding transactions carried out by relief response personnel during disaster response, surfaced as a practical challenge. Possible problems concerning the official appointments of personnel were not determined clearly by regulations. In other words, personnel should be appointed in accordance with the criteria of duty, rather than vice versa. There was an immediate need for the preparation of a legal basis in order to create harmony between national and international legislations on disaster management. Another challenge that surfaced, was realizing the public's expectations as to how the disaster should be managed, which did not coincide with the reality. Such expectations arose from the evident lack of public knowledge of legal procedures and enforcements on disaster management.

The 1999 disaster operations and problems that occurred in the aftermath, culminated in the serious legal, structural and operational changes in the institutions responsible for disaster management in the country. In this respect, the 1999-Marmara earthquake provided a sound basis for many improvements both at a national and international level. The outstanding aspects of the mentioned improvements can be listed as follows:

– The TRCS initiated its restructuring process following the 1999-Marmara earthquake. In this respect, AFOM (disaster operation center), regional and local disaster response and logistic centers were established; stocks were renewed and stock standards were increased. Technological developments were provided (data processing network at its Headquarters was established; modern standards were achieved with communication tools); in-service trainings directly concerning the TRCS's areas of work were provided and personnel participated in the international trainings used as a tool in disaster response. A modern approach was adopted in human resources management with the initiation of The Institutional Resource Planning Project (ERP) and branch development was brought to the forefront.
– Certain problems and obstacles determined as having been derived from the legislation were solved and certain deficiencies were addressed.
– Every institution initiated its own planning regarding the problems experienced in disaster response.
– Importance began to be attached to risk reduction.
– Disaster trainings increased.
– Individualism was brought to the forefront in disaster management.

- The number of non-governmental organizations (NGOs) increased.
- The new code on special provincial administration, the code on metropolitan municipalities and the code for municipalities, determined new duties regarding disasters for these institutions.
- Plans for the cooperation of the civilian authority and the military authority were developed.
- The earthquake council was held in 2004.
- The code for the strengthening of buildings and the construction control system were developed.
- Housing standards were developed.
- TAY was established.
- Search and rescue teams were established in 11 provinces.
- The Ministry of Health initiated the restructuring of disaster response (e.g. national medical rescue teams).
- Reception centers were established at the airports; the Turkish Armed Forces (TSK), civilian authorities and officials from the TRCS established themselves there and directed the incoming groups.
- The Turkish Search and Rescue Regulation was prepared by the General Directorate of Civil Defense (it should be prepared by the Ministry of Defense in the events of disasters, accidents, etc.).
- Certain coordination problems were resolved in the field with directions of the search and rescue service of provincial crisis centers.
- A study was initiated in order to determine damage determination criteria.
- The relevant legislation was taken into consideration and crisis centers were regulated on a 24-h basis.
- Acceptance of relief materials began to be controlled.
- The public was informed through the media on the type of relief materials to be donated.
- A protocol was recently made with 104 search and rescue teams.
- Cooperation was established with the Association of Amateur Radio Broadcasters.
- Central administration brought a new dimension to the decrees no: 583 and 600 but its infrastructure and regulation has still yet to be prepared.

As a result of the study, as well as the literature screening, workshop and survey which was conducted with representatives of domestic and foreign relief personnel who participated in rapid response operations for the 1999 earthquake, it became possible to contact groups that experienced general problems concerning the process of response and thereby receive suggestions and information that will contribute to the formation of immediate, efficiently equipped disaster response systems and relief teams in conjunction with the development of IDRL that may be applicable for possible future disasters response operations.

As a conclusion of the 1999 earthquake case study of and its level of disaster management level, it is possible to make the following the general suggestions:

- As an integral part of the study, a survey was sent to the representatives of international relief organizations who participated in the disaster operation of the 1999-Marmara earthquake. Although a total of 104 institutions actually participated in the disaster operation and efforts were made to contact 44 international and 23 national organizations through the survey, only two surveys were returned from the mentioned international organizations and 15 from the national organizations. This can be considered as an indication of interest/indifference in the matter. Besides which such organizations as the world Bank that have impotent roles to fulfill in international disaster relief, left the survey unanswered on the grounds that "they could not establish contact with their personnel working during the year 1999", this is a clear illustration of the "lack of organizational memory," when indeed one of the most important aspects of international relief work is reporting.
- Reports particularly about the work of institutions and personnel working in the disaster response area and for the disaster, should be kept regularly. Sources of general problems about the functioning of the system, suggestions for solutions and successful examples will be able to be shared and generated in this way.
- As part of improving the current system of disaster management in our country, the TRCS's disaster management and the applicability of the model in which local managements preferentially take place, developed in relation with the disaster response process in disaster response operations should be increased.
- Tax exemption provisions should be rearranged.
- Disaster legislation implementation should be centralized and coordinated from that central body.
- The TRCS should have priority and it should be exempt from the special consumption tax (ÖTV) and value added tax (KDV).
- The Turkish Red Crescent Law should be enacted rapidly.
- The relief donated following the disaster operation should be considered as exempt from the tax.
- Certain applications by the Turkish Government arrangements have reduced the income of the TRCS and thereby decreased the institution's financial capacity. Therefore searches for new and alternative resources should be made.

In spite of all the recoveries and improvements following the 1999-Marmara earthquake, there are still certain problems which need to be resolved and certain integrated approaches which should be brought to disaster legislation and disaster response operations encompassing public and private institutions, NGOs and international organizations. In this respect, it is of great importance that certain applications in relation to international response operations are put forth by States and a legal system from which they may benefit is developed, which in turn will maximize the benefit received by the victims of any future disasters.

10.10.2 Case Study 2: Tsunami

While for-profit enterprises deploy state-of-the-art technology to ensure the most efficient delivery of goods, not-for-profit organizations traditionally are left struggling when it comes to distributing food, clothing, building, medical and educational supplies to the world's needy. Often, the problem facing relief agencies is not a lack of donated goods – it's the difficulty in getting those goods to people in need. It's a major problem that came to light following the December 2004 Tsunami. In total, an estimated $6.2 billion of donated medical supplies and 96 billion pounds of food never make it to the people who need them each year, simply because the technology and skills required for effective distribution are prohibitively expensive for non-profit organizations. Enter Aidmatrix, a not-for-profit that is delivering what aid workers need most: supply chain management that's comparable to the best available in commercial enterprises. With roots in the i2 Foundation, Aidmatrix is a cooperative effort including such corporate sponsors as Accenture**, Sun Microsystems, Oracle, Dell and i2 Technologies. Aidmatrix provides both technology solutions and skilled resources to speed the delivery of humanitarian aid – and reduce waste – not just during disasters but on a day-to-day basis. At the heart of the ambitious project is Global Relief Network, the first Internet-based IT solution to match up surplus food, clothing, medical supplies and other relief materials to organizations like America's Second Harvest, the nation's largest hunger relief organization, which distributes surplus food to more than 23 million hungry Americans each year. Aidmatrix's successes include AgencyExpress, a web-based software application designed with America's Second Harvest to enhance the efficiency of relief agencies' ability to order items from their local food bank, and DonorExpress, a solution that adapts i2 supply chain software to fit America's Second Harvest's complex distribution network. DonorExpress replaces an antiquated system of phone calls, faxes and emails to help Second Harvest and more than 175 regional food banks receive donations from major food manufacturers. Since its inception in 2000, Aidmatrix has helped improve the lives of 37 million people – a figure that will almost double by the end of 2005, thanks to the tireless effort of an army of volunteers and its corporate sponsors, who are applying leading-edge technology and skilled resources to a challenge that is unmatched in its importance.

As the first not-for-profit organization to offer an Internet-based, supply chain management solution to increase efficiency and reduce waste in the delivery of humanitarian aid, Aidmatrix is unique. To our knowledge, this is the first global relief solution to aid in the quick delivery of humanitarian aid. Aidmatrix represents the first non-profit organization that donates commercially proven software in a hosted environment to facilitate the delivery of a variety of humanitarian aid items.

Among the original elements is AgencyExpress, a web-based software application designed by Aidmatrix and America's Second Harvest to enhance the efficiency of agencies' ability to order items from their local food bank. In the supply chain of hunger relief, food banks act as regional distribution centers; they regionally store large bulk donations and aggregate smaller mixed-item donations. Each food bank maintains relationships with the agencies that directly provide food to those in need. The agencies use their local food bank as a main supplier. Prior to implementing AgencyExpress, the typical workflow for an agency to order from a food bank was time-consuming and often ineffective. Agencies were sent a weekly or daily snapshot via fax of the total food bank inventory. The agency then ordered by either sending a return fax or placing a phone call to the food bank. The agency or phone order taker must manually account for the rules concerning the agency's maximum order quantity limit, credit limits, etc. In addition, since significant inventory changes may have occurred following the last snapshot, agencies were required to go through several iterations of making alterations to their order. Once the order process was complete, the agency then used local grocers to purchase any missing required items.

By using AgencyExpress, agencies now have 24/7 access to an online ordering system that provides real-time visibility of their inventory. The program processes all of the food banks' order rules, so that users place accurate orders based on the currently available inventory. As a result, AgencyExpress enables agencies to spend more time and money on their core competencies of helping those in need.

In order to ensure proper implementation of this tool, Aidmatrix and Accenture have developed a mutually beneficial program in conjunction with AgencyExpress. Accenture volunteers provide AgencyExpress training to agencies working with local food banks, such as shelters, soup kitchens, food pantries and daycare centers. This program serves an important need and is an excellent outlet for employees who wish to put their training and consulting skills to work for the good of local citizens that need help most.

Another original element is DonorExpress. In the spring of 2002, Aidmatrix partnered with America's Second Harvest (A2H), the largest domestic hunger relief charity to tackle a daunting issue – how can A2H leverage the Internet to more efficiently and effectively distribute 400 million pounds of donated food and grocery products to 216 food bank and food-rescue affiliates nationwide? At the time, A2H used an antiquated system of phone calls, faxes and emails to receive donations from major food and grocery manufacturers such as Kraft, ConAgra and General Mills and then distribute those goods to affiliates across the country.

America's Second Harvest and Aidmatrix adapted i2's existing supply chain software to fit A2H's complex distribution system. The result was DonorExpress, a free, easy-to-use web-based solution that allows A2H and their network of donors and affiliates to process product donations online. None of the other domestic hunger relief charities, including Feed the Children, Mazon, and Share our Strength, have an online system to process food and grocery product donations.

The originality of DonorExpress lies in the transaction-level process support for managing food donated through the charitable distribution process. In this sense it is far more difficult, and has far more impact, than other Web-based projects that steer money to charities via direct donation or share of-transaction-fee arrangements. Modernizing a large, complex distribution network such as America's Second Harvest's is a complex task, and DonorExpress is the only instance we know of where this has been accomplished in the non-profit sector. Recently, Aidmatrix has enabled A2H to further differentiate DonorExpress by working with donors to build direct interfaces between corporate donors' internal Enterprise systems and the back-end databases that support DonorExpress. This bypasses the Web interface entirely, allowing for direct system-to-system donation processing.

What's also original: Aidmatrix has tapped the expertise of retired Accenture partners who have helped the organization with critical program management, strategy and implementation advice. In addition, they help Aidmatrix staff gain mindshare for their solution offerings.

10.10.2.1 Success

Aidmatrix's hunger relief solution has already facilitated the delivery of more than 600 million pounds of food to 37 million people by efficiently linking corporate food donors, individual donors and nonprofit agencies to regional and national food banks.

DonorExpress is used to connect corporate product donors (i.e. Kraft, etc.), America's Second Harvest National Office and more than 175 regional food banks across the country in an effort to provide daily humanitarian aid. In 2004, four major hurricanes devastated the state of Florida with an estimated \$7–\$15 billion in damage. The destruction that resulted from Charley, Frances, Ivan and Jeanne created a need for a significant amount of crisis management and recovery assistance in the region and the strong logistics networks of DonorExpress and America's Second Harvest became a primary channel for aid relief. Through Aidmatrix's DonorExpress supply-chain technology, more than 5 million pounds of food moved through the logistics network to 17 food banks in the disaster area.

In terms of the successes as they relate to the plan;

– Expanding the deployment of their highly successful hunger relief solutions to 30 additional US cities and pilot internationally
    ◦ In less than 12 months, the 30 US city goal was exceeded
    ◦ A pilot solution has been developed for Europe, awaiting deployment
    ◦ Aidmatrix raised funds for ten countries through corporate Virtual Food Drives
– Developing advanced technologies for the improved and increased collection and distribution of food
    ◦ Developed integration from Kraft Food's surplus inventory system directly to Aidmatrix' national food donation system, creating a single, continuous value chain link from Kraft's business systems to 200+ food banks
    ◦ Aidmatrix is completing development of a demand-driven allocation system allowing 215 America's Second Harvest food banks and food rescue organizations to choose the best mix of product for their constituents' needs

– Building a basic medical supply chain solution to collect surplus medical products and efficiently donate them to leading medical relief charities
    - Solution platform developed
    - Aidmatrix will be piloting the solution with the National Association of Free Clinics in April of 2005
– Developing a disaster relief solution including providing wireless integration components enabling immediate collection of aid needs by field personnel
    - The Aidmatrix national food donations system was used by America's Second Harvest to facilitate the delivery of more than 5 million pounds (over 200 truckloads) through 17 food banks to supply the hurricane relief efforts in the Southeastern US this fall
    - Aidmatrix is also working with leading hunger organizations and government entities to determine the application of wireless technologies to reduce hunger through a variety of activities ranging from surplus food rapid response systems to food stamp outreach programs

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Chapter 11
Military Logistics and Supply Chains

Mohammad Hadji Molana

The word "logistics" is derived from the Greek adjective "logistikos" meaning "skilled in calculating." The first administrative use of the word was in Roman and Byzantine times when there was a military administrative official with the title *Logista*. At that time, the word apparently implied a skill involved in mathematical computations. Research indicates that its first use in relation to an organized military administrative science was by the French writer, Antoine-Henri Jomini, who, in 1838, devised a theory of war on the trinity of strategy, ground tactics, and logistics. The French still use the words *logistique* and *loger* with the meaning "to quarter."

The military activity known as logistics probably is as old as war itself. In the early history of man when the first wars were fought, each man had to find his own food, stones, and knotted clubs. Each warrior was his own logistician. Not until later, when fighters joined as groups and fighting groups became larger, was there any basis for designating certain men to specialize in providing food and weapons to the combatants. The men who provided support to the fighters constituted the first logistics organization.

Responsible officials must make judgments on these matters, using intuition and scientifically weighing alternatives as the situation requires and permits. Their judgments must be based not only upon professional knowledge of the numerous aspects of logistics itself but also upon an understanding of the interplay of closely related military considerations such as strategy, tactics, intelligence, training, personnel, and finance.

In major military conflicts, logistics matters are often crucial in deciding the overall outcome of wars. For instance, tonnage war – the bulk sinking of cargo ships – was a crucial factor in World War II. The failure of the German Navy to sink enough cargo in the Second Battle of the Atlantic allowed Britain to stay in the war; by contrast, the successful disruption of Japanese maritime trade in the Pacific effectively crippled its economy and thus its military production capabilities. More

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generally, protecting one's own supply lines and attacking those of an enemy is a fundamental military strategy.

Military logistics has pioneered a number of techniques that have since become widely deployed in the commercial world. Operations research grew out of WWII military logistics efforts (see http://www.answers.com).

