Global Supply Chain And Logistics Management

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Foreword

Marketing has strong influences on the management of a firm, internal, inter-firm relationships, and the supply chain. The marketing, as a business philosophy, guides firms to look for customer satisfaction at profit in a coordinated manner. Marketing means a basic set of values and beliefs about the importance of the customer that guide the firms in their daily operations. Marketing also provides philosophical foundation for human behaviors within a firm. In other words, marketing as a business philosophy, guides a firm's behaviors to develop, maintain, and enhance inter-firm relationships to satisfy customers. Marketing is also a necessary component for implementing supply chain management. One of the components of supply chain management implementation is partnership with compatible corporate philosophies, at least for key relationships. Marketing should be the compatible supply chain partners' philosophy, so all partners in the supply chain strive to satisfy customers at a profit through inter-functional coordination within and among the supply chain partners. Thus, under compatible marketing philosophies, supply chain partners become more willing to be efficient and effective toward a common goal which is customer satisfaction at a profit. Effective supply chain management requires all partners in the chain to build and maintain close long-term relationships. Successful supply chain relies on forming strategic partnerships that means long-term, inter-firm relationships with trading partners.

The first book published is about marketing and marketing management, their role and importance to the supply chain management in a global scale. This book published simultaneously is about the supply chain management on which marketing and marketing management have great impact. As marketing and supply chain are interrelated research areas, both of these books could be useful for university students to study the “Marketing Management” and “Supply Chain Management” courses at both graduate and postgraduate levels.

Dr. Nguyen Hoang Tien

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Chapter - 1

Introduction to Supply Chain Management

Objectives

- Define logistics management and SCM
- Understand impact of SCM on organization performance
- Understand the SCM model and barriers to effective SCM
- Establish roles of intermediaries in supply chains

1.1 Trends in Market Environment

In the last decades, managers have witnessed a period of change unparalleled in the history of the world in terms of advances in technology, globalization of markets, and stabilization or turbulence of world economies. With the increasing number of world-class domestic and foreign competitors, organizations have had to improve and integrate their internal and external processes rapidly in order to stay competitive.

In 1960s and 1970s, companies started developing detailed market strategies focused on creating and capturing customer loyalty. Organizations also realized that strong engineering, design, and manufacturing functions were necessary to support these market requirements. Design engineers had to be able to translate customer needs into product and service specifications, which then had to be massively produced at a high level of quality and sold in a wide scale at a reasonable cost. As the demand for new products escalated in the 1980s, manufacturing organizations were required to become increasingly flexible and responsive to modify existing products and business processes or to develop new ones in order to meet ever-increasing customer needs. In the 1990s, as internal manufacturing capabilities improved, managers realized that material and service inputs from suppliers had a major impact on their organizations' ability to meet customer needs. This led to an increased focus on the supply base and the organization's sourcing strategy. Later on, managers also realized that producing a quality product was not enough. Getting the products to customers when, where, how, and in the quantity that they wanted, in a cost-effective manner, constituted an entirely new type of challenge. The logistics renaissance has

been now a really rising trend, spawning a whole set of time-reducing information technologies and logistics networks aimed at meeting these challenges. These are the reasons why companies have to not only strengthen themselves but also take care and pay attention to the partners on their supply and demand side, considering themselves not as a central player but a part of the interrelated network, a linkage of the whole, global value chain.

The rules of business have changed. In today's environment, new products are launched and new businesses are set up every day. Customers are increasingly demanding, very difficult to keep and costly to replace. Companies face intense competition from traditional powerhouses (current competitors) and new players (potential competitors), and must continue to find new revenue opportunities and new way to increase efficiencies in terms of reducing cost. Today more than ever, businesses depend on strategic relations with their customers and suppliers in terms of providing services to create value systems that will enhance competitive edge for all sides in the market. In effect, there is a new network economy that has emerged where companies trade with suppliers and customers over the Internet in real time. The virtual corporation is now a reality, with companies outsourcing a wide range of functions including design, manufacturing, distribution, and others so that they can really focus on their core competencies. However, ensuring a seamless, consistent cooperation with customers and suppliers to create values together requires real-time automation of inter-organizational business processes that span across trading partners worldwide. Traditional business practices, such as e-mail, faxes, and voice mail introduce delays and often require data to be re-entered multiple times due to the total lack or integration. Hence, the need for dynamic business-to-business (B2B) integration that can automate business processes that encompass a diverse range of packaged applications and legacy systems within the corporation and among supply chain members. The ability to develop these B2B relationships and realize their potential in the shortest possible time is critical to the long-term success of any modern business. Indeed, no business can afford not to efficiently automate business processes with trading partners. Businesses are continually forging closer ties with their partners, suppliers and customers. Customers expect to be informed about state of transaction completion, 365 days a year, seven days a week and round the clock. Rather than adding the costly human resource traditionally required to maintain such a level of service, customers now interact directly with company via automated e-mail systems, self-service Web sites and information portals. Companies are empowering their customers to help themselves to their information. Customers not only expect their interaction to be real-time, but

also personalized, with information that represents their specific history with the company. In order to meet these demands, businesses must be able to integrate their information systems and applications with those of their suppliers and customers reliably, securely, and timely. Not surprisingly, this has led to a tremendous growth in B2B integration as companies look for ways to automate and accelerate their business processes, responding immediately to customer demands and changing to adapt to market opportunities. E-business integration significantly improves the performance of organization by supporting the key principles of business success:

- Faster to market with new products
- Better service and sales process
- Lower costs (operational, production, and inventory)

However, e-business also adds a significant amount of complexity in terms of security, reliability, fault tolerance, government regulations, etc., not to mention financial resources and time required to integrate and upgrade organization's business applications. Despite all of that, companies are undertaking significant restructuring initiatives to be able to function in the new era of e-commerce. After the initial wave of excitement about e-business, many companies are recognizing that beneath the Web, there still must be a physical distribution and sourcing structure and the supply chain management (SCM) is back in vogue. Supply chain management is concerned with more than just the movement of materials from point A to point B. The goal of supply chain management is the creation of value for the supply chain member organizations with a particular emphasis on the end customer in the supply chain. For this reason, supply chains should be designed and developed to create the maximum value for supply chain members. The need to create a new system of supply chain management has become even more apparent since the events of September 11, 2001. In response to the terrorist attacks, organizations have imposed a number of measures, including deep discounting to sustain profitability, significant downsizing of the workforce, changes in leadership, and even appeals to the federal government to restrict international competition. The impact on many organizations has been predictable: there are fewer people willing to work over time, significant cost pressures, high inventory levels, plant closings, and increasing conflicts between customers and suppliers. In some industries, companies are using the term “deferred commitments” to reflect the fact that they are not willing to purchase agreed-upon forecasted quantities from their suppliers. Some organizations have reverted to the traditional adversarial approach in managing their supply chain relationships,

resorting to the unpopular protective and uncooperative measures. However, the recent downturn in the economy has, more than ever, reinforced the need to improve performance across the entire supply chain. In the industries such as automobile, electronics, transportation, industrial equipment and many others, senior executives realize that raising prices is no longer an option, and neither is the possibility of dramatically increasing sales in a flat economy. This leaves only one option: reducing costs across the supply chain. In addition, there is tremendous growth in new markets and emerging economies. These regions will plug into the global economy and will add new dimensions and complexity to supply chains. In the automotive industry, giants like Toyota are moving production to these countries. Trade flow increases will stress supply chains even more, in terms of transportation and warehousing services. The fluctuations of cargo movement, freight costs, warehousing costs and production costs will result in less time to plan logistics processes. Outsourcing remains a mainstay of OEMs (*Original Equipment Manufacturers*) and the 3PLs (*Third Party Logistics*) are assuming more of their customers' workload and responsibilities. Increasing expertise is needed to handle these tasks and deliver the expected service level, which is increasing continually. Customers are also demanding high service level consistently. Companies which use supply chain strategies are more likely to build shareholders' value. Wal-Mart used supply chain to become a low-cost leader; Dell uses supply chain to deliver reliably and JIT (*Just in Time*); Apple refined its products to be able to innovate repeatedly and rapidly; IKEA engage its customers and end-consumers in the process of creating final products (assembly phase) reducing production, transport and distribution cost to minimum.

1.2 Supply Chain Management and Logistics Management

Supply chain revolution and a related logistical renaissance are two massive shifts in the expectation and practice concerning the performance of business operations. They are highly interrelated, but are significantly different aspects of the contemporary strategic thinking.

Supply chain (sometimes called the value chain or demand chain) consists of firms collaborating to leverage strategic positioning and to improve overall operating efficiency. For each firm involved, the supply chain relationship reflects strategic choice. A *supply chain strategy* is a kind of channel arrangement based on acknowledged dependency and relationship management. *Supply chain operations* require managerial processes that span across functional areas within individual firms and link trading partners and customers across organizational boundaries.

Supply chain management is defined as the integration of activities along the supply chain linking customer orders, distributor orders, inventorial orders, manufacturer orders, supplier orders and ultimately related cash flows.

Logistics means the art of calculation and reasoning, in contrast to supply chain management, it is the work required to move and to position inventory throughout a supply chain. As such, logistics is a subset of and occurs within the broader framework of a supply chain. Logistics with its history of development in the world of more than 5000 years, both in economics and military art and science, is the origin of supply chain management which has been known and become popular for several decades only. The most well-known logistics achievements in ancient time are the pyramids in Egypt and the Great Wall in China, to name a few. Logistics is the process that creates value by timing and positioning inventory; it is the combination of firm's orders management, its inventory, transportation policy, warehousing, materials handling, and packaging as integrated throughout a facility network. Integrated logistics serves to link and synchronize the overall supply chain as one giant continuous process and it is essential for effective supply chain connectivity. While the purpose of logistical work has remained essentially the same over decades, the way the work is performed continues to change radically in parallel with technology development and management innovation. According to the 5 Right conception logistics is the process of delivery the *right* product to the *right* place at the *right* time under the *right* condition and cost for the *right* customer (Douglas *et al*. 1998). According to Martin Christopher (1998) logistics is a process of strategic management of purchasing, transporting, storing materials, spare parts and semi-finished products, products and proper information flow in a company and its distribution channels to optimize profit now and in the future through carrying out all the orders at lowest cost and as fast as possible. According to David Simchi-Levi (2000) logistics system (network, chain) is a group of applied approaches linking suppliers, producers, warehouses, shopping outlets in an effective way for the purpose that goods and services are to be produced (delivered) and distributed in right quantity, right place, at right time in order to minimize cost in the whole system in a response to the needs of customers in terms of their expected level of service.

Logistics management, as has been defined by CLM (*Council of Logistics Management*), refers to the process of planning, implementing and controlling the efficient, effective flow and storage of goods, services and

related information from the point of origin to the point of consumption for the purpose of conforming to the customer requirements and expectations.

Most of the authors see logistics as the design and operation of the physical, managerial, and informational systems needed to allow goods and services to overcome time and space. Logistics entails planning and controlling of all factors that will have an impact on getting the correct product where it needs to go, on time, and cost-effectively. Superior logistical performance is a primary area in which organizations participating in an integrated supply chain management initiative can make themselves significant improvements. Logistical management is vital not only to manufacturing and assembly industries but also to retailing, transport, and other distribution or service-oriented industries. Owing to intensive competition in global markets, logistical management is considered an important source of competitive advantage. A study done by Council Logistics Management found that world-class firms are more apt to exploit logistics as a core competency than their less advanced competitors in less developed countries. This logic can certainly be extended to all the inter-organizational, cross-boundary and global supply chains. For instance, professional and strongly competitive German logistics service providers such as DB Schenker, Dachser, Yusen, Ziegler, APL, CEVA, DHL, Kuehne & Nagel are the powerful engines supporting German industry, export, growth and prosperity of German global corporations and Germany as an economic powerhouse in general. This Council Logistics Management study has identified what logistics firms can do to achieve world-class status. Key focus areas include:

- Positioning concerning the selection of strategic approaches to guide logistics operations
- Integration of internal logistical operating excellence and development of solid supply chain relationships
- The agility with respect to relevancy, accommodation, and flexibility
- Measurement of internal and external performance

Integrated supply chain management will only increase the importance of logistics activities. Supply chain management allows supply chain members to optimize their logistics performance at the inter-organizational level. This means integrated management of the movement (the flow) of materials, spare parts, semi-products or finished products first from the supplier to the next links across the supply chain to the end customer. This

represents a major departure from current logistics practices and concepts of many traditional companies, often characterized by independent efforts with limited mutual coordination between organizations. Logistics professionals will continue to be challenged to manage the movement of products across the supply chain in a timely and cost-effective manner that meets customers' service requirements. Meeting this challenge requires a logistics strategy that encompasses the entire supply chain. This overall strategy will be the primary driver for the specific logistics strategy within each of the supply chain member organizations. Distribution networks, transportation modes, carrier surveillance, inventory management, warehousing, order processing, and other related activities need to be addressed. The scope of the logistics strategy is now the entire supply chain, not just each individual unit in the chain. It will no longer be desirable or sensible for each of the supply chain member organizations to manage its logistics activities independently.

As said before, supply chain management is a new concept of management that has gained its popularity since 1980 and the logistics management has been perceived as organization’s traditional business or non-business activity since ancient time. Analyzing definitions and essence of both logistics management and supply chain management leads us to many schools of thought related to the issue on relationship between those fields as presented in the following figure 1:

a) Logistics management is a part of supply chain management
b) Supply chain management is a part of logistics management
c) Supply chain management is strongly and strictly identified with logistics management and vice versa
d) Supply chain management and logistics management have something in common and something of their own

From our point of view and in our strong belief, logistics management is part of the supply chain management and supply chain management encompasses all logistics activities of the firms, their partners they cooperate with, the synergy effect of those activities and more.

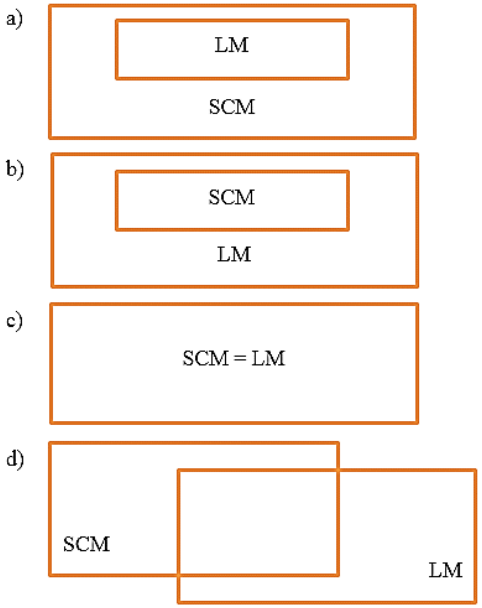

Fig 1: Supply Chain Management and Logistics Management

Source: *Own development*

1.3 Roles of Supply Chain Management in Organization

The management activities that need to be coordinated within a supply chain vary significantly from firm to firm, depending obviously on particular organizational structure, management's honest differences of opinion about what constitutes logistics, and the importance of individual activities to the logistics operations. Following along the supply chain as shown in Figure 2 and noting the important activities that usually take place, according to the Council of Logistics Management these are components, or activities, as to where they are most likely to take place in the supply channel (chain). The list of them is further divided into key and support activities, along with some of the decisions associated with each of the activities (table 1).

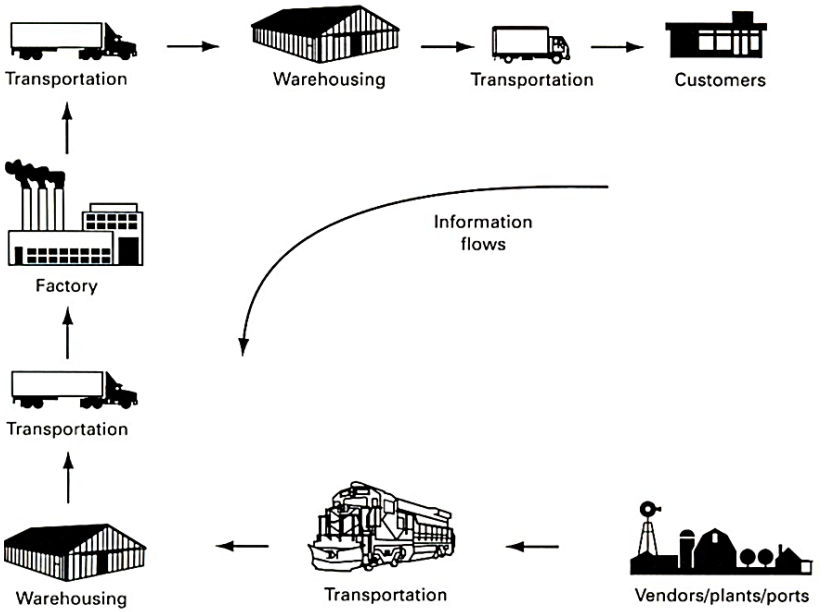

Fig 2: Logistics Activities in Supply Chain

Source: *Own development*

Table 1: Key and Support Logistics Activities in Supply Chain

Key Activities	Decisions Associated
Customer service standards	a. Determine customer needs and wants for logistics customer service
	b. Determine customer response to service
	c. Set customer service levels
Transportation	a. Mode and transport service selection
	b. Freight consolidation
	c. Carrier routing
	d. Vehicle scheduling
	e. Equipment selection
	f. Claims processing
	g. Rate auditing
Inventory management	a. Raw materials and finished goods stocking policies
	b. Short-term sales forecasting
	c. Product mix at stocking points
	d. Number, size, and location of stocking points
	e. Just-in-time, push, and pull strategies
Information flows and order	a. Sales order-inventory interface procedures

processing	b. Order information transmittal methods
	c. Ordering rules
Support Activities	**Decisions Associated**
Warehousing	a. Space determination
	b. Stock layout and dock design
	c. Warehouse configuration
	d. Stock placement
Materials handling	a. Equipment selection
	b. Equipment replacement policies
	c. Order-picking procedures
	d. Stock storage and retrieval
Purchasing	a. Supply source selection
	b. Purchase timing
	c. Purchase quantities
Protective packaging	a. Handling
	b. Storage
	c. Protection from loss and damage
Cooperate with production/ operations	a. Specify aggregate quantities
	b. Sequence and time production output
Information maintenance	a. Information collection, Storage, and manipulation
	b. Data analysis
	c. Control procedures

Source: Own development

Key and support activities are separated because the first activities will generally take place in every logistics channel (hub), whereas the second will take place, depending on the industry or circumstance (case), within a particular firm. Regarding key activities, they either contribute most to the total cost of logistics or are essential to the effective coordination and completion of the logistics task. The key activities are as follow:

- Customer servicing standards set the level of output and degree of readiness to which the logistics system must respond. Logistics costs increase in proportion to the level of customer service provided, such that setting the standards for service also affects the logistics costs to support that level of service. Setting very high service requirements can force logistics costs to exceedingly high levels.
- Transportation is primary cost-absorbing logistics activities. Experience has shown that it will represent one-half to two-thirds of total logistics costs. It is transportation that adds place value to

products and services, whereas inventories add time value. Transportation is essential because no modern firm can operate without providing for the movement of its raw materials, spare parts, semi and/or finished products. This essential nature is underscored by the financial strains placed on many firms by so-called national disasters, such as a national railroad strike or independent truckers' refusal to transport goods because of rate disputes and so on. In these circumstances, markets cannot be served, and products back up in the logistics pipeline to deteriorate or become obsolete.

- Inventories are essential to logistics management because it is usually not possible or practical to provide instant production or sure delivery times to customers. They serve as buffers between supply and demand so that needed product availability may be maintained for customers while providing flexibility for production and logistics to seek more efficient methods for manufacturing and distributing the products.
- Order processing is the final key activity. Its costs usually are minor compared to transportation or inventory maintenance costs. Nevertheless, order processing is an important element in the total time that it takes for a customer to receive goods or services. It also is the activity that triggers product movement and service delivery.

Support activities, although they may be as critical as the key activities in any particular circumstance, are considered here as contributing to the logistics mission. In addition, one or more of the support activities may not be a part of the logistics activity mix for firms.

- Warehousing and materials handling-products such as finished automobiles or commodities such as coal, iron, or gravel that do not need the weather and security protection of warehousing will not require the warehousing activity, even though inventories are maintained. However, warehousing and materials handling are typically conducted wherever products are temporarily halted in their movement to the marketplace.
- Protective packaging is a support activity of transportation and inventory, as well as of warehousing and materials handling because it contributes to the efficiency with which these other activities are carried out.
- Purchasing and product scheduling often may be considered more a concern of production than of logistics. However, they also affect

the overall logistics effort and specifically the efficiency of transportation and inventory management.

- Information maintenance supports all other logistics activities in that it provides the needed information for planning and control.

The key objective of supply chain management is to provide customer satisfaction by having the correct product in the correct place at the correct time. As competition worldwide is increasing, creating customer satisfaction is important to most companies. The concept of customer satisfaction has multiple dimensions that contribute to a feeling of overall satisfaction:

- Cost-what customers receive for what they paid
- Convenience-the effort expended to achieve the purchase
- Confidence-trust in the support services both included and promised

In the age of global markets, supplies, demands and competition, the ability to satisfy and retain customer loyalty is no longer a simple marketing proposition. The back office personnel and operations are equally vital. Firms currently strive to increase competitiveness by providing customization, value for money, quality and service. Customization of the service component may for instance include speed to market or responsiveness to customer enquiries. Consider Amazon.com, which provides books selected from the Internet store and delivered to customer's door within an appointed time period. The marketing proposition is simple and based on convenience. The same product could be purchased from a bookshop. If the back-office operation of Amazon either takes six weeks to deliver the book once ordered, or fails to meet a promised delivery date, then there is high probability that the customer would be dissatisfied. The same applies to FedEx with its delivery next day before 10AM promise. Speed is becoming an important aspect of service provision. McDonald's controls its supplies along the entire length of its supply chain from meat purchasing and paper cups to all franchise outlets worldwide. For major companies operating in global markets, the stakes are high. Managing the global supply chain offers the capability to create and to reach the markets before competitors, and achieve competitive advantage by providing increased customer satisfaction through delivering the right product at the right time at greater value for money as a result of reduced overall cost. The purpose of operations is to support business strategy while the purpose of supply chain management is to support the operations strategy.

1.4 Barriers to Effective Supply Chain Management

1.4.1 Barriers to Effective Supply Chain Management

There are several impediments (barriers) to collaboration within the supply chain: widespread human resistance to change, required time horizon and scale of investment, lack of trust, poor communication. Understanding these barriers and developing the collaborative mindset needed to overcome them are the first steps toward achieving truly integrated supply chain management.

a) Lack of Trust

For the better part of the last century, most firms have maintained an arm's length relationship with their suppliers and customers. In addition, many firms are found to engage in various questionable business practices in their relationships with trading partners both locally and globally. Where these negative behaviors occurred, there were significantly lower levels of trust and commitment. Given this legacy, it's not surprising that initiatives to establish collaborative relationships across the supply chain will be met with skepticism and distrust.

b) Little Understanding or Commitment to SCM Principles

Most managers are somewhat comfortable dealing with relationships in their own function. But they become less comfortable when the relationship involves other functions in the company. And they're least comfortable when it comes to dealing with external organizations in their supply chain. The inter-organizational comfort increases as managers begin to understand the importance of integrated activity and commit to working for the betterment of the whole supply chain as opposed to just their particular part. Firms will never achieve true collaborative behavior if they cannot overcome their fear of losing autonomy and of sharing sensitive information. This barrier to the adoption of supply chain management initiatives is especially troubling because for managers time is particularly a precious commodity. Faced with what they perceive as to be a time-consuming effort, few managers will make the effort to understand the new collaborative approach, its benefits, and its implementation requirements.

c) Fear of Relinquishing Control

Most managers want to be evaluated on actions that are completely under their control. Understandably, no one wants to be held accountable for results that are partially the responsibility of others, be they inside or outside the organization. Because many supply chain initiatives demand joint efforts

and close cooperation, it is easy for supply chain managers to feel at the mercy of another company or individual as they work to achieve a certain level of supply chain performance, for example, taking an initiative to reduce total cycle time for processing an order. This activity is not completely controlled by anyone inside or outside the company. For many, this is a major barrier to embracing the collaborative approach.

d) Different Goals and Objectives

The goals of the various partners may differ significantly, simply because they face different market and competitive situations, different strategic and financial circumstances, different environments as defined by company size, structure of ownership, culture and identity. If the overall supply chain goals are not universally accepted, the likelihood of agreeing on joint supply chain initiative is slim.

e) Inadequate Information Systems

Most firms do not possess their own information systems to gather all of the information required to integrate the processes and systems of all the supply chain participants. In fact, many companies still struggle with using and comprehending all the traditional data they gather on their own performance. Imposing an entirely new set of information requirements that spans all the corners of the company may be beyond the capacity of the existing systems. Efforts to build consensus around a set of information and performance measures must be consistently supported by the highest levels of management for any measure of supply chain collaboration to succeed. Firms also must invest significantly in information systems to support the new supply chain information requirements.

f) Short-Term Focus on Outcomes

The fact that top managers in major public corporations must pay so much attention to their stock value, and as a consequence to short-term performance, is a huge barrier to successful supply chain initiatives. The reason is that the effort associated with these initiatives typically requires considerable time and involves significant investment in resources. If top management is constantly besieged by market watch and stockholders, it may have scant opportunity to invest the time and effort necessary for true supply chain integration. It is easy for trade press to tout the benefits of integrated supply chains and collaborative behavior. However, a management under siege may not have the luxury of waiting for the benefits of integrated behavior to occur.

g) Involvement in Too Many Supply Chains

Involvement in multiple supply chains, both horizontally and vertically, poses another major hurdle to supply chain management. The problem revolves around competition and competitive actions. Many manufacturing companies sell their products to multiple retail customers that compete directly with each other. The retailers, for their part, sell products from multiple manufacturers in direct competition with each other. Firms need to be able to figure out how to keep their initiatives in each supply chain unique and mutually beneficial without giving away competitive information to participants in their other supply chains. This is a daunting task. In fact, it may mean that the only way to implement supply chain management successfully is to work with just a few but important supply chains and, in the remaining situations, simply conduct transactions in an arm's length manner. This may explain why most success stories only involve two large trading partners. Typically, these relationships do not extend beyond first tier, either upstream or downstream.

1.4.2 Overcoming the Barriers

Identifying the major barriers to supply chain management success is only the first step. Because supply chain management represents a significantly different business model and style of management, firms need to drastically change their philosophies and strategies to make it happen. The actions described below will help organizations make the necessary changes and overcome the barriers to supply chain management.

a) Develop a New Breed of Manager

Because of the quite long history of arm's length relationships, the new collaboration required by supply chain management will not be embraced quickly or easily. And if it is not fully supported by top management, it won't be embraced at all. Company leaders must visibly support the brand new approach and drive a collaborative culture down through the organization to all levels of operating management. If organizations are going to ask their people to share information with other companies, make sacrifices for the sake of the supply chain, develop stronger relationships, and change their current logistics practices, top management must lead the way in doing so. Through their words and actions, the leaders need to demonstrate that supply chain management is a worthy goal whose implementation will improve company performance in the long run.

b) Build Relationship-Management Skills

Relationship management is one critical skill required of the new breed of manager whether it is customer relationship management or supplier relationship management. A strong relationship with all trading partners is a core requirement of successful supply chain management program. Such relationships may significantly increase the likelihood that supply chain management initiatives will be fully and successfully implemented. The best way to develop a relationship management skill and capability is through intensive training and education. Top management needs to recognize the importance of forging strong relationships with trading partners and demonstrate that commitment by supporting these training efforts.

c) Establish Inter-Organizational Teams

Using inter-organization teams to develop and implement supply chain initiatives is an effective way to overcome many of the supply chain management barriers. Top-level executives should set the example first by participating on collaborative teams with their counterparts from partnering organizations. Inter-organizational units can work together on joint training programs to foster an understanding of the integrated supply chain management concept and to show how each functional area fits within the larger supply chain scheme. Training should also demonstrate how collaboration produces optimal results for all. The most effective approach to overcoming the barrier of conflicting goals and objectives, for example, is to involve supply chain members in a process of open dialogue for setting joint goals and resolving any conflicts that may arise. Consensus building is mandatory. If supply chain members cannot agree upon common objectives and performance levels, there is little hope that the supply chain will deliver any kind of competitive advantage. Forming joint teams of individuals from different disciplines, partners and management levels will facilitate the sharing of ideas regarding conflicting goals. At the end of the day, it may be necessary for top management of all the partnering companies to sit down and iron out differences in philosophy, culture, approach and orientation to achieve the desired performance levels.

d) Create New Performance Measures

Evaluation and performance measures must be carefully aligned to the overall supply chain goals and linked directly to the reward system. If this doesn't happen, individuals likely will start working at cross-purposes to the supply chain objectives. These measures can be part of a gain-sharing bonus scheme in which employee bonuses are tied to improvements realized across

the supply chain. As a means of controlling the measures, top management needs to reassure line managers that supply chain performance is a joint effort and only through this joint activity optimal results can be achieved. The challenge is to craft individual reward and recognition processes that are closely linked to supply chain performance measures. This can be quite difficult to achieve because it often requires people to sub-optimize their functional performance in order to benefit the entire supply chain. To illustrate, an individual charged with planning transportation loads to the retail customers would normally seek to build full truckloads to reduce the overall transportation costs. However, in the context of the overall supply chain, it may be more effective to ship smaller loads more frequently to minimize expensive retail inventories and maximize product availability. That changes the transportation load planner's evaluation and reward system. This individual's performance now must be measured on the criteria that go beyond simply achieving the lowest transportation costs.

e) Invest in Information Technology

Supply chain management is the management of a system that incorporates multiple companies performing a wide variety of business functions. Coordination and cooperation among these entities is crucial, which makes communication and information exchange a vital component of successful supply chain strategy. The ability to exchange more information at an increased speed brings a host of benefits to the supply chain, significantly reduces order cycle times being one of them. Companies can realize faster information exchange by investing in the state-of-the-art ICT [1] now available. To address the technology challenge, it's essential to have a champion in the IT department. This should be someone who understands the relevance of supply chain information requirements and who can work effectively with functional managers to develop and incorporate the cross-organizational informational requirements. To assure system compatibility across the partnering organizations, it's advisable to bring together several IT managers from the different supply chain member companies to develop common data formats and performance measures. It is encouraging to note the emergence of Enterprise Resource Planning (ERP) systems and Web based information solutions that can make supply chain information sharing a reality. Studies by Forrester estimated that almost largest companies were sharing demand, inventory, and order-status information with their trading partners. With the increasing ability to share these types of information,

[1] Information and Communication Technologies

companies will be able to create systems for tracking and sharing performance metrics that relate to overall supply chain outcomes.

f) Develop a Long-Term Focus

Today's businesses are managed largely with a short-term perspective. Yet supply chain management requires short-term sacrifices so that the entire supply chain can benefit in the long run. As is the case with individual managers, most companies continue to be evaluated from a short-term, quantitative perspective. For supply chain management to succeed, however, organizations must foster such an environment where the long-term implications of supply chain initiatives are considered and rewarded. The only way to correct the short-term focus of most corporations may be a public relations campaign directed at different stakeholders to explain supply chain management's benefits and the necessity of investing now for the future. A growing body of evidence suggests that those companies with world-class supply chains significantly outperform the rest of the pack. This may be the best message to be communicated to stockholders that building the collaborative supply chain relationships is necessary for the success and future market value increment.

g) Engage in More Practical and Applied Research

This last suggestion, however, applies equally to the academic community. Theory development is important for any discipline or business function, the management science in particular. But theory development is an iterative process that requires researchers to test propositions and adjust theory based on repeated empirical research. While academic researchers recently have conducted more practical studies of supply chain management implementations, much more still are needed. Managers need evidence demonstrating how supply chain initiatives can improve organization-wide performance. This evidence can be used to support efforts to train managers, to overcome their resistance, and to obtain the necessary resources. Solid evidence of supply chain management's value can also help buy more time from investors and stockholders, gain their trust and acceptation. In addition to the applied research, the academic community plays a positive role in the advancement of supply chain management. Their main challenge here is to bridge the gap between supply chain management in theory and in practice through research that makes a solid connection between the supply chain performance and business success cases. That link will help business practitioners get the support to implement their supply chain initiatives.

1.5 Model and Future of Supply Chain Management

1.5.1 Model of Supply Chain Management

The general concept of an integrated supply chain is typically illustrated by a line diagram that links participating firms into a coordinated competitive unit (see Figure 3). Within the model, one can see that the supply chain comprises supplier network (external suppliers), internal customers and partners (procurement, warehousing, manufacturing, transporting), the distribution network (distributors, wholesalers, retailers) and end-users. These intermediaries play different role depending on their location within the supply chain, whether they be in the upstream or downstream of the supply chain. Often, in almost all developing countries, intermediaries add costs rather than value to the supply chain making price offered to final consumers soaring and products less competitive. Conversely, in almost all developed countries organized retailers work very closely with the manufacturers thereby eliminate supply chain intermediaries delivering more added values to final consumers.

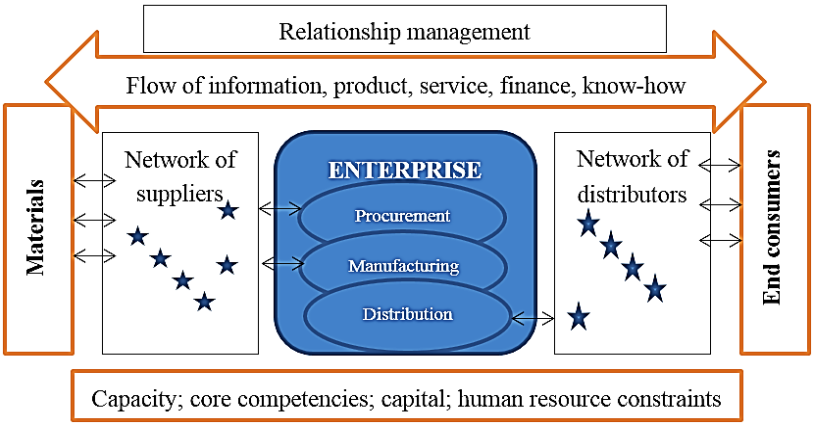

Fig 3: Intermediaries in Supply Chain Model

Source: Own development

In the farming business food products have to physically move between multiple agents, before they reach the food processor or retailer. Handling of products at multiple levels by multiple entities not only results in higher levels of wastage but also adds to the cost of the products. Cost escalations of from 40%-60% is not uncommon in the food chain because of non-value added costs.

In the case of steel industry, the supply chain is functional integration of a number of value added services provided by many intermediaries, starting

from the steel producer to the finished product. These intermediaries are involved in the processing of large quantities of a wide range of steel products. An example is a service center which buys or contracts the material from steel brokers. It processes steel products to different dimensions and modify the chemical composition in accordance with varied customer requirements. Service centers have slitters, levelers, saws, shears, burning units, plasma tables, grinders, cut-to-length lines-all the specialized equipment needed for efficient pre-production processing. There are also intermediaries who are providing precision processing to close tolerances, quality monitoring and inspection, and statistical quality control.

In the pharmaceutical industry, the intermediaries include industry suppliers of fine and specialty chemicals, laboratory equipment, R&D research, pharmacy stores, retail chains, supermarkets, mail order companies, hospitals, clinics, homes for elderly.

As long as humans have traded goods, supply chains have existed. The real issue is whether companies will choose to manage their supply chain, or abdicate this responsibility to other entities. For thousands of years, businesses have depended on Adam Smith's invisible hand to optimize supply chain's performance. Regardless of the kind of business, each element of the supply chain tried to optimize its individual gain by negotiating with direct suppliers to keep costs down, and with individual customers to maximize the income. Today, we have countless and countless examples of how managing the multiple links of a supply chain can improve performance by significant amounts. The principles of the new supply chain management model are threefold:

- The only entity that puts money into a supply chain is the end customer. Until the end customer decides to buy a product, the rest of us are shuffling his money back and forth among supply chain members.
- The only solution that is stable over the long term is one in which every element of the supply chain, from raw material to end customer, profits from the business. It is shortsighted for businesses to believe they can solve their cost problems by punishing suppliers and customers. Shifting costs problems among partners being in the supply chain without solving root causes is inherently unstable and unsuccessful over the long term. The best supply chain will solve problems, implement the best solutions, and share the benefits among their members.

- Supply chain management is about economic value added. Supply chain management is not just about cost. It's about the total content of a final product or service, including quality, technology, delivery, and after-sales service. If we cannot manage the total content, we will be unable to meet the needs of our customers.

To achieve these goals, supply chain management strategy should be an inherent part of any corporate strategy; just as product strategy, marketing strategy, and financial strategy. The context of an integrated supply chain management is the multi-firm relationship management within a framework characterized by capacity and core competencies limitations; information, capital, and human resource constraints. Within this context, supply chain structure and strategy results from efforts to operationally link an enterprise with customers as well as the supporting distributive and supplier networks to achieve competitive advantage. Business operations are therefore integrated from initial material purchase to delivery of final products and services to the end customers. Value results from the synergy among firms comprising the supply chain with respect to the five critical flows (see the top of Figure 2): Information, Product, Service, Finance, Know-how.

Logistics is the primary conduit of product and service flow within a supply chain arrangement. Each firm engaged in a supply chain is involved in performing logistics. Such logistical activity may or may not be integrated within that firm and within overall supply chain performance. Achievement of logistical integration is the main focus and desire for organizations to achieve competitive advantage in the market place in which the organization is competing.

The generalized supply chain arrangement logically and logistically links a firm and its distributive and supplier networks to end customers. The message conveyed is that the integrated value-creation process must be managed firstly from material procurement to finally end-customer product and/or service delivery. The integrated supply chain perspective shifts traditional channel arrangements from loosely linked groups of independent businesses that buy and sell inventory to each other toward a managerially coordinated initiative to increase the market impact, overall efficiency, continuous improvement, and competitiveness. In practice, the multilateral collaboration between firms is more complex than simple supply chain showed as line diagram in Figure 3. For example, many individual firms may simultaneously participate in multiple and competitive supply chains. To the degree that a supply chain becomes the basic unit of competition, firms participating in multiple arrangements may confront loyalty issues related to potentially conflict of interest.

Another factor that serves to add complexity to understanding supply chain structure is the high degree of mobility and change observable in typical arrangements. It's interesting to observe the fluidity of supply chains as firms enter and exit without any apparent loss of essential connectivity. For example, a firm and service supplier may be actively engaged in a supply chain structure during selected times, such as a peak selling season, and not during the balance of a year.

1.5.2 SCOR Model

Managers responsible for supply chain process improvement planning, implementation and measurement received a much needed guidance in November 1996 when the then Supply Chain Council (SCC) introduced its Supply Chain Operations Reference model (SCOR). Member companies, including such diverse industry leaders as Dow Chemical, Merck, Texas Instruments, Compaq, and Federal Express, worked together for over six months to develop the model. Specifically, they defined common supply chain management processes, matched these processes against best practice examples, and benchmarked performance data as well as optimal software applications. The result was a tool for:

- Measuring both supply chain performance and effectiveness of supply chain reengineering.
- Testing and planning for future process improvements.

This model was tested both in a mock supply chain situation and internally at Rockwell Semiconductor Systems with highly positive results. At the core of the SCOR model is a four-level pyramid that guides supply chain members on the road to integrative process improvement:

- **Level 1:** Consists of a broad definition of the *05 key supply chain process types* (plan, source, make, and deliver, return) and is the point at which supply chain competitive objectives are established.
- **Level 2:** Defines the *26 core supply chain process categories* established by the Supply Chain Council with which supply chain partners can jointly present their ideal or actual operational structure.
- **Level 3:** Provides partners with useful *information in planning and setting goals* for supply chain process improvement.
- **Level 4:** Focuses on the efforts to *implement supply chain process improvement.*

In the figure 4 below all 4 levels of SCOR model are presented. More about SCOR model will be discussed later on, in the chapter V concerning measurement and control of supply chain management performance.

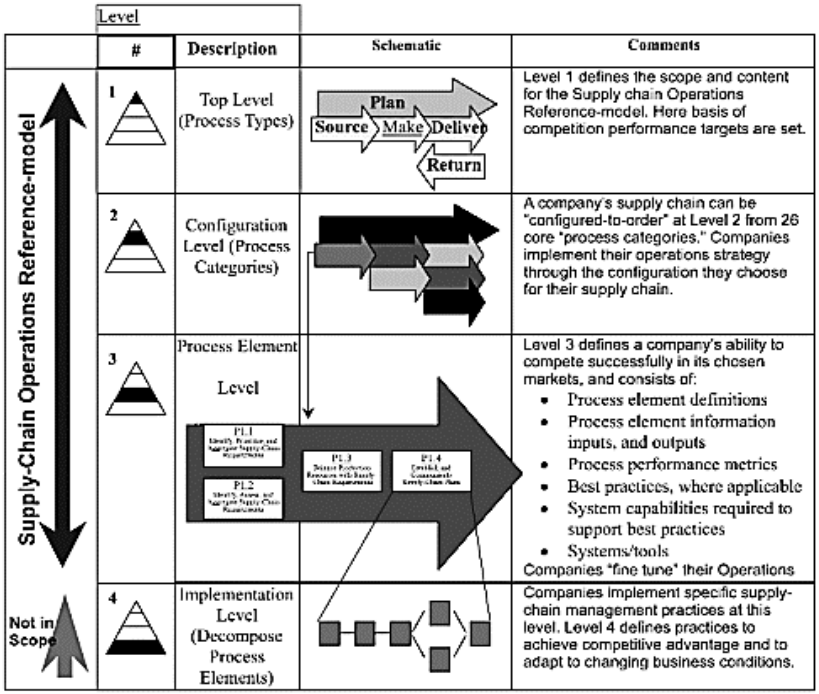

Fig 4: Levels of SCOR Model

Source: Supply chain operation reference model version 4.0, SCPR version 4.0, Supply Chain Council (august 2000).

The major benefit of SCOR is that it gives inter-organizational supply chain partners a basis for integration by providing them, often for the first time, with something tangible to talk about and to work with. The framework helped to break down functional structure and allowed people to look at real issues and practices holding back supply chain management improvements. In the past two decades, academics have labored to properly define supply chain management, explain how it differs from traditional logistics management and encourage practitioners to implement supply chain practices to improve customer service, lower logistics costs, and build sustainable competitive advantage. Despite all the attention being paid to supply chain management and the various initiatives pursued, few examples exist of truly seamless, integrated supply chain management. In truth, supply chain management remains more of a pipe dream than a reality.

Practitioners, in their attempts to realize the stated benefits of supply chain management, have launched a number of initiatives including:

- Efficient Consumer Response (ECR).
- Vendor-Managed Inventory (VMI).
- Collaborative Planning, Forecasting, and Replenishment (CPFR).

Not all of the mentioned supply chain management initiatives gain benefits to organizations. In fact, many organizations still carry large inventory of goods trapped in the supply chain due to intense competition. From corporate-wide and organization-wide perspective, there are a wide variety of different supply chain strategies targeting at achieving concrete results:

- **Market Saturation Driven:** Focusing on generating high profit margins through strong brands and ubiquitous marketing and distribution.
- **Operationally Agile:** Configuring assets and operations to react nimbly to emerging consumer trends along lines of product category or geographic region.
- **Freshness Oriented:** Concentrating on earning a premium by providing the consumer with product that is fresher than competitive offerings.
- **Consumer Customization:** Using mass customization to maintain close relationships with end consumers through direct sales.
- **Logistics Optimizer:** Emphasizing a balance of supply chain efficiency and effectiveness.
- **Trade Focused:** Prioritizing low price and best value for the consumer, focusing more on dedicated service to trade customers.

It is important to understand the key characteristics that distinguish supply chain management from traditionally understood logistics management. Supply chain management is an initiative that focuses on managing the entire process as products are transformed from raw materials into finished goods delivered to the ultimate customer. Supply chain management is primarily concerned with three flows: Product/service; Information; Money.

The scope of supply chain is extremely broad, involving multiple firms performing business functions. These business functions include not only logistics, transportation, and warehousing, but also sourcing and

procurement, manufacturing, materials handling, forecasting, order processing, inventory management and customer service. Supply chain management requires the integration of departments /functional areas within organizations such as marketing and sales, production, finance, accounting, human resource, purchasing, and logistics. More importantly, it requires integration and coordination among trading partners, through at least information sharing. The need for coordination and information sharing underscores the importance of strong relationships among supply chain partners. The broad goal of supply chain management is to implement a seamless flow of products from cradle to grave with the fewest resources and the highest customer service possible. By working together, firms in a supply chain should be able to decrease costs of transportation, ordering, inventory, storage and handling across the entire supply chain while improving the quality of service for each customer. The four major goals of supply chain management are:

1) Waste reduction
2) Time compression
3) Flexible response
4) Unit cost reduction

Achievement of these goals should lead to increased customer satisfaction, customer retention, and revenue growth. Without effective collaboration, the flow of material and information will be disrupted or inhibited. For this reason, it is helpful to have a systematic approach to defining and conducting collaboration.

1.5.3 The Future of Supply Chains

1.5.3.1 Collaborative Chains

Replenishment programs are designed to streamline the flow of goods within the distribution channel. There are several specific techniques for collaborative replenishment, all of which are building on the common denominator of rapidly replenishing inventory according to actual sales experience. The intent is to reduce reliance on forecasting when and where inventory will need to be positioned to meet consumer or end-user demand and instead allow suppliers to respond to demand on a just-in-time (JIT) basis. Effective collaborative replenishment programs require extensive cooperation and information sharing among different distribution channel participants. Specific techniques for automatic replenishment to be presented in detail below include: quick response; continuous replenishment; vendor managed inventory; and profile replenishment.

Quick Response

Quick Response (QR) is a cooperative effort between retailers and suppliers to improve inventory velocity while providing merchandise supply closely matched to consumer buying patterns. QR is implemented by monitoring retail sales for specific products and sharing information across the supply chain to guarantee that the right product assortment will be available when and where it is required. For example, instead of operating on 15- to 30-day order cycles, a QR arrangement can replenish retail inventories in 6 or fewer days. Continuous information exchange regarding availability and delivery reduces uncertainty for the total supply chain and creates opportunity to maximize flexibility. With fast, dependable order response, inventory can be committed as required, resulting in increased turnover and improved availability.

Continuous Replenishment and Vendor Managed Inventory

Continuous Replenishment (CR) and vendor managed inventory (VMI) are modifications of QR that eliminate the need for replenishment orders. The goal is to establish a supply chain arrangement so flexible and efficient that retail inventory is continuously replenished. The distinguishing factor between CR and VMI is who takes responsibility for setting target inventory levels and making restocking decisions. In CR, the retailer makes the decisions. In VMI, the supplier assumes more responsibility and actually manages inventory for the retailer. By receiving daily transmission of retail sales or warehouse shipments, the supplier assumes responsibility for replenishing retail inventory in the required quantities, colors, sizes, and styles. The supplier commits to keeping the retailer in stock and to maintaining inventory velocity. In some situations, replenishment involves cross-docking or Direct Store Delivery (DSD) designed to eliminate the need for warehousing between the factory and retail store.

1.5.3.2 Functional to Process Integration

One of the oldest and potentially most productive trends is the continued migration from functional to process integration. The work of logistics itself hasn't changed relatively over the past decade and will continue to remain the same during the next one. But what has and will continue to change rapidly is how we view it (the work of logistics). As power and control are developing within organizations, the traditional notion of functional department has been obsolete over time as indispensable part of an organization. While departments still remain the preferred method of managing organization and its work, the reality is that process-oriented, self-

directed work teams are increasingly the solution for significant breakthroughs in efficiency. Managers realize that functional excellence is only important in terms of the contribution by functions made to processes served. Information Technology developments such as ERP are starting to support more sophisticated approaches, lessening the difficulty of measuring across functions. While there has been substantial progress to retain functional and inter-functional approach, major opportunities to shift to the process focus approach remain. First, while purchasing, production, logistics, and marketing functions have each been integrated within their individual processes, there has been less progress in integration between these areas. But further integration across a firm's major functional boundaries is the first step toward additional process integration. Second, there must be substantial advancement of process integration with external supply chain partners, particularly with service providers. This requires more consistency in the definition, execution, and measurement of supply chain processes to establish common language and expectations. Third, most employees will do what they are measured on and what they are paid to do. The challenge is to convert metric and reward structures from department related budgets to coordinated process-related incentives. There has been substantial progress in this area, but more opportunities remain as additional cost information and accuracy will lead to more refined processes with reduced redundancy and duplication.

1.5.3.3 Vertical to Virtual Integration

Historically, firms have tried to reduce supply chain conflict by owning consecutive levels in the business process. Henry Ford's original business strategy is a legendary attempt at using ownership to achieve vertical supply chain integration. Ford's dream was a full ownership and management of the entire value-creation process in order to reduce waste and increase relevancy. Ford's rubber plantations, ships, and foundries converted raw iron ore to a finished car in just 07 days. The problem with vertical integration is that it requires tremendous capital investment and an incredibly complex organization structure. Re-creating Henry Ford's vertical supply chain is infeasible in today business as since that time the scale and size of business have grown immensely. Firms, therefore, must harness the expertise and synergy of external supply chain partners to achieve success. Virtually integrating operations with material and service suppliers to form a seamless flow of internal and external work should overcome financial barriers of vertical ownership while retaining many of the benefits. While many manufacturing and retail firms have traditionally worked with third-party

logistics providers to handle physical movements of products, there is a growing trend to outsource knowledge processes as well. Staff and process design activities are being outsourced to consultants. Information design, collection, maintenance, and analysis are also subjects of outsourcing to information integrators. Knowledge specialization will increasingly become an activity considered for outsourcing by the virtual enterprise. The benefits of outsourcing such as focusing core competency on core business requirements will continue to drive firms from vertical to virtual integration. While most firms have taken initial steps toward virtually integrating their supply chains, relatively few firms have achieved full-scale implementation. To move to virtual integration, three shifts must occur:

- First, managers who interface with material and service suppliers must learn how to manage assets and activities that they do not directly control and cannot directly see but whose performance they can and must monitor to ensure success. These suppliers represent a firm's extended family and will contribute as much to the future success or failure of the supply chain as any internal department. A firm's management strategy must reflect the recognition that a supply chain is only as strong as its weakest supplier link (partner).
- Second, supply chain partners must have a common vision of the total value creation process as well as shared responsibility for achieving it. Firms must carefully identify and select partners with complementary visions, strategies, and operational capabilities. Partners must carry out their operations in ways that reduce duplication, redundancy, and dwell time while maintaining synchronization. Additionally, firms must spread the risks and rewards of collaboration to solidify goal attainment. Evolving the structures to facilitate virtual integration is neither easy nor quick.
- Finally, firms must extend management practices beyond suppliers to include suppliers' suppliers. Suppliers' views on resource needs and constraints, threats, opportunities, and weaknesses must be considered when setting goals, objectives, and action plans as they play increasingly vital and irreplaceable roles in creating end-customer value.

1.5.3.4 Customizing and Postponement

The concept of modularization was introduced in 1966 (Starr 1966) which eventually led to customization. It implies product design whereby the product is assembled from a set of standardized constituent units. Different

assembly combinations from a given set of standardized units give rise to different end products and variations. In essence, modular design marries flexibility with standardization. It provides opportunities for exploiting economies of scales from a product design perspective. Perfect examples are Dell computers which are highly customizable.

The idea of postponement was introduced by Alderson (1950). It was defined as differentiating the product at a later date until the customer order was received. The concept was eventually expanded by Bucklin (1965) and Zinn & Bowersox (1988). By this time, the postponement concept had developed into form, time and place postponement.

In the 1990s, the idea of merging mass customization with postponement became a reality. In this model, more entities within the supply chain were involved unlike the earlier postponement model whereby only the manufacturer was involved (Hoek *et al*. 1998). Suppliers, transporters, manufacturers, wholesalers, distribution centers and resellers collaborate to ensure the timely delivery of products to end users. Zinn & Bowersox (1988) has developed 5 types of postponement: Labeling; Packaging; Assembling; Manufacturing; Time.

- **Labeling:** For companies which sell canned products to other companies, cans are labeled. One reason is the uncertainty in allocating the proportion of the materials for each label at the point of canning. There is no difference in the quality of the product under the labels. These companies postpone their labeling operation when they receive orders and just before the goods are distributed.
- **Packaging:** An example is the use of different packaging from a bulk of materials. Such materials include detergent or consumer goods such as baby diapers. In some countries, those products are sold in smaller packs due to weak purchasing power.
- **Assembling:** When companies have many product variants, assembling postponement is an ideal way of achieving it. Customization should not delay delivery if modularization is used. Many electronic products such as laptops, tablets or mobile phones fall into this category.
- **Manufacturing:** Products are manufactured until customer orders are received. Examples are easily made products or service, especially in food and beverage industry to preserve freshness and keep the expiry date as long as possible.
- **Time:** Finished products are shipped to a central distribution center, closer than the manufacturing plant. The aim is to respond quickly

to customers' requirements. With the emergence of e-commerce, virtual inventory are independent of the physical location of the inventories at the time the orders are placed. Amazon.com works with vendors to keep the books at the warehouses which are often located in cities and near to airport. Working with parcel delivers and vendors, books are shipped to end users.

1.5.4 Challenges of Supply Chains

Given the extreme changes that have occurred in supply chain management concepts and practices during the past several decades, an appropriate question is-What can we expect to happen during the next decade? The primary determinant of the shape and form of future supply chain requirements will be the nature of demand that needs to be serviced. The globalization of business promises to offer new and unique challenges for the logistical competencies of most firms. Few will be able to escape the impact of a global economy. Challenges will also increase in the environmental aspects of logistics, often referred to as green issues. The full ramification of long-term responsibility for the environmental impact of all products and services is just emerging. Finally, firms can fully expect that customers making major business commitments to supply chain partners will expect nearly perfect logistical performance. Even in today's business environment, firms that build strong customer and supplier relationships must be committed to operational excellence. Logistical systems of the future will face complex and challenging performance requirements. Even more so than today, logistics will be required to support multiple-product distribution to globally dispersed fast growing population in heterogeneous markets. People in general will increasingly have resources to participate in economic growth. However, significant differences are expected in lifestyle and related social priorities. Evidence suggests that consumers of the future will demand services and conveniences contained in the products they purchase. For instance, such items as frozen meat and vegetables might well be precooked and ready for consumption when bought. To the extent that this service/convenience pattern accelerates, more value will be added to the typical product before it begins the logistical process. In favor and to support this trend, the complexity of the total manufacturing/ marketing system will increase.

The priority placed on development of integrated management skills rests on the contribution that superior logistics performance can make to business success. A firm can achieve sustainable competitive advantage when its important customers perceive that it has the capabilities to

logistically outperform competitors. A prerequisite to logistical excellence is the development and implementation of supply chain integration. Managing logistics on an integrated basis is becoming increasingly relevant for the following reasons:

- First, there is considerable interdependence between areas of logistical requirements that can be exploited to the advantage of an enterprise. The idea of a total movement /storage system offers efficiency and synergistic potential. Throughout the logistical system, management is faced with ever increasing labor costs. Since logistical work is among the most labor-intensive performances within an enterprise, logistics managers must develop methods to substitute capital for labor-intensive processes. Complete integration increases the economic justification for substituting capital for labor.
- Second, a narrow or restricted functional approach in business may create dysfunctional behavior. Concepts relevant solely to market distribution, manufacturing support, or procurement can create diametrically opposite operational priorities and goals. The failure to develop the concept of integrated logistical management creates the potential danger for sub-optimization.
- Third, the control requirements for each individual aspect of operations are similar. The primary objective of logistical control is to reconcile operational demands in a cross-functional manner focused on overall goals.
- A fourth reason for the integration of logistical operations is an increasing awareness that significant trade-offs exist between manufacturing economies and marketing requirements and that these can be reconciled only by a soundly designed logistical capability. The traditional practice of manufacturing is to produce products in various sizes, colors, and quantities in anticipation of the future sale. The postponement of final assembly and initial distribution of products to a later time when customer preferences are more fully identified can greatly reduce risk and increase overall enterprise flexibility. Innovative production and marketing information systems are emerging in a bid to make use of logistical competency to increase the responsiveness and to reduce the traditional anticipatory commitment and risk of business.
- A final and most significant, reason for integration is that the complexity of future logistics will require innovative arrangements.

> The challenge for the new millennium is to develop new ways of satisfying logistical requirements, not simply using technology to perform the old ways more efficiently. While this is similar to the challenge faced in the 1990s, the stakes are getting higher. In the world of the future, leading firms can be expected to increasingly use integrated logistical competency to gain differential competitive advantage. The broad-based achievement of integrated logistical management will remain a prerequisite for such innovative breakthroughs.

The combined impact of these factors is that logistics will increasingly be managed on an integrated basis. However, the job of reengineering logistics as an integrated process is far from completed. Research continues to point out that a significant number of firms worldwide have only made limited progress toward logistical integration. Approximately 10% North American firms have achieved a level of integration that facilitates their use of logistical competency to gain and maintain customer loyalty. This percentage in other companies, especially in the developing world is even less optimistic.

Chapter - 2

Warehousing

Objectives

- Understand warehousing as a strategic competitive advantage.
- Establish the role of material handling equipment in warehousing.

2.1 Warehousing as Integrated Supply Chain Component

In the context of supply chain management, logistics exists to move and position inventory to achieve desired time, place, and possession benefits at the lowest total cost. Inventory has limited value until it is positioned at the right time and at the right location to support ownership transfer or value-added creation. If a firm does not consistently satisfy time and place requirements, it has nothing to sell and no value to offer. For a supply chain to realize the maximum strategic benefit of logistics, the full range of functional work must be integrated. Decisions in one functional area will impact the cost of all others. It is this interrelation of functions that challenges the successful implementation of integrated logistical management. The nature of the five following areas of logistical work is interrelated:

- Order processing
- Inventory
- Transportation
- Warehousing
- Facility network

As described below in the Figure 5, the work related to these functional areas combines to create the capabilities needed to achieve logistical value.

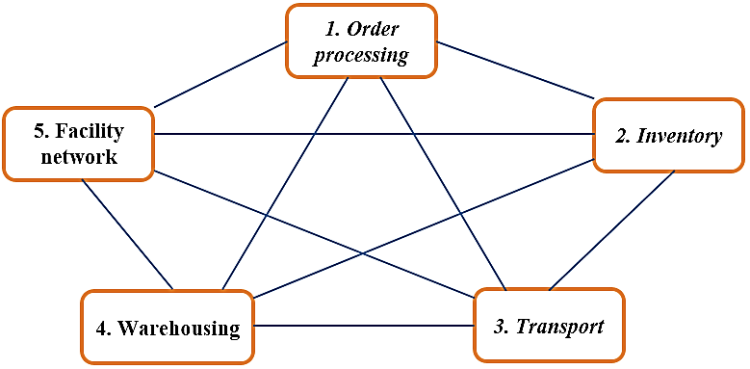

Fig 5: Warehousing and Other Logistical Functions

Source: Own development

The first three functional areas of logistics in the supply chain (order processing, inventory, and transportation) can be engineered into a variety of different operational arrangements. Each arrangement has the potential to contribute to a specified level of customer service with an associated total cost. In essence, these three functions are combined to create a system solution for integrated supply chain.

The fourth function of logistics (warehousing, materials handling, and packaging) also represents an integral part of a logistics operating solution. Warehousing, materials handling, and packaging are an integral part of other logistics areas. For example, inventory typically needs to be warehoused at selected times during the logistics process. Transportation vehicles require materials handling for efficient loading and unloading. Finally, the individual products are most efficiently handled when packaged together into shipping cartons or other unit loads. When distribution facilities are required in a supply chain system, a firm can choose between the services of a warehouse specialist or operating their own facility. The decision is broader than simply selecting a facility to store inventory since many value-adding activities may be performed during the time products are warehoused. Examples of such activities are sorting, sequencing, order selection, transportation consolidation, and, even in some cases, product modification and assembly.

Within the warehouse, materials handling and packaging are important activities. Products must be received, moved, stored, sorted, and assembled to meet customer order requirements. The direct labor and capital invested in materials handling equipment is a significant element of total supply chain/logistics cost. When performed in an inferior manner, materials

handling can result in substantial product damage. It stands to reason that the fewer times a product is handled, the less the potential exists for product damage and the overall efficiency of the warehouse is increased. A variety of mechanized and automated devices exist to assist materials handling. In essence, each warehouse and its materials handling capability represent a mini-system to support the overall logistical process. To facilitate handling efficiency, products in the form of cans, bottles, or boxes are typically combined into larger units. This larger unit, typically called the master carton**,** provides two important features. First, it serves to protect the product during the logistical process. Second, the master carton facilitates ease of handling, by creating one large package rather than a multitude of small, individual products. For efficient handling, master cartons are typically consolidated into larger unit loads. The most common units for master carton consolidation are pallets and various types of containers. When effectively integrated into enterprise's logistical operations, warehousing, materials handling, and packaging facilitate the speed and overall ease of product flow throughout the logistical system. In fact, several firms have engineered devices to move broad product assortments from manufacturing plants directly to retail stores without intermediate handling.