Because of its high security there are few references that publish academic or practical reports about military concepts. So we prefer to summarize the selected reports with the least interfering and mentioning to main references under each subtitle where needed.

11.1 Definitions

11.1.1 Military Supply

The *producer phase* of a military supply extends from determination of *procurement schedules* to *acceptance of finished supplies* by the military services.

The *consumer phase* of a military supply extends from *receipt of finished supplies* by the military services through issue for use or consumption (see http://www.answers.com).

11.1.2 Military Supply Chain Management

Military supply chain management is the discipline that integrates acquisition, supply, maintenance, and transportation functions with the physical, financial, information, and communications networks in a results-oriented approach to satisfy joint force materiel requirements (see http://www.dtic.mil/doctrine).

11.1.3 Military Logistics

Military logistics is the *science* of planning and carrying out the movement and maintenance of *armed forces*. In its most comprehensive sense, those aspects of *military operations* deal with: (see http://www.answers.com & http://www.dtic.mil/doctrine)

- Design, development, acquisition, storage, distribution, maintenance, evacuation, and disposition of material
- Movement, evacuation, and hospitalization of personnel
- Acquisition or construction, maintenance, operation, and disposition of facilities
- Acquisition or furnishing of services

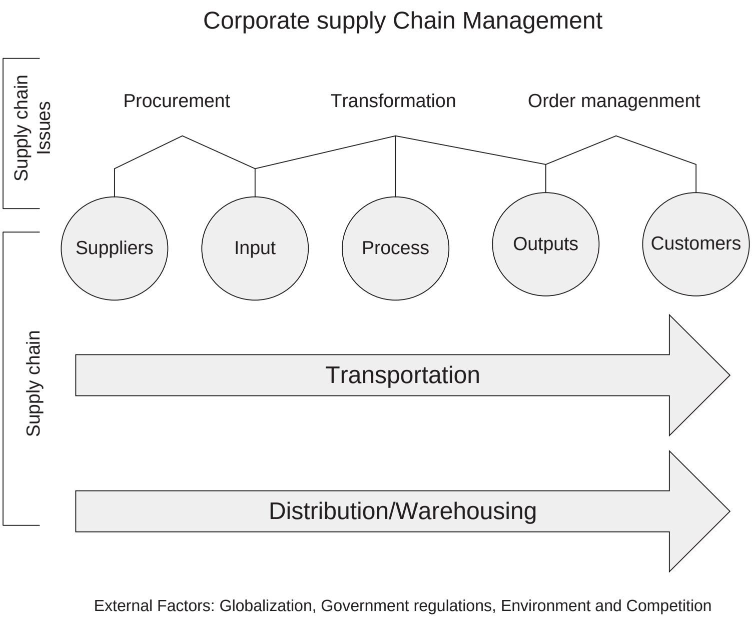

Fig. 11.1 Corporate SCM(I) (Lenzini 2002)

11.2 Fundamental Differences between Corporate and Army SCM

11.2.1 Corporate Supply Chain Management

SCM organizes the overall business process to enable the profitable transformation of raw materials or products into finished goods and their timely distribution to meet customer demands (Fig. 11.1).

11.2.2 Military Version of Supply Chain Management

For military logistics operations, SCM has some components and some essential success factors. SCM for the Army is slightly different from SCM for corporate organizations because the Army's focus is on mission requirements rather than on quarterly earnings (Fig. 11.2).

The components of SCM for the Army are the same as the components of business:

– Suppliers
– Procurement

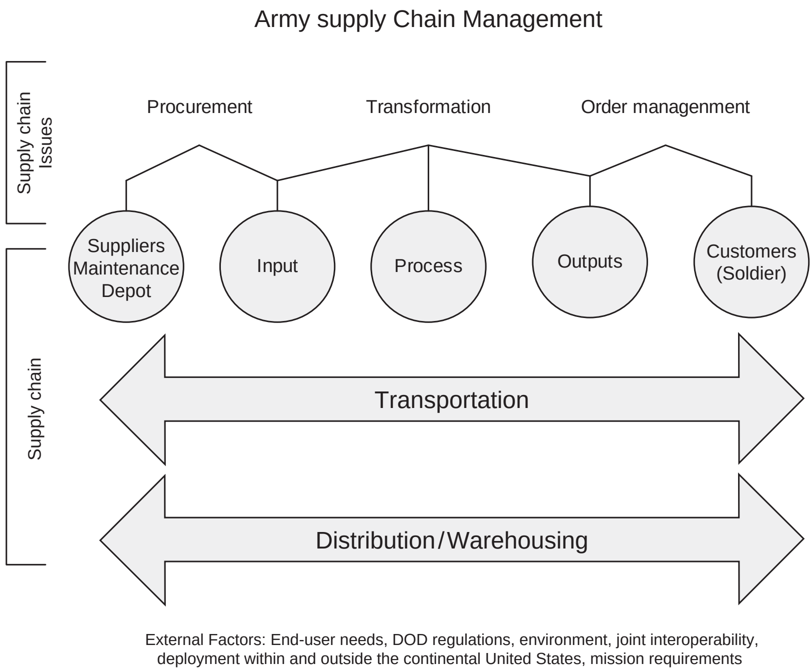

Fig. 11.2 Army SCM (Lenzini 2002)

– Manufacturing
– Order management
– Transportation
– Warehousing
– Customers (soldiers)

But the Army's essential success factors differ a little from corporate, for instance the United States Army's essential success factors are: (Lenzini 2002)

– Customer needs
– Information and communication technologies
– Deployment within and outside the continental United States
– Joint interoperability
– Department of Defense regulations
– Environmental concerns (to include enemy forces)
– Mission requirements

The SCM conceptual models for both business and the Army are remarkably similar; however, there are some significant differences. Most notable among them are the dual directional arrows on the chart for transportation and for distribution and warehousing in the Army SCM model. These illustrate that the Army may retrograde equipment and components for maintenance or retrograde personnel for medical care. Other differences are in the external factors that affect the supply chain (Piggee 2002). These factors include:

– Joint interoperability among the services' command, control, computer, communications, and intelligence systems
– Deployment of forces
– Soldier and mission requirements

The supply chain reflects the Army's focus on mission accomplishment as opposed to business' focus on profitability.

11.3 Anticipatory Logistics: The Army's Answer to Supply Chain Management (See http://www.dtic.mil/doctrine)

The Army is experimenting the concept of anticipatory logistics for class III (petroleum, oils, and lubricants), class V (ammunition), and maintenance. Anticipatory logistics uses technologies, information systems, and procedures to predict and prioritize customer requirements and provide appropriate sustainment. Although this sounds simple enough, future logisticians will use current and future technologies as tools to monitor supply levels and equipment conditions for combat units. They also will use decision support software to determine the best use of combat service support[1] assets. How this concept is related to the supply chain management (SCM) technique that corporations use?

Like the corporate world, the Army faces two diametrically opposing forces: the need to support combat maneuver forces in a better way, more responsively, and at a lower cost; and the need to reduce the logistics footprint of the Army's future forces. The Army is exploring how to better support brigade combat teams (BCTs) by using some underlying SCM concepts, such as information and communication technologies, order management, and transportation using current and new technologies.

By using the "tactical Internet" to achieve situational awareness, future logisticians will be able to track the status of supplies for individual units and better predict the needs of combat units. Systems that provide logistics leaders enhanced situational awareness will provide instantaneous supply status, predict component failures, and even provide two-way messaging. Sensors in both combat and combat service support vehicles will monitor supply levels, unit locations, and equipment status and be able to transmit this information to logistics leaders. Knowing on hand supply levels will help logistics leaders to better configure "pulsed" logistics resupplies, typically consisting of 3–7 days' worth of supplies. Leaders will use this new, enhanced level of situational awareness, provided by decision support tools such as embedded diagnostics, automated testing, and data analysis, to better support combat forces with fewer logistics assets.

[1] CSS.

In an endeavor to revolutionize anticipatory logistics at the wholesale level, the Army is forming a strategic alliance with SAP to integrate and streamline the wholesale logistics process. This alliance will manage demand, supply availability, distribution, financial control, and data management better and provide more flexible and dynamic logistics at the wholesale level to meet specific customer requirements. The benefits will include a synchronized global supply, distribution, and financial network that will increase weapon system readiness and manage mission-based requirements more responsively.

Industry's SCM and the Army's anticipatory logistics for supporting future combat forces are similar. Whereas anticipatory logistics concentrates on the wholesale and tactical (brigade and below levels), which is a small slice of the supply chain that culminates with the customer, SCM takes a holistic approach to the entire supply chain. Both anticipatory logistics and SCM share various fundamental concepts in order to meet their respective goals and objectives. The future of logistics in the Army is evolving toward a holistic approach, much like business' SCM efforts, to improve its logistics capability while reducing its logistics footprint.

11.4 Investigating SCM Implementation in DoD

11.4.1 About DoD (See https://acc.dau.mil & http://www.wikipedia.org)

The United States Department of Defense (DOD or DoD) is the federal department charged with coordinating and supervising all agencies and functions of the government relating directly to national security and the military. The organization and functions of the DoD are set forth in Title 10 of the United States Code.

The DoD is the major tenant of The Pentagon, and has three major components: the Department of the Army, the Department of the Navy, and the Department of the Air Force. Among the many DoD agencies are the Missile Defense Agency, the Defense Advanced Research Projects Agency (DARPA), the Defense Intelligence Agency (DIA), the National Geospatial-Intelligence Agency (NGA), and the National Security Agency (NSA). The department also operates several joint service schools, including the National War College.

The Pentagon is the headquarters of the United States Department of Defense. The Pentagon, in Arlington County, Virginia across the Potomac River from Washington, DC, is the headquarters of the Department of Defense. The Department includes the Army, Navy, Air Force, Marine Corps, as well as noncombat agencies such as the National Security Agency and the Defense Intelligence Agency. The DoD's annual budget was roughly $425 billion in 2006.

The multiplicity of inter-organizational relationships that can exist in supply chains adds to their complexity and management challenge. This complexity is even more extensive in DoD supply chains that involve the management of more than four million stock numbers, across thousands of customer activities, using hundreds of logistics management information systems.

11.4.2 PBL[2] and SCM

PBL is a strategy for weapon system product support that meets performance goals for a weapon system through a support structure based on long-term performance agreements with clear lines of authority and responsibility (Fig. 11.3).

The development and management of PBL arrangements consist of 12 discrete steps: (see https://acc.dau.mil)

1. Integrate Requirements & Support
2. Form the PBL Team
3. Baseline the System
4. Develop Performance Outcomes
5. Select Product support Integrator
6. Workload Allocation Strategy
7. Supply Chain Management Strategy
8. Establish Performance-Based Agreements
9. Business Case Analysis

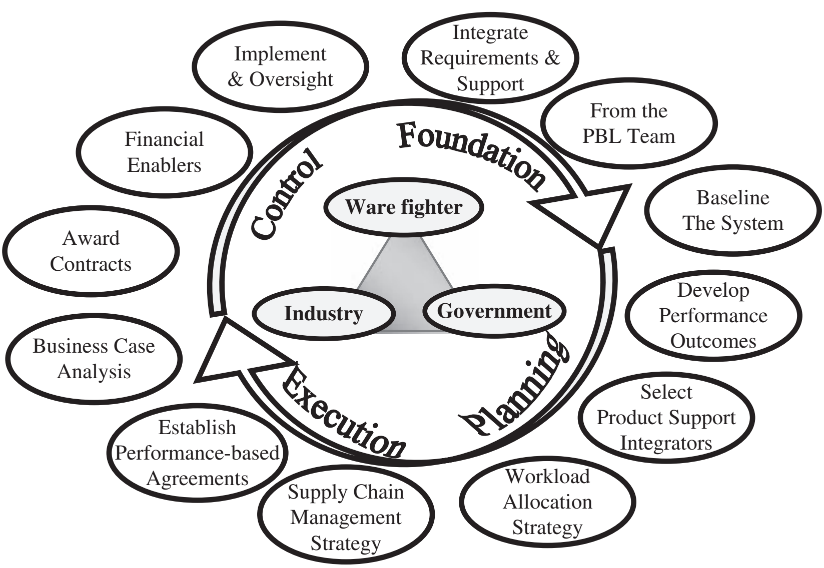

Fig. 11.3 PBL modules (see https://acc.dau.mil)

[2] Performance-Based Logistics.

10. Award Contracts
11. Financial Enablers
12. Implement & Oversight

Each step contains directions to support the successful completion of each step, as well as supporting materials to provide users the resources they need (see https://acc.dau.mil).

The seventh step of PBL is "Supply Chain Management Strategy." The DoD try to implement SCM concepts via implementing PBL in conjunction with other PBL concepts, and use of SCOR model. In the remainder we investigate these concepts more.

11.4.3 How Does DoD Think about SCM?

Supply chain management in DoD is an integrated process that begins with planning the acquisition of customer-driven requirements for materials and services and ends with the delivery of materials to the operational customer, including the material returns, disposal segments of the process and the flow of required information in both directions among suppliers, logistics managers, and customers.

To supply materiel and logistics services to DoD units throughout the world, the DoD Components maintain a supply chain consisting of weapon system support contractors, retail supply activities, distribution depots, transportation networks including contracted carriers, Military Service and Defense Logistics Agency (DLA) integrated materiel managers (IMMs), weapon system program offices, commercial distributors and suppliers including manufacturers, commercial and organic maintenance facilities, and other logistics activities (e.g., engineering support activities (ESAs), testing facilities, cataloging services, reutilization, and marketing offices). Effective supply chain management breaks down traditional functional stovepipes of procurement, transportation, materiel management, maintenance, and so forth, and instead facilitates an integrated end-to-end customer-focused perspective. Although there is no one single universally accepted DoD-commercial sector definition of Supply Chain Management.

The DoD supply chain process encompasses those government and private-sector organizations, processes, and systems that individually or collectively play a role in planning for, acquiring, maintaining, or delivering material resources for military or other operations conducted in support of the United States national defense interests. Materiel support is a critical link in weapon systems supportability, arguably the most critical link in supporting weapon system operational availability. Accordingly, a comprehensive supply chain management strategy is critical for a successful PBL effort.

DoD 4140.1-R emphasizes the importance of structuring material management to provide responsive, consistent, and reliable support to the war fighter during peacetime and war, with that support being dictated by performance agreements with customers to the furthest extent. For weapon system materiel, those agreements should be negotiated with weapon system users or their representatives as part of a performance-based logistics strategy. For other materiel, the agreements should be negotiated between support providers and customer representatives. This structuring of support should be done within the context of total life-cycle systems management (Figs. 11.4 and 11.5).

The vast majority of items transitioning through a supply chain originate as newly manufactured items, while in DoD a significant percentage of items used to meet supply requirements come from repaired items. The differences in complexity, management, and efficiency are significant, and necessarily involve other functions primarily maintenance, which multiplies the problems of developing and executing an efficient and effective supply process.