2.2 Warehouse Strategy and Functionality

Warehousing incorporates many different aspects of supply chain operations. Due to the interaction, warehousing does not fit the neat classification schemes used when discussing order management, inventory, or transportation. A warehouse is typically viewed as a place to hold or store inventory. However, in contemporary supply chain systems, warehouse functionality can be more properly viewed as inventory mixing. So herein we provide a foundation for understanding the value that warehousing contributes to the supply chain of organization. The discussion is relevant for all types of warehouses ranging from distribution centers, consolidation terminals, break-bulk [2] facilities, and cross-docks [3]. The objective is to introduce general managerial responsibilities related to warehousing. While effective logistics systems should not be designed to hold inventory for extended times, there are occasions when inventory storage is justified on the basis of cost and service.

2.2.1 Strategic Warehousing

Storage has always been an important aspect of economic development. In the pre-industrial era, storage was performed by individual households

[2] Moving small and loose quantity of goods
[3] Moving goods without warehousing

forced to function as self-sufficient economic units. Consumers performed warehousing and accepted the attendant risks. As transportation capability developed, it became possible to engage in specialization. Product storage shifted from households to retailers, wholesalers, and manufacturers. Warehouses store inventory in the supply chain pipeline, serving to coordinate and balance product supply and consumer demand. Because the value of strategic storage was then not well understood, warehouses were often considered as “necessary evils” that added cost to the distribution process. The concept that middlemen simply increase cost follows from that belief. The need to deliver product assortments was limited. Labor productivity, materials handling efficiency, and inventory turnover were not the major concerns during this early era. Because labor was relatively inexpensive, human resources were used freely. Little consideration was given to efficiency in space utilization, working methods, or materials handling. Despite such shortcomings, these initial warehouses provided a necessary bridge between production and marketing.

Following World War II, managerial attentions were shifted toward strategic storage. Management began to question the need for vast warehouse networks. In the distributive industries such as wholesaling and retailing, it was traditionally considered best practice to dedicate a warehouse containing a full assortment of inventory to every sales territory. As the forecasting and production scheduling techniques improved, management questioned such risky inventory deployment. Production planning became more dependable as disruptions and time delays during manufacturing decreased. Seasonal production and consumption still required warehousing, but overall need for storage to support stable manufacturing and consumption patterns was reduced. As a result of manufacturing improvements, changing requirements in retailing do more than offset any reduction in warehousing. Retail stores faced with challenges of providing consumers an increasing assortment of products found it is more difficult to maintain adequate purchasing and transportation costs and quality when buying from suppliers. The cost of transporting small shipments made direct ordering prohibitive. This created an opportunity to establish strategically located warehouses to provide timely and profitable inventory replenishment for retailers. Progressive wholesalers and integrated retailers developed state-of-the-art warehouse systems to logistically support retail replenishment. Thus, the focus on warehousing shifted from passive storage to strategic assortment that leads to strategic supply chain management providing the organization with lots of competitive advantage. For manufacturers, strategic warehousing offered a way to reduce dwell time

of materials and parts. Warehousing became integral with the Just-in-Time (JIT) concept and stockless production strategies. While the basic point of JIT is to reduce work-in-process inventory, such manufacturing strategies need dependable logistics. Achieving such logistical support across the vast territory requires strategically located warehouses. Utilizing centralized parts inventory at a central warehouse reduces the need for inventory at each assembly plant. Products can be purchased and shipped to the strategically located central warehouse, taking advantage of the consolidated transportation. At the warehouse, products are sorted, sequenced, and shipped to specific manufacturing plants as needed. Where fully integrated, sortation and sequencing facilities become a vital extension of manufacturing.

On the outbound side of manufacturing, warehouses can be used to create product assortments for customer shipment. The capability to receive mixed product shipments offers customers two specific advantages. First, logistical cost is reduced because an assortment of products can be delivered while taking advantage of consolidated transportation. Second, inventory of slow-moving products can be reduced because of the capability to receive smaller quantities as part of a consolidated shipment. Manufacturers that provide assorted product shipments can achieve a competitive advantage. An important advantage in such warehousing is maximum flexibility. Such flexibility can often be achieved through information technology. Technology-based applications have influenced almost every area of warehouse operations and created new and better ways to perform storage and handling function. Flexibility is also an essential part of being able to respond to expanding customer demand in terms of product assortments and the way shipments are delivered. Information technology facilitates this flexibility by allowing warehouse operators to quickly react to changing customer requirements.

2.2.2 Warehouse Functionality

Benefits realized from strategic warehousing are classified on the basis of cost and service. No warehouse functionality should be included in a supply chain system unless it is fully justified on some combination of cost and service basis. Ideally, a warehouse will simultaneously provide economic and service benefits and an improved supply chain management.

2.2.2.1 Economic Benefits

Economic benefits of warehousing occur when overall logistics costs are reduced. For example, if adding a warehouse in a supply chain system

reduces overall transportation cost by an amount greater than required investment and operational cost, then total cost will be reduced. When total cost reductions are achievable, the warehouse is economically justified. Four basic economic benefits are: Consolidation and break-bulk; Assortment; Postponement; Stockpiling.

Consolidation and Break-Bulk

The economic benefits of consolidation and break-bulk are to reduce transportation cost by using warehouse capability to increase shipment economies of scale. In consolidation, the warehouse receives materials from a number of sources, which are combined into a large single shipment to a specific destination, such as a customer. The benefits are the realization of the lowest possible freight rate, timely and controlled delivery, and reduced congestion at a customer's receiving dock. The warehouse enables both the inbound movement from origin and the outbound movement to destination to be consolidated into a larger shipment, which generally incurs lower transportation charges and often quicker delivery. A break-bulk operator receives a single large shipment and arranges for delivery to multiple destinations. Economy of scale is achieved by transporting the larger consolidated shipment. The break-bulk warehouse or terminal sorts or splits out individual orders and arranges local delivery. Both consolidation and break-bulk arrangements use warehouse capacity to improve transportation efficiency. Many logistical arrangements involve both consolidation and break-bulk.

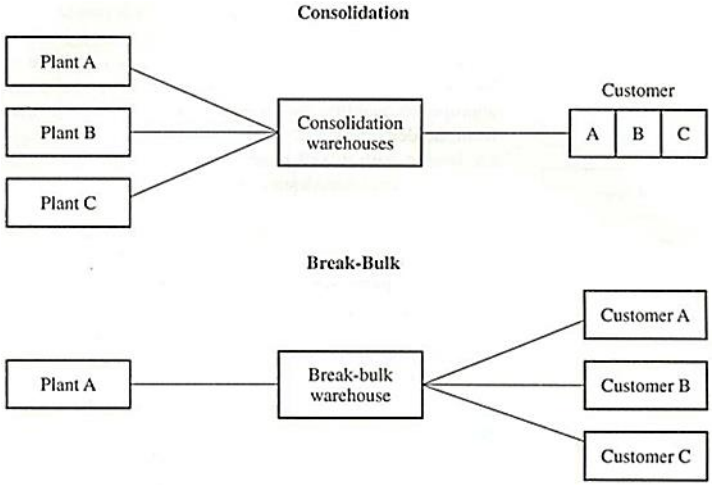

Fig 6: Consolidation and Break-Bulk

Source: Own development

Assortment

The basic benefit of assortment is to reconfigure freight as it flows from origin to destination. There are three types of assortments: Cross-docking, Mixing, and Assembly, which are widely used in logistical systems. Figure 7 illustrates these three assortment applications.

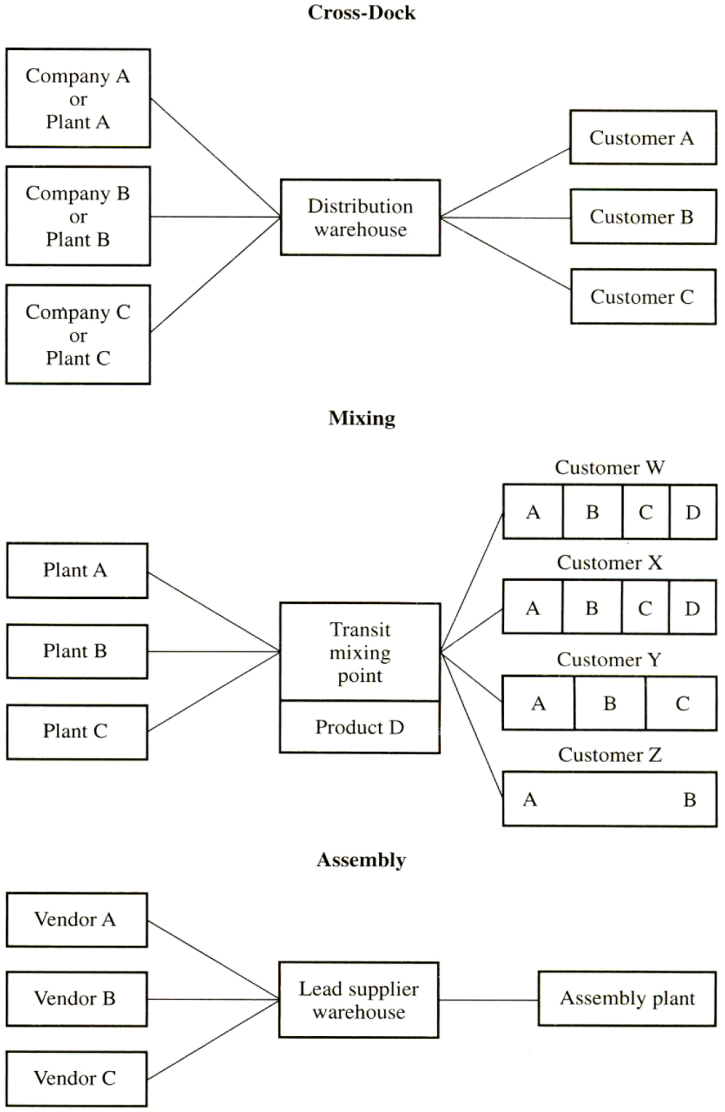

Fig 7: Assortment Applications

Source: *Own development*

The objective of cross-docking is to combine inventory from multiple origins into an assortment for a specific customer. Retailers make extensive use of cross-dock operations to replenish fast-moving store inventories. Precise and on-time performance from each manufacturer is required. As product is received and unloaded at the facility, it is sorted by store destination. In most instances, the retailer has communicated precise volume requirements of each product for each store. The manufacturers, in turn, may have sorted, loaded, and labeled the appropriate quantity for each store. Product is then literally moved across the dock from the delivery into a truck destined for the appropriate store location. Once trucks are loaded with mixed product from multiple manufacturers, they are released for transport to the retail destination.

Mixing achieves an end result similar to cross-docking. However, mixing is usually performed at an intermediate location between shipment origin and destination. In a typical mixing operation, carloads or truckloads of products are shipped from origin to mixing warehouses. The shipments are planned to minimize inbound transportation cost. Upon arrival at the mixing warehouse, shipments are unloaded and sorted into the combination desired by each customer. In-transit mixing has been traditionally supported by special transportation rates that provide incentives to facilitate the process. During the mixing process, inbound products can be combined with those regularly stored at the warehouse. Warehouses that perform in-transit mixing have the net effect of reducing overall product storage in a logistical system while achieving customer-specific assortments and minimizing transportation cost.

The objective of assembly is to support manufacturing operations. Products and components are assembled from a variety of second-tier suppliers by a warehouse located in close proximity to manufacturing plant. While manufacturing organizations have traditionally performed assembly, it is becoming common to utilize value-added services of lead or tier-one suppliers to sort, sequence, and deliver components when needed in manufacturing. Similar to cross-docking and mixing, assembly serves to achieve a process grouping of inventory at a precise time and location.

Postponement

Warehouses can also postpone commitment to final product configuration by completing final packaging, labeling, and light manufacturing. For example, fruits and vegetables can be processed and canned without labels at the processing plants. Holding inventory as cans

without labels means that product is not committed to specific customers or carton configuration during processing. Once a specific customer order is received, the warehouse can complete labeling and finalize packaging. Postponement provides two economic benefits:

- Risk is minimized because customized packaging is not performed in anticipation of customer orders or to accommodate a forecast.
- Total inventory can be reduced by using inventory of the base product to support multiple customers' labeling and package requirements.

The combination of reduced risk and lower inventory can result in reduced total costs to service even if packaging performed at the warehouse is more expensive per unit than if it were completed during manufacturing.

Stockpiling

The direct economic benefit of stockpiling is to accommodate untypical seasonal production or demand. For example, lawn furniture and toys are typically produced year-round but are sold only during a very short marketing period. In contrast, agricultural products are harvested at specific times, with subsequent consumption occurring throughout the year. Both situations require inventory stockpiling to support marketing efforts. Stockpiling provides an inventory buffer, which enhances production efficiencies within the constraints imposed by material sources and consumers' demand.

2.2.2.2 Service Benefits

Warehouse service can provide many benefits through enhanced revenue generation. When a warehouse is primarily justified on service, the supporting rationale is that sales can be increased, in part, by such logistical performance. It is typically difficult to quantify service return-on-investment because it is difficult to measure. For example, establishing a warehouse to service a specific market may increase cost but should also increase market sales, revenue, and potentially gross margin. Warehouses can provide service as a result of: Reverse Logistics, Spot Stocking (stocking on the spot), Full-line Stocking, Product Support (accompanying service), and Market Presence.

Reverse Logistics

Warehousing plays a key role in performing reverse logistics. Most of the physical works are related to product recall and reclamation. Even the disposal of overstock and damaged inventory is performed at warehouses.

Many firms are generating significant cash flow from refurbishment, recycling, and disposal of damaged and defective product. Reverse logistics is concerned with controlled and regular inventory:

- Controlled inventory consists of hazardous materials and product recalls that have potential impact on consumer's health or need environmental considerations. The reclamation of controlled inventory must be performed under strict operating scrutiny that prevents possible redistribution or improper disposal. Varied governmental agencies, such as Consumer Product Safety Commission (CPSC), Department of Transportation (DOT), Environmental Protection Agency (EPA), Food and Drug Administration (FDA) and Occupational Safety and Health Administration (OSHA) are directly involved in disposal of controlled inventory.
- Less attention has traditionally focused on reclamation of regular inventory. In 1997 the disposition of unsalable product was estimated to cost companies 4 billion USD. The food industry alone was estimated to have unsalable inventory approaching 2.6 billion USD and growing at a rate approaching 20% per year. The product involved in such reclamation is typically damaged or aged beyond the recommended expiry date. Some unsalable product results from warehouse damage, most is returned from retail or even from the end-customer (consumer).

While reclamation is difficult for regular inventory, it is far more challenging for controlled inventory. In both return situations, product flow lacks the orderly process characteristic of outbound movement. Reverse movement typically consists of non-uniform individual packages and cartons as contrasted to the outbound movement of cases, boxes and pallet loads. Packages are often broken, and product inside is not packaged correctly. Returned products typically require significant manual sortation and inspection to determine appropriate disposal. However, the opportunity to recover cost by reimbursement and recycling is significant.

Spot Stocking

Spot stocking is typically used to support market distribution. Manufacturers of highly seasonal products often spot stock. Rather than maintaining inventory in a warehouse year-round, or shipping to customers direct from manufacturing plants, responsiveness in peak sales periods can be enhanced through temporary inventory positioning in strategic markets.

Under this concept, select inventory is positioned or spot stocked in a local market warehouse in an anticipation of responding to customers' need during the critical sales period. Utilizing warehouse facilities for spot stocking allows inventories to be placed in a variety of markets adjacent to key customers and just prior to a maximum period of seasonal sales. For example, agricultural fertilizer companies sometimes spot stock near farmers in anticipation of the growing season. After the growing season, such spot stocking would likely be reduced or removed.

Full Line Stocking

The traditional use of warehouses by manufacturers, wholesalers, retailers is to stock product inventory combinations in an anticipation of customers' orders. Typically, retailers and wholesalers provide assortments representing multiple products from different manufacturers. In effect, these warehouses can provide one-stop shopping capability for goods from multiple manufacturers. The difference between stock spotting and full line stocking is the extent and the duration of warehouse utilization. A firm following a spot stocking strategy would temporarily warehouse a narrow product assortment in a large number of warehouses for a limited time period. The full line stocking warehouse is more often restricted to a few strategic locations and operates year-round. Full line stocking warehouses improve service by reducing the number of suppliers that wholesalers and retailers must deal with. The combined assortments also make larger shipments possible.

Production Support

The field and the scope of operations of manufacturers may justify warehousing an inventory of specific parts, materials and components. Production support warehouses stock inventory to support manufacturing operations. Safety stocks on items purchased from outside vendors may be justified because of long lead times, potential supply discontinuity, and significant variations in usage rates. In such situations the most effective supply practice may be the establishment of a production support warehouse containing an inventory of processed materials, components, and subassemblies. This service benefit of warehousing is closely related to assembly assortment discussed under economic benefits. The primary difference between production support warehousing and assortment assembly is the size and purpose of the warehouse. In production support warehousing, average inventory is higher and turnover is lower.

Market Presence

While benefits of market presence may not be as obvious as other service benefits, it is often cited by executives as a major advantage of local warehouses. The underlying belief is that a local warehouse can respond faster to customer needs than can a more distant warehouse. It is anticipated that local warehouse presence will increase market share and potentially profitability. While the market presence factor is a frequently discussed strategy, little solid research exists to confirm or refute its existence. In addition, more reliable transportation and technology-based order processing are closing the response time gap regardless of distance. Unless a warehouse is economically or service justified it is unlikely that local market presence will favorably influence operational results.

2.3 warehouse Operations and Storage

Once a warehouse mission is determined, managerial attention focuses on establishing the operation. A typical warehouse contains materials, parts, and finished goods on the move. Warehouse operations consist of break-bulk, storage, and assembly procedures. The objective is to efficiently receive inventory, possibly store it until required by the market, assemble it into complete orders, and initiate movement to customer. This emphasis on product flow renders a modern warehouse as a mixing facility. As such, a great deal of managerial attention concerns how to perform storage to facilitate efficient materials handling.

2.3.1 Movement Continuity and Materials Handling

The first consideration focuses on movement continuity and scale economies throughout the warehouse. Movement continuity means that it is better for a material handler with a piece of handling equipment to perform longer moves than to undertake a number of short handlings to accomplish the same overall move. Exchanging the product between handlers or moving it from one piece of equipment to another will waste time and increase the potential for product damage. Thus, as a general rule, longer warehouse movements are preferred. Goods, once in motion, should be continuously moved until arrival at their final destination. Scale economies justify moving the largest quantities or loads possible. Instead of moving individual cases, handling procedures should be designed to move cases grouped on pallets or containers.

The overall objective of materials handling is to eventually sort inbound shipments into unique customer assortments. The three primary handling activities are Receiving, In-storage Handling, and Shipping:

- Receiving-Merchandise and materials typically arrive at warehouses in large quantity shipments. The first handling activity is unloading. At most of the warehouses, unloading is performed mechanically, using a combination of a lift truck and manual processes. When freight is floor stacked on the transport vehicle, the typical procedure is to manually place products on pallets or to use a conveyor (conveying belt). When inbound product has been unitized on pallets or containers, lift trucks can be used to facilitate receiving. A primary benefit of receiving unitized loads is the ability to turn inbound transportation equipment more rapidly. Receiving is usually the unloading of a relatively high volume of similar product.

In-Storage Handling

In-storage handling consists of movements within the warehouse. Following receipt and movement to a staging location, product must be moved within the facility for storage or order selection. Finally, when an order is processed it is necessary to select the required products and move them to a shipping area. These two types of in-storage handling are typically referred to as transfer and selection. There are at least two and sometimes three transfer movements in typical warehouses. The merchandise is initially moved from the receiving area to a storage location. This movement is typically handled by a lift truck when pallets are used or by other mechanical means for other types of unit loads. A second internal movement may be required prior to order assembly depending upon warehouse operating procedures. When unit loads have to be broken down for order selection, they are usually transferred from storage to an order selection or picking area. When products are large or bulky, such as appliances, this intermediate movement to a picking area may not be necessary. Such product is often selected from the storage area and moved directly to the shipping staging area. The shipping staging area is the area adjacent to the shipping dock. In order selection warehouses, the assembled customer order is transferred from the selection area to the shipping staging area. Characteristically, in-storage handling involves lower volume movements than receiving but still relatively similar products. Order selection is one of the major activities within warehouses. The selection process requires that materials, parts, and products be grouped to facilitate order assembly. It is typical for one area of a warehouse to be designed as a selection or picking area to assemble orders. For each order, the combination of products must be selected and packaged to meet specific customer order requirements. The typical selection process is coordinated by a warehouse management system.

Shipping

Shipping consists of order verification and transportation equipment loading. Similar to receiving, firms may use conveyors or unit load materials handling equipment such as lift trucks to move products from the staging area into the transportation vehicle. Relative to receiving, warehouse shipping must accommodate relatively low-volume movements of a mixture of product, thus reducing the potential for economies of sales. Shipping unit loads are becoming increasingly popular because considerable time can be saved in vehicle loading. A unit load consists of unitized or palletized product. To facilitate this loading and subsequent unloading upon delivery, many customers are requesting that suppliers provide mixed combinations of product within a unit. The alternative is to floor stack cases in the transportation vehicle. Shipment content verification is typically required when product changes its ownership. Verification may be limited to a simple carton count or a piece-by-piece check for proper brand, size, and in some cases serial number to assure shipment accuracy.

2.3.2 Warehouse Storage

The second consideration is that warehouse utilization should position products based upon individual characteristics. The most important product variables to consider in a storage plan are: product volume, weight, and storage requirements.

Product volume or velocity is the major factor driving warehouse layout. High volume product should be positioned in the warehouse to minimize movement distance. For example, high-velocity products should be positioned near doors, primary aisles, and at lower levels in storage racks. Such positioning minimizes warehouse handling and reduces the need for frequent lifting. Conversely, products with low volume should be assigned locations more distant from primary aisles or higher up in the storage racks.

Similarly, the storage plan should take into consideration product weight and special characteristics. Relatively heavy items should be assigned storage locations low to the ground to minimize lifting. Bulky or low-density product requires cubic space. Floor space along outside walls is ideal for such items. On the other hand, smaller items may require storage shelves, bins, or drawers. The integrated storage plan must consider individual product characteristics.

A typical warehouse is engaged in a combination of *active* and *extended* product storage alternatives. Warehouses that directly serve customers typically focus on active short-term storage. In contrast, warehouses use

extended storage for speculative, seasonal, or obsolete inventory. When control and measure warehouse operations, it is important to differentiate the relative requirements and performance capabilities of active and extended storage.

2.3.2.1 Active Warehouse Storage

Regardless of inventory velocity, most goods must be stored for at least a short time. Storage for basic inventory replenishment is referred to as active storage. Active storage must provide sufficient inventory to meet the periodic demands of the service area. The need for active storage is usually related to the capability to achieve transportation or handling economies of scale. For active storage, materials handling processes and technologies need to focus on the quick movement and flexibility with relatively minimal consideration for extended and dense storage. The active storage concept includes flow-through distribution which uses warehouses for consolidation and assortment while maintaining minimal or no inventory in storage. The resulting need for reduced inventory favors flow-through and cross-docking techniques that emphasize movement and de-emphasize storage. Flow-through distribution is most appropriate for high volume, fast-moving products with reasonably predictable quantities. While flow-through distribution places minimal demands on storage requirements, it does require that product be quickly unloaded, de-unitized, grouped and sequenced into customers' assortments, and reloaded into transportation equipment. As a result, the materials handling emphasis is on accurate information and quick movement.

2.3.2.2 Extended Warehouse Storage

This is a somewhat misleading term as it refers to inventory in excess of that required for normal replenishment of customer stocks. In some special situations, storage may be required for several months prior to customer shipment. Extended storage uses materials handling processes and technologies that focus on maximum space utilization with minimal need for quick access. A warehouse may be used for extended storage for several different reasons. Some products, such as seasonal items, require storage to await demand or to spread supply across time. Other reasons for extended storage include erratic demand items, product conditioning, speculative purchases and discounts. Product conditioning sometimes requires extended storage, such as to ripen the bananas. Food warehouses typically have ripening rooms to hold products until they reach peak quality. Storage may also be necessary for extended quality checks. Warehouses may also store

goods on an extended basis when goods are purchased on a speculative basis. The magnitude of speculative buying depends upon the specific materials and industries involved, but it is very common in marketing of commodities and seasonal items. For example, if a price increase for an item is expected, it is common for a firm to buy ahead at the current price and warehouse the product for later use. In this case, the discount or savings has to be traded off against extended storage and inventory carrying cost. Commodities such as grains, oil, and cardboard are often stored for speculative reasons. The warehouse may also be used to realize special discounts. Early purchase discounts may justify extended storage. The purchasing manager may be able to realize a substantial price reduction during a specific period of the year. Under such conditions the warehouse is expected to hold inventory in excess of active storage. Manufacturers of fertilizer, toys, and lawn furniture often attempt to shift the warehousing burden to customers by offering off-season warehouse storage allowances.

2.4 Warehouse Ownership

Warehouses are typically classified based on the ownership. A private warehouse is operated by the enterprise that owns the merchandise handled and stored in the facility. A public warehouse, in contrast, is operated as an independent business offering a range of for-hire services, such as storage, handling, and transportation. Public warehouse operators generally offer a menu of relatively standardized services to customers. Contract warehousing, which is a customized extension of public warehousing, combines the benefits of private and for-hire warehousing. Contract warehousing is a long-term business arrangement that provides unique or tailored logistics services for a limited number of customers. The client and the integrated service supplier typically share the risks associated with the warehousing operation. The important differences between contract and public warehouse operators are the anticipated length of the relationship, the level of exclusive or tailored services, and shared incorporation of benefits and risks.

2.4.1 Private Warehouse

A private warehouse is typically operated by the firm owning the products. The building, however, may be owned or leased. The decision concerning ownership or lease is essentially financial. Sometimes it is not possible to find a warehouse for lease that fits specialized logistical requirements; for example, the physical nature of an available building may not be conducive for efficient materials handling, such as buildings with

inappropriate storage racks pillar constraints. The only suitable course of action may then be to design and arrange for construction. The major benefits of private warehousing are control, flexibility, cost, and a range of intangibles. Private warehouses offer substantial control since management has authority to prioritize activities. Such control should facilitate integration of warehouse operations with the balance of a firm's logistics operations. Private warehouses generally offer more flexibility since operating policies and procedures can be adjusted to meet specific customer and product requirements. Firms with very specialized customers or products are often motivated to own and operate warehouses. Private warehousing is usually considered less costly than public warehousing because private facilities are not operated for a profit even though they may be required to make some contribution to the firm to ensure competitiveness. As a result, both the fixed and variable cost components of a private warehouse may be lower than the for-hire counterparts. Finally private warehousing may offer. This perception may provide marketing advantage over competitors. Nonetheless, the use of private warehousing is declining due to an increasing interest in reducing logistics assets since warehouse facilities account for a substantial portion of those assets. Also, the perceived cost and benefit of private warehousing is potentially offset by a public warehouse's ability to gain economies of scale based on leveraging the combined throughput of multiple clients.

Table 2: Advantages and Disadvantages of Private Warehouse

Advantages of Private Warehouse	Disadvantages of Private Warehouse
Substantial control since management has authority to prioritize activities and facilitate integration of warehouse operations with the balance of a firm's logistics operations	Increasing interest in reducing logistics assets since warehouse facilities account for a substantial portion of those assets
More flexibility since operating policies and procedures can be adjusted to meet specific customer and product requirements	Inability to gain economies of scale based on leveraging the combined throughput of multiple clients
Less costly than public warehousing because private facilities are not operated for a profit even though they may be required to contribute to the firm to ensure competitiveness	
Both the fixed and variable cost components of a private warehouse may be lower than the public counterparts	
Intangible benefits, with the firm’s name on its sign, private warehouse may stimulate customer perceptions of responsiveness and stability	

Source: Own development

2.4.2 Public Warehouse

Public warehousing facilities are owned and operated by a third party provider. This is typically considered the best option for short-term warehouse needs because there is little commitment involved. Warehousing space is offered under a lease agreement as short-term as month-to-month. Facilities owners lease their space on a fee per square foot or pallet system. However, these fees tend to be on the higher end, so oftentimes this is the most expensive option. Public warehousing can be an ideal solution for the right business. An example is a company that is seeking visibility into new markets. Public warehousing provides economical and practical means to test new waters with no capital investment and little commitment.

Public warehouses are used extensively in logistical systems. Almost any combination of services can be arranged on a for-hire basis for either short or long term. Public warehouses have traditionally been classified based on operational specialization such as: general merchandise, refrigerated merchandise, special commodity, bonded and household goods and furniture. General merchandise warehouses are designed to handle package products such as electronics, paper, food, small appliances, and household supplies. Refrigerated warehouses typically offer frozen or chilled capacity designed to protect food, medical, photographic, and chemical products requiring special temperatures. Special commodity warehouses are designed to handle bulk material or items requiring special handling considerations, such as tires or clothing. Bonded warehouses are licensed by the government to store goods prior to payment of taxes or import/export duties. They exert tight control over movements in and out of the facility since documents must accompany each move. Finally, household goods or furniture warehouses specialize in handling and storing large, bulky items such as appliances and furniture. Of course, many public warehouses offer a combination of services. Public warehouses provide flexibility and shared services benefits. They have the potential to offer operating and management expertise since warehousing is their core business. From a financial perspective, public warehousing may be able to achieved lower operating cost than private facilities. Such variable cost differential may result from lower pay scales, better productivity, shared resources, and economy of scale. Public warehouses typically do not require capital investment on the part of customers. When management performance is judged according to return on investment, the use of public warehousing can be an attractive alternative. Public warehousing offers flexibility concerning size and number of warehouses, thus allowing users to respond to supplier, customer, and

seasonal demands. In comparison, private warehouses are relatively fixed and difficult to change because buildings have to be constructed, expanded, or sold. Public warehousing can also have the potential to share scale economies since the combined requirements of users can be leveraged. Such leverage spreads fixed costs and may justify investment in state-of-the-art handling equipment. A public warehouse may also leverage transportation by providing combined customer delivery consolidation. For example, rather than requiring both supplier A and supplier B to deliver to a retail store from its own warehouse, a public warehouse serving both clients could arrange combined delivery, thus providing reduced transportation cost for the customer.

Table 3: Advantages and Disadvantages of Public Warehouse

Advantages of Public Warehouse	Disadvantages of Public Warehouse
Any combination of services can be arranged on a for-hire basis for either short or long term	No control since management has no authority to prioritize activities and integrate of warehouse operations with the balance of a firm's logistics operations
Service and a combination of service for general merchandise, refrigerated merchandise, special commodity, bonded and household goods and furniture	Less flexibility since operating policies and procedures cannot be adjusted to meet specific customer and product requirements
Shared services benefits and flexibility concerning size and number of warehouses, thus allowing users to respond to supplier, customer, and seasonal demands	Both the fixed and variable cost components of a public warehouse may be higher than the private counterparts
Lower operating cost resulting from lower pay scales, better productivity, shared resources, and economy of scale	No intangible benefits, no firm's name on its sign, public warehouse may not stimulate customer perceptions of responsiveness and stability
No capital investment	
Combined transportation and requirements of users can be leveraged	

Source: Own development

The table 4 below will summarize the types of services offered by many public warehouse operators who have full capabilities and are very competent in doing so compared to other warehouse operators, private or contract based.

Table 4: Public Warehouses' Services

Types of service
Cross dock/trans-loading
Customer returns
Customization /postponement
Home or catalog delivery
In-transit merge
Inventory control
Kan Ban
Kitting
Labeling/pre-ticketing
Lot control
Manufacturing support
Order fulfillment
Put-away/Pick/pack
Pool distribution
Repair/refurbish
Returnable container management
Reverse logistics
Sequencing/metering

Source: Own development

A great number of firms utilize public warehouses for market distribution because of the variable cost, scalability, a wide range of services, and flexibility. In a variety of situations, public warehouse facilities and services can be designed and performed to meet exact operational requirements. A public warehouse charges clients a basic fee for handling and storage. In the case of handling, the charge is assessed on the cases or weight moved. For storage, the charge is assessed on the cases or weight in storage over a designated time period. Special or value-added services are typically priced on a negotiated basis.

2.4.3 Contract Warehouse

Contract warehousing facilities are also owned and operated by a third party provider. This is in a sense a hybrid of public warehousing. Space is leased for a fixed term, usually six months or longer. The cost per square foot or pallet is normally more affordable than with public warehousing. Another advantage to contract warehousing is its flexibility and value-added services. A contract warehouse can offer features like forklifts, dock rentals, security, as well as providing other custom solutions for managing supply chains.

Contract warehouse combines features of private and public warehousing operations. A long-term contractual relationship will typically result in lower total cost than a public warehouse. At the same time, contract warehouse operations can provide benefits of expertise, flexibility, scalability, and economies of scale by sharing management, labor, equipment, and information resources with multiple clients. Contract warehouses typically offer a range of logistical services such as transportation management, inventory control, order processing, customer service, and return merchandise processing. There are contract warehouse operators who are capable of assuming total logistics responsibility for an enterprise. For example, Kraft Foods has increasingly utilized contract warehousing as a replacement for private and public frozen and dry grocery facilities. Since the late 1990s, Kraft has used Americold Logistics, an integrated warehousing and distributing company, to perform storage, handling, and distribution services. The arrangement has multiple benefits for both parties. The long-term contractual arrangement allows Kraft Foods to expand its distribution network without incurring the time or cost of building expansion. Kraft is assured that there will always be space for new products, so its distribution network is protected. Americold doesn't have to be concerned with selling space for the Kraft Foods warehouses. It can focus on providing service. Moreover, the longer Kraft utilizes Americold services the better the contract warehousing firm's capability to understand business needs and provide customized services.

Table 5: Advantages and Disadvantages of Contract Warehouse

Advantages of Contract Warehouse	Disadvantages of Contract Warehouse
A long-term contractual relationship will typically result in lower total cost than a public warehouse	
Benefits of expertise, flexibility, scalability, and economies of scale by sharing management, labor, equipment, and information resources with multiple clients	
Capability of assuming total logistics responsibility for an enterprise: transportation management, inventory control, order processing, customer service, and return merchandise processing	

Source: Own development

As would be expected, many firms utilize a combination of private, public and contract facilities. Full warehouse utilization throughout a year is rare. As a managerial guideline, a typical warehouse will be fully utilized between 75% and 85% of the time; so from 15% to 25% of the time, space

needed to satisfy peak requirements will not be used. In such situations an attractive strategy may be the use of private or contract warehouses to cover the 75%-85% requirement while using public facilities to accommodate peak demand.

Developing a warehouse strategy requires answers to two questions. The first is how many warehouses should be established. The second question focuses on which warehouse ownership types should be used in specific markets. For many firms, the answer is a combination of warehouse alternatives, differentiated by customer and product. Specifically, some customer groups may be served best from a private warehouse, while public or contract warehouses may be appropriate for others. This warehouse segmentation is increasingly popular as key customers are requiring more customized and focused services and capabilities.

Table 6: Warehousing Modes' Cost Structure Comparison

Cost Component	**Private Warehouse**	**Public Warehouse**	
		Pure Public Warehouse	**Contract Warehouse**
Capital cost	• Building cost • Facilities & equipment • Materials handling equip • (Un)loading docks/rail	Not applicable	Based on contracted responsibilities for land, buildings, and facilities
Expenses	• Safety equipment • Insurance, taxes, • Maintenance/repairs • Utilities • Salaries/wages • Employee benefits	Per unit cost based on the type of services used	As stated in the contract
Rates/Fees	Not applicable	**Time based:** Storage charges **Transaction-based:** Handling charges; in/out special handling fees, documentation, special services, etc.	Time and/or transaction based, as stated in the contract
Risks	The company assumed all risks	Defined and bear in accordance with the standard terms and conditions of the warehouse agreement	Risks are assigned and assumed as stated in the lease and/or contract

Source: http://www.geocities.ws/liame_/Warehousing.htm

2.5 Warehouse Planning

Initial decisions related to warehousing are concerned with its planning. The basic concept that warehouses provide as an enclosure for material storage and handling requires detailed analysis before the size, type, and shape of the facility can be determined. This section reviews planning issues that establish the character of the warehouse, which in turn determines attainable handling efficiency.

2.5.1 Site Selection

The first task is to identify both the general and then the specific warehouse location. The general area concerns the broad geography where an active warehouse makes sense from a service, economic, and strategic perspective. There are a number of techniques that can assist in determining the best combination of general warehouse areas. Once the combinations of broad areas are determined, a specific building site must be identified. Typical areas in a community for locating warehouses are the commercial zone in the city center or downtown, outlying areas served primarily by motor truck only. Drivers in site selection are service availability and cost. Land cost is the most important factor. A warehouse need not be located in a major industrial area. In many cities, warehouses are among industrial plants for light or heavy industry. Most warehouses can operate legally under restrictions placed upon general commercial property. Beyond procurement cost, setup and operating expenses such as rail sidings, utility hookups, taxes, insurance rates, and highway access require evaluation. The cost of such services typically varies extensively between sites. Several other requirements must be satisfied before a site is purchased. The site must offer adequate room for expansion and necessary utilities must be available. The soil must be capable of supporting the structure. The site must be sufficiently high above sea level to afford proper water drainage. Additional requirements may be occasionally necessary, depending upon the structure to be constructed. For these reasons and others, the final selection of the sight must be preceded by extensive analysis.

Warehouse design must consider product movement characteristics. Three factors to be determined during the design process are the number of floors to include in the facility, a cubic utilization plan, and product flow. The ideal warehouse design is a one-floor building that eliminates the need to move product vertically. The use of vertical handling devices, such as elevators and conveyors, to move product from one floor to the next requires time, energy, and typically creates handling bottlenecks. It is not always possible, particularly in central business districts where land is restricted or

expensive to follow the rule that warehouses should be designed as one-floor operations to facilitate materials handling. Warehouse design should maximize cubic utilization. Most warehouses are designed with 6m to 10m clear ceilings, although modern automated and high-rise facilities effectively use heights over 30m. Maximum effective warehouse height is limited by the safe lifting capabilities of materials handling equipment, such as lift trucks, rack design, and fire safety regulations imposed by fire extinguishing systems. Warehouse design should facilitate continuous straight product flow through the building. This is basic rule whether the product is moving into storage or is being cross-docked. In general, this means that product should be received at one end of a building, stored as necessary in the middle, and shipped from the other end. Figure 8 illustrates straight-line product flow that facilitates velocity while minimizing congestion and redundant handling.

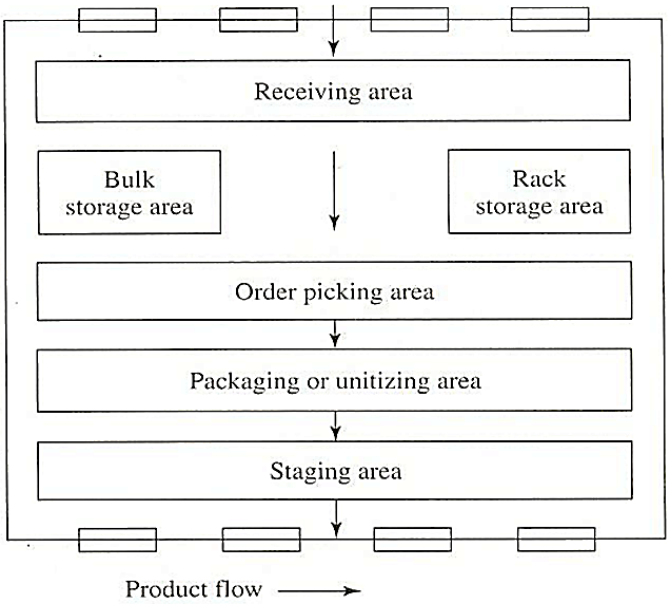

Fig 8: Straight-Line Product Flow Concept in Warehouse Design

Source: Own development

2.5.2 Product-Mix, Future Expansion and Materials Handling

Product-Mix

Another independent area of quantitative analysis is detailed study of products to be distributed through the warehouse. The design and operation of a warehouse are related directly to the product mix. Each product should

be analyzed in terms of annual sales, demand, weight, cube, and packaging. It is also desirable to determine the total size, cube, and weight of the average order to be processed through the warehouse. These data provide necessary information for determining warehouse space, design and layout, materials handling equipment, operating procedures, and controls.

Future Expansion

Because warehouses are increasingly important in contemporary logistical networks, their future expansion should be considered during the initial planning phase. Well-managed organizations often establish 5-to 10-year expansion plans. Potential expansion may justify purchase or option of a site three to five times larger than required to support initial construction. Building design should accommodate future expansion without seriously affecting ongoing operations. Some walls may be constructed of semi-permanent materials to allow quick removal. Floor areas, designed to support heavy movements, can be extended during initial construction to facilitate expansion.

Materials Handling

Materials handling system is the basic driver of warehouse design. As noted previously, product movement and assortment are the main functions of a warehouse. Consequently, the warehouse is viewed as a structure designed to facilitate efficient product flow. It is important to stress that the materials handling system must be selected early in the warehouse development process.

2.5.3 Layout and Sizing

Layout

The layout or storage plan of a warehouse should be planned to facilitate product flow. The layout and the materials handling system are integral. In addition, special attention must be given to location, number, and design of receiving and loading docks. It is difficult to generalize warehouse layouts since they are usually customized to accommodate specific handling requirements.

If pallets are utilized, an early step is to determine the appropriate size. A pallet of nonstandard size may be desirable for specialized products. However, whenever possible, a standard size pallet should be used throughout a warehouse. In general, the larger the pallet load, the lower the movement cost per weight unit or package over a given distance. One lift truck operator can move a large load in the same time and with the same

effort required to move a smaller load. Analysis of product cases and stacking patterns will determine the size of pallet best suited to the operation. Regardless of the size finally selected, management should adopt one pallet size for the overall warehouse. The second step in planning warehouse layout involves pallet positioning. The most common practice in positioning pallets is 90 degree (or square placement). Square positioning is widely used because of layout ease. Square placement means that the pallet is positioned perpendicular to the aisle. Finally, the handling equipment must be integrated to finalize layout. The path and tempo of product flow depend upon the materials handling system. To illustrate the relationship between materials handling and layout, two systems and their respective layouts (A and B) are presented in the figure 9.

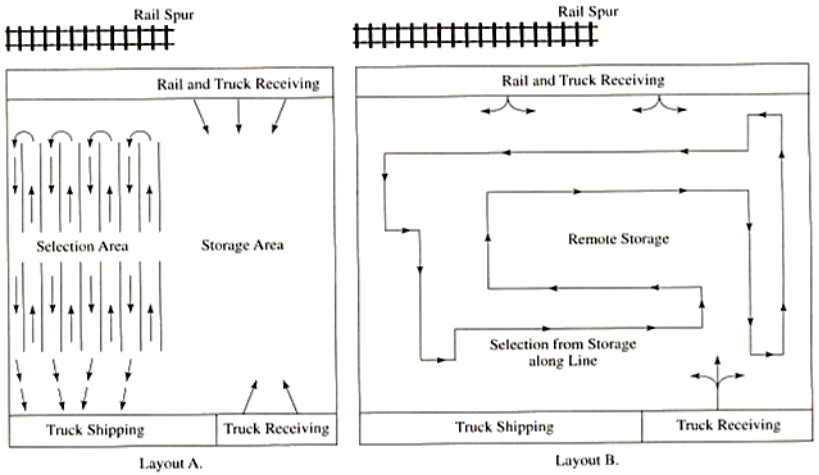

Fig 9: Two Materials Handling Systems and Their Layouts

Source: Own development

Layout A, presented in Figure 9, illustrates a materials handling system and layout utilizing lift trucks for inbound and inventory transfer movements and tow tractors with trailer for order selection. This scenario assumes that products can be palletized. This layout is greatly simplified because offices, special areas, and other details are omitted. The floor plan of layout A is approximately square. The advocates of square design feel that it provides the best framework for overall operating efficiency. Products should be positioned in specific areas of warehouse for order selection such as the case of layout A. This is a selection, or picking area. Its primary purpose is to minimize the distance order pickers must travel when assembling an order. The selection area is supported by a storage area. When products are

received they are palletized and moved to the storage area. The selection area is replenished from storage as required. Within the selection area, products are positioned according to weight, bulk, and replenishment velocity to minimize outbound movement. Customer orders are assembled by an order selector using a tow tractor pulling trailers through the selection area. The arrows in layout A indicate product selection flow.

Layout B illustrates a materials handling system utilizing lift trucks to move product inbound and for transfer movements. A continuous towline is used for order selection. The floor plan in layout B is rectangular. In a system using a continuous movement towline, the compact selection area is replaced by order selection directly from storage. Products are moved from receiving areas into storage positions adjacent to the towline. The orders are then selected directly from storage and loaded onto carts, which are propelled around the warehouse by the towline. Merchandise is stored or positioned to minimize inbound movement. The weakness of the fixed towline is that it facilitates selection of all products at an equal speed and frequency and does not consider special needs of high-velocity products. The arrows in layout B indicate major product movements. The line in the center of the layout illustrates the path of the towline.

Both layouts A and B presented above are greatly simplified. The purpose here is to illustrate the extremely different approaches managers have developed to reconcile the relationship between materials handling and warehouse layout.

Sizing

Several techniques are available to help estimate the warehouse size. Each method begins with a projection of the total volume expected to move through the warehouse during a given period. The projection is used to estimate base and safety stocks for each product to be stocked in the warehouse. Some techniques consider both normal and peak utilization rates. Failure to consider utilization rates can result in overbuilding, with corresponding increase in cost. It is important to note, that a major complaint of warehouse managers is underestimation of warehouse size requirements. A good rule of thumb (practice) is to allow 10% additional space to account for increased volume, new products, and new business opportunities.

2.5.4 Initiating Warehouse Operations

To initiate warehouse operations, management must plan and perform initial stocking, personnel staffing, and work procedures, as well as implement a Warehouse Management System (WMS) and outbound

distribution operations. Although this focuses on the warehouse start-up process, many of these activities are relevant for ongoing warehouse operations as well.

2.5.4.1 Stocking

The ideal initial stocking procedure is to receive and stock all inventory items prior to initiating operations. Individual products to be distributed through the warehouse and the quantities of each inventory are determined during warehouse planning. The challenge in initial stocking is to schedule and sequence product arrival. Time required to initially stock a warehouse depends upon the number and quantity of products. In most situations the initial stocking process will require in average 2 to 4 weeks for completion. In a storage area, full pallet loads of product are assigned to predetermined positions. Two common methods of slot assignment are variable and fixed:

- A variable-slot placement system, also called dynamic slotting, allows the warehouse location to be changed each time a new shipment arrives. The goal of variable slotting is efficient utilization of warehouse space.
- A fixed-slot system assigns product to a permanent location in the warehouse. The product is stocked at this location as long as it sustains volume. As volume increases or decreases, the product location may be reassigned. The advantage of fixed slotting is that warehouse operations personnel become familiar with the location of specific product, making them more efficient.

However, newer WMS capabilities have substantially increased location recording accuracy. Regardless of which slotting system is employed, each inbound product must be assigned an initial location.

2.5.4.2 Training

Major concern in logistical operations over the past several decades has been the labor productivity. The basic nature of raw materials, parts, and finished goods flowing through and between vast networks of facilities makes logistics labor-intensive. In fact, warehousing is the single largest consumer of logistics labor. Hiring and training qualified personnel to operate a warehouse is a challenge. Regardless of how efficient the proposed warehouse system is in theory, in practice it will only be as good as its operating personnel. Part of the challenge is to attract competent, productive workers to a warehouse environment. Because warehousing is demanding physical work completed at times and in locations that are less than ideal, it

becomes particularly difficult to attract workers in periods of relatively full employment. Compounding this challenge in warehouse start-up as well as ongoing operations is the need to find operating personnel who can pass necessary aptitude and drug tests. Newer materials handling equipment requires the ability to interface with computers and the discipline to follow specific directions. The drug tests are required to reduce the liability for personal injury or damage while operating materials handling equipment. Once hired, personnel then must be properly trained to ensure desired system results. The full workforce should be available for test operations prior to the arrival of merchandise. Personnel hired for specific assignments should be fully trained to perform job requirements and to understand the role of their contribution to total system performance. After orientation, all employees should be given specific training. Personnel hired to operate a warehouse may be grouped in the following categories: administrators, supervisors, selectors, equipment operators, laborers, material handlers, and support workers such as maintenance. Prior to actual operations it is desirable to simulate the work that each group performs. Such simulation provides hands-on experience doing work without the risk of creating operational problems. When initial warehouse stocking begins, the workforce receives actual experience in merchandise handling. Normally, the manufacturer supplying the basic materials handling system and equipment provides instruction regarding operations under both simulated and initial stocking conditions. Once the initial inventory is on hand, it is good practice to simulate fulfilling customer orders. Simulated orders can be selected and loaded into delivery trucks, and the merchandise may then be treated as a new arrival and transferred back into stock.

2.5.4.3 Warehouse Management Systems

The development of work procedures goes hand in hand with training warehouse personnel. Most firms implement a WMS to standardize work procedure and encourage best practice. It is management's responsibility to see that all personnel understand and use these procedures.

In a mechanized warehouse, approximately 65% of personnel are employed in some facets of order selection. The two basic methods of order picking are individual and area selection (also known as batch selection). Using individual selection, one employee completes a customer's total order. This system is not widely used. Its primary application occurs when a large number of small orders are selected for repack or consolidated shipment, such as e-commerce fulfillment. Under the more commonly used area selection system each employee is assigned responsibility for a specific

portion of the warehouse. To complete a customer's order, several different selectors are required. Because each employee has a thorough knowledge of a specific selection area, less time is required to locate items.

Work procedures are also important for receiving and shipping. Established procedures for receiving and ensuring product entry into inventory records are critical. If pallets are used, the merchandise must be stacked in appropriate patterns to ensure maximum load stability and consistent case counts. Personnel working in shipping must have knowledge of trailer loading practices. In specific types of operations, particularly when merchandise changes ownership, items must be checked during loading. Work procedures are not restricted to floor personnel. Procedures must be established for administration and maintenance. Replenishment of warehouse inventory can cause operational problems if proper ordering procedures are lacking. Normally, there is limited interaction between buyers and warehouse personnel although such communication is improving with integrated supply chain management organizations. Buyers tend to purchase in quantities that afford the best price, and little attention is given to pallet compatible quantities or available warehouse space.

Ideally, buyers should coordinate with warehouse staff personnel before commissioning large orders or introducing new products. The experience of some companies has forced management to require buyers to predetermine warehouse space assignment prior to ordering. Another potential problem is the quantity of cases ordered. The goal is to purchase in pallet-multiple quantities. For example, if a product is ideally stacked on pallets in a 50-case pattern, the buyer should order in multiples of 50. If an order is placed for 120 cases, upon arrival the cases will fill two pallets plus 20 on a third pallet. The extra 20 cases will require the warehouse cubic space typically used for a pallet of 50 and will require the same amount of materials handling capacity to move.

2.5.4.4 Security Issues

In a broad sense, security in a warehouse involves protection against merchandise pilferage and deterioration. Each form of security requires special management attention.

Pilferage Protection

In warehouse operations it is necessary to protect against theft by employees and thieves as well as from riots and civil disturbances. Typical security procedures used throughout a business should be strictly enforced at each warehouse. Security begins at the fence. As standard procedure, only

authorized personnel should be permitted into the facility and surrounding grounds. Entry to the warehouse yard should be controlled through single gate. Without exception, no private automobile, regardless of management rank or customer status, should be allowed to enter the yard or park adjacent to the warehouse. Shortages are always a major concern in warehouse operations. Many are honest mistakes that occur during order selection and shipment, but the purpose of security is to restrict theft from all angles. The majority of thefts occur during normal working hours. Inventory control and order processing systems help protect merchandise from being carried out of the warehouse unless accompanied by a computer release document. If samples are authorized for salesperson use, such merchandise should be maintained in a separate inventory. Not all pilferage occurs on an individual basis.

Organized efforts between warehouse personnel and carrier truck drivers can result in deliberate over-picking, or high-for-low-value product substitution occurring in order to move unauthorized merchandise out of the warehouse. Employee work assignment rotation, total case counts, and occasional complete line-item checks can reduce vulnerability to such collaboration.

A final concern is the increased incidence of hijacking over-the-road trailer loads from yards or while in transit. Hijacking is a major logistical concern. Over-the-road hijack prevention is primarily a law-enforcement matter, but in-yard theft can be eliminated by tight security provisions. Usually, such over-the-road theft is a significant problem in developing countries.

Product Deterioration

Within the warehouse, a number of factors can reduce a product or material to non-saleable status. The most obvious form of product deterioration is damage from careless materials handling. For example, when pallets of merchandise are stacked in great heights, a marked change in humidity or temperature can cause packages supporting the stack to collapse. The warehouse environment must be carefully controlled and measured to provide proper product protection. of major concern is warehouse employee carelessness. Product deterioration from careless handling within the warehouse is a form of loss that cannot be insured against or offset with compensating revenue.

Another major form of deterioration is incompatibility of products stored or transported together. For example, care must be taken when storing

or shipping chocolate to make sure that it doesn't absorb odors from products it is being transported with, such as household chemicals. Most shipments from distribution warehouses to customers are completed by truck. When private trucking is utilized, a managerial concern is to schedule shipments to achieve efficient transportation. Computer-assisted load planning and equipment routing techniques are very useful for organizing transportation requirements.

Safety and Maintenance

Accident prevention is a real concern of the warehouse management. A comprehensive safety program requires constant examination of work procedures and equipment to locate and take corrective action to eliminate unsafe conditions before accidents result. Accidents occur when workers become careless or they are exposed to mechanical or physical hazards. For example, the floors of a warehouse may cause accidents if not properly cleaned. Proper cleaning procedures can reduce the accident risk of such hazards. Environmental safety has become a major concern of government, such as OSHA (*Organization for Safety and Health Assurance*), and it cannot be neglected by management staff. A preventive maintenance program is also necessary for materials handling equipment. Unlike production machines, handling equipment is not stationary, so it is more difficult to properly maintain. A preventive maintenance program scheduling periodic checks of all handling equipment should be applied in every warehouse. The role of warehouse is more than a temporary storage. It offers both protection and preservation of inventory in the supply chain. While many activities of the warehouse are mainly receiving, storage and issuing inventory stock, the information is crucial in the warehouses management. Real-time and on-line information is necessary to make inventory visible to all the entities in the supply chain.

Chapter - 3

Inventory Management

Objectives

- Understand inventory management as a critical supply chain component
- Study the financial side of inventory
- Apply inventory management techniques to improve SCM

3.1 Inventory as Critical Component of Supply Chain

The inventory requirements of a firm are directly linked to the facility network and the desired level of customer service. Theoretically, a firm could stock every item sold in every facility dedicated to servicing each customer. Few business operations can afford such a luxurious inventory commitment because the risk and total cost are prohibitive. The objective in inventory strategy is to achieve desired customer service with the minimum inventory commitment. Excessive inventory may compensate for deficiencies in basic design of a supply chain system but will ultimately result in total logistics cost higher than necessary. Supply chain strategies should be designed to maintain the lowest possible financial investment in inventory. The basic goal is to achieve maximum inventory turn while satisfying service commitments. A sound inventory strategy is based on a combination of five aspects of selective deployment:

Core Customer Segmentation

Enterprise that sells to a variety of different customers confronts uneven opportunity. Some customers are highly profitable and have outstanding growth potential while others do not. The profitability of customer's business depends upon the products purchased, volume, price, value-added services required and supplemental activities necessary to develop and maintain long term ongoing relationship. Because highly profitable customers constitute the core market of every enterprise, inventory strategies need to focus on them. The key to effective logistical segmentation rests in the inventory priorities dedicated to support core customers.

Product Profitability

Most enterprises experience a substantial variance in the volume and profitability across product lines. If no restrictions are applied, a firm may find that less than 20% of all products marketed account for more than 80% of total profit according to Pareto principle. Management staff must avoid such outcomes by implementing inventory strategies based on fine-line product classification. A realistic assessment of the incremental value added by stocking low-profit or low-volume products is essential to avoiding excessive cost. For obvious reasons, an enterprise wants to offer high availability and consistent delivery of its most profitable products. High-level support of less profitable items, however, may be necessary to provide full-line service to core customers. The trap to avoid is high service performance on less profitable items that are typically purchased by fringe and non-core customers. Therefore, product line profitability must be considered when developing a selective inventory policy.

Transportation Integration

The product stocking plan at a specific facility has a direct impact upon transportation performance. Most transportation rates are based on the volume and size of specific shipments. Thus, it may be sound strategy to stock a sufficient range or assortment of products at a warehouse to be able to arrange consolidated shipments. The corresponding savings in transportation may be more than to offset the increased cost of holding the inventory.

Time-Based Performance

A firm's degree of commitment to deliver products rapidly to meet a customer's inventory requirement is a major competitive factor. If products and materials can be delivered quickly, it may not be necessary for customers to maintain large inventories. Likewise, if retail stores can be replenished rapidly, less safety stock is required. The alternative to stockpiling and holding safety stock is to receive exact and timely inventory replenishment. While such time-based programs reduce customer inventory to absolute minimums, the savings must be balanced against other supply chain costs incurred as a result of the time-sensitive logistical process.

Competitive Performance

Inventory strategies cannot be created in a competitive vacuum. A firm is typically more desirable to do business with, than competitors, if it can promise and perform rapid and consistent delivery. Therefore, it may be

necessary to position inventory in a specific warehouse to gain competitive advantage even if such commitment increases total cost. Selective inventory deployment policies may be essential to gain customer service advantage or to neutralize strength that competitors currently enjoy.

3.2 Inventory Flow and Functionality

3.2.1 Inventory Flow

The operational management of logistics is concerned with movement and storage of materials and finished products. Logistical operations start with the initial shipment of a material or component part from a supplier and are finalized when a manufactured or processed product is delivered to a customer. From the initial purchase of a material or component, the logistics process adds value by moving inventory when and where it is needed. Providing all goes well, materials and components gain value at each step of their transformation into finished inventory. In other words, an individual part has greater value after it is incorporated into a machine than it had as a part. Likewise, the machine has greater value once it is delivered to a customer. To support manufacturing, work-in-process inventory must be properly positioned. The cost of each component and its movement becomes part of the value-added process.

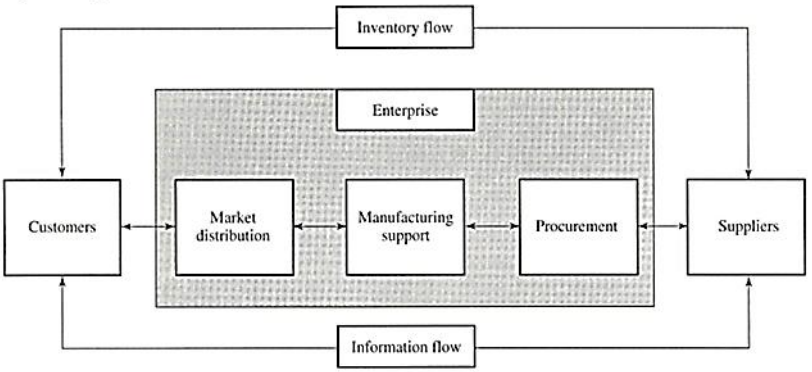

Fig 10: Inventory as Critical Component in Supply Chain

Source: Own development

Figure 10 illustrates the function/component of inventory in organization's supply chain to contribute to meeting business objectives. Inventory management is concerned with information required to implement the supply chain plan. Using combination of human resources and information technology, inventory is deployed and managed to satisfy

planned requirements. The work of inventory management is to make sure that the overall supply chain system has appropriate resources to perform as planned. Inventory decisions are of high risk and high impact for supply chain management. Inventory committed to support future sales drives a number of anticipatory supply chain activities. Without a proper inventory assortment lost sales and customer dissatisfaction may occur. Likewise, inventory planning is critical to manufacturing. Material or component shortages can shut down a manufacturing line or force modification of a production schedule, which creates added cost and potential finished goods shortages. Just as shortages can disrupt planned marketing and manufacturing operations, inventory overstocks also create operating problems. Overstocks increase cost and reduce profitability as a result of added warehousing, human resource, capital, insurance, taxes, and obsolescence. Management of inventory resources requires an understanding of the principles, cost, impact, and dynamics.

3.2.2 Inventory Functionality

Inventory policy formation requires understanding the role of inventory in a manufacturing and logistics environment. In order to understand the importance of inventory decisions, one should consider the magnitude of assets committed by a typical enterprise.