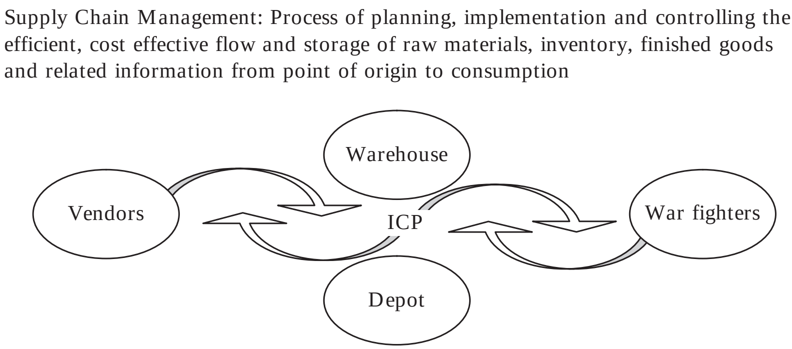

Fig. 11.4 SCM in DoD (see https://acc.dau.mil)

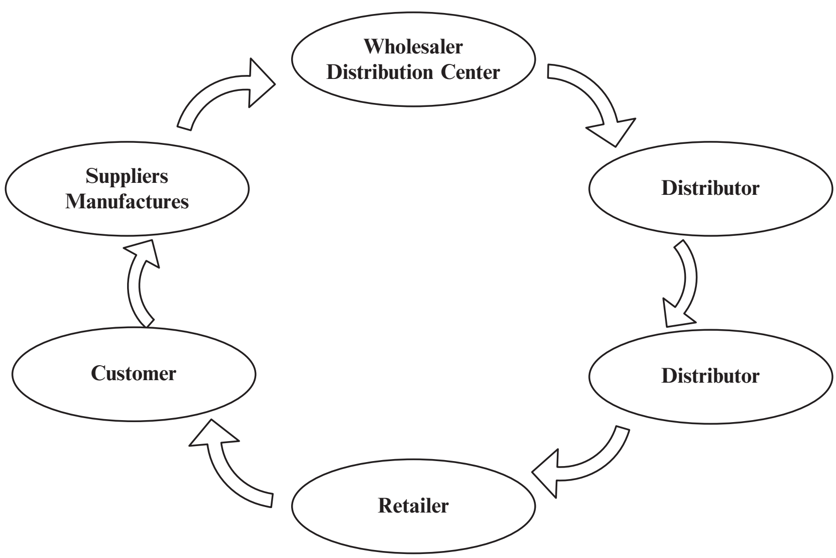

Fig. 11.5 SCM in commercial sector (see https://acc.dau.mil)

11.4.4 Relating SCOR Model to DoD Logistics Chain

Although efforts have been made to reflect the DoD supply chain process in the SCOR model (primarily through the use of the "Make/Repair" Process shown in the graphic), its use and application within DoD is still evolving.

The DoD supply system is predicated upon Wholesale and Retail supply processes, similar to the private sector. The wholesale portion of the system encompasses the procurement of items from the system developers, commercial suppliers, the manufacturers, or wholesale suppliers. Wholesale items are generally stored in distribution warehouses, sometimes called inventory control points, where they are held pending requisitions from the retail supply system. Wholesale warehouses are often collocated with Defense Depots or Integrated Materiel Management Centers or, in the case of Defense Logistics Agency (DLA) items may be stored in regional supply centers or forward located distribution points. In many cases, (i.e., DLA) the assets are not even procured or owned by the military services. The retail supply systems are owned and managed by the individual military Service Departments, and are usually located at operating locations, either in the Continental United States (CONUS) or outside the United States (OCONUS). As the retail system requires parts, it requisitions the needed items from the wholesale supply system, which constitutes a buy and sell transaction, the wholesale system sells the item to the retail system, and is reimbursed accordingly. In general, all retail supply functions are operated by organic DoD personnel, including military personnel where applicable.

In general, the Military Departments have a strong preference for organic operation of the retail supply function, since many of these supply sources are located in forward battle theater areas. Conversely, there is no strong preference for ownership or management of wholesale supply activities. In PBL support strategies, it is quite common to see contractor-managed wholesale supply support. There are inherent benefits to commercially managed wholesale supply functions, where industry flexibility, capability, and proprietary spares support can be utilized. Within this context, the general preference regarding management of supply items is articulated below.

DoD Materiel Management usually addresses four categories of supply support items:

– *Unique Reparable Items:* These are reparable (subject to repair) parts that are unique to the system (not common with other DoD systems). They are usually sourced by the Prime Vendor or Original Equipment Manufacturer (OEM) of the system. Strong consideration should be given to allocating responsibility for wholesale support of these items to the Prime Vendor, who has readily available technical data and identified sources at disposal.
– *Common Reparable Items:* These parts are common with other systems and may have a variety of sources. They are usually managed organically within the DoD materiel management process but are also candidates for corporate PBL contracts.

Table 11.1 General alignment of material management responsibilities (see https://acc.dau.mil)

Item type	Materiel Mgmt wholesale	Depot repair	Retail supply
Unique reparable	Contractor	Contractor (subject to title 10 USC)	Organic
Common reparable	Organic	Organic	Organic
Unique consumables	Contractor (DLA preferred source)	N/A	Organic
Common consumables	DLA (w/option to use other source)	N/A	Organic

– *Unique Consumable Items:* These are consumable (discarded after use) items that are used only on the target system, and are usually sourced by the Prime Vendor/OEM of the system. Strong consideration should be given to allocating responsibility for acquisition of these items to the Prime Vendor, which may elect to use the Defense Logistics Agency (DLA) as the preferred source of supply.
– *Common Consumable Items:* These are consumable items used across more than a single system, and are generally managed and provided by DLA. It may be viable to allow the Prime Vendor to procure these items should DLA be unable to meet time, cost, or quantity requirements, as appropriate. If needed, the PM should encourage establishing a PBA between DLA and the vendor when total private support is chosen.

This general alignment of material management responsibilities between organic and contractor service providers in a PBL strategy is graphically portrayed in Table 11.1.

I. ***Plan***: In DoD, organizational realities, the constraint of out-moded systems, and legal requirements must be taken into consideration. The challenge for DoD is to develop and maintain planning coordination and integration across organizations and over time in order to reduce costs, increase customer satisfaction, and improve weapon system readiness (Fig. 11.6).
II. ***Source***: This item’s applications are the same as corporate SCM.
III. ***Make/Repair***: The activities that occur in the maintenance process directly affect the timing and cost of the supply chain. Planning, scheduling, and the actual repair process determine the length of the repair cycle which in turn impacts the amount of inventory in the supply chain and the time it takes to deliver material to the warfighting customer (Fig. 11.7).

Applying the PBL resources provided for them, DoD Maintainers use their knowledge, skills and abilities to keep DoD equipment in good material condition or, if damaged or defective, to restore material condition to an acceptable level such that the equipment is capable of being used as intended by its designer and manufacturer.

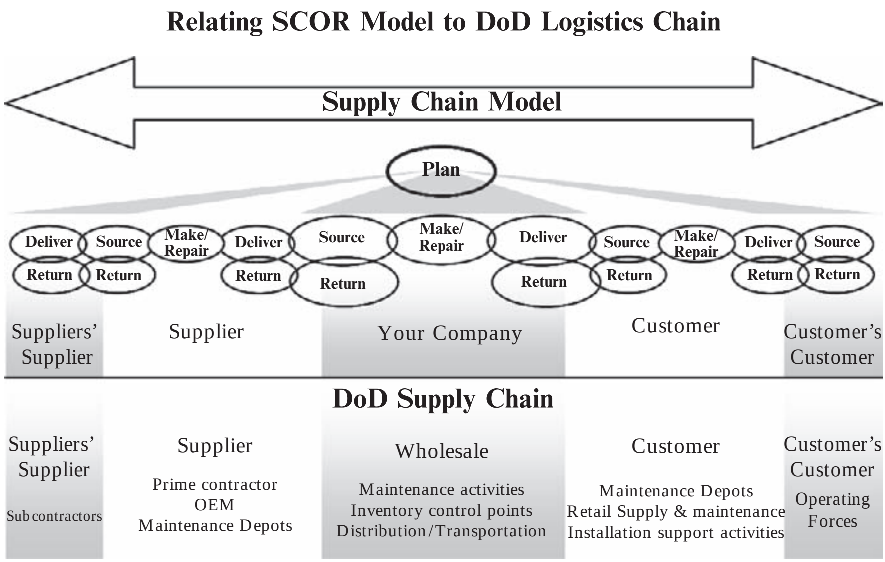

Fig. 11.6 Plan module of SCOR in DoD logistics chain (see https://acc.dau.mil)

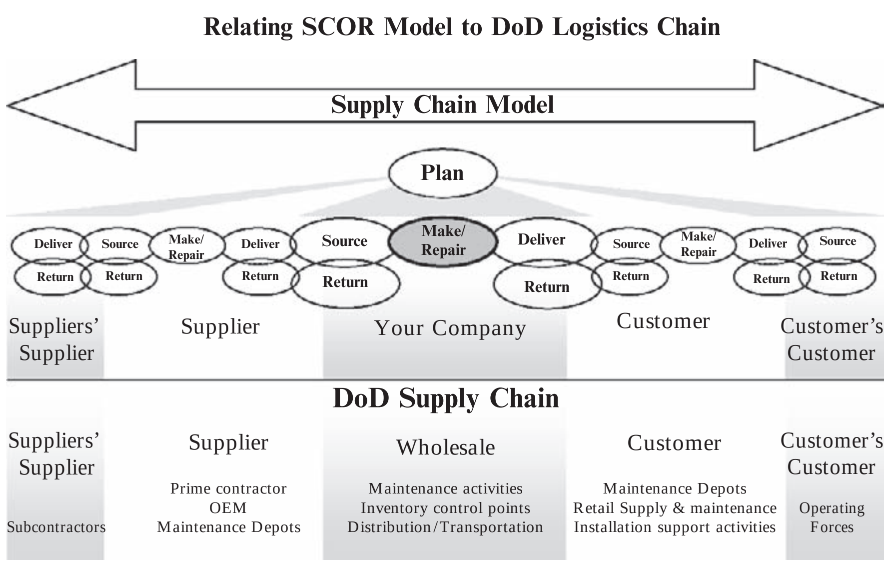

Fig. 11.7 Make/Repair module of SCOR in DoD logistics chain (see https://acc.dau.mil)

Activities included in make-repair are:

- Process returned items
- Schedule production activities, issue product, produce and test, package, stage product, and release product to deliver

– Finalize engineering for engineer-to-order product
– Manage rules, performance, data, in-process products (WIP[3]), equipment and facilities, transportation, production network, and regulatory compliance for production

In a SCOR make-repair process model, functions associated with material manufacturing or repairs are:

– Make to stock
– Make to order
– Engineer to order

One noteworthy addition, namely the expansion of the "Make" process to "Make/Maintain" which acknowledges the importance of weapon systems and equipment maintenance within DoD.

IV. ***Deliver***: this item's applications are also the same as corporate SCM.
V. ***Return***: Considerable value exists in returning serviceable and unserviceable materiel to the logistics system from using customers. Whether customers are returning that materiel so that it can be repaired or stored for immediate use or as excess to current needs, the time, quality, cost, and variability incurred in the return process represents value to DoD activities. That value diminishes over time from the last gainful use of the materiel until it becomes useful again.

11.4.5 Logistics Customer Relationships across DoD

11.4.5.1 Defense CRM Definition

CRM is the *aligning of resources* within the organization to meet the service requirement of the customer in a way that is appropriate to the level of importance to the defense mission (see https://acc.dau.mil).

In Fig. 11.8 estimated level of integration in army SCM is shown, there is an obvious gap between current level and needed level to support future requirements.

– DoD agencies cannot dictate which markets they serve
– DoD agencies have a readiness mission in addition to a revenue mission
– DoD agencies have very dynamic customer priorities, which include units that change from deployed to nondeployed status
– DoD agencies typically have organizational structures that have not been developed from a standpoint of customer service

[3] Work In Progress.

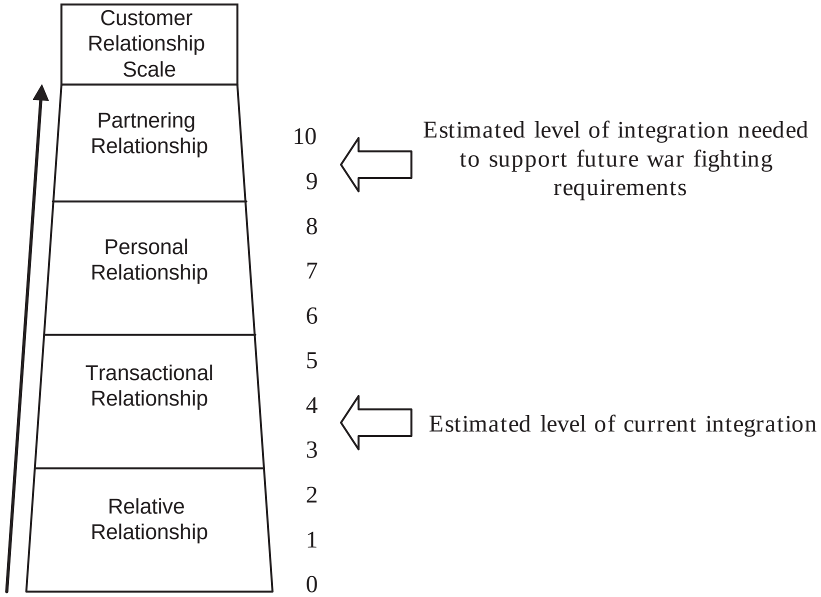

Fig. 11.8 Estimated levels of integration (see https://acc.dau.mil)

11.4.5.2 CRM Benefits Suppliers and Customers

Benefits to Suppliers (see http://www.dtic.mil)

– Increased sales and reduced costs
– Better alignment and deployment of internal supplier resources to meet external (i.e., customer) needs and expectations
– More solid position of DoD suppliers in an increasingly competitive marketplace by leverage their core competency-knowledge of military customers
– Benefits to DoD Customers (see http://www.dtic.mil)
– Supports future warfighting vision, which requires a more effective understanding and support of customers requirements
– Increased readiness through more reliable delivery and information about those deliveries, as well as more tailored solutions to unique requirements

11.4.5.3 Segmenting Customer Requirements

In Table 11.2 different levels of customer requirements in different SCM environments is shown, some aspects are more important than the others.

Table 11.2 Segmenting customer requirements (see https://acc.dau.mil)

	Delivery needs	Service receipt	Price sensitivity	Internal inventory	Planning requirements	Information requirements
Combatant commanders	Advance planning	Complex often changing deliver sites	None	N/A	Long-term, contingency planning	High need, for both historical and current information
	Contingency support	Changes quickly				
	24 × 7 support					
Deployable operating units	Real-time need	Complex – often changing deliver sites	Little to none	Limited on-hand and safety stock	Predeployment planning	Consumption information
	24 × 7 support	Changes quickly		On-demand fulfillment		Status of requisitions
	Most emergent items are critical	Unscheduled deliveries				
Industrial	Time definite delivery is more important than instant delivery	Fixed delivery sites	Critical items – sensitive	Replenishment of stocked items	Forecasting of scheduled maintenance activities	Technical info, consumption patterns, trends
		May be scheduled	Sensitive – metrics based on cost	Nonstocked items may be critical	Demand planning on item level	
		Critical items may require alternative delivery				
Installations	Time definite delivery	Simple	Mostly commodities –	Limited on-hand stocks	Predictable planning for maintenance and consumption needs	Technical info, consumption patterns, trends
		Fixed locations				
	Short lead times	Planned and scheduled	Price is negotiated from vendor	Third party resupply		

11.5 Revolution in Military Logistics[4] (See Piggee (2002))

Logistics is the lifeblood of any Army. Changing how we fight influences changes in how we support. Future force is defined less by size and more by mobility and swiftness. That force will be easier to deploy and sustain and will rely heavily on US advantages in stealth, precision weaponry and information technologies.

The Chief of Staff of the Army (CSA) of US has stated "*the transformation objective is to field a force that is strategically responsive and dominant every point on the spectrum of operations.*" This transformation challenges the Army to balance near-term readiness and force modernization in an environment of increased missions and fewer resources.

At the joint level, change started with Joint Vision 2010 and Focused Logistics; at the Army level, change started with the Revolution in Military Logistics. The RML is not only central to preparing for future military operations; it is the fulcrum of the Army's effort to balance readiness and modernization.

Army transformation is about changing the way we fight. It is the process of converting the army's focus and structure from a Cold War construct to a full spectrum combat force that is strategically responsive and dominant at every point on the spectrum of conflict.

It is more than technology; it is doctrine, training, leadership, organizations, materiel readiness, installations, and soldiers. These changes are vital for a RML.

The first wave of RML focuses on exploiting improvements in automation, communications, business practices, and reshaping command and control relationships to provide better unity of command and reduced logistics footprint (Piggee 2002).

11.5.1 Automation

The Revolution in Military Logistics requires more than just changes in technology. The precision delivery of CSS is anticipatory; it provides significant efficiencies in both supply and distribution.

To harness these economies, the Army must capture, process, and manage the disparate data and communications systems that make CSS occur. At the heart of the CSS information system is the Global Support System-Army (GCSS-Army). This system is much more than a close combat coordination and CSS delivery information system. It integrates and fuses information from the factory to the foxhole-coordinating, expediting, and managing the numerous activities in between.

As the Army continues to streamline its operations, both in peace and in combat, a passive approach to logistics simply is not acceptable. Waiting for support is not a strategy.

GCSS-Army is an evolutionary logistics information system that builds on the functions and processes of existing systems to generate data, integrate databases,

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[4] RML.

and fuse CSS information from external sources as necessary to execute the RML. GCSS-Army modernizes CSS automation through its integration of three hardware configurations, seven operating systems, eight programming languages, and five communication protocols into a single system baseline.

GCSS-Army software will be delivered in a number of modules, according to the particular function needed (Piggee 2002):

– Maintenance module
– Property accountability module
– Ammunition and supply modules
– The integrated materiel management center (IMMC) module
– Management module

Without doubt, GCSS-Army is an ambitious program. But it is well within the bounds of current technological capabilities and war fighting doctrine.

11.5.2 Communications

A seamless logistics system that ties all parts of the logistics community into one network of shared situational awareness and unified action can be achieved only in an environment dominated by global, wireless, assured communications.

Global wireless communications will provide soldiers the capability to reach and "see" virtually anywhere on the battlefield or in the world.

– Putting up more satellites
– Increase the speed of information flow
– Competition for market share
– Battery life

11.5.3 Best Business Practices

Methodologies and applications used in private industry that elevate a commercial enterprise above the competition are referred to as "commercial best practices."

Best practices enable leading-edge organizations to deliver world-class standards of performance to their customers. The emergence of commercial best practices took place because of downsizing and a hunger for profitability, or doing more with less, so it stands to reason that there could be a great deal of benefit to Army implementation of these best practices.

These technologies can provide the capability to receive, transmit, store, and retrieve information in a single seamless logistics system supporting a modern force in tomorrow's Army: (Piggee 2002)

– Integrated supply chain management
– Industry's changing view of logistics
– Electronic commerce
– Automated identification technology
– Direct vendor delivery, load optimization
– Outsourcing
– Smart simple design

Are all examples of commercial best practices can be very useful in helping the Army achieve the RML?

The Army Materiel Command (AMC) will be transformed into a more responsive Army Support Provider [5]. This ASP will ensure that:

– Sustainability is designed into future systems with enormous improvements in reliability, availability, and maintainability
– A single command, control, communication, computers/information and technology (C4/IT) architecture provides logistics information at all levels
– Centralized contracting information is always available
– Embedded diagnostics/prognostics and Automatic Identification Single Stock Fund

11.5.4 Infrastructure and Reduced Logistical Footprint

The RML requires increased agility in a number of dimensions. Army logistics will have to become more agile structurally, physically, and mentally in order to cope with the demands of dynamic RML support to the agile and mobile forces of the Objective Force, the goal of the current Revolution in Military Affairs[6]. (Piggee 2002)

11.5.4.1 Structural Agility

Structural agility will be accomplished through total integration of all Army components, as well as incorporation of support teams from other services, allies, and the Army's partners in industry to meet the demands of specific missions.

11.5.4.2 Physical Agility

Physical agility enhances the ability to deploy and maneuver the operational infrastructure of the distribution-based logistics system. Mental agility refers to attitude.

[5] ASP.
[6] RMA.

RML logistics is fast logistics. All logistics managers in the supply chain need to think several steps ahead, all the time. Acquisition agility is a key Army goal in RML.

11.5.5 Distribution-Based Logistics

The operational concept Distribution-based logistics[7] relies on distribution velocity and precision, rather than redundant supply mass, to provide responsive support to war fighters. It reduces the mass required to compensate for the lethal uncertainties of war by reducing uncertainty across the Joint Theater. DBL rests upon three pillars: visibility, capacity, and control. (Piggee 2002)

11.5.5.1 Visibility

The acquisition of near real-time situational understanding, or visibility, has been a major objective of Force XXI. Visibility can be grouped into three major categories. First, there is visibility of the supported war fighting units, the second category of visibility is logistic capabilities and constraints, and the third category of visibility includes logistic requirements and priorities to the supporting organizations at the theater and strategic levels.

11.5.5.2 Capacity

The logistics force must have the physical capacity to act on the knowledge provided by real-time visibility. This includes the array of materiel systems: the lean but adequate inventories; road, rail and facilities infrastructure; and skilled personnel.

11.5.5.3 Control

Some of the most important logistics modernization efforts fall under the tenet of control. These include the tactical force structure of the brigade combat teams; the theater support command; and the single seamless Army logistics organization, the Army Readiness Command.

DBL will comprise a system of innovative policies, doctrine and concepts; reengineered logistic functional processes; redesigned organizations; new materiel systems with embedded sensors and prognostics; advanced information, decision-support and command and control systems; and well-led, highly trained soldiers and civilians to operate and manage it.

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[7] DBL.

The Army must revolutionize its logistics program and provide on time support, in the right place and in the right quantity. It must become predictive, anticipatory, and responsive.

RML aims to improve our logistics processes by implementing business practices that leverage the advantages of technology and automation.

11.6 Logistics Systems for the Finnish Defense Forces (See http://www.almc.army.mil)

Benchmarking is a viable method of developing effective and competitive companies in the business world. The same technique can be used to improve military operations. The question is: Is it relevant to use the logistics characteristics and principles of the US Army as a benchmark for comparison with the Finnish Defense Forces[8]? Can the FDF use US Army combat service support transformation tenets to meet its logistics needs?

11.6.1 Demographics

Finland is a republic located in northern Europe. A quarter of its total area lies in the north of the Arctic Circle. Finland's neighboring countries are Sweden, Norway, and Russia. Its eastern border with Russia, which is the easternmost border of the European Union, is about 800 miles long. Finland has a population of 5.2 million. It has an advanced industrial economy, with the metal, engineering, and electronics industries accounting for 50% of the country's export revenue. The forest products industry accounts for 30% of the export revenue.

11.6.2 Finland's Defense System

Finland's security policy is based on nonparticipation in military alliances and on a credible national defense. While not a member of any military alliances, Finland participates in the North Atlantic Treaty Organization (NATO) Partnership for Peace program. Finland's military doctrine is based on a territorial defense that will be adjusted to meet future threats. The President of the Republic is the supreme commander; the Chief of Defense directs the defense of the nation and assigns tasks and resources to lower echelons.

Finland's peacetime command structure includes the Army, the Air Force, and the Navy. The Army has three regional military commands Eastern, Western, and

[8] FDF.

Northern that are divided into 12 military provinces. Each military command is an echelon capable of independent warfare and must coordinate the operations of the Air Force, the Navy, and other relevant authorities. The strength of the wartime FDF is 470,000 men; this will be reduced to 350,000 men by the year 2008. The Army consists of 22 brigades (2 armor brigades, 9 jaegers [mechanized] brigades, and 11 infantry brigades), troops from different branches of the Army and from other services, and local defense units [somewhat like US Army National Guard].

The FDF's main wartime ground forces are the three highly mobile readiness brigades (Brigade 2005) that are based on a concept similar to that of the US interim brigade combat team (IBCT). In 2 years, these brigades will be the most capable and best-equipped units in the Finnish Army.

11.6.3 The Changing Environment

Significant changes have occurred within the military doctrines and structures of many countries during the past decade because of changes in the political, strategic, and security environments and because of new threats. The new, asymmetric battlefield creates new requirements for logistics systems. Business logistics also has changed over the same period. Many countries and their armed forces face the same challenges: reorganizing the armed forces and reducing defense budgets. The dilemma all nations face is whether to change their military logistics systems or to depend on old principles and doctrines.

How can Finland estimate future military requirements? Many nations look to the United States for guidance. As US Army logistics is being transformed as a part of the Revolution in Military Affairs, a number of logistics factors have been identified for change. Finland may find that many of the ideas the US Army has implemented and the principles it uses also would be useful within the FDF. Of course, changes in the Finnish strategic environment, and thus in the FDF, would be smaller.

11.6.4 Comparison of Tasks and Doctrines

Comparing the FDF to the US Army is quite complicated because of the major differences in organizational structures, tasks, and duties. As stated in the US National Security Strategy and National Military Strategy, the US Armed Forces must respond to the full spectrum of crises all over the world. The distinction between US strategy and the Finnish territorial defense strategy is notable. However, the armed forces of both countries have a homeland security mission.

Although there are many differences, the basic functions of both the US Army and the FDF have a number of similarities. Both systems must be able to sustain forces in all situations and during different types of crises. Both logistics systems must be able to provide support operations at home, overseas, and during international crises.

After the incidents of 11 September 2001, both countries are closely examining homeland defense and their logistics systems, although the tenets of ongoing transformation seem to respond well to a new kind of asymmetric battlefield. However, the FDF focuses mainly on logistics operations on its own land and the US Army concentrates on operations abroad.

11.6.5 Characteristics of Logistics

Successful logistics operations should be both effective and efficient. The tools to achieve this goal are the characteristics of logistics shown in the Table 11.3. These characteristics guide logistics planning at every level and help logisticians develop plans based on the requirements of the mission, enemy, terrain, troops, time available, and civilian considerations (METT-TC) and the commander's guidance.

But are these characteristics universal, and do the FDF and US Army have equivalent guidelines? The comparison of US, Finnish, and business logistics characteristics in Table 11.3 shows that the basic meanings behind different terms are almost the same. The US Army's logistics functions are clearer. A comparison of the US and FDF military logistics characteristics with business logistics characteristics reveals that they are very much alike. The comparison shows no contradictions, so

Table 11.3 Comparison of logistics characteristics (see http://www.almc.army.mil)

Joint logistics	Combat service support	Business logistics	FDF logistics	Analysis
Responsiveness	Responsiveness	Responsiveness quality	Long term planning and foresight	+
Simplicity	Anticipation integration	Automation minimum materials handling	Simplicity	+
Flexibility	Improvisation	Flexibility	Flexibility	+
Attainability	Anticipation Integration	Minimum use of storage	Concentration and prioritization of resources	+
Sustainability	Continuity anticipation	Quality	Sustainability	+/−
Sustainability	Continuity	Resistance	Security force protection	+
Economy	Integration	Economy minimized cost and time	Concentration and prioritization of resources	+
Integration	Integration	Automation information	Synchronization in multinational and joint operations	−

the direction of development appears to be the same among them all. It also shows that the characteristics of the FDF are comparable, although they are expressed in different, less concise terms.

An analysis of the comparison reveals that the FDF needs to update two characteristics. The first is survivability- the ability of CSS elements to prevail in the face of potential destruction and the ability to protect support functions. One way to reinforce the FDF's logistics survivability is to increase the combat capabilities of its CSS units when reviewing their organization and equipment. The second characteristic that the FDF needs to update is integration. CSS operations must be synchronized with all aspects of operations. The national logistics system must be able to support international operations without special arrangements. Although the FDF has a long history of sending units to peacekeeping missions around the world, the support system does not respond fully to today's requirements for rapid reaction and force deployment.

11.6.6 Principles and Functions of Logistics

A revolution in the Finnish logistics system is underway. A new FDF Logistics Handbook was published in 2001 that provides principles and basic structures and acts as a guideline for other handbooks that were released in 2002. The major change in the handbook was a move from traditional logistics functions, which have been maintained for about 85 years, to support functions. The old system was based on independent branches of logistics, such as ordnance. The new logistics functions are supply, combat health, field services, maintenance, and transportation. The effects of this change are widespread and create the need to streamline many things. Areas needing improvement include not only manuals but also CSS unit organizations, the ideology of older logisticians who are used to doing things the old way, and CSS personnel training systems.

The CSS functions of the FDF are similar to US Army logistics functions (see Table 11.4.). The main difference is that combat health is a logistics function for the FDF and a personnel function for the US Army. In the FDF, the personnel section is responsible for human resources, religious support, legal services, and the band; however, mortuary affair is a logistics function that is led by the chaplain, and financial management is an operations function. A flaw in the FDF is a slight fragmentation of responsibilities because too many functions are logistics by nature but are not considered logistics functions. These differences are the result of tradition and history.

Overall, the FDF's new logistics functions provide a solid foundation for developing the FDF's future logistics systems. However, the FDF supply classification system correlates with the US Army classification only in principle, because the FDF uses neither the US Army supply class system nor the NATO classification system. The supply classification system is an integral part of the supply system.

Table 11.4 Comparison of logistics functions (see http://www.almc.army.mil)

CSS tactical logistics functions	New logistics functions	FDF logistics functions	How FDF logistics functions differ from US logistics functions
Sustaining	Supply financial management religious services legal band	Supply (includes all classes except VII and IX)	Financial management falls under the operations branch. religious, legal and band fall under the personal branch
	Combat health	Combat health	Combat health falls under logistics, not personal as it does in the US Army
	Field services	Field services	Mortuary affairs fall under logistics, but chaplains fall under the personal branch
Arming	Explosive ordnance disposal		Explosive ordnance disposal is part of ammunition supply (part of the cycle system)
Fueling			
Fixing	Maintenance	Maintenance	
Moving	Transportation	Transportation	Movement belongs to the operators branch, but there are some problems
Manning	Human resources		Human resources falls under Personal

Making the FDF supply system compatible with US or NATO systems undoubtedly would increase its usefulness. Movement control responsibilities also need review. Logisticians should play greater roles in movement control functions in corps and brigade rear areas, where traffic is related to logistics.

A fundamental difference between FDF and US Army ideology is the method the FDF uses to support its combat forces. The main principle of US Army logistics doctrine is to release operational commanders from worrying about logistics arrangements by giving the responsibility to logisticians. The chain of command and logistics doctrine enable this principle to work. The US Army's organizational modularity makes it possible to provide interchangeable and tailorable units to meet changing needs. The flexible use of units allows better response to asymmetric warfare and the shattered battlefield. This also fits well into various tasks of the US Army's CSS units, such as domestic support operations and peacekeeping operations.