Table 7: Selected Data for Consumer and Industrial Goods Manufacturers and Merchandisers

Company	Total Assets (TA) (in Million USD)	Inventory Investment (in Million USD)	Inventory Investment as % of TA (in %)
Albertson's	15,701	3,249	20.69
Kruger	17,996	3,938	21.92
Safeway	14,990	2,445	16.41
Fleming	3,573	998	27.93
Spartan Stores	571	82	14.36
Supervalu	6,495	1,491	22.96
Hershey	3,347	602	17.99
Kellogg	4,809	503	10.46
Nabisco	11,961	898	7.51

Source: Based on VLI internal teaching materials

Table 7 presents total assets and inventory investment for select consumer and industrial goods manufacturers and merchandisers. This table illustrates the significant percentage of assets that are inventory related. Because inventory is a significant cost center, the reduction of a firm's

inventory commitment by a few percentage points can result in dramatic profit improvement. Attention to inventory management has significantly decreased inventory level required to support growth of sales. Inventory management is rather risky, and the risk varies depending upon a firm's position in the distribution channel. The typical measures of inventory commitment are time duration, depth, and width of commitment.

For the manufacturer, inventory management risk is quite long term. The manufacturer's inventory commitment starts with raw material and component parts, includes those works-in-process, and ends with finished goods. In addition, finished goods are often positioned in warehouses in anticipation of customer demand. In some situations, manufacturers are required to consign inventory to customer facilities. In effect, this practice shifts all the inventory risk to the manufacturer. Although a manufacturer typically has a narrower product line than a wholesaler and much narrower than a retailer, the manufacturer's inventory commitment is deep and of long duration.

A wholesaler purchases large quantities from manufacturers and sells smaller quantities to retailers. The economic justification of a wholesaler is the capability to provide retail customers with assorted merchandise from different manufacturers in specific quantities. When products are seasonal, the wholesaler may be required to take an inventory position far in advance of the selling season, thus increasing depth and duration of risk. One of the greatest challenges of wholesaling is product-line expansion to the point where the width of inventory risk approaches that of the retailer while the depth and duration of risk remain characteristic for traditional wholesaling. In recent years, retail clientele have also forced a substantial increase in depth and duration by shifting inventory responsibility back to wholesalers.

For a retailer, inventory management is about buying and selling velocity. The retailer purchases a wide variety of products and assumes a substantial risk in the marketing process. Retailer inventory risk can be viewed as wide but not deep. Due to the high cost of store location, retailers place prime emphasis on inventory turnover and direct product profitability. The inventory turnover is a measure of inventory velocity and is calculated as the ratio of annual sales divided by average inventory. Although retailers assume a position of risk on a variety of products, their position on anyone product is not deep. Risk is spread across more than 30,000 stock keeping units (SKUs) in a typical supermarket. A discount store offering general merchandise and food often exceeds 25,000 SKUs. A full-line department store may have as many as 50,000 SKUs. Faced with this width of inventory, retailers attempt to reduce risk by pressing manufacturers and wholesalers to

assume much greater inventory responsibility. Pushing inventory back up the channel has resulted in retailer demand for fast delivery of mixed-product shipments from wholesalers and manufacturers. Specialty retailers, in contrast to the mass merchandisers, normally experience less width of inventory risk as a result of handling narrower assortments; however, they must assume greater risk with respect to depth and duration of inventory holding.

If a business plans to operate at more than one level of the distribution channel, it must be prepared to assume related inventory risk. For example, the food chain that operates a regional warehouse assumes risk related to the wholesaler operations over and above the normal retail operations. To the extent that an enterprise becomes vertically integrated, inventory must be managed at all levels of the supply chain.

Functions of Inventory

From an inventory perspective, the ideal situation would be a response capability to manufacture products to fit customer specification. At various points in early chapters, the practicality of becoming fully response-based has been discussed in terms of the total costs and timeliness of customer support. While a zero-inventory manufacturing and distribution system is typically not attainable, it is important to remember that each dollar invested in inventory is a trade-off with an alternative use of assets that may provide a better return. Inventory is a major asset that should provide return for the capital invested. The return on inventory investments is the marginal profit on sales that would not occur without inventory. Accounting experts have long recognized that measuring the true cost and benefits of inventory on the corporate profit-and-loss is quite difficult. Lack of measurement sophistication makes it difficult to evaluate the trade-offs among service levels, operating efficiencies, and inventory levels. While aggregate inventory levels have decreased, many enterprises still carry an average inventory that exceeds their basic requirements. This generalization can be understood better through a review of the four following prime functions of inventory.

- **Geographical Specialization:** Allows geographical positioning across multiple manufacturing and distributive units of an enterprise. Inventory maintained at different locations and stages of the value-creation process allows this kind of specialization.
- **Decoupling:** Allows economy of scale within a single facility and permits each process to operate at maximum efficiency rather than having the speed of the entire process constrained by the slowest.

- **Supply/Demand Balancing:** Accommodates elapsed time between inventory availability (for manufacturing, for distribution) and moment of purchasing by end-consumers.
- **Buffering Uncertainty:** Accommodates uncertainty related to demand in excess of forecast or unexpected delays in order receipt and order processing on delivery and is typically referred to as safety stock.

The above four functions require inventory investment to achieve managerial operating objectives. While lean logistics has made significant progress in reducing overall supply chain inventory, inventory properly deployed can create value and reduce total cost. Given a specific manufacturing/marketing strategy, inventories planned and committed to operations can only be reduced to a level consistent with performing the four inventory functions. All inventories exceeding the minimum level are excess commitments. At the minimum level, inventory invested to achieve geographical specialization and decoupling can only be modified by changes in facility location and operational processes of the enterprise. The minimum level of inventory required to balance supply and demand depends on the difficult task of estimating seasonal requirements. With accumulated experience over a number of seasonal periods, the inventory required to achieve marginal sales during periods of high demand can be projected fairly well. As a consequence, seasonal inventory plan can be formulated based upon this experience. Inventories committed to safety stocks represent the greatest potential for improved logistical performance. These commitments are operational in nature and can be adjusted rapidly in case of errors or changes in policy. A variety of techniques are available to assist management in planning safety stock commitments.

3.3 Inventory Cost

Inventory carrying cost is the expense associated with maintaining inventory. Inventory expense is calculated by multiplying annual inventory carrying cost percentage by average inventory value. Standard accounting practice is to value inventory at purchase or standard manufacturing cost rather than at selling price. Assuming an annual inventory carrying 20% cost percentage, the annual inventory expense for an enterprise with $1 million in average inventory would be $200,000 (20% x $1,000,000). While the calculation of inventory expense is basic, determining the appropriate carrying cost percentage is less obvious. Determining carrying cost percentage requires assignment of inventory-related costs. Financial

accounts relevant to inventory carrying cost percentage are capital, insurance, obsolescence, storage, and taxes. While cost of capital is typically a standard assessment, expense related to insurance, obsolescence, storage, and taxes varies depending on the specific attributes of individual products.

3.3.1 Capital Cost

The appropriate charge to place on capital invested in inventory varies widely. Review of a variety of enterprises indicates that assessments range from the prime interest rate to as high as 25%. The logic for using the prime interest rate or a specified rate pegged to the prime rate is that cash to replace capital invested in inventory can be obtained in the money markets at that rate. Higher managerially specified capital costs are based on expected or target return on investment for all funds available to an enterprise. Any funds invested in inventory lose their earning power, restrict capital availability, and limit other investment. For example, if a firm expects a 20% before-tax return on invested capital, similar logic suggests that capital tied up in inventory should be assessed or charged the same 20%. Confusion often results from the fact that senior management frequently does not establish a clear-cut capital cost policy. For logistical planning, the cost of capital must be thought out clearly since the final rate of assessment will have a significant impact on overall inventory performance.

3.3.2 Taxes, Insurance and Obsolescence

Tax

Taxing authorities typically assess inventory held in warehouses. The tax rate and means of assessment vary by location. The tax expense is usually a direct levy based on inventory level on a specific day of the year or average inventory level over a period of time.

Insurance

Insurance cost is an expense based upon estimated risk or loss over time. Loss risk depends on the product and the facility storing the product. For example, high-value products that are easily stolen and hazardous products result in high insurance cost. Insurance cost is also impacted by facility characteristics such as security cameras and sprinkler systems that might help reduce risk.

Obsolescence

Obsolescence cost results from deterioration of product during storage. A prime example of obsolescence is product that ages beyond recommended sale date, such as food and pharmaceuticals. Obsolescence also includes

financial loss when a product becomes obsolete in terms of fashion or model design. Obsolescence costs are typically estimated based on past experience concerning markdowns, donations, or quantity destroyed. This expense is the percentage of average inventory value declared obsolete each year.

3.3.3 Storage Cost

Storage cost is the facility expense related to product holding rather than product handling. Storage cost must be allocated on the requirements of specific products since it is not related directly to the inventory value. In public or contract warehouses, storage charges are billed on an individual basis. With privately owned facilities, the total annual depreciated expense of the warehouse must be calculated in terms of a standard measure such as cost per day, per square or cubic foot. The cost of total annual occupancy for a given product can then be assigned by multiplying the average daily physical space occupied by the standard cost factor for the year. This figure can then be divided by the total number of units of merchandise processed through the facility to determine average storage cost per merchandise unit. Table 8 illustrates the components of annual inventory carrying cost and typical range of component costs. It should be clear that the final inventory carrying cost percent used by a firm is determined by managerial policy. Decisions regarding inventory carrying cost level are important because carrying cost is traded off against other logistics cost components in all business and operating decisions.

Table 8: Inventory Cost Components

Component	Average percentage	Percentage range
Cost of Capital	15%	8-40%
Tax	1%	0.5-2%
Insurance	0.05%	0-2%
Obsolescence	1.2%	0.5-2%
Cost of Storage	2%	0-4%
Total	19.25%	9-50%

Source: Based on VLI internal teaching materials

3.4 Inventory Planning and Management Practices

Inventory planning, beside management activities related with inventory monitoring and control, is to answer the following questions:

- When to order?
- How much to order?

The "when to order" question is determined by demand and performance average and variation. The "how much to order" question is determined by the order quantity.

3.4.1 Determining When to Order

The reorder point defines when a replenishment shipment should be initiated. A reorder point can be specified in terms of units or days' supply. This discussion focuses on determining reorder points under conditions of demand and performance cycle certainty. The basic reorder point formula is:

$R = D \times T$

Where:

R = Reorder point in units

D = Average daily demand in units

T = Average performance cycle length in days

To illustrate this calculation, assume demand of 20 units per day and a 10-day performance cycle. In this case,

$R = D \times T$ = 20 units/day x 10 days = 200 units

The use of reorder point formulations implies that the replenishment shipment will arrive as scheduled. When uncertainty exists in either demand or performance cycle's length, safety stock is required. When safety stock is necessary to accommodate uncertainty, the reorder point formula is:

$R = D \times T + SS$

Where:

R = Reorder point in units

D = Average daily demand in units

T = Average performance cycle length in days

SS = Safety stock in units

3.4.2 Determining How Much to Order

Lot sizing balances inventory carrying cost with the cost of ordering. The key to understanding the relationship is to remember that average inventory is equal to one-half the order quantity. Therefore, the greater the order quantity the larger the average inventory and consequently, the greater the annual carrying cost. However, the larger the order quantity, the fewer orders required per planning period and consequently, the lower the total ordering cost. Lot quantity formulations identify the precise quantities at

which the annual combined total inventory carrying and ordering cost is lowest for a given sales volume. Figure 11 illustrates those basic relationships. The point at which the sum of ordering and carrying cost is minimized represents the lowest total cost. Simply stated, the objectives are to identify the economic ordering quantity (EOQ) that minimizes the total inventory carrying and ordering cost.

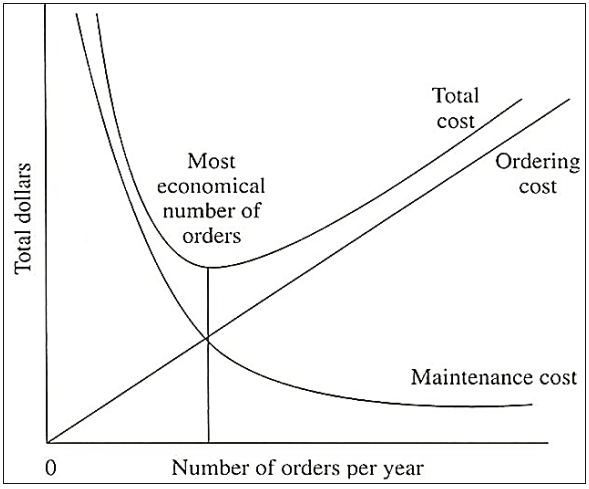

Fig 11: Economic Order Quantity

Source: VLI internal teaching materials

The EOQ is the replenishment practice that minimizes the combined inventory carrying and ordering cost. Identification of such a quantity assumes that demand and costs are relatively stable throughout the year. Since EOQ is calculated on an individual product basis, the basic formulation does not consider the impact of joint ordering of products.

The standard formulation for EOQ (Economic order quantity) is:

$$EOQ = \sqrt{(2C_oD)/C_iU}$$

Where:

C_o = Cost per order

C_i = Annual inventory carrying cost

D = Annual sales volume, units

U = Cost per unit

D-Annual demand volume 2400 units

U-Unit value at cost $5.00

C_i-Inventory carrying cost percent 20% annually

C_o-Ordering cost $19.00 per order

EOQ = $\sqrt{(2 \times 19 \times 2400)/(0.20 \times 5)} = \sqrt{91{,}200} = = 302$ (round to 300)

Total ordering cost would amount to $152 (2400/300 x $19.00), and inventory carrying cost to $150 [300/2 x (5 x .020)].

Thus, after rounding to allow ordering in multiples of 100 units, the annual reordering and inventory carrying cost have been equated. To benefit from the most economical purchase arrangement, orders should be placed in the quantity of 300 units rather than 100, 200, or 600. Thus, over the year, eight orders would be placed and average base inventory would be 150 units. The impact of ordering in quantities of 300 rather than 200 can be observed. An EOQ of 300 implies that additional inventory in the form of base stock has been introduced into the system. Average inventory has been increased from 100 to 150 units on hand. While the EOQ model determines the optimal replenishment quantity, it does require some rather stringent assumptions. The major assumptions of the simple EOQ model are:

- All demand is satisfied
- Rate of demand is continuous, constant, and known
- Replenishment performance cycle time is constant and known
- Constant price of product that is independent of order quantity or time
- Infinite planning horizon
- No interaction between multiple items of inventory
- No inventory is in transit
- No limit is placed on capital availability

The constraints imposed by some of these assumptions can be overcome through computational extensions. However, the EOQ concept illustrates the importance of the trade-offs associated with inventory carrying and replenishment ordering cost. Relationships involving the inventory performance cycle, inventory cost, and economic order formulations are useful for guiding inventory planning. First, the EOQ is found at the point where annualized order cost and inventory carrying cost are equal. Second, average base inventory equals one-half order quantity. Third, the value of the inventory unit, all other things being equal, will have a direct relationship with replenishment order frequency. In effect, the higher the product value, the more frequently it will be ordered.

3.4.3 Safety Stock

3.4.3.1 Role of Safety Stock

No matter how hard a firm tries to meet customers' requirements in terms of quantity and delivery, there are forces at work which will result in the firm falling short. Besides customers' demands, other forces are at play include shipping delay, quality issues, discrepancies at inbound area, pilferage etc. While excess stock is a major concern, here, we will focus on the shortages, i.e. when demand exceeds quantity on hand. Safety stock can be referred to stock that would be used if there is an unusual peak demand. This definition implies that during normal demand, safety stocks will be dormant, waiting to be used when demand surges. Implicitly, this will be a permanent layer of stock, adding to the increased inventory costs. Usually, customer service is defined as number of orders which can be satisfied out of the total demands for a specified period. Supply chain managers often have to weigh the balance of increasing service level versus the increase in inventory level. In spite of such attempts, shortages are not uncommon. There are two types of shortages:

- **Out-of-Stock:** This is a planned situation. An example is when there is no demand, the stock is set to zero or the stock may be zero until a customer demands it.
- **Stock-Out:** This is unplanned situation and any zero stock is undesirable. This condition can heightened customer dissatisfaction.

In order to minimize stock-outs, organizations do consider safety stocks as an option. The choice of safety stocks will depend on:

- Company's customer service philosophy.
- Customer service level e.g. no of stock-outs per period.
- Stock investment.
- Cost of stock-out versus cost of non-stock-out.
- Product life cycle (PLC).

3.4.3.2 Safety Stock Techniques

There are generally three methods of computing safety stocks:

- **Statistical Method:** The level of safety stock is computed using statistics, based on the historical demand. It uses deviation of forecast and actual demand.

Safety stock = $Z + \sigma * \sqrt{LT}$

Where Z = service level, σ = standard deviation, LT = lead-time

- **Fixed Method:** The level of safety stock is fixed, ignoring the usage rate.
- **Time Method:** The level of safety stock is determined by looking at the future demand of items.

3.4.4 Product Classification

Inventory control is the managerial procedure for implementing an inventory policy. The accountability aspect of control measures units on hand at a specific location and tracks additions and deletions. Accountability and tracking can be performed on a manual or computerized basis. An integrated inventory management strategy defines the policies and process used to determine where to place inventory, when to initiate replenishment shipments, and how much to allocate. The strategy development process employs three steps to classify products and markets, define segment strategies, and operationalize policies and parameters. The objective of product/market classification is to focus and refine inventory management efforts. Product/market classification groups products, markets, or customers with similar characteristics to facilitate inventory management. The classification process recognizes that not all products and markets have the same characteristics or degree of importance. Sound inventory management requires that classification be consistent with enterprise strategy and service objectives. Classification can be based on a variety of measures. The most common are sales, profit contribution, inventory value, usage rate, and nature of the item. The typical classification process sequences products or markets so that entries with similar characteristics are grouped together. The products are classified in descending order by sales volume so that the high-volume products are listed first, followed by slower movers. Classification by sales volume is one of the oldest methods used to establish selective policies or strategies. The 80/20 Pareto's rule, which is based on widespread observations, states that for a typical enterprise 80% of the sales volume is typically accounted for by 20% of the products. A corollary to the rule is that 80% of enterprise sales are accounted for by 20% of the customers. The reverse perspective of the rule would state that the remaining 20% of sales are obtained from 80% of the products, customers, etc. In general terms, the 80/20 rule implies that a majority of sales results from a relatively few products or customers. Once items are classified or grouped, it is common to label each category with a character or description. High-volume, fast-moving products are often described as "A" items. The moderate volume

items are termed the "B" items, and the low-volume or slow movers are known as "C" items. These character labels indicate why this process is often termed ABC analysis. While fine-line classification often uses three categories, some firms use four or five categories to further refine classifications. Grouping of similar products facilitates management efforts to establish focused inventory strategies for specific product segments. For example, high-volume or fast-moving products are typically targeted for higher service levels. This often requires that fast-moving items have relatively more safety stock. Conversely, to reduce overall inventory levels, slower-moving items may be allowed relatively less safety stock, resulting in lower service levels. In special situations, classification systems may be based on multiple factors. For example, item gross margin and importance to customers can be weighted to develop a combined index instead of simply using sales volume. The weighted rank would then group items that have similar profitability and importance characteristics. The inventory policy, including safety stock levels, is then established using the weighted rank.

3.5 Lead Time Issues and Bullwhip Effect

3.5.1 Lead Time Issues of Inventory

Superiority in cost, quality, delivery, and technological performance do not always guarantee success for a supply chain. Organizations must also be able to compete on the basis of time. This does not mean that cost, quality, delivery, and technology considerations are no longer important; conversely they are critically important. However, individual organizations and supply chains must be vigilant and competitive in these areas and be able to get their products and services to their customers faster than the competition. Increasingly, organizations are realizing that they are competing on the basis of time. In fact, reducing the time required to provide the end customer with products or services is one of the major forces leading organizations to participate in all supply chain management initiatives. Adopting an integrated supply chain management approach provides the means to make significant reductions in the cycle time required to move materials among supply chain members to the end customer. Several authors have shown time to be a highly effective area in which to focus overall improvement efforts within an organization. The opportunity for improvement appears to be even greater in an inter-organizational supply chain environment. This time-sensitive environment presents new challenges and opportunities for the individual organizations and their supply chains. This section introduces the concept of cycle time, presents common causes of lengthy cycle times, discusses an approach for making cycle time improvements, and proposes

several critical success factors that should be considered as part of the cycle time reduction initiatives.

Cycle time is the total elapsed time required to complete a business process. Too often only a small percentage (e.g. 3% to 5%) of the total elapsed time required to complete a process has anything to do with the real work. The rest of the time is typically devoted to a wide range of counterproductive, time-consuming activities and events. Identifying, improving, and/or eliminating these time-consuming activities represent one of the major supply chain management opportunity areas. However, cycle time reduction is not just about completing a process quickly (i.e., speed for the sake of speed); it is concerned with completing the given process effectively. By focusing on key processes, supply chain member organizations can significantly improve cycle time performance to lend more competitive advantages for the supply chain.

A number of causes of long process cycle times can be found in a supply chain environment. In examining supply chain processes, typically one or more of the following causes will be present. Several common causes of long process cycle times and key issues that should be addressed when these situations are encountered include, but are not limited to, the following:

Waiting

In many multi-step processes, significantly more time is devoted to waiting between processed steps than is spent in all of the processing steps combined. Following questions should be addressed:

- Where are the longest waits occurring in the process?
- What are the causes of these delays?
- What actions can be taken to reduce or eliminate the time spent waiting?
- Does the organization or supply chain need additional capacity in terms of facilities, equipment, or personnel?

Non-Value-Added Activities

The key processes found in many supply chains have existed for many years. When examining supply chain processes, it is worthwhile to determine the value that is being added by the overall process and individual process activities. It is not uncommon to find processes or activities within a process that were essential at one time, but that now add little or no value. Activities that do not add value should be eliminated. We should address following questions:

- Is this process necessary?
- Do all activities in the process add value?
- Is the adding value process activity being conducted in the best possible way given current practices and available technologies?

Serial versus Parallel Operations

Many supply chain process activities are conducted serially (sequentially). We should investigate whether there are opportunities for them to take place in a parallel manner.

Repeating Process Activities

A significant cause of poor supply chain cycle time performance is repeating process steps due to product or service quality problems. We should address the following questions:

- Are parts of the process repeated due to inability to get it right the first time?
- What are the causes of these problems?
- What actions are necessary to resolve these problems?

Batching

Batching occurs when some quantity of materials or orders is accumulated at one step in the process or organization in the supply chain before it is released to the next process step or supply chain member organization. The rationale for batching should be economic and cost-focused only. For example, a firm might wish to take advantage of lower transportation rates by batching orders to create larger shipment quantities. In such circumstances, however, the firm should periodically revisit the situation to be sure that the savings associated with the batch approach are worth the additional time required.

Excessive Controls

How much time is spent and potentially wasted following the rules and regulations governing processes within and among supply chain member organizations? A common internal example of this situation is seen in purchase order processing. We should answer following questions:

- How many signatures are needed for a purchase order?
- How many of these signatures are merely being rubber stamped?

We do not mean to imply that all controls should be abandoned. However, organizations would be well served to periodically review the

controls it uses to govern both internal and external supply chain processes, and determine if the level of control provided is worth the associated cost. A periodic cost/benefit analysis for intra-organizational and inter-organizational controls as they apply to the supply chain is likely to be time well spent. Many organizations discover that their rules and regulations serve only to increase their response time, and that many of these control mechanisms are more of a burden than a benefit.

Lack of Synchronization in Materials Movement

- Are materials being moved across the supply chain in the most effective manner?
- Are product movements across the supply chain managed so as to ensure that the right quantity of the right product is getting to the right location at the right time?
- Are materials arriving at customer's location too early (causing additional storage costs and materials handling activities), or too late (disrupting customer's operations) and so doing damaging the supplier's reputation?

Ambiguous Goals and Objectives

- Do all supply chain members clearly understand the overall supply chain goals and objectives?
- Do all of them understand what their organization must contribute for the overall supply chain to be successful?

Poorly Designed Procedures and Forms

- Do the procedures and forms associated with a specific process lead to the efficient completion of the process or only create more work while adding little value?

Outdated Technology

- Are the supply chain members making the best use of available technology?
- How is key information communicated across the supply chain?
- Are purchasing orders transmitted from the buyer to the supplier by fax, EDI, Internet, or by traditional mail?
- Are warehousing operations within the supply chain utilizing a high level of automation or are they primarily manual operations?

Lack of Information

The cycle time for supply chain decision making is often lengthy owing to the time needed to gain access to the information required. The required information may originate within the decision-making organization or other supply chain member organizations.

- Do decision makers have the information they need, when they need it, and in the desired format?
- How much time is being spent identifying, collecting, and manipulating the information required to make a decision versus making the actual decision?

Poor Communication

Intra-organizational and inter-organizational communications are critical to overall supply chain performance.

- Do managers have the necessary lines of communication been established across the supply chain member organizations?
- Do managers within supply chain know whom to contact in other functional areas within their own organization, as well as in other supply chain organizations, if problems appeared?

Limited Coordination

Coordinating supply chain processes is important factor in determining supply chain performance.

- Do all parties involved in a given process have a clear understanding of their respective roles and associated responsibilities?
- Are the inter-organizational processes effectively coordinated?
- Are there any engagements to ensure that the desired level of coordination is maintained?

Limited Cooperation

If all supply chain members not truly committed to management initiative, it is time to reevaluate the membership of those organizations that lack the required level of commitment. Cycle time and overall supply chain performance hinges on the cooperative efforts of the member organizations. We should be sure that all organizations have the appropriate cooperative philosophy.

Lack of/Ineffective Training

Proper training reduces the time for people to become proficient in their jobs and also can lead to ongoing improvements.

- Do we have all people involved in supply chain processes received adequate training for their specific jobs?
- Are there ongoing training opportunities for employees that focus on supply chain performance improvement in general and cycle time reduction in specific?

3.5.2 Bullwhip Effect

Lead-time issues can lead to problems in supply chains. One of these effects is the bull whip effect. One of the main challenges in supply chains is dealing with variability, which seems to occur if one does not monitor and control it. It is a known fact that for all metrics, they vary around an average value. If the variations swing wildly, then supply chain managers need to manage these and minimize them as the greater the variability the more difficult and expensive is to run the chain. Supply chains are particularly vulnerable to variability because of the sequence and interdependence of activities across the entire supply chains. A delay, no matter how small, will cascade down the chain and creating havoc in inbound, storage, production and finally shipment and delivery. The inventory presented so far is used to cope with variability. Inventory acts as a buffer and balancer that protect against supply variability. Even with inventory, variability is manifested in many forms. These include but not limited to the following:

- Quality issues.
- Delivery issues.
- Forecasting issues.
- Demand issues.

The flow of inventory is often down the chain, from suppliers to end users. Supply variability in this case is amplified down the chain. Demand variability can also be amplified up the chain. This observation holds across most industries. The result is increased cost and poorer service. Sources of variability can be demand variability, quality problems, strikes, plant shutdowns and many others. Variability with time delays in the transmission of information up the chain and time delays in the manufacturing and shipment down the chain create the bullwhip effect. A small variation in demand at the retailer makes it amplified up the supply chain. A small

change in finished goods is experienced quite differently at the supplier's end. There is a big swing for raw materials. Some of the causes of bullwhip effect are:

- Overreaction to backlogs.
- Neglecting to order in an attempt to reduce inventory.
- No communication and coordination up and down the supply chain.
- Delay in information and material flows.
- Order batching.
- Shortage gaming.
- Demand forecast (adding another layer of buffer to the demand estimates).

Some of the strategies that have been usually used in order to minimize the bullwhip effect are:

Order Batching: EDI (*Electronic Data Interchange*) is used to capture real demand. Random peak demand is countered by more frequent small orders. And smaller orders have smaller variance. When a downstream entity orders more often, it will not see a reduction in its own demand variance. This is not critical. What is more critical is that the upstream entity sees a reduction in demand variance.

Demand Signaling: Lack of demand visibility can be addressed by either EDI or e-POS. Another method is the use of VMI. There is only one point of control of inventory demand and hence demand variability can be minimized.

Shortage Gaming: Unrestricted ordering is not allowed. Entities can reserve a fixed quantity per year and then specify ordering quantities per order, as long as the total quantity at the end of the year is equal to the reserved quantity. For this system to work, information must be shared with all upstream partners in the supply chain.

Delivery Synchronization: There ought to be agreement at the start of the lead-time and quantity.

Fluctuating Prices: Often, when there is speculation, material prices will swing upwards. Contracts need to be negotiated upfront in order to stabilize the supply chains without the purchasing department constantly haggling prices. The end result could see a speculative build-up of inventory in the supply chain. Speculations have the characteristics of feeding itself. Retailers in attempts to secure inventory will increase demand further fueling the virtual accumulation of inventory.

The flow of inventory in supply chains is critical to the efficiency of supply chains. While inventory is an important component, it carries risks in terms of costs. On one hand, inventory is kept as supply is subject to variability and demand can be erratic. The challenge is therefore to maintain a balance between the supply and demand sides. Keeping too much stock while is comforting but decreases the efficiency of supply chains. Having a low inventory can be devastating to customer service level. Firms attempt to address the bullwhip effect by different strategies via EDI, JIT delivery, Lean approach and others including safety stocks. Safety stocks are not a perfect answer. It provides protection when there is peak demand, but supply chain managers have take steps to monitor and control them.

Chapter - 4

Transport and Distribution

Objectives

- Understand the importance of efficient transportation and distribution to SCM.
- Understand and implement pricing and distribution strategies and their trade-offs.

4.1 Transport Functionality, Principles and Participants

4.1.1 Role of Transportation to Supply Chain

The role of transportation in supply chain and logistics operations has changed dramatically over the last decades. Prior to deregulation, the purchase of transportation service could be likened to buying a commodity such as coal or grain. There was very little difference between transportation service suppliers in terms of product, quality and price. Transportation deregulation in 1980 introduced pricing flexibility and significantly increased the range of services transportation companies could provide customers. Today a wide range of transport alternatives are available to support product or raw material supply chain. For example, supply chain managers may integrate private own with for-hire transportation to reduce total logistics costs. Many for-hire carriers offer a wide variety of value-added services such as product sortation, sequencing, customized freight delivery and presentation. Technology has enhanced real time visibility of where freight is throughout the supply chain and when it will be delivered. Precise product delivery reduces inventory, storage, and materials handling. As such, the value of transportation has become greater than simply moving product from one location to another. Transportation and inventories are the primary cost-absorbing logistics activities. Transportation adds “place value” to products and services, whereas inventories add “time value”. Transportation is essential because no modern firm can operate without providing for the movement of its raw materials and/or finished products from one place to the next place of business process. This essential nature is underscored by the financial strains placed on many firms by so-called

national disasters, such as a national railroad strike or independent truckers' refusal to move goods because of rate disputes. In these circumstances, markets cannot be served, and products back up in the supply chain pipelines to deteriorate or become obsolete. Supply chain is about creating value for customers and suppliers of the firm, and value for the firm's stakeholders. As mentioned above, value in supply chain is expressed in terms of time and place. Products and services have no value unless they are in the possession of customers when (time) and where (place) they wish to consume them. Good supply chain management views each activity in the supply chain as contributing to the process of adding value. If little value can be added, it is questionable whether the activity should exist. However, value is added when customers are willing to pay more for a product or service than the cost to place it in their hands. For many firms throughout the world, supply chain management has become an increasingly important value-adding process for a number of reasons and transportation is one of the key supply chain value-adding activities.