In the FDF, the commander has total responsibility at all a level, that is why organizations at brigade and below are fixed. They are also more logistically independent, because forward support battalion-level capability is built into the brigade organization. This has proved to be a foresighted strategy since it is the direction the US Army is taking in developing new concepts to respond to future challenges. US CSS units above brigade level are not fully modular and therefore are not fully able to respond to tomorrow's requirements.

11.6.7 US Army CSS Transformation Tenets

Focused Logistics is a significant cornerstone in providing all the necessary CSS assets and sustainment to customers at all levels of operations. Focused Logistics enablers are integrated maneuver and CSS systems command and control, Total Asset Visibility, modular organization, the Movement Tracking System, and a wireless management information system. Focused Logistics will ensure the delivery of the right equipment, supplies, and personnel in the right quantities, to the right place, at the right time.

The US Army has developed six CSS Transformation tenets to help attain Focused Logistics:

– Seamless logistics system
– Distribution-based logistics
– Agile infrastructure
– Total asset visibility
– Rapid force projection
– Adequate logistics footprint

A remarkable point is that both the Joint Vision and the Army Vision emphasize the importance of logistics as a key factor in developing a more capable military force. Unfortunately, the role of logistics in the FDF appears to be growing dimmer because it is more fashionable to concentrate on developing maneuver units. Perhaps one reason for this unfavorable trend is the last 56 years of peace in Finland. Logistics development has been guided more by peacetime economics than by wartime readiness issues.

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Chapter 12
Logistics and Supply Chain Management Information Systems

Shabnam Rezapour, Mohammadreza Sadeghi Moghadam, and Majid A. Dehkordi

Nowadays, companies are racing for improving their organizational competitiveness in order to compete in the global market.

According to Gunasekaran and Ngai (2004), global market is completely connected and dynamic in nature. Therefore, companies are trying to improve their agility level with the objective of being flexible and responsive in order to meet the changing market requirements. In this effort, many companies have decentralized their value-adding activities by outsourcing and developing virtual enterprise (VE). All of these facts highlight the importance of information technology (IT) in integrating suppliers/partnering firms in virtual enterprise and supply chain. Supply chain management (SCM) is an approach that has evolved out of the integration of these considerations.

Simchi-Levi et al. (2000) defined SCM as a set of approaches utilized to effectively integrate suppliers, manufacturers, warehouses, and retailers, so that goods are produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimize total cost while satisfying service level requirements.

It is impossible to achieve an effective supply chain without IT. Since suppliers are located all over the world, it is necessary to integrate the activities both inside and outside of an organization. This requires an integrated information system (IS) for sharing information on various activities along the supply chain. IT is similar to a nerve system for SCM (Gunasekaran and Ngai 2004).

With the development of information and communication technologies (ICT) that include electronic data interchange (EDI), the Internet and World Wide Web (WWW) to overcome the ever-increasing complexity of the systems driving buyer–supplier relationships, the concepts of supply chain design and management have become a popular operations paradigm. The complexity of SCM has also forced companies to go for online communication systems. According to Watson et al. (1998), the Internet increases the richness of communications through greater interactivity between the firm and the customers. For example, three

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auto makers in the US are in the process of launching the automotive network exchange (ANX) to further understand the impending effects of electronic business communities. ANX will establish a standard method for parts suppliers to communicate and obtain order information from the auto manufacturers (Graham and Hardaker 2000).

According to Motwani et al. (2000), nowadays companies spend large amount of money for redesigning internal organizational and technical processes, changing traditional product distribution channels and customer service procedure and training staff to achieve IT-enabled supply chain.

In order to reduce uncertainty and enhance shipment performance of suppliers and improve the performance of the supply chain system, EDI technology should be used for information sharing between members of a supply chain (Srinivasan et al. 1994).

12.1 Literature on IT in SCM

This section is based on Gunasekaran and Ngai (2004).

Gunasekaran and Ngai (2004) proposed classification scheme to review the literature available on IT integrated SCM, based on certain major critical areas for the successful development of IT-enabled SCM. This classification is as follows:

12.1.1 Strategic Planning for IT in SCM

The strategic planning is a critical task for IT-enabled SCM. Strategic planning of IT should support the long-term objectives and goals of SCM both in terms of flexibility and responsiveness to changing market requirements. Cerpa and Verner (1998) present a longitudinal study of the information systems strategic planning process (ISSP) within a large Australian organization. They discuss ISSP with regard to its strategic relevance, factors affecting IS strategic planning, key issues in ISSP, the effects of infusion and diffusion levels together with the effect of IS maturity on ISSP. Manufacturing information system's strategic role includes achieving parity with competitors, minimizing manufacturing's negative potential, providing credible support to the business strategy and pursuing a manufacturing-based competitive advantage. Kardaras and Karakostas (1999) suggest the use of fuzzy cognitive maps as an approach to existing strategic information systems planning models. Fletcher and Wright (1996) report a study into the relationship between strategic use of information technology in financial service organizations.

Top management participation is important in making strategic decisions in IT investment decisions to achieve an effective SCM system. It requires some major changes in business processes and in the way the company operates.

To compete in a new global market, organizations should be capable of reconfiguring its resources to meet the changing requirements. Market factors such as customer requirements, competitors, and price affect the way organizations manage their operations. The economic reasons here are the cost reasons. The cost still plays an important role in being competitive. Obviously, flexibility and responsiveness are interconnected with cost. IT helps to improve the accurate information flow and decisions to support the business process in an effort to meet the changing market requirements. Talluri (2000) presented a multi-objective model that incorporates tangible and intangible criteria for the evaluation of IT systems for SCM. His model integrates four critical factors: flexibility, quality, time, and cost. Strategic planning of IT in SCM includes organizational issues such as organizational structure, awareness of top management, business processes, strategic alliances, and information technology that influence the overall performance of IT-enabled SCM. Business strategies require the organization to change. IS is a supportive facilitator of these changes. Lower information processing costs make coordination processes more efficient, thereby improving organizational performance. It also supports decentralized and less hierarchical organizational structure.

Rogerson and Fidler (1994) presented a framework for classifying strategic information system planning methodologies which involves two dimensions; structural complexity and application complexity. Henderson and Venkataraman (1993) proposed a framework of IS strategic alignment incorporating the four fundamental domain of strategic choice: business strategy, IT strategy, organizational infrastructure and processes, and IT infrastructure and processes. IT-enabled SCM facilitate effective technology transfer between partners in a network of firms. Christiaanse and Kumar (2000) develop principles for ICT-enabled redesign of supply chains which include a rethinking of the governance structures, a choice of the supply chain actors, redesign of the supply chain structure (sequence of activi-ties in the chain), and redesign of information communication and co-ordination structures.

12.1.2 Virtual Enterprise in SCM

Virtual enterprise is a network of independent companies, often former competitors, who quickly come together to exploit fast-changing opportunities. Developing a network of firms requires a communication system to achieve a co-operative supported work. This can be achieved by utilizing various telecommunication technologies. That is, IT is very important in developing and operating a VE.

Virtual teaming is the most appropriate mechanism to examine the relationship between all parties along the value chain, with members separated geographically. Virtual team needs to be built by concentrating on process, teaming and technology factors. Sarkis and Sundararaj (2002) discuss how brokering's role and practice needs to evolve with evolving organizational forms and supporting tools, technologies, and mechanisms which are needed to implement e-commerce. Turowski (2002) explained how agent-based e-commerce could support the development of a system for customization. Clements (1997) presents the issues concerning the development of international standards for virtual enterprises. The supply chain format is different from traditional e-commerce and purchasing approaches in that (van Hoek 2001):

– A supply chain-wide information infrastructure is used to directly disseminate relevant market information throughout the chain as a whole, avoiding a loss of time.
– Information is used for long-term innovation and enhanced customer relationship.
– Co-operation among supply chain part.

Sufficient training in information technology including JAVA, XML and web development is required for the development of a VE.

12.1.3 E-Commerce and SCM

EC can take a variety of forms such as EDI, direct link-ups with suppliers, Internet, Intranet, Extranet, electronic catalog ordering, and e-mail. According to Lancioni et al. (2000) the Internet helps to manage supply chain activities by offering information about what kind of product is demanded, what is available in the warehouse, what is in the manufacturing process, and what is entering and exiting the physical facilities and customer sites. Webster (1995) highlights the power of EDI in supporting collaboration and resolving conflict in a supply chain. E-commerce can cause cost savings resulting from reduced paper transactions, shorter order cycle time and inventory reduction resulting from speedy transmission of purchase order related information, and enhancement of business-to-business communication networks. Min and Galle (1999) identified the potential problems of online purchasing. Some of the major issues in cyber purchasing include size of the firms, security concerns, global sourcing, contract laws and government regulations. E-commerce should be viewed less as a phenomenon of business online and more as a challenge of organization redesign (Wang 2000). Collaborative network of partners are emerging to support business to consumers (B2C), B2B and government to citizen interactivity through Intranets (Hackney et al. 2000; Marshall and McKay 2000). Most of the B2B activity falls under the sphere of portals that dynamically match buyers and sellers or e-procurement, where buyers and sellers are aggregated (Kaplan and Sawhney 2000).

Clarke (1998) presents the concept of “virtual logistics”. With virtual logistics, the physical and information aspects of logistics operations are treated independently from each other. In such operations, ownership and control of resources are affected by the Internet or the Intranet applications rather than direct physical control and resources that can be owned and utilized remotely.

The experiences reported indicate that IT is an indispensable tool for logistic operations. E-logistics has been gaining ground after companies selected to go for third party logistics. Damen (2001) developed service-controlled agile logistics as a new model for a logistics control system.

E-commerce provides opportunities for an organization to expand their markets worldwide. E-commerce opens up the communication and enlarges the networking opportunities. E-commerce supports seamless integration of partnering firms. This facilitates the increase in agility and reduction in cost. B2C, B2B and customer-to-customer (C2C) are some examples of e-commerce models. For effective SCM, B2B e-commerce models would be appropriate. To improve the communication between customers and suppliers, Internet, web and EDI would be useful in exchanging the information about products and services. These require education and training and also government support to facilitate easy access to the Internet service and development of web site for e-commerce.

12.1.4 Infrastructure for IT in SCM

Companies need to have enough knowledge on the type of IT infrastructure required for their business to achieve an IT-enabled supply chain. The organizational infrastructure requirements include top management involvement, strategic fitness of IT, major players in the organization (power brokers), IT skills available, etc. The information systems for supply chain management should be accessible, compatible, user-friendly, stable and reliable, requiring minimal training and offering strong after-sales service.

Cheng et al. (2001) present an e-business infrastructure for construction. Attaran (2001) focuses on the organizational characteristics of online procurement systems. Jayaram et al. (2000) study the effects of information system infrastructure and process improvements on supply chain time performance. Au and Ho (2002) discuss the B2B e-commerce enabled supply chain management and present the IT infrastructure required for SCM. Al-Mashari and Zairi (2000) discussed the importance of IT infrastructure for the successful implementation of SAP/R3 for the reengineering supply chain.

There are many Internet Portals (Yahoo, AOL, JUNO, etc.) which offer services to companies to have their products on e-marketplace. Developing IT infrastructure requires investment on Internet services, web development and updating. IT migration is required from time to time based on the changes to the business process and organizational objectives and strategies.

12.1.5 Knowledge and IT Management in SCM

Knowledge and IT management requires a systemic approach or framework for educating and training workers in teamwork and to be innovative.

Knowledge management is concerned with recognizing and managing all of an organization's intellectual assets to meet its business objectives. Knowledge networks allow their participants to create, share, and use strategic knowledge to enhance operational and strategic efficiency and effectiveness. In the emerging e-procurement marketplaces, firms establish efficient web-based electronic relationships that allow for closer integration between buyer–supplier. Talluri (2000) presented a multi-objective mathematical model for the acquisition and justification of IT/IS systems for SCM. There are several researchers (Angeles and Nath 2000; Nah et al. 2001; Motwani et al. 2000; Boubekri 2001; Spekman et al. 2002) who deal with the information technology management from a supply chain perspectives.

It is important that we have the complete co-operation of employees at all levels; technologies alone will not improve the organizational competitiveness. Tracey and Smith-Doerflein (2001) point out that the human dimension of communication and co-operation across all parties comprises the chain.

There are different ways to manage the knowledge and IT. These include strategic alignment with partnering firms, collaboration with local universities and training and education in IT. Company has limited resources therefore; suitable and critical areas need to be identified with the objective of optimizing the investment in knowledge and IT projects.

12.1.6 Implementation of IT in SCM

Integration of the supply chain's activities and processes before the development and implementation of the information systems in SCM is needed. Implementation of IT in SCM requires a project management approach with the right team for the planning and implementation of IT projects to provide financial and technical support for the implementation of IT for achieving SCM.

Cumberland Packaging Corporation decided to replace its 20-year-old manufacturing system with a fully integrated ERP: ADAGE. By implementing ADAGE Cumberland has been able to reduce inventory by 10–15%, with the value of approximately $2 million. In addition, the system has helped Cumberland shorten delivery lead-times, improve customer service, and better plan and forecast demand, thereby cutting production costs (see http://www.sctcorp.com/SMDS/ClientProfiles.htm).

Successful implementation of IT depends upon the support of top management and overall organizational structure. Ho (1996) discussed in detail IT implementation strategies for manufacturing organizations. Skills available within an organization influence the success of IT in supply chain. Project management and planning method can be used for the implementation of IT in SCM. There are different tools that could be used for the implementation of IT in SCM, some of which include (a) quality function deployment (QFD), (b) concurrent engineering, and (c) life cycle approach. Pawar and Driva (2000) point out six major issues in the implementation of EDI in supply chain: (a) develop strategy, (b) assessment, (c) create culture, (d) prioritize improvements, (e) plan the change, (f) implement improved situation and support implementation. Angeles and Nath (2000) examine the importance of congruence between trading partners for the successful implementation of EDI networks. Cooper and Zmud (1990) propose a technological diffusion approach for information technology implementation for the networked and collaborative enterprise environment.

Human factors such as the behavioral attitude towards the implementation of IT in SCM, level of education, knowledge in computers, training and education, ... impact the successful implementation of IT in SCM. Williford and Chang (1999) describe the development of a macro model that predicts staffing, training and infrastructure funding for the FedEx Information Technology Division.

Implementation of IT requires a strong team that includes key and IT knowledgeable managers from all functional areas. There are several tools and methods for effectively managing the implementation of IT: QFD, CE and life cycle approach. Suitable performance measures and metrics should be developed to monitor the implementation of IT over a time period. Strategic alliances and benchmarking studies on implementing IT for SCM would be helpful.

12.2 A Framework for the Development of IT for Effective SCM

Gunasekaran and Ngai (2004) pointed out the major issues that need to be addressed when attempting to enhance the role of IT in supply chain integration. These issues are showed by them in the framework like the Fig. 12.1.

12.3 Roles of E-Government in Business

Government institutions are repositories of knowledge (e.g. laws, regulations, case histories), and provide and consume services that are of key importance to individuals and businesses (Navarro et al., 2007). Important users of e-Government are not only citizens but are also businesses. E-Government to business consists of electronic interactions and allows for transaction initiatives such as procurement and the development of an electronic marketplace for government (Fang 2002). Clearly, e-Government is related to e-Business which is any information system or application that enhances business processes and often refers to the application of web technologies (Poon and Swatman 1999; Amit and Zott 2001).

An e-Government strategy is a fundamental element in modernizing the public sector, through identifying and developing organizational structure, the ways of interactions with citizens and business, and reducing cost and layers of organizational business processes. It provides a wide variety of information to citizens and businesses through internet. E-Government can develop the strategic connections between public sector organizations and their departments, and make a communication between government levels. This connection and communication improve the cooperation between them through facilitating the provision and implementation of the government strategies, transactions, and policies, and also better use and

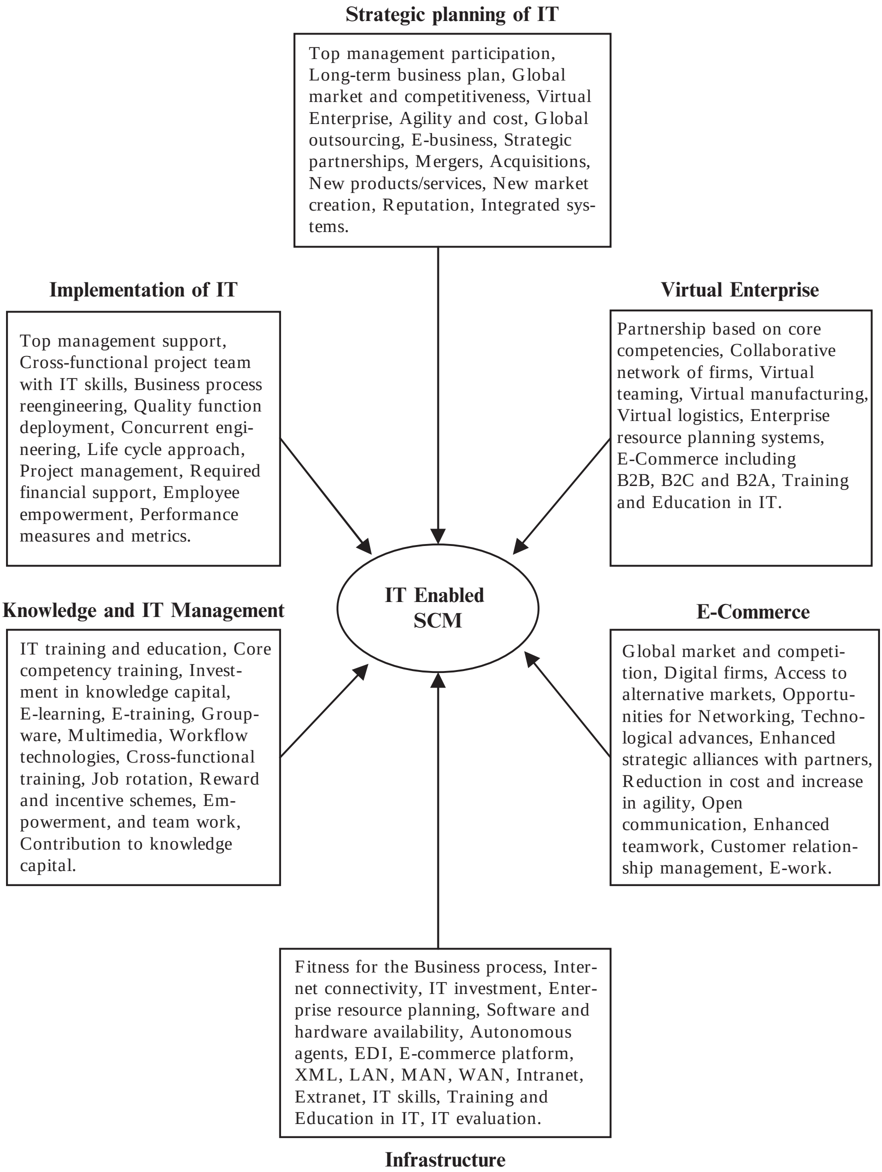

Fig. 12.1 A framework for the development of IT for effective SCM (Gunasekaran and Ngai 2004)

running of government processes, information, and resources (Cabinet Office 2000; Heeks 2001). E-Government strategy is enabling public sector organizations to interact directly and work better with businesses, irrespective of their locations within the physical world.

Researchers agree that ICT has considerable potential to contribute to learning efficiency, gains and cost reductions for companies. The opportunity to access new knowledge, learn about government and conduct on-line transactions will reduce red tape and simplify regulatory processes, therefore helping businesses to become more competitive (Navarro et al., 2007).

There are many different definitions for E-Government. Tapscott (1996) defines e-Government as an internet-worked government, which links new information communication technologies (ICT) with legal systems internally and, in turn, links such government information infrastructure externally with everything digital and with everybody such as: the tax payer, suppliers, business customers, voters and every other institution in the society. Fraga (2002) pointed out that e-Government is the transformation of internal and external relationships in the public sector (citizens and businesses) through net-enabled operations. For Unpa and Aspa (2001), e-Government simply consists of the creation of a web site where information about political and governmental issues is presented. (Abramson and Means 2001) define e-Government as digital governmental information or a way of engaging in digital transactions with the public (citizens and businesses) and employees. Durrant (2002) defines e-Government as a permanent commitment of government to improve the relationship between the citizens and businesses and the public sector through enhanced, cost-effective and efficient delivery of services, information and knowledge. The IDABC[1] web site has the following definition for e-government: "e-Government is the use of information and communication technologies in public administration to improve public services and democratic processes and to strengthen support to public policies". Heichlinger (2004) defines e-government as a set of activities supported by information systems for improving the relationships between government institutions and citizens.

Adoption of e-Government is not straightforward and cannot be done in a limited period of time, rather it requires an integrative architecture framework approach to place government information and services online. Also e-Governments require significant changes in organizational infrastructure, which, in turn, can engender resistance.

12.4 How ICTs Lead to Successful Use of E-Government

This section is based on Navarro et al. (2007).

A successful use of e-Government comes from making connections between individuals, departments, ideas, and even between government institutions via ICT media. Several factors influence the use of e-Government by businesses. ICT applications are needed to create organizational information capability, which is an essential resource for the exchange of strategic and tactical information with all stakeholders in an e-Business. Timmers (1998) suggests ICT classification based on the vertical or horizontal integration of various companies and industries, and

[1] Interoperable Delivery of European e-Government Services to public Administrations, Businesses and Citizens.

considers e-shops, e-procurement, e-actions, e-malls and marketplaces. Rayport and Jaworski (2001) suggest two main criteria to classify ICT:

– The sources of content organization (which may refer to products, services and information).
– The focus on e-commerce business strategy, which can be on the supply side (e.g. supply chain movement) or on the demand side (e.g. better customer experience).

Navarro et al. (2007) point out three different types of technologies that may be associated with e-business:

– The internet, which enables customers and employees to have access to instantly available information about products and services across time and distance (Tetteh and Burn 2001; Porter 2001).
– Groupware, which provides collaborative groups formed by employees, managers and sometimes customers with the ability to link large amounts of information in a dynamic manner (Rodgers and Thorson 2000; Brown 2002).
– Collective systems, which facilitate flows of information that may be controlled by users (Fowler 2000; Lee and Runge 2001).

Hirst and Norton (1998) identify three types of connections between business and e-Government:

– External, where ICTs open up new possibilities for governments to be more transparent to businesses, giving access to a greater range of information collected and generated by governments.
– Relational, where ICT adoption may enable fundamental changes to the relationships between businesses and the state. Vertical and horizontal integration of services can be realized, enabling the integration of information and services from various government agencies to help businesses and other stakeholders get seamless services like procurement of goods and services between government institutions and businesses.
– Internal, which refers to the extent that government services are re-engineered from an off-line to an e-service.

Internet systems, groupware systems and collective systems are positively associated with e-Government (Navarro et al. 2007). The existence and use of internet and intranet systems is essential for using e-Government and defines the external connection between business and e-Government. Connection between businesses and government requires collaboration within and between organizations which are facilitated through groupware. Kambil et al. (1999), the internal connection between businesses and government institutions requires collective systems aimed at improving efficiency, for example through on-line forms and transactions.

According to Montazemi (1988), larger businesses can allocate greater financial and personnel resources to the adoption and use of technology. As a business increases in size, its coordination may become more complex, and therefore its reliance on the movement of information might also increase, hence increasing the need for computerized systems. The size of a company is related to the level of web adoption.

ICT has a direct impact on business performance. We expect that more successful businesses would be taking advantage of ICT and consequently would be more likely to use e-Government.

Firms with higher internet resources have a higher usage of information technologies, are possibly more aware of interacting on-line with customers, and are more likely to envision benefits from the use of government e-services.

The larger the business, the greater is the use of the internet. However, we have found that if businesses do use the internet, the size of the business becomes less important for making full use of e-Government. Navarro et al.'s (2007) findings did not indicate any significant effects of business performance on e-Government use, although there was a positive correlation between them, it was not significant.

Businesses should consider e-Government as a source of knowledge and not just a cost reduction opportunity. Use of e-Government by businesses will depend on how government institutions handle internet, groupware and collective systems. Groupware and collective systems affect e-Government in a positive and meaningful way so companies need to support connections between employees and their customers and between companies and government. Not only will the internet make government more transparent and provide access to a greater range of information and services, but also groupware systems will create opportunities for partnership and collaboration between businesses, government and other businesses (Tapscott 1996; Tan and Pan 2003).

Collective systems, vertical and horizontal integration of government services can be realized enabling businesses to get seamless services. According to Tan and Pan (2003) it is necessary but not sufficient that government services be simply transferred from an off-line to an on-line service, but all users should be informed and educated of the value and use of e-Government. So in order to implement e-Government, companies need to provide and support internet systems, groupware systems and collective systems as a prior step, and large companies provide and support ICT to a greater extent than small companies.

12.5 E-Government Architecture Framework

This section is based on Ebrahim and Irani (2005).

A public sector organization planning to adopt an e-government initiative and formulate its IT strategies must evaluate its business models and select appropriate technology solutions that deliver on central government policy. The e-government architecture defines the standards, infrastructure components, applications, technologies, business model and guidelines for electronic commerce among organizations that facilitates the interaction of the government and promotes group productivity. A number of studies have pointed out to the architecture or components of e-government, such as Cabinet Office (2000), Heeks (2001), Sharma and Gupta (2002), Office of Information Technology (2001) and Daniels (2002).

Ebrahim and Irani (2005) provide an integrated architecture framework for e-government that represent the alignment of IT infrastructure with business process management in public sector organizations. They discuss the required business process for the successful implementation and management of e-government activities. This framework is structured into four layers connected through two-direction arrows which present the hierarchical level of e-government implementation and portray the logical connection of each relevant layer that allow two-way transmission of data and services. Figure 12.2 shows this architecture framework of e-government which is divided into four layers: access layer, e-government layer, e-business layer, and infrastructure layer.

12.5.1 Access Layer

This is the simplest level of e-government architecture which is controlled and managed by government users. This layer involves the channels that government users (citizens, business, employees, other governments, and other community members) can access the various government services. Access channels consist of online and offline channels of distribution through which products, services and information are used, accessed and communicated by multiple technologies.

12.5.2 E-Government Layer

This layer is about integrating digital data of various organizations into a web-portal of government services, in the form of a one-stop e-government portal. This may result in improved access to government resources, reduction in service-processing costs, and enabling organizations to provide a higher quality of service (Ho 2002; Gant and Gant 2001; Sharma and Gupta 2002).

Government web-portals have an important role when public sector organizations try to create electronic interaction between government and citizens (G2C), government and business (G2B), government and its employees (G2E), and government and government (G2G). An integrated portal will reduce overhead and improve information flow. Security is another key element of this layer, through deploying government authentication and privacy standards to secure online transactions and protect the portal contents.

12.5.3 E-Business Layer

This layer is focused on using ICT tools to harness a network of trust, knowledge sharing and information processing that takes place both within and between organizations (Moodley 2003). This layer includes several tools to help determine, assess,

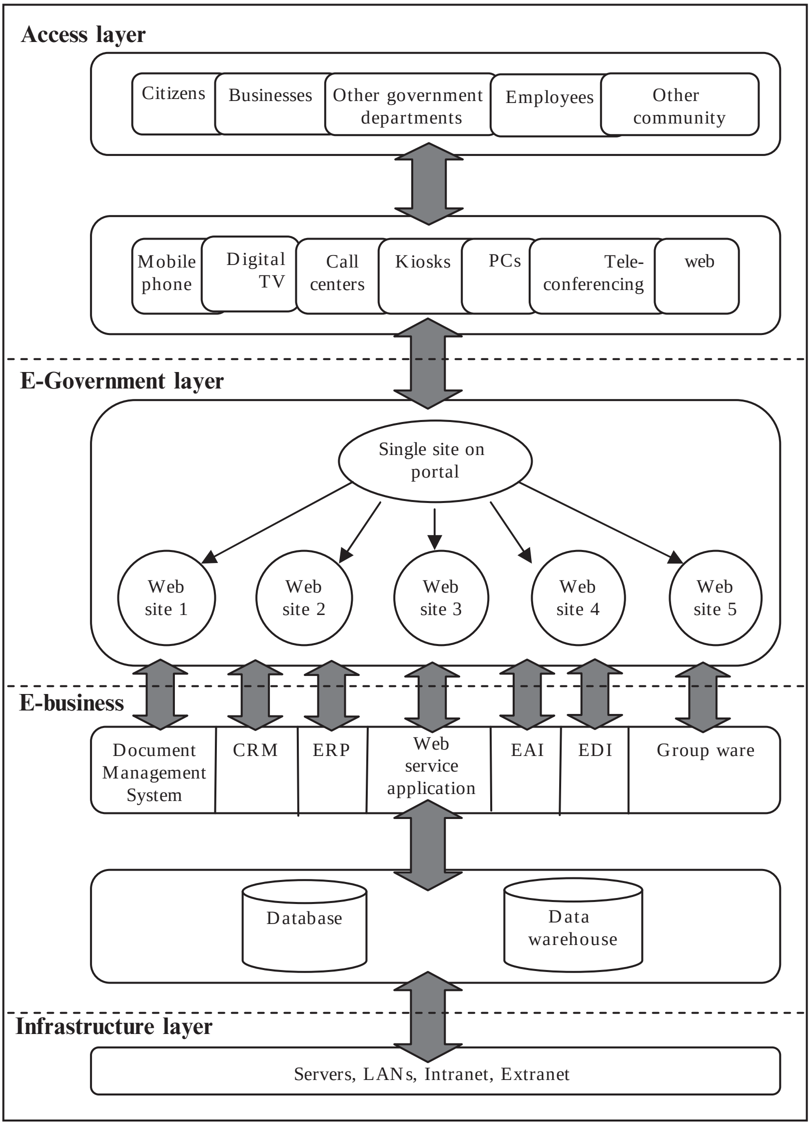

Fig. 12.2 Framework of e-government architecture (Ebrahim and Irani 2005)

and achieve consistent and integrated processes and information systems in public sector organization.

The implementation of this layer will make a strong foundation to build single e-government portal and also support the relationship and interaction between G2G and G2E. This layer support decision-making in the formation of new value chains, and reinforces the existing business partner's relationship in form of electronic procurement. Legacy systems and applications across government organizations need to be upgraded to a web-enabled level to extend their functionalities beyond organizational boundaries and to achieve full communication between all information systems and their processes.