4.1.2 Transport Functionality

Transportation is a very visible element of the supply chain. Consumers are accustomed to seeing trucks and trains transporting product or parked at business facilities. Few consumers fully understand just how dependent our economic system is upon economical and dependable transportation. Transportation enterprises provide two major services: Product Movement and Product Storage.

Product Movement

Whether in the form of materials, components, work-in-process, or finished goods, the basic value provided by transportation is to move inventory to the next stage of the business process. The primary transportation value proposition is product movement up and down the supply chain. Transportation is vital to procurement, manufacturing, and market distribution. Transportation also plays a key role in reverse logistics. Without reliable transportation, most commercial activity could not function. Transportation consumes time, financial, and other resources. It uses time resources because product is generally inaccessible during the movement process. Product captive to the transport system is referred to as in-transit inventory. Naturally, when designing supply chain systems, managers strive to reduce in-transit inventory to minimum. Transportation also uses financial resources. Transportation cost results from driver labor, vehicle operation, capital invested in equipment and administration. In addition, cost results from product loss and damage. Transportation also uses environmental

resources. In direct terms, transportation companies constitute largest consumers of fuel and oil. Indirectly, transportation impacts the environment through congestion, air pollution, and noise pollution.

Product Storage

A less visible aspect of transportation is product storage. While a product is in a transportation vehicle, it is being stored. Transport vehicles can also be used for product storage at shipment origin or destination, but they are comparatively expensive storage facilities. Since the main value proposition of transportation is movement, a vehicle committed to storage is not otherwise available for transport. A trade-off exists between using a transportation vehicle versus temporarily keeping products in a warehouse. If the inventory involved is scheduled to move within a few days to a different location, the cost of unloading, warehousing, and reloading the product may exceed the temporary charge of using the transportation vehicle for storage. Another form of temporary product storage is diversion. Diversion occurs when a shipment destination is changed while product is in transit. Traditionally, telephone was used to implement diversion strategies, but satellite communication between enterprise headquarters and vehicles allows more efficient diversion. While diversion is primarily used to improve logistical responsiveness, it also impacts transit storage. So although costly, product storage in transportation vehicles may be justified from a total cost or performance perspective when loading or unloading costs, capacity constraints, and ability to extend lead times are considered.

4.1.3 Transport Principles

There are two fundamental economic principles that impact transportation efficiency: Economy of Scale and Economy of Distance.

Economies of Scale

The cost per unit of weight decrease as the size of a shipment increases. For example, truckload shipments that utilize an entire vehicle’s capacity have lower cost per pound than smaller shipments that utilize a limited portion of vehicle capacity. It is also generally true that larger capacity transportation vehicles such as rail and water are less costly per unit of weight than smaller capacity vehicles such as trucks and air. Transportation economies of scale exist because fixed cost associated with moving a load is allocated over the increased weight. Fixed costs include administration related to scheduling, cost of equipment, time to position vehicles for loading or unloading, and invoicing. Such costs are considered fixed because they do not vary with shipment size.

Economy of Distance

This refers to decreased transportation cost per unit of weight as distance increases. For example, a shipment of 1000 km will cost less to perform than two shipments of the same weight each moving 500 km. Transportation economy of distance is often referred to as the tapering principle. The rationale for distance economies is similar to economies of scale. Specifically, longer distances allow fixed cost to be spread over more miles, resulting in lower per mile charges. These scaling principles are important when evaluating transportation alternatives. The goal from a transportation perspective is to maximize the size of the load and the distance being shipped while still meeting customer service expectations.

4.1.4 Transport Participants

The transportation environment impacts the range of decisions that can be implemented in a logistical system. Unlike commercial transactions, transportation decisions are influenced by the involvement of six parties: Shipper (consigner); Destination party (consignee); Carriers and agents; Government; Internet; The public.

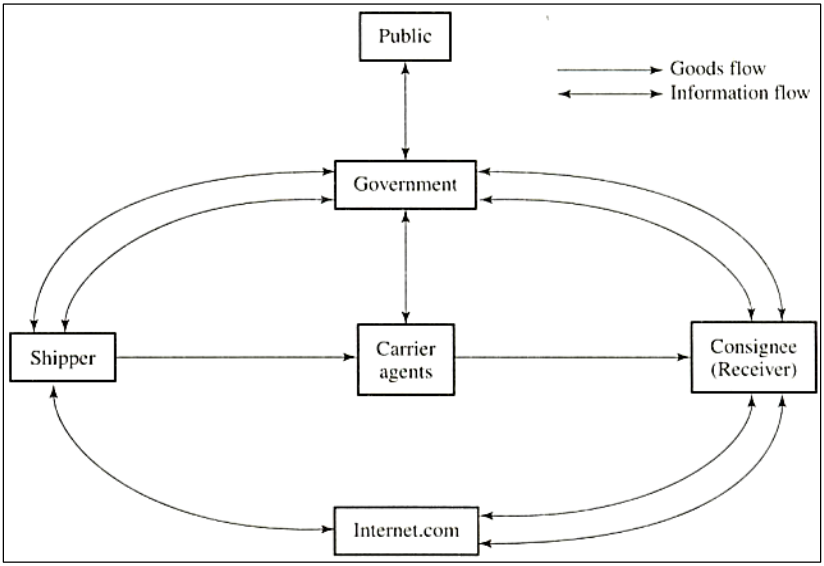

Fig 12: Relationships between Transportation Participants

Source: Based on VLI internal teaching materials

Figure 12 illustrates relationships among the involved parties. To understand the complexity of the transportation environment it is useful to review the role and perspective of each party.

Shipper and Consignee

The shipper and consignee have a common interest in moving goods from origin to destination within a given time at the lowest cost. Services related to transportation include specified pickup and delivery times, predictable transit time, and zero loss and damage as well as accurate and timely exchange of information and invoicing.

Carrier Agents

The carrier, a business that performs a transportation service, desires to maximize its revenue for movement while minimizing associated costs. As a service business, carriers want to charge their customers the highest rate possible while minimizing labor, fuel, and vehicle costs required. To achieve this objective, the carrier seeks to coordinate pickup and delivery times in an effort to group or consolidate many different shippers' freight into movements that achieve economy of scale and distance. Brokers and freight forwarders are transport agents that facilitate carrier and customer matching.

Government

The government has a vested interest in transportation because of the critical importance of reliable service to the economy and society. Stable and efficient transportation environment are desired to support national economic growth. A stable and efficient transportation environment requires that carriers provide essential services at reasonable cost. Because of the direct impact of transportation on economic success, governments have traditionally been more involved in providing the transportation service than any of other private commercial enterprises. Moreover, government also actively regulates carriers by restricting markets they could service and setting prices they could charge. Government also promotes carrier development by supporting research and providing right-of-way such as roadways and airports. In some countries government maintains absolute control over markets, services, and rates. Such control allows government to have a major influence on the economic success of regions, industries, or firms. The overall nature of transportation regulation has changed significantly over several past decades.

Internet

A recent development in the transportation industry is a wide assortment of Internet-based services. The primary advantage of Internet-based communication is the ability of carriers to share real time information with customers and suppliers. In addition to direct Internet communication

between businesses engaged in logistical operations, a wide variety of Web-based enterprises (services) have been launched in recent years. Such enterprises (services) typically provide two types of marketplaces. The first is a marketplace to exchange information for matching carrier freight capacity with available shipments. These Web-based services may also provide a marketplace to facilitate transactions. Beyond freight matching a second form of Internet-based information exchange relates to the purchase of fuel, equipment, parts, and supplies. Information exchange operating over the Internet provides carriers the opportunity to aggregate their purchasing and identify opportunities across a wide range of potential vendors. Finally, the use of the Internet as a communications backbone is rapidly changing the nature of transportation operations. The availability of real time information is improving shipment visibility to the point where tracing and tracking are no longer a challenge. In addition to real time visibility, the Internet can be used to share information concerning scheduling and capacity planning.

Public

This final transportation system participant is concerned with transportation accessibility, expense, and effectiveness as well as environmental and safety standards. The public indirectly creates transportation demand by purchasing goods. While minimizing transportation cost is important to consumers, concerns also involve environmental impact and safety. The effect of air pollution and oil spillage is a significant transportation-related social issue. The cost of environmental impact and safety is ultimately paid by consumers.

The formation of transportation policy is complex due to interaction between these six parties. Such complexity results in frequent conflict between shippers, consignees, and carriers. The concern to protect public interest served as the historical justification for government involvement in economic and social regulation.

4.2 Effective Transport System

Transportation usually represents the most important element in logistics costs for most firms. Freight movement has been observed to absorb between one-third (33%) and two-thirds (66%) of total logistics costs. Thus, the supply chain personnel need a good understanding of transportation matters. One needs only to contrast the economies of developed nations with those that are developing to see how important is the part that transportation plays to create high level of economic activity. It is typical in the developing nation that production and consumption take place in parallel; much of the

labor force is engaged in agricultural production; and a low proportion of the total population lives in urban areas (metropolis). With the advent of inexpensive and readily available transportation services, the entire structure of the economy changes toward that of developed nations. Large cities result from the migration of the population to urban centers, and the economic standard of living for the average citizen usually rises. More specifically, an efficient and inexpensive transportation system contributes to:

1) Greater Competition in the marketplace
2) Greater Economies of Scale in production
3) Reduced Prices for goods

Greater Competition

With a poorly developed transportation system, the extent of the market is limited to the areas immediately surrounding the point of production. Unless production costs are extremely low compared with those at a second production point, that is, the production cost difference offsets the transportation costs of serving the second market, not much competition is likely to take place. However, with improvements in the transportation system, products in distant markets can be competitive with other products selling in the same, home markets. In addition to encouraging direct competition, inexpensive, high-quality transportation also encourages an indirect form of competition by making goods available to a market that normally could not withstand the cost of transportation. Sales can actually be increased by penetrating markets normally unavailable to certain products. The goods from outside a region have a stabilizing effect on prices of all similar goods in the marketplace.

Economies of Scale

Wider markets can result in lower production costs. With the greater volume provided by these markets, more intense utilization can be made of production facilities and specialization of labor usually follows. In addition, inexpensive transportation cost also permits decoupling of markets and production sites. This provides a degree of freedom in selecting production sites such that production can be located where there is a geographic advantage.

Reduced Prices

Inexpensive transportation also contributes to reduced product prices. This occurs not only because of the increased competition in the marketplace but also because transportation is a component cost along with production,

selling, and other distribution costs that make up the aggregate product cost. As transportation becomes more efficient, as well as offering improved performance, society benefits through a higher stand of living.

4.3 Transport Cost Characteristics

The prices a logistician must pay for transportation services are pertained to the cost characteristics of each type of service. Just and reasonable transportation rates tend to follow the costs of producing the service. Because each service has different cost characteristics, under any given set of circumstances there will be potential rate advantages of one mode that cannot be effectively matched by other services.

4.3.1 Variable and Fixed Costs

A transportation service incurs a number of costs, such as labor, fuel, maintenance, terminal, roadway, administrative, and others. This cost mix can be arbitrarily divided into those costs that vary with services or volume (variable costs) and those that do not (fixed costs). Of course, all costs are variable if a long enough time period and a great enough volume are considered. For purposes of transport pricing, however, it is useful to consider costs that are constant over the normal operating volume of the carrier as fixed. All other costs are treated as variable. Specifically, fixed costs are those for roadway acquisition and maintenance, terminal facilities, transport equipment, and carrier administration. Variable costs usually include costs such as fuel, labor, equipment maintenance, handling, pickup and delivery. This is not a precise allocation between fixed and variable costs, as there are significant cost differences between transportation modes, and there are different allocations depending on the dimension being examined. All costs are partly fixed and partly variable, and allocation of cost elements into one class or the other is a matter of individual perspective.

4.3.2 Joint Costs

It was mentioned previously that reasonable transport rates are those that follow the costs of producing the service. Beyond the problem of deciding whether a cost is fixed or variable, determining what the actual costs are for a particular shipment requires some arbitrary cost allocations, even though the total costs of operating may not be known. The reason is that many transportation costs are indivisible. Many shipments in different sizes and weights move jointly in the same haul. The two important questions are to be answered: How much of the cost should be assigned to each of the shipments; and should the costs be assigned on the basis of shipment weight to total load, on the proportion of total cubic footage used, or on some other basis.

There is no simple formula for cost allocation, and production costs on a per-shipment basis remain a matter of judgment. The back haul that all carriers experience, with the exception of pipeline, is a case in point. Carriers rarely can perfectly balance the traffic between the forward movement and the return movement (back haul). By definition, the forward haul is the heavy traffic direction, and the back haul is the light traffic direction. Shipments in the back haul may be allocated their fair share of total costs of producing the back haul. This makes the cost per shipment high compared with the forward haul. The back haul may be treated as a by-product of the forward haul because it results from producing the forward haul. All, or most of the costs, are then allocated to forward-haul shipments. Back-haul costs would be considered zero, or assigned only the direct costs to move a shipment in the backhaul direction. There are several dangers in the latter approach. For one, rates on the forward haul may have to be set at a level that would restrict volume in this direction. Also, back-haul rates could be set low to help cover some fixed expenses. The effect may be that the back haul gains significantly in volume and possibly surpasses the forward-haul volume. A carrier then may find itself not meeting its fixed expenses and faced with rate adjustments that could greatly alter the traffic balance. The by-product has now become the main product. In addition, a significant difference in cost allocation and in rates that follow these costs may lead to questions of rate discrimination between forward-haul and back-haul shippers. The key to discrimination is whether the service in both directions is judged to be under essentially the same conditions and circumstances.

4.3.3 Cost Characteristics by Mode

The type of services that a carrier is likely to emphasize is indicated by the nature of the general cost function under which it operates and by the relationship of the function to those of other carriers.

Rail: As a transporter of freight and passengers, the railroad has the characteristics of high fixed cost and relatively low variable cost. Loading, unloading, billing and collecting, and yard switching of multiple-product, multiple-shipment trains contribute to high terminal costs for rail. Increased per shipment volume and its effect on reducing terminal costs result in some substantial economies of scale, that is, lower per-unit costs for increased per-shipment volume. Roadway maintenance and depreciation, terminal facilities' depreciation, and administration expenses also add to the level of fixed cost. Railroad line-haul (variable) costs typically include wages, fuel, oil, and maintenance. Variable costs by definition vary proportionately with distance and volume; however, a degree of indivisibility does exist in some

variable costs (labor, for example), so variable costs per unit will decrease slightly. Traditionally, variable costs have been taken as 33% to 50% of total costs, though there is a great deal of controversy over the exact proportion. The net effect of high fixed costs and relatively low variable costs is to create significant economies of scale in railroad costs. Distributing the fixed costs over greater volume generally reduces the costs per unit.

Water: The major capital investment that a water carrier makes is in transport equipment and, to some extent, terminal facilities. Waterways and harbors are publicly owned and operated. Little of this cost, especially for inland waterway operations, is charged back to water carriers. The predominant fixed costs in a water carrier's budget are associated with terminal operations. Terminal costs include the harbor fees, as the carrier enters a seaport, and the costs for loading and unloading cargo. Loading-unloading times are particularly slow for water carriers. High stevedoring costs make terminal costs almost prohibitive for all but bulk commodities and container freight where mechanized materials-handling equipment can be used effectively. These typically high terminal costs are somewhat offset by very low line-haul costs. Without user charges for the waterways, variable costs include only those costs associated with operating the transport equipment. Operating costs (excluding labor cost) are particularly low because of the minimal drag to movement at slow speeds. With high terminal costs and low line-haul costs, ton-mile costs drop significantly with distance and shipment size. Thus, water is one of the least-expensive carriers of bulk commodities over long distances and in substantial volume.

Air: Air transportation has many of the same cost characteristics as water carriers. Air terminals and the air space are generally not owned by the airline companies. Airlines purchase airport services as needed in the form of fuel, storage, space rental, and landing fees. If we include ground handling and pickup and delivery in case of airfreight operations, these costs are the terminal costs for air transportation. In addition, airlines own (or lease) their own equipment, which, when depreciated over its economic life, becomes an annual fixed expense. In the short run, airline variable expenses are influenced more by distance than by shipment size. Because an aircraft has its greatest inefficiency in the takeoff and landing phases of operation, variable costs are reduced by the length of haul. Volume has indirectly influenced variable costs as greater demand for air transportation services has brought about larger aircraft that have lower operating costs per available ton-mile. Combined fixed and variable expenses generally make air transportation a premium service, especially for short distances; however,

distribution of terminal expenses and other fixed charges over increased volume offers some reduction in per-unit costs. Substantial per-unit cost reduction comes from operating aircraft over long distances.

Pipeline: Pipeline parallels the railroad in its cost characteristics. Pipeline companies, or the oil companies that own the pipelines, own the pipe, terminals, and pumping equipment. They may own or lease the right-of-way for the pipe. These fixed costs plus others give pipeline the highest ratio of fixed cost to total cost of any mode. To be competitive, pipelines must work on high volume so as to spread these high fixed costs. Variable costs mainly include power to move the product (usually crude oil or refined petroleum products) and costs associated with the operation of pumping stations. Power requirements vary markedly, depending on the line throughput and the diameter of the pipe. Larger pipes have disproportionately less circumference to cross-sectional area as compared with smaller pipes. Frictional losses, and therefore pumping power, increase with the pipe circumference, and volume increases with the cross-sectional area. As a result, costs per ton-mile decrease substantially with larger pipes, provided that there is sufficient throughput to justify the larger pipe. There are also diminishing returns to scale if too large a volume is forced through a pipe of a given size.

Table 9: Transportation Modes Comparison

Mode	Prod-UCT Options	Speed	Accessibility	Cost	Capacity	Intermodal Capability	% of US Product Movement
Truck	Very Broad	Mode-rate	High	Mode-rate	Low	Very High	28%
Railroad	Broad	Slow	Mode-rate	Low	Mode-rate	Very High	41%
Air	Narrow	Fast	Low	Very High	Very Low	Moderate	<1%
Water	Broad	Very Slow	Mode-rate	Very Low	Very High	Very High	13%
Pipeline	Very Narrow	Very Slow	Low	Low	Very High	Very Low	17%
Digital	Very Narrow	Very Fast	Very High	Very Low	Mode-rate	Very Low	?

Source: https://www.knowthis.com/managing-product-movement/modes-of-transportation-comparison

Intermodal: Each mentioned method of transport has its advantages and disadvantages as stated above and shown in the table. Ideally, we should

combine the advantages of each method to create one innovative method. That's exactly what intermodal transportation is. Intermodal transportation combines various methods of transportation to give the fastest shipping time possible. Not only is this method time-efficient, it's cost-efficient as well. More shippers are taking advantage of the option to reap the benefits of the cost savings, environmental benefits, and highway safety results. With the lower rates, predictable pricing, standardized schedules of transit, and the general flexibility, intermodal transportation is continuing to rise in popularity.

4.4 Carrier Pricing Strategy

When setting rates to charge shippers, carriers typically follow one or a combination of two strategies. Although it is possible to employ a single strategy, the combination approach considers trade-offs between cost of service incurred by the carrier and value of service to the shipper.

Cost-of-Service

The cost-of-service strategy is a build-up approach where the carrier establishes a rate based on the cost of providing the service plus a profit margin. For example, if the cost of providing a transportation service is $200 and the profit markup is 10 percent, the carrier would charge the shipper $220. The cost-of-service approach, which represents the base or minimum for transportation charges, is most commonly used as a pricing approach for low-value goods or in highly competitive situations.

Value-of-Service

It is an alternative strategy that charges a price based on value as perceived by the shipper rather than the carrier's cost of actually providing the service. For example, a shipper perceives transporting 1000 pounds of electronics equipment as more critical or valuable than 1000 pounds of coal since electronics are worth substantially more than the coal. As such, a shipper is probably willing to pay more for transportation. Carriers tend to utilize value-of-service pricing for high value goods or when limited competition exists. Value-of-service pricing is illustrated in the premium overnight freight market. When FedEx first introduced overnight delivery, there were few competitors that could provide comparable service, so it was perceived by shippers as a high-value alternative. They were willing to pay 22 USD for overnight delivery of a single package. Once competitors such as UPS and the United States Postal Service entered the market, rates dropped to current discounted levels of 5 USD to 10 USD per package. This rate decrease reflects more accurately the value and cost of this service.

The combination pricing strategy establishes the transport price at an intermediate level between the cost-of-service minimum and the value-of-service maximum. In practice, most transportation firms use such a middle value. Logistics managers must understand the range of prices and the alternative strategies so they can negotiate appropriately.

Net-Rate Prices

In accordance with the simplified pricing format termed net-rate pricing rates are set individually with customers. Carriers are now, in effect, able to simplify pricing to fit an individual customer's circumstances and needs. The net-rate pricing approach does away with the complex and administratively burdensome discount pricing structure that has become common practice. Established discounts and accessorial charges are built into the net rates. In other words, the net rate is an all-inclusive price. The goal is to drastically reduce carriers' administrative cost and directly respond to customer demand to simplify the rate-making process. Shippers are attracted to such simplification because it promotes billing accuracy and provides a clear understanding of how to generate savings in transportation.

4.5 Distribution Strategy

Many of the principles and concepts that guide logistics and supply chain planning are derived from the unique nature of logistics activities, especially transportation. Others are a result of general economic and market phenomena. All give insight as to what the supply chain strategy might be and set the stage for more detailed analysis. Several of these will now be outlined and illustrated.

4.5.1 Total Cost Concept

Central to the scope and design of the supply chain and logistics system is trade-off analysis, which, in turn, leads to the total cost concept. The cost trade-off is the recognition that cost patterns of various activities of the firm frequently display characteristics that put them in conflict with one another. This conflict is managed by balancing the activities so that they are collectively optimized.

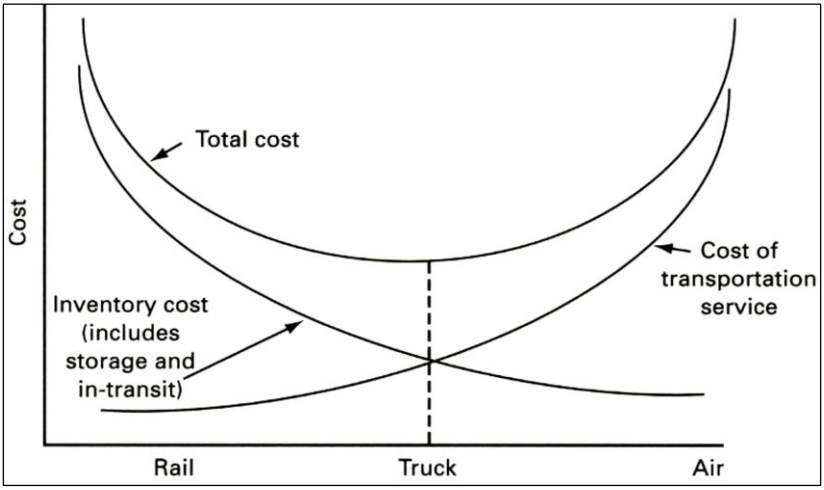

Fig 13: Cost Conflict between Transportation and Inventory as Functions in Supply Chain Management

Source: Own development

For example, Figure 13 shows that when a transportation service is being selected, the direct cost of the transport service and the indirect cost effect on inventory levels in the logistics channel due to different delivery performance of carriers are said to be in cost conflict with each other. The best economic choice occurs at the point where the sum of both costs is lowest, as indicated by the dashed line in Figure 13. Choosing a transportation service on the basis of either lowest rates or fastest service may not be the best method. Therefore, the basic problem in supply chain is one of cost-conflict management. Wherever there are substantial cost conflicts among activities, they should be managed in a coordinated manner. The network incorporates most of the potential cost conflicts relevant to supply chain and logistics.

The total cost concept applies to more than the problem of selecting transportation service. Additional examples of logistics problems, where a trade-off of costs is indicated, are shown in Figure 14.

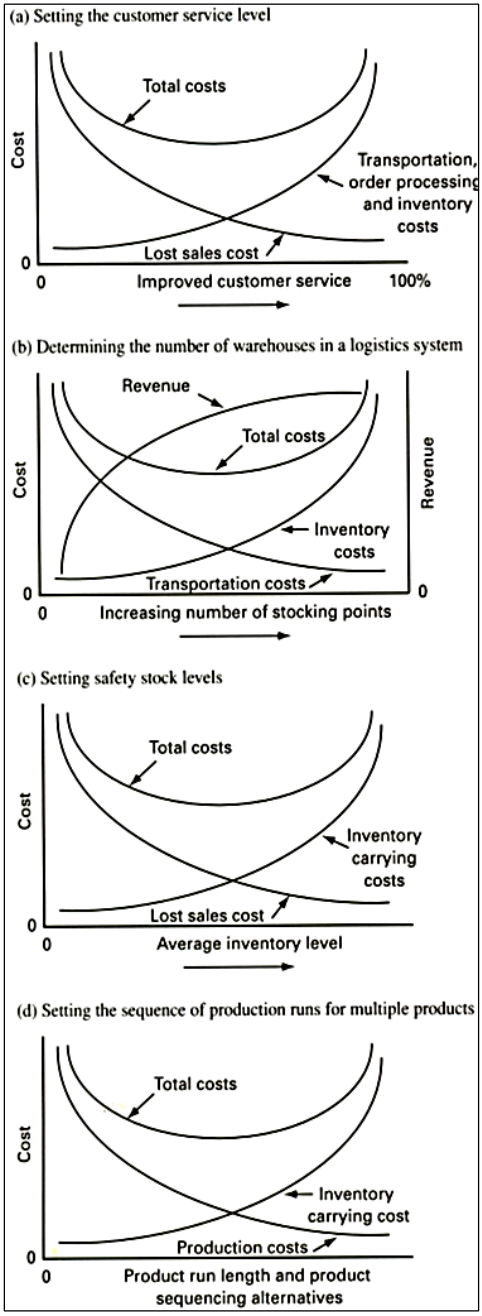

Fig 14: Trade-Offs in Supply Chain and Logistics Systems

Source: Own development.

Figure 14(a) illustrates the problem of setting the customer service level. As customers receive a higher level of service, fewer of them are lost as a result of out-of-stock situations, slow and unreliable deliveries, and inaccurate order filling. Putting simply, the cost due to lost sales is decreasing with improved service. Counterbalancing the lost sales cost is the cost of maintaining the level of service. Improved service usually means that more must be paid for transportation, order processing, and inventories. The best trade-off occurs at a point below 100 percent (perfect) customer service.

Figure 14(b) shows the basic economic considerations in determining the number of stocking points in a logistics network. Where customers purchase in small quantities and stocking points are replenished in large quantities, the cost of transportation from the stocking points exceeds the inbound costs so that transportation costs decline when the number of stocking points is increased. However, as the number of stocking points increases, the inventory level for the entire network increases, and inventory costs rise. In addition, the customer service level is affected by this decision. The problem is one of balancing the combined inventory-transportation costs against the contribution to revenues from the customer service level provided.

Figure 14(c) illustrates the problem of setting the safety stock level for inventories. Because safety stock increases the average level of inventories and also affects the customer service level through the availability of stock when an order is placed, the cost of lost sales declines. Increasing the average level of inventories will increase the inventory carrying cost. Transportation costs remain relatively unaffected. Again, a balance is sought between these opposing costs.

Figure 14(d) shows the basic features of a multiple-product scheduling problem. Production costs are affected by the sequence in which the products are produced and the length of production runs. As the production sequence is changed, inventory costs will increase, because orders will not necessarily be received at the optimum time to replenish depleted stocks. The effect is to raise the average inventory level. The best production sequence and run length in which to produce the products are found where the combined production and inventory costs are minimized.

These examples illustrate the total cost concept as applied to the internal problems of the firm and specifically to logistics problems. However, at times, decisions made by a firm in a channel of distribution affect the logistics costs of another firm. For example, the inventory policies of a buyer

affect both the inventory costs of the shipper and the operating costs of the carrier. In this case, it is necessary to extend the boundaries of the system beyond either the logistics function or the firm, possibly to include several firms. Thus, the total cost equation would be expanded, and the scope of management decision-making would extend beyond the legal limits of the firm. The point is that the total cost, or alternately the total supply chain system, concept is a concept without clear boundaries. Although one might argue that in some way all activities of the entire economy are economically related to the supply chain problem of the firm, to attempt to assess all the various cost trade-offs that might relate to any decision problem is folly. It is left to the judgment of management to decide which factors to consider relevant and to include them in the analysis. This defines whether the total cost analysis will include only factors within the supply chain and logistics function as we have defined it or whether the analysis should be extended to include other factors under the control of the firm and even some beyond the immediate control of the firm.

4.5.2 Differentiated Distribution

Not all products should be provided the same level of customer service. This is a fundamental principle for logistics planning. Different customer service requirements, different product characteristics, and different sales levels among the multiple items that the typical firm distributes suggest that multiple distribution strategies should be provided within the product line. Managers have made use of this principle when they broadly classify their products into a limited number of groups such as high, medium, and low sales volume and then apply a different stocking level to each. To a lesser extent, the principle is also applied to inventory location. When a firm stocks all products at all warehouse locations, it may do so to simplify administration, but this strategy denies the inherent differences between products and their costs, and it leads to higher-than-necessary distribution costs. An improved strategy might be first to differentiate those products that should move through the warehouse from products that should be shipped directly to customers from plants, vendors, or other source points. Because the transportation rate structure encourages shipments in vehicle-load volumes, the products might first be divided according to shipment size. Those customers ordering in high-volume quantities would be served directly while all others would be served from warehouses. Of the sales volume remaining, the products should be differentiated by location. That is, the fast moving items should be placed in the field warehouses with the most forward locations in the distribution channel. Medium-volume items should

be placed in fewer regional locations. The slow moving items should be located only at centralized stocking points such as plants. As a result, each stocking point may contain a different product mix. Differentiated distribution may be applied to factors other than volume. That is, separate distribution channels may be established for regular customer orders and back orders. The regular distribution channel might be to fill orders from warehouses. When an out-of-stock situation occurs, backup distribution system may come into play that fills the order from secondary stocking points and uses premium transportation to overcome the disadvantage of increased delivery distances. Similarly, many other examples can be offered where multiple distribution channels give lower overall distribution costs than a single channel design.