The integration of government database systems, processes and applications play a critical role in this layer. This layer emerges widespread applications and systems that help maintain governments' existing data and business processes. These applications can use access layer to deliver information and services to citizens through different channels, such as CRM, which focuses a new concept of relationships between government and citizens, "citizen-focused", through delivering services to citizens and enabling joined-up and automated service delivery. CRM system cannot work independently in this layer, there is a need for integrated information systems and applications that support its operations and provide essential data such as database management system (DBMS), document management systems, and data warehousing, which can hold citizen's records, official documents, historical information, and maintain business processes and procedures.

Common approaches for e-business layer involve integrating legacy systems, or computer systems that are not connected and do not share data, for example, enterprise resource planning (ERP), EAI, and web services. EAI systems have emerged to overcome some of the limitations of ERP, through providing an integrated organizational infrastructure (Erasala et al. 2003). Web services are standards-based and suited to build common infrastructure to reduce the barriers of business integrations, hence, enable e-government systems to collaborate with each other regardless of underlying infrastructure (Huang and Chung 2003; Ratnasingam and Pavlou 2002).

12.5.4 Infrastructure Layer

Building an effective information community by using e-business layer requires a technology infrastructure that reaches out to all parts of public sector organization. This layer focuses on technologies that should be in place before e-government services can be offered reliably and effectively to the public. They try to support and integrate the operations of information systems in e-business layer across organizations by offering the necessary standards and protocols through network and communication infrastructure approaches (e.g. intranet, extranet, and internet). This layer provides basic technologies, such as LAN, which support the provision of user-friendly and innovative online services involving the transmission of data of various formats such as text, graphics, audio and video.

To have a successful e-government strategy, the public sector must create an IT infrastructure. IBM (2001) indicates that the key component of IT infrastructure in government organizations is the application server. It consists of server hardware, server operating system, and different applications server software that runs the e-government application logic and manages the user interaction. These servers operate through efficient network technology and internet connectivity. Security of infrastructure is still one of the most crucial and least understood issues associated with internet-based communication and applications (Medjahed et al. 2003).

The consistency of layers should be given the required attention during the implementation of e-government. Each layer connected to the adjacent layer so poor implementation of one layer could affect the performance of the rest of layers, and therefore, will degrade the performance of e-government.

12.6 Barriers to E-Government Adoption

This section is based on Ebrahim and Irani (2005).

Many e-government initiatives are in their strategic phase of implementation, however, some key problems and barriers are already beginning to emerge. There are a number of barriers experienced in public sector organizations that prevent the realization of anticipated benefits and degrade successful adoption of e-government projects. Ebrahim and Irani (2005) analyze and summarize the barriers of e-government adoption experienced in public sector organizations.

Despite the cost of IT going down, an adequate IT infrastructure which is composed of hardware and software that will provide secure electronic services to citizens, businesses, and employees, still represents the key barrier for e-government adoption. Most researchers such as: Bonham et al. (2001), Bourn (2002), Dillon and Pelgrin (2002), McClure (2000) and National Research Council (2002), agree that governments view a lack of technical infrastructure as a significant barrier to the development of e-government.

The key to success in an e-government strategy is to implement an adequate IT infrastructure that will support a users' experience of easy and reliable electronic access to government. As discussed earlier, LAN, reliable server, and internet connections are important to build a strong foundation for e-government infrastructure.

Another significant barrier to the development of e-government is the need to ensure adequate security and privacy in an e-government strategy (Daniels 2002; James 2000; Joshi et al. 2001; Lambrinoudakis et al. 2003; Layne and Lee 2001; Sanchez et al. 2003; Bonham et al. 2001; Gefen et al. 2002). IT departments in organizations should be aware that security and privacy are not only critical for the availability and delivery of government services but also to build citizen confidence and trust in the online services and transactions they will be providing. Investing in the best available privacy and security applications and tools is worthwhile, as a shortage of them could lead to failure of the entire e-government project.

Chen and Gant (2001), Heeks (1999), Ho (2002) and (Moon 2002) identify the shortage of IT skills as another potential barrier to provide the e-government services. One of the reasons for this is the difficulty of attracting and retaining the right IT talent, and also there is a lack of skilled staff in market who are familiar with major IT skills, as noted by McClure (2000, p. 18). These skills include computer information systems analysis, systems design, network construction, applications integration, maintain middleware technologies, transaction-oriented, message-oriented, operational management, web development, project management, and systems maintenance. Moon (2002) concluded that to move towards a higher level of e-government development, public sector organizations require more and highly trained technical staff.

Some of the researchers like Li and Stevenson (2002) have pointed out that in order to maximize the potential offered by an e-government initiative, government organizational culture, management strategy and individual attitudes within the organization need to be changed. While effective top management leadership involvement is a cornerstone of any IT investment strategy, strong government leadership and responsive management processes must support an e-government initiative. Some government officials perceive e-government as a potential threat to their power and viability, so become reluctant to the idea of online transactions (Ebrahim et al. 2003; Sanchez et al. 2003). Government staff should be prepared for new ways of dealing with new technologies that emerge with e-government. Some of the departments are reluctant to share their business data or processes with other departments within the same organization or with external partners. They believe that will weaken their authority.

Another barrier to the adoption of e-government is central government funding (Bonham et al. 2001; Heeks 1999; Ho 2002). The lack of financial resources from central government for e-government investments was seen as a major barrier, particularly by stakeholders from the government sector. Another important financial problem is the high operational cost of the existing IT infrastructure. The maintenance cost of such an infrastructure is high, which presents additional financial barriers. Today some public sector organizations turn to outsource their information systems activities to run e-government implementation in order to cut costs and thereby achieve more within financial constraints.

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Chapter 13
Case Studies

Maryam Abedian and Sara Sharahi

In this chapter we will introduce some case studies related to supply chain management and logistics in different countries.

13.1 A Bitter Pill at Hershey (Sridharan et al. 2005)

This case study shows the impact of supply chain implementation issues on the market value of the firm. The null hypothesis indicates that supply chain implementation issues do not affect firm value. The against hypothesis indicates that poor supply chain implementation can have a negative impact on firm value.

Hershey Foods Corporation and its subsidiaries deal in the manufacturing, distribution, and selling of consumer food products. The Company's main product groups include chocolate and non-chocolate confectionery products sold in the form of bagged items, bar goods and boxed items, and grocery products in the form of baking ingredients, chocolate drink mixes, peanut butter, dessert toppings and beverages. In September 1999, the firm abruptly alerted Wall Street that it would lose up to $150 million in sales that year and miss analysts' earnings estimates by as much as 10%.

Explaining the earnings failure, Hershey's officials said that the company's nationwide order-taking and distribution system had been interfered by the introduction of systems intended to facilitate shipping and logistics between Hershey plants and retailers. The supply chain system which cost $112 million dollars involved software and computer systems from SAP AG, Manugistics, and Siebel Systems. The supply chain management system was assumed to automate and modernize everything. Having software from three different providers created unforeseen delays and elaborate problems of implementation. The US confectionery market experienced increased demand for Hershey's products in 1998 and 1999; yet by September1999,

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Hershey had missed earning estimates in five out of the previous six quarters. It was apparent that Hershey has difficulties for delivering its products to retailers in a timely fashion because of a shortage of warehouse space. System start-up is another problem which added additional delays of up to 8–12 days in delivering products to retailers. Since Hershey was unable to fill its retailers' orders in time, the retailers in turn routed their orders to Mars Inc. and Nestle, two of Hershey's main rivals. The delay cost Hershey more than lost sales in the Halloween season of 1999; it cost them lost shelf space that is generally hard to win back. According to Ron Coppel, Vice-President of business development at Eby-Brown Co., a Napierville, Illinois candy distributor, candy eaters are more loyal to the type of candy (e.g. chocolate or lollipops) than to a particular brand, so if a customer does not find a Hershey's chocolate bar at a store there is a suitable opportunity that they will opt for another brand rather than leave the store without buying the candy. The unfortunate part of the situation for Hershey was that it had sufficient candy on hand to fill all of its orders. It is apparent that moving the candy from its warehouses to its customers is difficult.

Hershey produced about 3,300 different candy products in 1999. The acquisition of Leaf North American, the maker of Good & Plenty, Heath, Jolly Rancher, Milk Duds, Payday and Whoppers, Hershey's product offerings increased by 30% in 1996. Hershey had also been adding variations in size such as king-size and bite-size to its common sizes and introduced variations such as Reese Sticks and reduced fat Sweet Escapes. It also had made different wrappings and packages for different holidays. The proliferation of candy cause Hershey's sales grow was faster than the overall industry in the mid-nineties. But in 1998 and 1999, sales growth slowed at Hershey. In 1996, Hershey computerized its systems to satisfy retailers who increasingly demanded that Hershey fine-tune its deliveries so that the retailers could keep their inventories and costs down. The project called for 5,000 PCs as well as network hubs, servers and software from Siebel Systems, Manugistics and SAP AG. IBM was also hired to cooperate with system implementation. Hershey's 1,200 person sales force and other departments were to use the system for handling every step in the process. The system was assumed to run the firm's accounting, track raw material ingredients, schedule production, measure the effectiveness of promotional campaigns, help in setting the prices and even decide diminutive details such as how products should be massed inside Hershey's trucks.

Hindsight shows that the critical mistake for Hershey was the decision to implement the entire system all at once instead of in stages. Initially, the system was to start up in April 1999, but as testing and development were not complete, the date lagged to July 1999. Orders for Halloween candy began to come in July 1999 and Hershey had difficulty entering customer orders into the systems and conveying the specifications of the orders to its warehouses for fulfillment. The end result was that the supply chain system, which was part of a broader reviewing intended to sharpen the company's focus on its core mass-market candy business, resulted in much hazard to the company's core business because of poor implementation. Hershey hoped it would make up some of the goner sales of the Halloween 1999 season during the Christmas season of 1999. However, continued technology and order fulfillment problems resulted in lower than expected sales in December 1999 as well.

13.2 Assessing Supply Chain Management Success Factors (Tummala et al. 2006)

A questionnaire was designed based on all identified operational subjects related to five strategic success factors (building customer–supplier relationships, implementing information and communication technology, re-engineering material flows, creating corporate culture, identifying performance measurements) and pilot tested using several purchasing, logistics, and manufacturing managers at a large Midwestern consumer and building products company. This corporation is referred as the "company". The goal of the survey is to evaluate the current practices and the extent to which these factors are perceived as important in formulating SCM initiatives. The questionnaire was revised after of pilot testing and the revised questionnaire was formatted to a spreadsheet for easy collection and compilation of survey data. It was sent by e-mail to 129 managers dealing in purchasing, logistics and manufacturing functions in the company. This company has 60 plus operating facilities, which manufacture consumer and building products including cabinets and related products, plumbing products, decorative architectural products, and insulation and other services. The survey questionnaires were e-mailed first to purchasing managers and they were asked to forward the survey to the appropriate personnel in related unit such as purchasing, manufacturing or logistics. The average respondent had 7.5 employees reporting to him/her, between seven and ten years of experience in their present occupational field. Analyzing the forward and backward channels shows that a large proportion of respondents interacted with customers and suppliers that were both internal and external. Also the response rate and the profile of the respondents show that the survey sample well represents the practices of supply chain management in all operating facilities of the company.

Why is supply chain management (SCM) used? A significant majority of respondents perceived purchasing, inventory control, logistics and manufacturing as the most important functions to be integrated within the supply chain management paradigm. Still a significant proportion of respondents felt that predicting and quality functions should be integrated. These observations are supported by the survey results as 98, 96, 87, and 85% of the respondents agree that purchasing, inventory control, logistics, and manufacturing functions should be integrated within the SCM approach. Also, 80 and 79% of the respondents indicated that predicting and quality functions should also be integrated within supply chain management paradigm. Clearly these results, with 95% confidence intervals shown in the parenthesis of each statistics, are statically significant.

The survey respondents were asked to weight each factor on a six-point scale. At last, the survey results are summarized and the results are as following:

In examining corporate culture, the survey results indicate that there are a good deal of commitment from senior and middle management to SCM. There is also generally a good level of communication, employee engagement, and cross-functional interactions and participative management, and acceptance of employee suggestions. This is an excellent indication that internal planning will support the concerns of business units and support continuous improvement efforts. At the same time, the responses of the survey respondents indicate that not enough resources were assigned to implement and support SCM activities in their divisions. In addition, they perceived that resource assignment could be developed in the areas of better information systems, greater commitment, increased training, more personnel, and aligning SCM initiatives with current priorities and resource commitments. The responses also indicate the need for improvement in setting clear cut SCM agenda in the respective business units and adequate investment in technology to support SCM activities. This shows that the corporate and divisional senior and middle managers could take further actions to provide direction to address these problems in reaching strategic and operational objectives of SCM philosophy. These initiatives could help employees identify the requirements of SCM and benefits to be achieved. It also makes them feel that they are supported by senior management to implement SCM plans. Most of the respondents showed the lack of use of information and communication technologies other than email and faxes, bar-coding and scanning, and EDI. The use of bar-coding and scanning, and EDI appears not to be not common. Equally interesting observation is that ICT platforms are used only in the placement and receipt of orders. It is perceived by the respondents that they are not significantly used in sharing information, production scheduling, inventories, problem solving, purchasing, and internet auctions, etc. Clearly this area needs more improvement. Training and education in the selection and use of ICT systems and their compatibility with the systems used by other supply chain members would enable employees to use more suitable ICT systems to achieve supply chain effectiveness and efficiency. As a case in point, investing in ICT and using it in purchasing transactions would enhance purchasing competency, which requires training in the use of the chosen IT system. Building trust and recognizing the mutual benefits that would be again by sharing information among supply chain partners is also critical. Perceiving the SCM philosophy and its requirements also enables employees to understand which of these areas could bring in the most efficiencies and learn how to implement appropriate SCM plans.

Use of ICT to achieve supply chain effectiveness is necessary. Also, the use of internet technology to perform real time supply chain activities is essential. Indeed, the use of internet technology is changing the way the supply chain members conduct their business transactions regularly. improving and maintaining customer–supplier relationships is also important. The corporate and division level senior management could provide the strategic direction to gain this purpose without compromising the underpinning entrepreneurial approach of “maximizing value to shareholder” by the company. Interestingly, the respondents indicated that conveying accurate information, maintaining trustworthy communications and long term commitment, joint problem solving and conflict resolution, and using compatible technologies are important to develop and maintain relationships or alliances among the supply chain members. This is a good position to be in because the employees do not have to be persuaded how important the customer–supplier relationships are in implementing effective SCM plans. By providing appropriate environment to support, SCM would enable employees to take necessary actions.

Another interesting observation is that the operating business units of the company appear to be more proactive with their upstream suppliers than with their downstream customers as indicated by the respondents' attitudes towards re-engineering their internal and external logistics operations. Integration of upstream suppliers and downstream customers is extremely important to gain supply chain effectiveness. Focusing on one and leaving the other unattended is a odd strategy as it seriously compromises customer service levels and hence SCM goals and objectives. The company needs to seek ways to improve internal and external logistical operations throughout its operating business units to define system-wide costs and service levels to satisfy customers and the company's desired goals and objectives. Using good IT systems would be most helpful to achieve this purpose. It is possible that some operating divisions have implemented plans but others do not know about them. Consequently, the majority of the respondents may have indicated that they are not defining logistical initiatives to achieve supply chain efficiency. This could be the reason that the respondents did not perceive the SCM performance measures related to logistics such as customer satisfaction, delivery times, responsiveness, etc. as important. In addition to addressing logistics operations, understanding SCM requirements would enable employees define good SCM performance measures and use them to examine the effectiveness of the SCM plans that are implemented. However, it is interesting to see that inventory turns, cost reduction and on-time delivery are perceived to be the three important performance measures to assess the impact of SCM.