4.5.3 Mixed Strategy

The concept of a mixed strategy is similar to that of differentiated distribution: A mixed distribution strategy will have lower costs than a pure, or single, strategy. Although single strategies may benefit from economies of scale and administrative simplicity, they are at an economic disadvantage when the product line varies substantially in terms of cube, weight, order size, sales volume, and customer service requirements. A mixed strategy allows an optimal strategy to be established for separate product groups. This often has lower costs than a single, global strategy that must be averaged across all product groups.

4.5.4 Postponement

The principle of postponement can be stated as: The time of shipment and the location of final product processing in the distribution of a product should be delayed until a customer order is received. The idea is to avoid shipping goods in anticipation of when demand will occur (time postponement) and to avoid creating the form of the final product in anticipation of that form (form postponement). There are broadly 05 types of postponement classification available to organizations that might be interested in applying the principle. Four types are form postponement (labeling, packaging, assembly, and manufacturing) and the final fifth is time postponement. Table 10 presents the types, table 11 presents the characteristics of the firms that are interested in using types of forms and time postponement.

Table 10: Types of Firms Interested in using Time and Forms of Postponement

Postponement type	Type of firms
Labeling	Firms selling a product under several brand names
	Firms with high unit value products
	Firms with high product value fluctuations
Packaging	Firms selling a product under several package sizes
	Firms with high unit value products
	Firms with high product sales fluctuations
Assembly	Firms selling products with several versions
	Firms selling a product whose cube is greatly reduced if shipped unassembled
	Firms with high unit value products
	Firms with high product sales fluctuations
Manufacturing	Firms selling products with a high proportion of ubiquitous materials
	Firms with high unit value products
	Firms with high product sales fluctuations
Time	Firms with high unit value products
	Firms with a large number of distribution warehouses
	Firms with high product sales fluctuations

Source: Own development based on VLI internal teaching materials

Table 11: Characteristics of Firms Interested in using Time and Forms of Postponement

Technology and Process Characteristics	
	Feasible to decouple primary and postponed operations
	Limited complexity of customizing
	Modular product design
	Sourcing from multiple locations
Product characteristics	
	High commonality of modules
	Specific formulation of products
	Specific peripherals
	High value density of products
	Product cube and/or weight increases through customization
Market Characteristics	
	Short product life cycles
	High sales fluctuations
	Short and reliable lead times

	Price competition
	Varied markets and customers

Source: Own development

4.5.5 Consolidation

Creating large shipments from small ones (consolidation) is a powerful economic force in strategic planning. It is a result of the substantial economies of scale that are present in the transport cost-rate structure. Managers can use this concept to improve strategy. For example, customer orders arriving at a warehouse might be combined with orders received at a later time period. This would increase the size of the average shipment, which, in turn, would lower average per-unit shipping costs. Potentially reduced customer service resulting from increased delivery time must be balanced with the cost benefits of order consolidation. In general, the concept of consolidation will be most useful in strategy formulation when quantities shipped are small. That is, the smaller the shipment size, the disproportionately greater will be the benefits of consolidation.

4.5.6 Standardization

Variety exacts its price in the logistics channel. Proliferation of product variety can increase inventories and decrease shipment sizes. Just adding a new item to the product line that is similar to an existing one can increase the combined inventory levels of both items by 40% or more, even though total demand does not increase. The key question in strategy formulation is how to provide the variety in the marketplace that customers desire without dramatically increasing logistics costs. The use of the concepts of standardization and postponement in combination is often effective for this problem. Standardization in production is created by interchangeable parts, modularizing products, and labeling the same products under different brand names. This effectively controls the variety of parts, supplies, and materials that must be handled in the supply channel. The disadvantages of product variety are controlled in the distribution channel through postponement. For example, automakers create endless product variety without increasing inventories by adding or substituting options at the point of sale and creating multiple brands from the same basic components. Clothing manufacturers do not attempt to stock exact sizes that many customers require, but alter standard sizes to fit.

Chapter - 5

Measurement and Control

Objectives

- Understand the role of SCM performance measurement and control in driving business performance
- Balance various approaches to SCM performance measurement and control
- Nurse long term viability of company in terms of cost reduction

5.1 The Importance of Performance Measurement

Supply chain related costs might exceed a bulk of the cost of doing business. For this reason, better management of the supply chain offers the potential for large savings which can contribute to improved corporate profitability. In mature markets in which large percentage of sales increases are difficult to achieve and corporate profitability is continuously being eroded by increasing costs and competition it is necessary to look for ways to improve productivity. In many firms, supply chain has not been managed as an integrated system. Even in firms that have accepted the concept of integrated supply chain management, evidence suggests that the cost data required for its successful implementation are not readily available. The accurate measurement and control of supply chain related costs offers significant potential for improving cash flow and return on assets. In order to accurately assess the performance of an existing supply chain and its related processes, one must have objective performance information. Ideally, this information should cover the full range of performance areas, including, but not limited to:

- Products and services offered Sales
- Market share
- Cost
- Quality
- Inventory holdings

- Delivery
- Cycle times
- Assets utilized
- Responsiveness
- Customer service

Developing and maintaining a supply chain performance measurement system represents one of the most significant challenges faced in all supply chain management initiatives. However, if supply chains are to be improved, decisions need to be based on objective performance information and will require sharing of this type of information with key supply chain members. Organizational willingness to share information with other supply chain members is a critical selection criterion for supply chain membership. An organization that is willing to receive information from other supply chain members but is reluctant to share information is a poor candidate for inclusion in supply chain management initiatives. Benchmarking analysis has been proved to be an effective means of determining the supply chain's performance relative to those of other organizations. Cook (1995) defines benchmarking as “the process of identifying, understanding, and adapting outstanding practices from within the same organization or from other businesses to help improve performance”. This involves comparing practices and procedures to those of the best to identify ways in which an organization can make improvements. Thus new standards and goals can be set which, in turn, will help better satisfy the customer’s requirements for quality, cost, product and service. The steps typically found in the benchmarking process include:

a. Identify and understand current processes
b. Form a benchmarking team
c. Determine what to benchmark
d. Identify benchmarking partners
e. Collect data
f. Analyze data and identify performance gaps
g. Take actions to improve
h. Review results

Benchmarking provides a means to focus the supply chain management efforts on those areas most in need of improvement. Measurement is important, as it affects organizational and individual behavior that impacts

the performance of the supply chain. As such, performance measurement provides the means by which a company can assess whether its supply chain has been improved or degraded. There are several important factors pointing to the importance of measurement of the supply chain's performance. Measurements are important directly to controlling behavior and indirectly to performance in terms of achieving the supply chain's improvement objectives:

- Drive achievement toward business goals
- Provide focus on business strategies
- Align employees' efforts toward objectives
- Sustain improved business performance
- Guide shifts in business direction
- Achieve balanced results across stakeholder groups

5.2 Total Cost Analysis and Trade-Offs

Back in the early time, the supply chain management concept did not exist, and only logistics was viewed as a fragmented and often uncoordinated set of activities spread throughout various organizational functions. However, many major corporations have since accepted the notion that a firm's total logistics costs can be lowered, customer service improved, and inter-departmental conflicts substantially reduced by the coordination of logistics activities. The advent of information technology, operations research techniques, and the system approach brought not only changes in transportation strategy, inventory control techniques, warehousing location policy, order processing systems, and logistics communication, but also the desire to manage the costs associated with these functions in an integrated format. Nowadays, accurate cost data are required for successful implementation of the integrated supply chain management concept using total cost analysis. They also are required for the management and control of logistics operations.

5.2.1 Total Cost Analysis Concept

Total cost analysis is one of the key concepts of managing supply chain functions. For a given level of customer satisfaction, the management is required to understand the need to maintain overall cost visibility rather than just focusing on individual cost element of individual activities. One of the shortcomings of non-integrative supply chain management related to cost performance control is that attempt to reduce specific costs within the supply chain function may be less than optimal for the system as a whole, leading to

greater total costs. Total supply chain costs do not correspond to cost cutting techniques individually geared to warehouse, transportation or inventory costs. Reductions in one cost invariably result in increases in one or more of the others. For example, aggregating all finished goods inventory into fewer distribution centers may minimize warehousing costs and increase inventory turnover, but it also may lead to increased transportation expense. Savings resulting from favorable purchase prices on large orders may be entirely offset by greater inventory carrying costs. Thus, to minimize total cost, management must understand the effect of trade-offs within the distribution function, and how various cost factors interact.

5.2.2 Cost Trade-Offs

It is also important to understand the concept of cost trade-offs when conduct total cost analysis for supply chain systems. Profit for the overall supply chain system can be enhanced if the cost trade-off is managed properly. For example, if the increase in inventory has a much greater impact on the customer service level and yields much better revenue over the cost of investment incurred to stock goods, or inventory carrying cost, then it is therefore a good trade-off to be made as there is a net benefit is doing so. If knowledgeable trade-offs are to be made, management must be able to account for the costs of each component and to explain how changes in each cost contribute to total costs. Usually, most managers are only concerned about their own functional costs or revenues and there is no total picture per se. That must be changed for a better supply chain performance management.

5.3 Approaches to Measure SCM Performance

Traditionally, companies have tracked performance based largely on financial accounting principles. Financial accounting measures are certainly important in assessing whether or not operational changes are improving the financial health of an enterprise, but they are insufficient to measure supply chain performance for the following reasons:

- The measures tend to be historically oriented and not focused on providing a forward-looking perspective
- The measures do not relate to the important strategic, non-financial performance, like customer service/loyalty and product quality
- The measures do not directly tie to the operational effectiveness and efficiency

In response to some of these deficiencies in traditional accounting methods for measuring supply chain performance, a variety of measurement approaches have been developed and adopted, including the following:

- The Balanced Scorecard (BSC)
- The SCOR Model (SCORM)
- The Logistics Scoreboard
- Activity-Based Costing (ABC)
- Economic Value Analysis (EVA)

5.3.1 The Balanced Scorecard

The Balanced Scorecard recommends the use of executive information systems (EIS) that track a limited number of balanced metrics that are closely aligned to strategic objectives. The approach was initially developed by Robert S. Kaplan and David P. Norton (1992) and was discussed in an article entitled "*The Balanced Scorecard-Measures That Drive Performance*" published in the *Harvard Business Review*, January-February 1992. While not specifically developed for supply chain performance measurement, the Balanced Scorecard principles provide excellent guidance to follow when doing it. The approach would recommend that a small number of balanced supply chain measures be tracked based on four perspectives:

- Financial perspective (e.g., cost of manufacturing and cost of warehousing)
- Customer perspective (e.g., on-time delivery and order fill rate)
- Internal business perspective (e.g., manufacturing adherence-to-plan and forecast errors)
- Innovative and learning perspective (e.g. new product development cycle time)

5.3.2 The SCOR Model

The SCOR, which stands for Supply Chain Operations Reference model was developed by Supply Chain Council (SCC). The Supply Chain Council is an independent, not-for-profit, global corporation with membership open to all companies and organizations interested in applying and advancing state-of-art supply chain management systems and practices. The model defines common supply chain management process and matches them against best practices. It provides companies with powerful tool in improving supply chain operations. It allows manufacturers, suppliers, distributors and retailers with a framework to evaluate the effectiveness of their supply chain operations and to target and measure specific process operations. The SCOR model was designed to enable companies to

communicate, compare and learn from competitors both within and outside of their industry. It not only measures supply chain performance but also effectiveness of supply chain reengineering. Further, it has the ability to test and plan future process improvements.

5.3.2.1 Process Reference Model

Process reference model integrate the concepts of business process reengineering, benchmarking, and process measurement into a cross-functional framework. A process reference model helps organizations capture the current and inherent state of a process with the objective to achieve the desired future state. Further, it allows organization to quantify the operational performance, establish internal targets based on best-in-class results in similar companies. It describes standard management processes, exploring relationship among different processes. It defines standard metrics to measure process performance and evaluate the management practices that produce the best-in-class performance. Finally it characterizes the management practices and software solutions that result in best-in-class performance. Process reference helps the complex management process be captured in standard process reference model. This in turn helps organization to communicate unambiguously and measure, manage, (re)tune specific process.

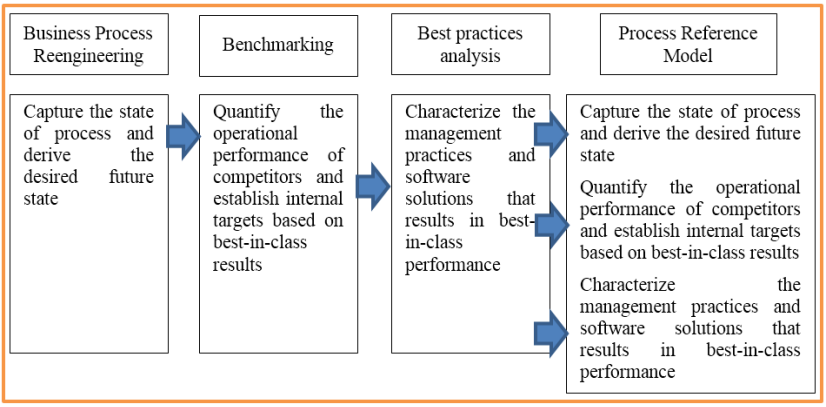

Fig 15: The Process Reference Model

Source: Based on VLI's internal teaching materials

5.3.2.2 Scope of SCOR Processes

The scope of SCOR processes includes the following:

- PLAN-Demand/Supply Planning and Management

- Balance resources with requirements and establish/communicate plans for the whole supply chain, including Return, and the execution processes of Source, Make, and Deliver.
- Manage the business rules, supply chain performance, data collection, inventory, capital assets, transportation, planning configuration, and regulatory requirements and compliance.
- Align the supply chain unit plan with the financial plan.
- SOURCE-Sourcing Stocked, Make-to-Order, and Engineer-to-Order Product.
- Schedule deliveries; receive, verify, and transfer product; and authorize supplier payments.
- Identify and select supply sources when not predetermined, as for engineer-to-order product.
- Manage business rules, assess supplier performance, and maintain data.
- Manage inventory, capital assets, incoming product, supplier network, import/export requirements, and supplier agreements.
- MAKE-Make-to-Stock, Make-to-Order, Engineer-to-Order Production Execution.
- 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, equipment and facilities, transportation, production network, and regulatory compliance for production.
- Deliver-Order, Warehouse, Transportation, and Installation Management for Stocked, Make-to-Order, and Engineer-to-Order Product.
- All order management steps from processing customer inquiries and quotes to routing shipments and selecting carriers.
- Warehouse management from receiving and picking product to load and ship product.
- Receive and verify product at customer site and install, if necessary.
- Invoicing customer.

- Manage deliver business rules, performance, information, finished product inventories, capital assets, transportation, product life cycle, and import/export requirements.
- RETURN-Return of Raw Materials (to Supplier) and Receipt of Returns of Finished Goods (from Customer), including Defective Products, MRO (Maintaining, Repairing, Operating) Products, and Excess Products.
- All return defective product steps from authorizing return; scheduling product return; receiving, verifying, and disposition of defective product; and return replacement or credit.
- Return MRO product steps from authorizing and scheduling return, determining product condition, transferring product, verifying product condition, disposition, and request return authorization.
- Return excess product steps including identifying excess inventory, scheduling shipment, receiving returns, approving request authorization, receiving excess product return in source, verifying excess, and recover and disposition of excess product.
- Manage return business rules, performance, data collection, return inventory, capital assets, transportation, network configuration, and regulatory requirements and compliance.

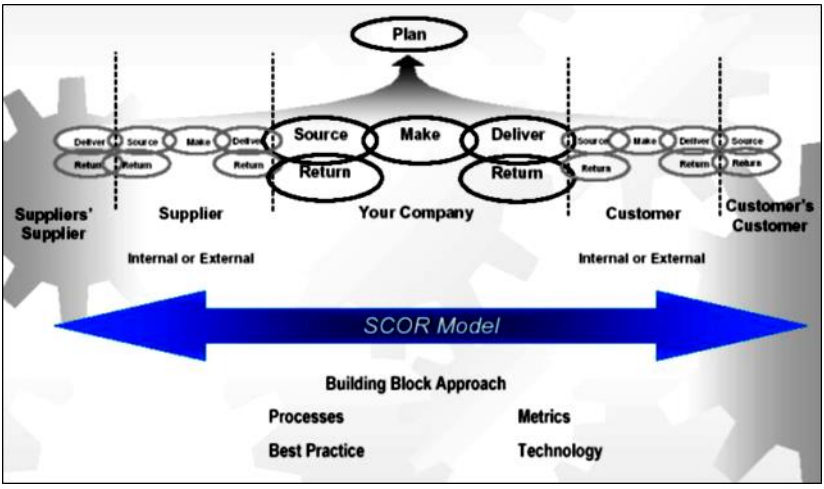

Fig 16: SCOR Model

Source: VLI's internal teaching materials

5.3.2.3 Four Levels of SCOR Process Model

- **Level 1:** Provides definition of the Plan, Source, Make, and Deliver process types. This is the point where a company establishes its supply-chain competitive objectives.
- **Level 2:** Defines 30 core process categories that are possible components of a supply chain. Organizations can configure their ideal or actual operations using these processes.
- **Level 3:** Provides the information required for successfully planning and setting goals for supply-chain improvements. This includes defining process element, setting target benchmarks, defining best practices, and system software capabilities to enable best practices.
- **Level 4:** Focuses on implementation, i.e. putting specific supply chain improvements into action. These are not defined within industry standard model, as implementation can be unique to each company.

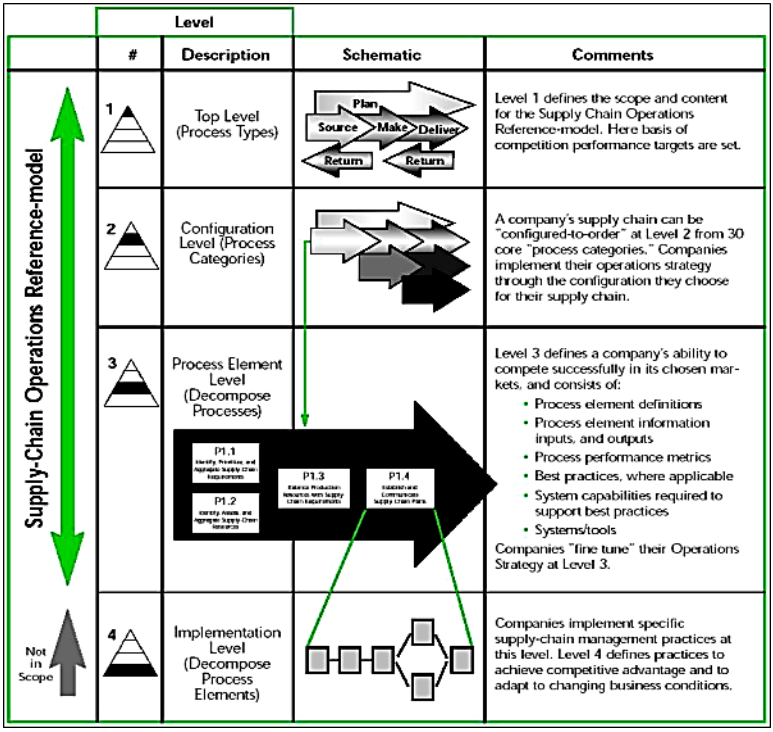

Fig 17: 04 Levels of SCOR Model

Source: VLI's internal teaching materials

5.3.2.4 Applications and Benefits of Using the SCOR Model

The SCOR model can be used in all kinds of companies. In the beginning users tend to feel like their company is an exception, but in the end they always discover that all companies have the same problems. The SCOR model is generic enough to be used in all industries. 7% of the Fortune 1000 companies accounting for 35% of the profits are Supply Chain Council (SCC) members and use SCOR on some level. The average profit margins of these companies are twice as high as the profit margins of non-SCC members. SCOR companies are thus in general more profitable than non-SCOR companies owing to the following benefits:

Delivery Lead-Time Improvement

Siemens medical, which is the winner of the SCC 2001 operational excellence award, is an exemplary SCOR model user. Siemens medical had cut its delivery lead times from 22 weeks to two weeks; it had increased its delivery reliability by 65% to 99.5%. This was achieved by using the SCOR model, implementing more direct distribution systems, increasing the percentage of goods that are made to order and implementing the Kanban system.

Supply Chain Process Improvement

Avon was striving to transform its supply chain using SCOR. Avon sells cosmetics directly to consumers with a network of agents. Avon's aims were similar to most companies: better asset performance, reduced inventories and improved forecasting. The objectives were to cut cycle times by over 50% and increase the perfect order rate to 90% from 62%. This was to be achieved by simplifying networks and processes and optimizing the manufacturing locations of different products. Supply chain planning was centralized, suppliers started managing inventories, the supply base was rationalized and manufacturing facilities were placed in eastern European countries with direct deliveries from two hubs. The SCOR model was used to map the processes. Process owners were named for the SCOR processes and a scorecard based on SCOR was used. The main benefits of using SCOR were increased common understanding, reduced problems in designing processes and forced integration between functions. SCOR is a key enabler for the process-based organization.

5.3.3 The Logistics Scoreboard

Another approach to measuring supply chain performance was developed by Logistics Resources International Inc. (Atlanta, GA), a

consulting firm specializing primarily in the logistical (i.e., warehousing and transportation) aspects of a supply chain. The company recommends the use of an integrated set of performance measures falling into the following general categories:

- Logistics financial performance measures (e.g., expenses and return on assets)
- Logistics productivity measures (e.g., orders shipped per hour and transport container utilization)
- Logistics quality measures (e.g., inventory accuracy and shipment damage)
- Logistics cycle time measures (e.g., in-transit time and order entry time)

In contrast to the other approaches discussed, The Logistics Scoreboard is prescriptive and actually recommends the use of a specific set of supply chain performance measures. These measures, however, are skewed toward logistics, having limited focus on measuring the production and procurement activities within a supply chain.

5.3.4 Activity Based Costing

The Activity-Based Costing (ABC) approach was developed to overcome some of the shortcomings of traditional accounting methods in tying financial measures to operational performance. The method involves breaking down activities into individual tasks or cost drivers, while estimating the resources (i.e., time and costs) needed for each one. Costs are then allocated based on these cost drivers rather than on traditional cost-accounting methods, such as allocating overhead either equally or based on less-relevant cost drivers. This approach allows better assessment of the true productivity and costs of a supply chain process. For example, use of the ABC method can allow companies to more accurately assess the total cost of servicing a specific customer or the cost of marketing a specific product. ABC analysis does not replace traditional financial accounting, but provides a better understanding of supply chain performance by looking at the same numbers in a different way. ABC methods are useful in conjunction with the measurement approaches already discussed as their use allows us to more accurately measure supply chain process/task productivity and costs by aligning the metrics closer to actual labor, material, and equipment usage.

5.3.5 Economic Value Added

One of the criticisms of traditional accounting is that it focuses on short-term financial results like profits and revenues, providing little insight into

the success of an enterprise towards generating long term value to shareholders-thus, relatively unrelated to the long-term prosperity of a company. For example, a company can report many profitable quarters, while simultaneously disenfranchising its customer base by not applying adequate resources towards product quality or new product innovation. To correct this deficiency in traditional methods, some financial analysts advocate estimating a company's return on capital or economic value-added. These are based on the premise that shareholder value is increased when a company earns more than its cost of capital. One such measure, EVA, developed by Stern, Stewart & Co., attempts to quantify value created by an enterprise, basing it on operating profits in excess of capital employed (through debt and equity financing). Some companies are starting to use measures like EVA within their executive evaluations. Similarly, these types of metrics can be used to measure an enterprise's value-added contributions within a supply chain. However, while useful for assessing higher level executive contributions and long-term shareholder value, economic value-added metrics are less useful for measuring detailed supply chain performance. They can be used, however, as the supply chain metrics within an executive-level performance scorecard, and can be included in the measures recommended as part of The Logistics Scoreboard approach.

5.4 Selecting and Implementing Measurements

While the approaches described above provide guidance for supply chain measurement, they provide less help in assessing specific metrics to be used. In this regard, a key driving principle, as espoused by the Balanced Scorecard, is that measures should be aligned to strategic objectives. Supply chain strategy, however, differs from company to company and depends upon its current competencies and strategic direction. Companies can generally fall into the following developmental stages that will dictate the types of measures and the degrees to which they will need to focus:

Functional Excellence

A stage in which a company needs to develop excellence within each of its operating units such as the manufacturing, customer service, or logistics departments. Metrics for a company in this stage will need to focus on individual functional departments.

Enterprise-Wide Integration

A stage in which a company needs to develop excellence in its cross-functional processes rather than within its individual functional departments. Metrics for a company in this stage will need to focus on cross-functional processes.

Extended Enterprise Integration

Stage in which a company needs to develop excellence in inter-enterprise processes. Metrics for a company in this stage will focus on external and cross-enterprise metrics. Historically most companies have focused their performance measurement on achieving functional excellence. With the advent of supply chain management principles aimed at integrating their supply chains, many have objectives to increase their degree of enterprise-wide integration and extended enterprise integration. In order to achieve these types of objectives, their performance measurement systems will need to align to them. Advice for these supply chain measurement systems falls into five areas that include:

- Function-based measures
- Process-based measures
- Cross-enterprise measures
- Number of measures to be used
- Alignment of executive to management level measures

A set of measures developed by a leading consumer products manufacturer is also discussed, providing an illustration of the type that might be selected.

5.4.1 Function-Based and Supply Chain Measures

A major problem encountered with most performance measurement systems is that they are functionally focused. Within these systems, each functional area measures its performance in its own terms, with individuals evaluated based on their ability to meet objectives consistent with their department's performance measures. Individuals working under these measurement systems tend to drive operations toward improving their own area's performance, frequently at the expense of the performance of other functional areas. When each functional area sets its performance measures in isolation from those of others, it often leads to conflicting organizational goals. The figure 18 below depicts a typical set of function-based supply chain-related performance measures used by many manufacturers.

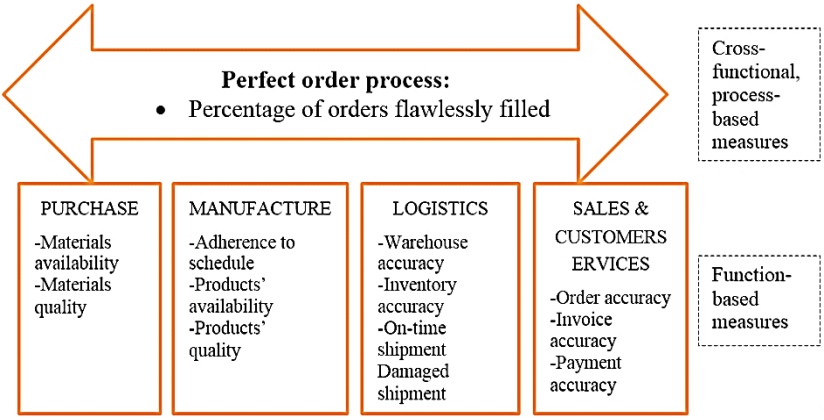

Fig 18: Benefits of Cross-Functional, Process-Based Measures

Source: Larry Lapide, 'What about Measuring Supply Chain Performance', AMR Research

These types of measures used in isolation of each other tend to create conflicting goals among functional areas as follows:

Customer Service and Sales

In these functional areas, employees are measured by their ability to maintain customer service levels. Measured in this context only, these employees tend to drive operations toward satisfying potentially smaller sized customer orders and carrying high levels of finished goods inventories by stocking inventories in multiple locations close to customers to shorten cycle times.

Logistics

In this functional area, employees are measured by transportation and warehousing costs, and inventory levels. Measured in this context only, logistics personnel tend to keep inventories low and batch customer orders to ensure that trucks are shipped full and picking operations are minimized. On the inbound side, these employees will want to receive full truckloads at their warehouse docks to minimize receiving costs, usually at the expense of increased inventories.

Manufacturing

In this functional area, employees are measured in terms of manufacturing productivity. Measured in this context only, they want to make longer production runs that result in higher levels of finished goods inventories. In a make-to-order manufacturing environment there will be a

tendency to consolidate customer orders into longer production runs, making them less responsive to dynamic customer demands.

Purchasing

In this functional area, employees are typically measured by materials costs and supplier delivery performance. Measured in this context only, buyers will purchase in large quantities to get volume discounts and use more suppliers for each item to ensure a low price. This behavior results in purchasing excess, potentially low quality, raw materials.

The above mentioned behaviors that use of only function-based measures could drive employees toward changing functional performance in entirely different directions. These types of measures alone have reinforced functional focus, reducing the effectiveness of many supply chains and fostering arms-length transactions among departments, leading to processes that are slow to respond. In addition, performance improvement initiatives get focused on a single objective that frequently runs counter to increasing the efficiency of the total supply chain. For example, an initiative focused on reducing transportation costs focuses on filling up outbound trucks. While this seems benign, it may not be best from a total supply chain perspective when customer orders are held up to fill up a truck, or they are forced to order in greater quantities.

Below, in the table 12, there are some possible supply chain measures classified by functional and non-functional areas.