The lack of use of ICT and lack of focus on re-engineering the material flow and the weakness of using other SCM performance measures as perceived by the survey respondents could have been the reasons for many respondents to believe that SCM initiatives are not fully done at their respective business units. Given the perceived strengths in corporate culture and customer–supplier relationships issues as indicated by the survey respondents, and addressing the resource allocation that could be improved in the areas of better information systems, increased training, and aligning.

SCM initiatives with current priorities, these weaknesses can be overpower if the senior management at the corporate and division level provides a strategic and operational environment for SCM support. The company can implement effective SCM plans to realize system-wide costs savings while satisfying the customer service levels. This would improve the company's entrepreneurial approach of maximizing the shareholder value.

13.3 An Assessment of the Danish Pork Supply Chain (Hobbs et al. 1998)

When a firm is seeking to state its competitive position within a market, one of the techniques often used are an internal and external audit. This involves the firm's managers in identifying the internal strengths and weaknesses of the firm, the external opportunities and threats posed by conditions in the firm's marketing environment. This analytical procedure is sometimes referred to as strengths, weaknesses, opportunities, threats (SWOT) analysis.

Danish pork industry looks very uncompetitive in comparison with its rivals in international markets, yet Danish exports account for between 20 and 30% of global pork trade. This study explores the reasons for this success, finding answers in the organization of the Danish pork supply chain. This case study used SWOT analysis to analyze the competitive position of Danish pork supply chain.

SWOT analysis of the Danish pork supply chain is as follows:

13.3.1 Strengths

- Vertical coordination of industry through cooperative structure
- Education and training of labour force
- High quality products, tailored to the needs of individual markets
- Efficient transfer of product quality information along production-processing chain
- Research

13.3.2 Weaknesses

- Farm cost structure: highly capitalised
  - High feed costs
- Processing cost structure
  - High labour costs
  - High capital equipment costs
  - Slower line speeds
- Co-operative structure – must take all pigs
- Presence in Japanese market
  - Sell to processors/wholesalers
  - No Danish brand identity with consumers
  - Sell only frozen product

13.3.3 Opportunities

- Research and development advances, e.g. measurement of:
  - Carcass colour
- Reform of CAP – cheaper foodstuffs
- Expanding existing markets
  - Japanese market
- New markets
  - Korean market
  - Other Asia-Pacific Rim markets
  - Central and eastern Europe and the new independent states

13.3.4 Threats

- Farm level production:
  - Environmental restrictions on herd size
  - Consumer animal welfare concerns
- Markets
  - Decline in UK market
  - Difficulties of doing business in central and eastern Europe
- Competitors
  - Taiwanese regain strength in Japanese market
  - Industrialisation of the US industry

The blossom of The Danish pork industry is the result of a coordinated approach of production, processing and marketing, which is built on the basis of a thorough finding of the requirements of different markets, a dedication to quality which includes the ability to provide a consistent and reliable supply of high quality products tailored to the requirements of different markets, and a well-organized co-operative industry structure. The long tradition of agricultural marketing co-operatives in Denmark has evolved a complex system of support for the activities of the industry, from the education and training of the labor force to research and development into pig breeding and the latest within plant logistics and processing technology. Co-operation, not confrontation, is the watchword throughout the supply chain.

13.4 A Study of Supplier Logistics Performance Measurement in the Automotive Industry (Schmitz and Platts 2004)

The aim of this case study is to identify functions of performance measurement as a management control mechanism and tool in supply chain management in the automotive industry. This case is focused on its use at the vehicle manufacturer as the dominant partner in the supply chain. Its role is examined in terms of communication and co-ordination between vehicle manufacturer and its first tier suppliers. The companies under study used a whole range of different performance measurements: Quality audits and ratings, product and process FMEA, total cost analysis, strategic vendor categorization, etc. This case emphasizes one particular area of measurement: the ongoing measurement of the logistics performance of suppliers. Within this relatively constrained field, differences in the practice of performance measurement are assessed at each of the companies and explored whether these can be explained through different functions that are fulfilled by measurement or through idiosyncrasies of the power structure and culture within the organizations.

Two main vehicle manufacturers were studied by questionnaires as well as semi-structured interviews during site-visits. The European logistics director and three to five additional managers and analysts from the purchasing and logistics departments at their European headquarters and at one of their German plants were interviewed in each company. The companies provided documents on quality management, supplier selection and evaluation procedures, etc. as well as actual supplier ratings and exemplary correspondence with suppliers. Additionally, a more detailed study was undertaken at Company A over the period of more than one and a half years involving observation of meetings in the logistics department, between logistics and purchasing managers and between Company A's representatives and supplier representatives. An overview of the performance measurement systems is presented at each of the two companies in Table 13.1.

Although the basic activities at all companies are similar – after all, they are in the same industry, dealing with the same suppliers, using very similar processes – the measurement process at the companies showed some differences. Although the criteria at two companies bear correspondence, the form in which they are evaluated differed: Company A has the most formalized supplier rating system and the most advanced information system to support performance evaluation. It also is the most centralized company in this study. Company A tries to establish performance measurement as a main tool for communication with suppliers and control of the supply base. Supplier ratings are produced on a monthly basis and are used in order to get the attention of the suppliers and to begin action by threatening them with downgrading. This use of performance measurement as an instrument of threat towards suppliers follows a perceived lack of power over the suppliers.

It is interesting to know that the effect of the logistics rating on purchasing decisions is indeed very limited. One purchasing manager represented that she did not know any case in which a preferred supplier was not chosen because of its

Table 13.1 Summary of supplier logistics performance measurement in the two companies (Schmitz and Platts 2004)

	Company A	Company B
Evaluation criteria	1. Communication systems (25 points)	1. Schedule adherence
	2. Up-to schedule shipping performance (25 points)	2. Early warnings (e.g. material shortfall without prior advice)
	3. Reaction to problems (15 points)	3. Reliability (e.g. response to faxes, questionnaires, etc.)
	4. Over shipment (10 points)	4. Flexibility (e.g. reaction to increase or decreases of requirements)
	5. Record maintenance by supplier (15 points)	5. EDI (meets all EDI requirements)
	6. Other supplier performance (10 points)	
Rating method	Weighted scoring (additive model)	Worst rating of any single criteria equals overall score (conjunctive model)
Scale	0 (worst) to 100 points (best)	1 (best) to 5 (worst)
Frequency of evaluation	Monthly	Once per year and in cases of serious under-performance
Level of formality	*High*. High degree of reliance on quantitative data, guidelines and rules	*High to medium*. Formal guidelines. Based to great extent on subjectivity/ experience
Action	<80 for 6 month: Quality certificate (QC) suspended. No new orders	"4": Initiating of improvement process. If no improvement visible, then: "5": Find replacement
	<80 for 12 month: loss of QC. Re-sourcing	
Consistency of actions	*Medium to low*. Not enough personnel to follow-up on underperformance	*Seemingly high*. But very reluctant to downgrade suppliers in first place
Introduction	Same criteria since 1996	Same criteria since 1993
Initiator	Central logistics department, QM	Central purchasing department, QM
Centralization of logistics activities	*High*. Central department involved in most logistics issues (incl. Supplier follow-up)	*High to medium*. Plant is responsible for most logistics issues. PM administered centrally

logistics rating. In the eyes of Company A, the logistics department that originally had only quite limited impact on suppliers, received a very powerful lever to influence suppliers by implementing an integrated supplier performance measurement system that links logistics performance to the purchasing decision.

Company A is officially assumed to follow-up on every under-performing supplier, ask detailed improvement plans, and offer technical assistance. Company B, on the other hand, offers assistance to almost every supplier that is under-performing. However, Company B is very unwilling to rate suppliers as “unsatisfactory” in the first place and does not have such strict guidelines and fixed trends in its rating process as Company A.

13.5 Comparison of Asian and European Logistics Systems (Bookbinder and Tan 2003)

This case study compares the logistics systems of Europe and Asia, first by providing a geographical, political and social overview of these two regions, then by addressing the strategic effect of various issues on each region’s logistics. European and Asian logistics systems are separated into tree logistic tiers by applying cluster analysis to data from authoritative source. Infrastructure, performance, information system, human resource, business environment, political environment are some of the general specific criteria that determine logistic tiers. There are several surprises, the main one being that the UK was classified as Tier 2. A surprised set of attributes that the UK could improve on to be qualified as the tier 1 group is suggested. Sensitivity analyses are done to determine changes to the classification. After finding that the top-ranking logistics systems of Europe and Asia are from Denmark and Singapore, respectively, those two countries are studied in detail. You can see summary of this comparison in Table 13.2.

13.6 Challenges to Bangladesh Logistics Development (Abdur Razzaque 1997)

The contentions many less developed countries currently face for developing their logistics systems are legacies of the past. These are fundamental problems inherited not only from their embryonic trappings, but also from lack of understanding of logistics’ role. This case study attempts to identify the major challenges confronting logistics development in Bangladesh. This is a South Asian less developed countries that represents an environment dramatically different from that of any developed nation in terms of socio-cultural, politico-legal, and economic realities. The findings of the study will provide the prospective investors with a practical idea of what to expect in Bangladesh and motivate policy makers to shape policies to address logistics problems in the country.

Data for this research were collected through interviews. A systematic sample of 137 male traffic managers, materials managers, purchasing managers and distribution managers employed in the manufacturing, wholesaling and retailing industry was drawn from the Bangladesh Trade and Commercial Guide 91/92. They came

Table 13.2 Summary of comparison between Denmark and Singapore

	Denmark	Singapore
Performance/process management	Goods can be pre-cleared by electronic document transfer	Developing an electronic freight container seal, an RF communications protocol for sealing freight containers. Developing pallet size standards to reduce supply chain costs and increase productivity in consumer goods industry
Performance/customer orientation	Minimum red tape with service priority geared towards business and trade	Minimum red tape with service priority geared towards business and trade
Information system/new information technology	Integrated EDI technology linking shippers and consumers	TradeNet, the world's first nationwide Internet ready EDI system, streamlines procedures for import and export, and clears transshipment document from two days to within 15–30 min
Human resource/skilled labor	Literacy rate 100%	Literacy rate 93%. Education is not compulsory
Human resource/employee training	Logistics training in a number of technical schools	Many logistics training schools
Business environment	Pro-logistic policy: can store commodities as long as necessary without paying value added tax until shipment to final destination. Free sport and bonded warehouse facilities available	Pro-logistic policy: GST (3%) waiver on goods taken by traders from bonded warehouses that are operated by logistics companies. Free trade zones available

from a cross-section of Bangladesh's public and private sector business organizations and MNCs covering all the major business sectors including food, jute and textile, tea, petroleum and chemicals, steel and paper. Each of these managers was contacted by the author requesting an interview. Each interview was organized in three sections. The first section asked questions causing respondent profile such as age, organizational affiliation, designation, experience in current position and educational attainments. The second section consisted of three sub-parts. The first sub-part of five questions considered respondents' general awareness of logistics. In the second part, respondents were presented with 12 statements giving popular conceptions and misconceptions of the logistics discipline and were desired to record their agreement or disagreement with each statement. The last sub-part listed 12 primary and secondary logistics activities developed according to logistics theory and asked respondents to determine and match each activity to four management functions: production, marketing, logistics, and others.

Results represent that respondents are generally aware (80.9%) of what logistics is, but a small fraction of them (14.5%) consider the system adequate for Bangladesh. It is logical to suppose that the awareness adequacy mismatch reminds a large majority of the interviewees (70.9%) to express the need for upgrading the existing logistics system in the country. It is worth noting that while less than a third of the respondents (32.7%) reported having a separate logistics or logistics related department in their firms, more than two-thirds (67.3%) expressed the exigency of having such a department. It is further observed that the firms with a separate logistics department are almost equally distributed among the MNCs, larger firms in the private sector, and public sector organizations. Also, the results show that the challenges of developing a good logistics system in Bangladesh are multifaceted. The five challenges seem to have captured the essence of the problems as Infrastructure related challenges, Management system problems, managerial problems, challenges posed by the economic system, general problems such as political instability, lack of policy continuity, and inadequate financial resources.

Some necessary efforts for omitting these challenges are government level efforts, private sector enterprise level efforts, improving education and research, and regional/international co-operation.

13.7 Strategic Logistics Management in Singapore (Sum and Teo 2001)

Many companies are going globally to acquire market share and take advantage of higher production and sourcing efficiencies In today’s highly competitive environment. A key determinant of business performance is the role of the logistics function in providing the smooth flow of materials, product and information throughout the company’s supply chains. To compete effectively, companies must recognize the strategic importance of the logistics function. In this case the strategic management of logistics and supply chain practices of companies in Singapore is evaluated. The research methodology is the mail questionnaire survey of profile of the logistics users and insights on logistics management in Singapore. This method was chosen to reach out to as many logistics user as possible in Singapore. The target respondents were middle to senior management staff familiar with the corporate strategies and logistics operation of their companies. The study provides an update on the strategies, management prioritization, and thinking of logistics users at a time when the logistics industry is booming.

A framework is proposed to cluster companies according to the extent that logistics is used as a competitive weapon. The practices and characteristics of the various strategic groups are then examined and analyzed. Finally the best practices of companies with strategic logistics are also identified.

13.8 Logistics Management Practices and Development in Thailand (Goh and Pinaikul 1998)

This paper evaluate logistics management practices and development in Thailand. Thailand is a global player in goods like rice and rubber, and finished goods like commercial vehicles and computers. With the weakening of the Thai baht and the prevailing regional currency crisis, the stimulus for greater export potential is strong. Also, air and sea transportation have been growing and will continue to experience growth of particular practical interest to those foreign firms, logistics managers, third party logistics providers and consultants which are keen to enter the markets of this developing country but which lack an extensive day-to-day operating experience. The findings of this study can provide prospective international investors with a realistic idea and informational base of what to expect when operating in Thailand. The uninitiated foreign firm would then not have to face a long learning curve before they are satisfied with their firm's or supplier's logistics performance. Further, the empirical results can serve to motivate policy makers and the relevant government agencies to shape policies accordingly to address issues of logistics concern.

The information used in this case comes from a postal survey that was sent to a sample of 150 randomly selected industrial and commercial firms listed on the Thai Stock Exchange. The choice of the sample is rationalized as follows. These listed firms are indicative of the most forward firms in Thailand, and have their headquarters located in the capital and its environs. There will be a severe resource constraint of time and finances to attempt to reach a wider and more heterogeneous geographical area. An exploratory survey instrument is used to evaluate as many issues related to logistics management practices as possible to provide an extensive coverage. Designed in English, the survey was translated into Thai and then re-translated into English to eliminate translation errors. In most question items, a five-point Likert scale (with "1" representing unaffected and "5" critically important) is used. Following testing with three companies and subsequent refinement, the survey was sent by mail and fax to the target firms.

This initial study has found that logistics managers in Thailand lack in modern technology and logistics operations skills. Contrary to Richardson, the traditional view of logistics as being transport and warehousing still stays in Thailand. While some firms have set up formalized logistics departments, they have not fully appreciated the integrative logistics concept and as such do not operate under an integrated logistics umbrella. An ineffective organizational structure can be a major hindrance to the development and management of logistics.

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