Table 12: Supply Chain Measures

Functional Measures	
Customer Service Measures	• Number of complaints per period of time
	• Respond to complaints within a period of time
	• Provide resolution on time
	• Customer loyalty index
	• Customer returns
	• Line item fill rate
	• Quantity fill rate
	• Order entry times
	• Accuracy of order entry
	• Backorder/stock-outs
	• Customer satisfaction
	• Order fill rate

Logistics Related Measures	• Warehousing costs
	• Inventory obsolescence
	• Inventory carrying costs
	• On-time delivery
	• Standard lead time per shipment lane
	• Finished goods inventory days
	• Lines picked/hour
	• Pick accuracy
	• Transportation cost
	• Shipment accuracy
	• In-transit inventories
	• Premium freight charges
	• Warehouse space utilization
	• Finished goods inventory turns
	• Documentation accuracy
	• Damaged shipments
	• Inventory accuracy
Manufacturing Related Measures	• Production cycle time
	• Manufacturing productivity
	• Bill-of-materials accuracy
	• Setup/Changeover costs
	• Plant space utilization
	• Percent scrap/rework
	• Product quality
	• WIP inventories
	• Line breakdowns
	• Warranty costs
	• Source-to-make cycle time
	• Compliance-to-schedule
	• Yields
	• Cost per unit produced
	• Setups/Changeovers
	• Routing accuracy
	• Production stoppages
	• Machine availability
	• Overtime usage

	• Master schedule stability
	• Plant utilization
	• Percent of demand/supply on VMI/CRP
	• Total supply chain inventory
Purchasing Related Measures	• Expediting orders from suppliers
	• Unit purchase costs
	• Purchasing cost per man-hour
	• Material acquisition costs
	• Supplier delivery performance
	• Number of complaints related to supplier
	• Quality of material/component
	• Material stock-outs
	• Material inventories
Enterprise-Wide, Process, Cross-Functional Measures	
	• Schedule changes
	• Percent perfect orders
	• Planning process cycle time
	• Forecast accuracy
	• New product time-to-first make
	• New product time-to-market
Extended Cross-Enterprise Measures	
	• Percent of suppliers getting shared forecast
	• Percent of customers sharing forecasts
	• Percent of EDI transactions successfully completed
	• Supplier inventories
	• Total landed cost
	• Point of consumption product availability

Source: Own development

5.4.2 Implementing Performance Metrics

There is no single best approach for company to implement performance metrics to manage their supply chain process. Companies however can use the Balanced Scorecard, SCOR Model, Logistics Scoreboard, as the excellent guidance when developing a supply chain performance measurement system. Implementing supply chain performance measurement system cannot be in a hurry. It has to start with the top-level objectives from the corporate level first and roll it down to next levels. The following are six

phases for developing and using Balanced Scorecards to manage performance: Collect, Create, Cultivate, Cascade, Connect and Confirm.

Collect

- Obtain top-level objectives, measures, and targets.
- Identify customers and key requirements.
- Define core process chains.
- Document high-level process flows.
- Gather existing measurement data.
- Plan the scorecard development session and agenda.
- A snapshot of your customer-supplier process chain.
- High-level flow charts of core processes.
- Inputs and agenda for scorecard development session.

Create

- Review Scorecard development planning inputs.
- Define key result areas.
- Relate business objectives to key result areas.
- Brainstorm potential measures.
- Select the key indicators for your performance scorecard.
- Define the key indicators.
- Develop action plans for compiling and reviewing the key indicators.
- Team objectives.
- Scorecard measures linked to corporate goals, business objectives, and customer requirements.
- Action plans to develop measures.

Cultivate

- Gather, display, and analyze historical data.
- Conduct performance reviews.
- Determine appropriate targets.
- Develop improvement action plans.
- Strengthen horizontal and vertical linkages.

- Shorter, more effective performance reviews.
- Appropriate and challenging targets for scorecard measures.
- Specific and measurable improvement actions.
- Stronger scorecard links.

Cascade

- Determine scorecard measures for next level in the cascade.
- Verify cascaded measures are at the appropriate levels.
- Establish and affirm linkages and alignment.
- Clarify targets.
- Establish summary measures, as needed.
- Refine steps for gathering, reporting, and reviewing results.
- A balanced and linked set of scorecard measures.
- Appropriate feedback measures for each level of accountability.

Connect

- Review your performance management process.
- Develop an individual performance plan.
- Conduct coaching sessions.
- Provide evaluation summaries.
- Review links and outcomes.
- Individual contributions linked to scorecard outcomes and business results.
- Indications of where the scorecard should be refined or adjusted.

Confirm

- Evaluate your scorecard.
- Prioritize and act on improvements.
- Identify and resolve measurement issues.
- Establish a process to refine your scorecard continually.
- Scorecard assessment.
- Scorecard improvement strategies and plans.
- Improved scorecards.

5.5 Strategic Logistics Plan

Strategy also has been defined as a set of dynamic, integrated decisions absolutely must be made in order to position business in its complex environment. Thus, strategy represents the overall actions or approach to be taken to achieve the firm's goals and objectives.

Strategic plan can be defined as a plan, method, or series of maneuvers or stratagems for obtaining a specific goal or result.

Strategic logistics plan is a unified, comprehensive, and integrated planning process to achieve competitive advantage through increased value and enhanced customer service, which results in superior customer satisfaction, by anticipating future demand for logistics services and managing resources of the entire supply chain. This planning is done within the context of the overall corporate goals and plan.

5.5.1 Importance and Hierarchy of Planning

Importance of Planning

It is importance to align all company employees' understanding together so that any plan, action, that made are conformed to the corporate strategy. If logistics managers do not understand the corporate strategy, they will not be able to make decisions that are in the best interest of the organization. Even if logistics managers use the system approach to make decisions and analyze trade-offs, they will still not be able to make the best decisions without a good understanding of the corporate strategy and the corresponding logistics strategy. Without this knowledge, logistics personnel will not know how to value various alternatives in making trade-offs. For example, if the goal is to achieve differentiation by offering fast, reliable deliveries, management would choose air freight over sea freight. If low cost is the primary objective, management might choose sea freight to deliver products to customers. Therefore, if logistics managers do not understand corporate strategy, they will be unable to make decisions that are consistently in the best interests of the company as a whole. Hence, a plan should be developed in order to execute strategy and monitor performance and progress.

Hierarchy of Planning

There are many levels of planning within an organization and each level of planning has different timeframe. There are basically three levels of planning: Strategic plan, Tactical plan, and Operating plan.

- **Strategic Plan:** Strategic plan has the longest time period as it considers organization's objectives, overall logistics service

requirements, and how managers intend to achieve the corporate vision.

- **Tactical Plan:** Tactical plan is an intermediate level of planning, which generally takes between one to five years' time in the future. Tactical plans are often more specific than strategic plans in terms of product lines, markets and may be broken down to detailed revenues and expenses.
- **Operating Plan:** Operating plan is the most detailed plan when compared with strategic and tactical plans. It can be on annual basis detailing things like revenues, expenses, and associated cash flows and activity by month for a one-year period. The detailed operating plan is prepared to guide the activities for the following year.

5.5.2 Strategic Planning Process

The major steps in the corporate strategic planning process are:

- Evaluation of consumer and/or industrial customer needs.
- Identification of possible target markets.
- Evaluation of target markets.
- Selection of target markets.
- Formulation of channel objectives and strategy.
- Identification and evaluation of channel structure alternatives.
- Selection of the channel structure.
- Development of the strategic logistics plan.

Developing a Strategic Logistics Plan

Before any strategic logistics plan can be developed, the individuals or team responsible for developing the plan should have sufficient and adequate information relating to their corporate strategy and supporting marketing plan in order to optimize cost-service trade-offs. The team has to understand customer's expectation and requirements and each customer service elements, and how the performance of the company is comparing with its competitors. In addition, the team is required to be knowledgeable about the cost and profitability of channel alternatives, such as carriers, warehouses, logistics service providers, etc.

With the development of strategic plan, a concrete logistics plan needs to be developed to support that strategy. The plan includes the specific activities that the logistics function will undertake to achieve its objectives.

Generally, logistics plan can be deployed in three levels, namely: Strategic level, Tactical level and Operational level:

- **Strategic Level:** At this level, the company considers only issues pertaining to business objectives and customer service requirements.
- **Tactical Level:** At this level, the company makes decisions on the number, size, and location of distribution centers; transportation modes preferred; and the type of inventory control system.
- **Operational Level:** At this level, company considers about day-to-day decisions, such as expediting policies, vehicle routing, and scheduling. These decisions are usually iterative by nature.

Chapter - 6

Supply Chain Management in Light of Strategic Alliance

Objectives

- Conceptualize strategic alliance in SCM
- Understand the role 3PL and LLP

6.1 Strategic Alliance

6.1.1 External Partnership

The success of an integrated supply chain management process is really about developing and maintaining a good and trustful relationship between all members in the supply chain. Without confidence for each other in a supply chain, there are many issues that could potentially impede a successful supply chain initiative. In deploying the integrated supply chain, developing trust in partners and projecting trustworthiness to them are critical components for success. Maintaining trusting relationship is a long-term goal, which needs to be consolidated on an on-going basis. How does a special supply chain relationship come about? It usually started with a supply chain member that is willing to put forth the time and effort required to create a strong mutual relationship. In such cases, firms may consider developing a special type of supply chain relationship in which confidential information is shared, assets are invested in joint projects, and significant joint improvements are developed continuously. These types of relationship between all supply chain members are sometimes called strategic alliances. Strategic alliances can deliver substantial benefits to organizations by improving efficiency and effectiveness through the elimination of waste and duplication across the supply chain.

6.1.1.1 Level of Logistics Partnership

The logistics partnership/relationships usually are classified into following types presented in the Figure 19:

- **Transaction Logistics:** A relationship built on a series of separate single events called otherwise transactions.
- **Contract Logistics:** a specifically defined relationship that is contractually oriented and is dependent on the supplier meeting the shipper's defined performance goals.

- **Strategic Alliance:** A planned ongoing relationship where both parties have needs that the other can fulfill, and both parties share same values, goals, and strategies for mutual benefit.

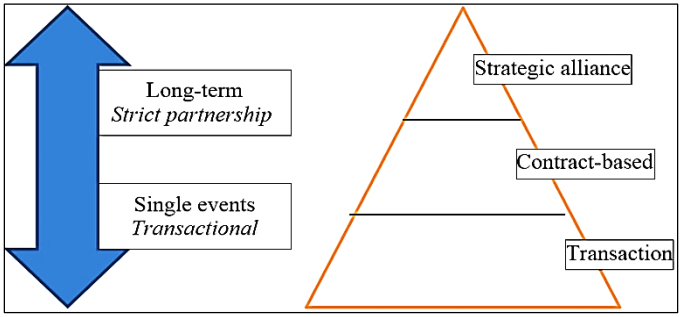

Fig 19: Level of Logistics Partnership

6.1.1.2 Logistics Partnership Decision

Deciding whether to perform the logistics function in-house or to seek other arrangements is a balance of two factors:

- How critical logistics is to the success of the firm
- How competent the firm is in managing the logistics function

The strategy to follow depends on the self-assessment and position among competitors in the market in which the company finds itself. The Figure 20 presents 04 available options to be considered.

Performing logistics activities in-house: A company that has high customer service requirements, significant logistics costs as a proportion of total costs, and efficient logistics operations administered by competent personnel will find little benefit to partnering or outsourcing logistics activities.

Outsourcing: A company where logistics is not central to strategy and a high level of logistics competency is not supported within the firm, outsourcing the logistics activities to the third-party providers may well lead to significant cost reductions and customer service improvements.

Seeking a Competent Partner: Where logistics is critical to strategy but logistics management competency is low, finding a firm with which to partner may provide significant benefits. A strong partner may provide facilities located in existing and new markets, transportation capability, and administrative expertise not available within the company.

Being a Partnership Leader: Where logistics is not especially critical to strategy but managed by capable personnel, managers may want to be aggressive by taking the lead in seeking partners to share the logistics system, thus reducing the company's costs through increased volume and the economies of scale.

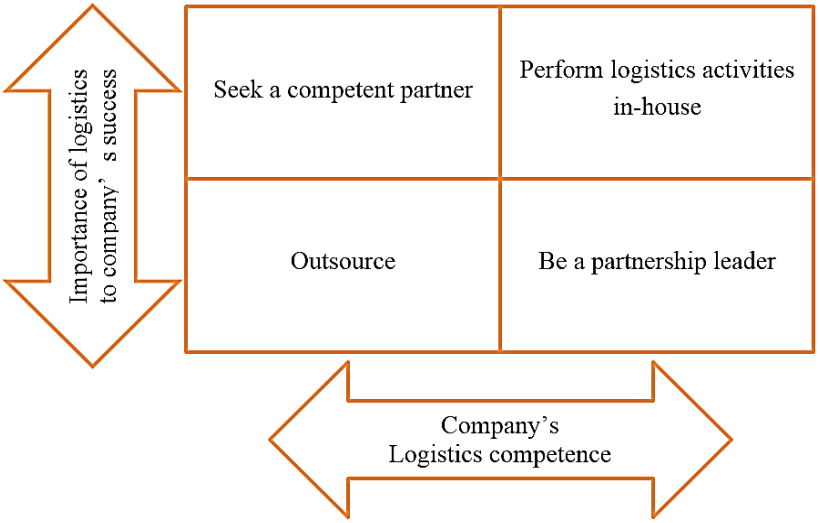

Fig 20: Logistics Partnership Decision

Source: (Ballou 2007, pp. 628)

6.1.2 Strategic Alliance

A strategic alliance (also see strategic partnership) is an agreement between two or more parties to pursue a set of agreed upon objectives needed while remaining independent organizations. As such, strategic alliance is a close, long term, cooperative relationship between two or more participants who are willing to share information and risks, gain equally benefits, trust one another, and improve their performance for strategic planning. This is a formal relationship, with possible ending in form of merger or acquisition later on, between two or more companies, established for the purpose of gaining synergy effect because in some of aspects the two or more companies complement each other. Strategic alliances occur when two or more separate businesses join together to offer a broader set of skills or services to joint clients, to the mutual benefit of those companies. An alliance between companies that provide different, but complementary services or products allows all of them to create an advantage over competitors by broadening the scope of their operations.

The analysis of world literature related to strategic management and strategy for enterprises' cooperation in international market pointed out to the immense diversity of understanding and defining strategic alliance. Each of the literature positions presents own approach to strategic alliance. Hence, there exists a need to elaborate strategic alliance's definition to unambiguously determine the essence and form of this kind of cooperation between enterprises. K. R. Harrigan (1988) stated that strategic alliances are joint ventures, cooperative agreements giving partners possibility to work together to achieve certain strategic goals. In terms of the way to select the partners to the strategic alliance agreement, M.E. Porter (1990) asserts that strategic alliance may be concluded both with suppliers (customers) and with current or potential competitors. On the other side, J.L. Badaracco, B. Garrette and P. Dussage represent the standpoint that the choice of partners should be limited to the real and potential competitors of enterprise. Recapitulating, one might assert that strategic alliances are the long term and purposeful agreement among enterprises, concluded on the partnership basis and the basis of adequacy of benefit associated with alliance preserving the organizational integrity of parties engaging in this kind of structure agreement. Strategic alliance appears in three principle forms (Cygler 2002):

- Non-Equity alliances-agreements on common researches, marketing and other activities creating value chain for each of partners. In this group of alliances such forms as franchising and licensing (only in case of asset contribution from one of the agreement's parties) could be found.
- Joint Ventures-agreements on forming a new business entity.
- Minority equity alliances-strategic alliances may be in form of partly buy out, however it should be carried out in a way that agreement's parties preserve further their own independence.

In order to further comprehend this specific but very popular business phenomenon, the table 13 below presents us several common understandings about strategic alliances collected from many sources.

Table 13: Strategic Alliance Understandings

1	A strategic alliance is a "partnership" between two organizations where both parties are able to derive value from the engagement vs. a relationship where only 1 party sees value. Strategic alliance is in place when companies are unable to achieve results on their own, or when the strategic alliance will dramatically improve the final expected results.
2	A strategic alliance is a positive relationship between two companies that increases revenue, industry reach and internal knowledge.

3	A strategic alliance is a long-term value-creating relationship.
4	A 'together we are stronger' win-win relationship.
5	A collaborative relationship which leads to success for both parties.
6	An opportunity for each member of the relationship to achieve their goals, but assisting the other party to achieve theirs.
7	A strategic alliance is a (formal) agreement based on mutual trust to cooperate intensively in order to achieve a goal that partners cannot achieve (easily) independently.
8	A strategic alliance means creating value beyond an individual company can do. The equation is "1+1>2″.

Source: Own selections

Based on the above mentioned definitions and common understandings about strategic alliances, it is possible to imply the principle characteristic feature of them as following:

- Trusting relationship
- Long term goal
- Complementary
- Broader skills, products and services
- Impacting end results
- Synergy
- Competitive advantage
- Win-Win
- New value chains through collaboration

Beside the great strategic advantages of causing that alliances are irreversible business trends, there are still many concerns related to this phenomenon and to the risks entailed in case of the potential failure of their implementations:

- Loss of control over the logistics channel.
- Fear of being 'written out of the logistics picture.
- Increased concern of logistics failures and no direct way to handle them for their customers.
- Adequate checks and balances may not be able to be identified to the satisfaction of the partner.
- There may simply not be enough trust to try such an arrangement.
- Partners may not be viewed as equals where one partner's requirements may take precedence over another's.

- Difficulty of identifying the economic benefit to be achieved as compared with the partner's current logistics cost.

6.2 Model for Strategic Alliance Development

As developed by J.M. Schmitz, R. Frankel, and D.J. Frayer in their article "ECR Alliances' (Schmitz *et al*. 1995) the conceptual model of alliance development can be depicted by the figure below which shows how organizations typically setup and develop supply chain alliances. There are three following components that make up the model:

- **Strategic Component:** Strategic component examines how strategic expectations and evaluations of alliance's effectiveness evolve as alliance progresses in the development stage.
- **Process Component:** Process component outlines the stages of alliance development that show the required stages for formation, implementation and maintenance of an alliance.
- **Operational Component:** Operational component presents the operating standards for managing an alliance.

At each horizontal stage, managers must consider both the strategic and operational components and there are basically four levels.

- **Level 1:** This level is about alliance conceptualization and it begins when a firm prefers a special arrangement through strategic alliance with a trust worthy partner over its current arrangement. This level involves a lot of joint planning to determine what the 'ideal strategic alliance' is all about.
- **Level 2:** This level is about alliance pursuance and it is at this level that a decision to form an alliance is finalized. The firm will establish operational and strategic criteria to select the strategic alliance partner.
- **Level 3:** This level is about alliance confirmation and this is the level for the firm to determine the strategic and operational expectations for the arrangement. Joint meetings are usually conducted between partners and through this kind of interaction, the relationship of partners become solidified.
- **Level 4:** This level is about alliance implementation and continuity. This level is more focused on performance assessment to determine whether an alliance will be sustained, modified or get terminated. A conflict resolution process is required to put in place to manage conflicts.

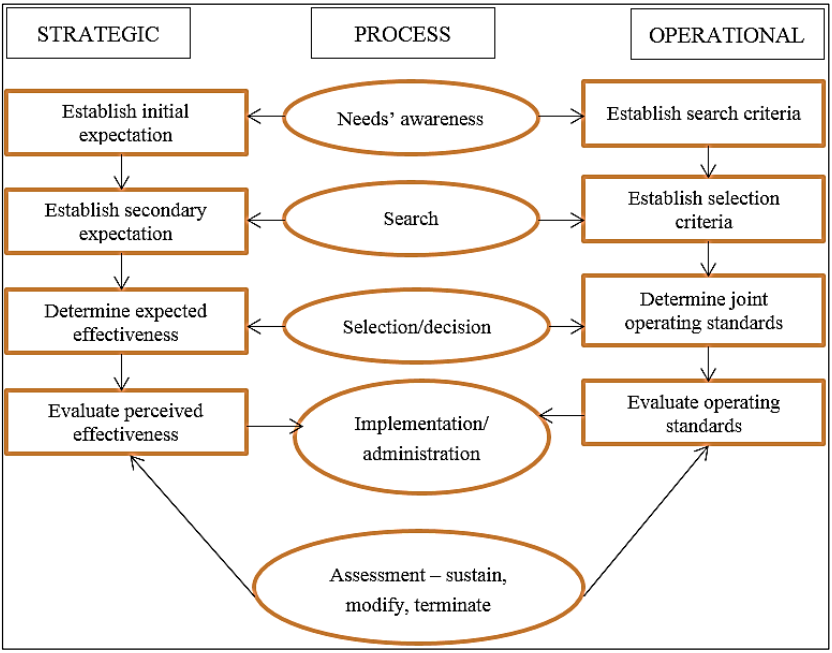

Fig 21: Model for Strategic Alliance Development

Source: (Schmidt *et al*. 1995)

6.3 Trust and Challenges to Strategic Alliance

6.3.1 Developing Trusting Relationships

Trust is a value that exhibits between two persons, which is difficult to quantify. When trust has developed, it acts as an extended arm of resource and capability that ones can depend upon in times of threats and needs from friends, relatives, colleagues, etc. Hence, developing trusting relationship is beneficial to individual because he/she can seek helps, supports, and advices, among others from social circles. Like human beings, companies can also develop trusting relationship through interactions in business cooperation over time. In the current competitive marketplace, no single company can survive the keen competition in a run long without having to established partnership and alliance, the latter is a more closely knitted relationship. Trust is not something that simply happens. Trust is developed when a company's performance history and the reliability of its supply chain linkages can be demonstrated. Trust is not easy to measure or identify. The elements of trust vary considerably depending on the situation. In the subsequent paragraphs, several major types of trust are presented and we will explain how they are developed, illustrating each type with a supply chain example.

Reliability

This type of trust is based on the ability to produce a consistent and predictable outcome over a period of time. Apart from this, one could also expect that being reliable is also meant that there is integrity and honesty of the other party and the party is consistently act on a set of moral codes or standards even in unusual situations. By applying pressure to get something done on the other party in a supply chain partnership is not going to achieve collaborative outcome because it is just not on a willingness and commitment basis by both supply chain parties and the relationship is not going to last to produce the desired outcomes. For example, if a supply chain partner forces a supplier into a supply chain relationship then the supplier is less likely to act reliably. On the other hand, if a freight forwarder commits to deliver on time based on standard lead-time but repeatedly delivered longer than the prescribed time, the shipper who engages the freight forwarder will likely to look for a more reliable freight forwarder some time later.

Competence

Competence is about ability in doing something special that other cannot do. When we say a person is competent, it means that the person is able to do something relatively well. This form of trust is different from the trust that developed due to reliability. The competence type of trust has three key areas:

- **Functional Competence:** The ability to know, understand and find a solution to a specific area. For example, a buyer purchasing electrical component from a supplier trusts that the supplier can answer any relevant question about the electrical component.
- **Interpersonal Competence:** The ability to work with others and the ability to listen, negotiate, communicate, make a presentation, reach an agreement with a group, and other related skills to deal with people on a day-to-day basis.
- **Business Sense Competence:** Is about individual's experience, wisdom and common sense.

Affect-Based Trust

Affect-based trust can be broken down into two elements:

- **Openness:** This is about being open with other party on problem or information. For example, a supplier who provides information on internal costs or a buyer who provides information on future forecasts.

- **Benevolence:** This is about the acknowledgement of duty by one party to protect the rights and interests of the other party. Alternatively, it can be described as faith or goodwill of others, which is produced through repeated personal interactions.

Vulnerability

In supply chain situation, two types of vulnerabilities can arise.

- **Adverse Selection:** This refers to the inability to evaluate accurately the quality of the assets the other partner brings to the relationship. For example, a buyer may not know exactly whether the supplier's production system can meet his requirements.
- **Moral Hazard:** This refers to the inability to evaluate the assets committed when a relationship exists. For example, if a supplier based on a buyer's request, increase its production capacity and advised that he has done that. However, there is no means to ascertain that the supplier has indeed invested in the plant and increase the production capacity then a moral hazard exists. This will result in asymmetric investment by which one partner commits more to the relationship than other.

Loyalty

Loyalty is about truthfulness and faithfulness. This only occurs after a period of time and produces reliable performance and one party develops a sense of loyal bonding with the other party. When this happens, it is the belief of one party that the other party will perform well in unusual situations, when it really counts. This relationship only happens through strong interpersonal bonds. For example, if there is a big order that comes just before the end of financial quarter and this order will make a different in your organization financial statement, you may need your supplier to rush the material on overnight delivery and even work over weekends and holidays. In order to do this, the supplier may have to make some drastic changes in its production plan and also to hire more production operators and work longer hours. A supplier who can perform and deliver to such requirements does show loyalty to your company.

6.3.2 Challenges to Strategic Alliance

In any supply chain structure, a number of risks exist that must be managed between participating companies. Some of these challenges relate to the issue of confidentiality, research and development (R&D), demanding service levels, mass customization, and shared responsibility.

Confidentiality

For supply chain to work effectively in a partnership arrangement, both parties need to know more about one another than before. Sometime organizations need to share strategic level information (such as market intelligence, investments, business strategies, etc.) as well as operational level information (such as number of orders, forecasts, product pricing, seasonal promotion information, etc.). If there is an anticipated demand due to promotion strategy, all supply chain partners need to have advance notice in order to prepare their own organizations for the increase in demand. As companies become more and more dependent on their supply chain members, they will have to find new and innovative ways to manage the risks associated with sharing proprietary and sensitive information with supply chain members.

Research and Development

In the area of new product development, supply chain partners will have to share new product information. Suppliers will bring with them proprietary technologies to be used in their customer's products, and customers may need to share new product specifications and requirements with their suppliers. Hence, with the increasing partnership between supply chain members, the control of information and new technologies sharing become increasingly important.

Increased Service Level Requirements

Companies must find innovative ways to improve customer service through the process of improvement. In order to meet the challenge of ever increasing customer requirements, supply chain partners must work together to manage pre-transaction and post-transaction elements.

Mass Customization

Mass customization is always a preferred option for customers and this demand will be intensified in the future as customers' demand increase. Though the aggregate demand forecasts may remain relatively stable, the number of different products will continue to increase resulting in a fragmented array of customer options. Moreover, the forecasts for the products mix, demand at different locations, and volumes required will become increasingly difficult to develop and manage.

Shared Responsibility

As supply chain structures begin to evolve, increasing investments in information systems and technology will be required to integrate supply

chain organization. Such inter-organization issues will continue to challenge supply chain managers.

6.4 Third Party Logistics

6.4.1 General Overview

Partnership is defined as a tailored business relationship featuring mutual trust, openness, and shared risk and reward that yields strategic competitive advantage. Often the formula for success in logistics is the one that leads to partnership. According to a 1996 CLM (Council for Logistics Management) study into the market positioning and development of the third-party logistics industry, partnerships with third parties add value for a growing number of companies. 72% of respondents used third-party logistics providers with outbound transportation as their most frequently outsourced service, followed by warehousing at just under 60%. In the future, freight consolidation and distribution will be the logistics activities most likely to be outsourced (by 22.1% of respondents), followed by warehousing and inbound transportation and/or freight bill auditing/payments (18.2% and 16.6% of respondents, respectively). Outsourcing of logistics activities was considered to be extremely successful for the customers of 38% of respondents. Another 52% of respondents' customers considered outsourcing somewhat successful. Many firms engaged in international business also use external logistics service providers to handle most of their logistics needs. This clearly shows the need for these companies to establish a close relationship with their service providers. These partnerships reduce uncertainty and complexity in an ever-changing global environment; minimize risk while maintaining flexibility. Research on international third-party service provider shows that partnerships are extremely important for minimizing problems associated with information flow that can easily damage the supplier-customer relationship. Third-party partnership provides the advantages of ownership without the associated burden, allowing organizations to take advantage of best-in-class expertise, achieve customer service improvement, respond to competition, and eliminate assets. However, partnerships are not the way to go in all cases as they may not always be feasible or appropriate. Partnerships are complex relationships demanding corporate cultural compatibility, a strong perspective of mutuality, and symmetry between the two sides. As organizations adopt integrated supply chain management approaches, the role of third-party logistics service providers is likely to expand. This will be the case particularly for those third-party service providers that function effectively as part of the overall supply chain team. Third-party service providers will

increasingly be sought out for their supply chain management expertise. Relative to domestic supply chains, international supply chains often entail the following:

- Greater geographic distances and time differences.
- Multiple national markets.
- Multiple national locations of operation.
- Greater opportunities due to diversity of supply and demand conditions.

Additional costs are also associated with global supply chains. Major costs categories for a global supply chain include:

- Manufacturing costs-purchased materials, labor, equipment charge, and supplier's margin.
- Movement costs-transportation cost, inventory in pipeline and safety stock cost and duty.
- Incentive costs and subsidies-taxes and subsidies.
- Intangible costs-quality costs, product adaptation or performance costs, and coordination.
- Overhead costs-total current landed costs.
- Sensitivity to long-term costs-productivity and wage changes, exchange rate changes, product design, and core competence.

Global supply chain performance improvement by leading organizations has involved the following:

- Rationalizing supply chains by changing locations and transportation modes.
- Reducing the buffers of inventory and time between successive steps in the supply chain.
- Increasing the geographic and international scope of the supply chains.
- Increasing the sophistication of the goods and services accessed through supply chains.

The 3PL market is currently going through a fundamental redefinition. An increase in the globalization process, the role of information technology and a series of acquisitions and mergers, are fast transforming the 3PL industry. The business models that supported arms-length relations with

customers are no longer attractive or desired. The new focus is on integrated logistics as one-stop solutions. There is also a significant migration from asset-based logistics to value-added and integrated contract logistics solutions.

The emergence of the concept of lead logistics provider (LLP) discussed later has brought about higher degree of specialization within the 3PL market. Also the gradual transformation of 3PL players into a 4PL service provider mentioned later in this chapter is just about taking shape and promises to be an exciting phase in the logistics services market globally. In reality, logistics has been classified according to many diverse criteria, including the form of logistics activities. Figure 22 and table 14 present forms of logistics activities from 1PL to 5PL.

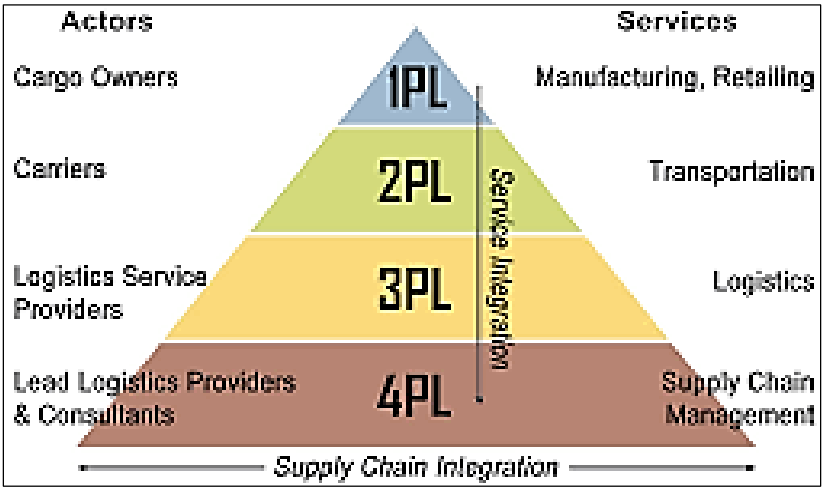

Fig 22: Forms of Logistics Activities

Source: Internet

Table 14: Forms of Logistics Activities

Forms of logistics	
1PL-first party logistics	The owner of goods organize and carry out all logistics activities on his/her own to respond to his/her own needs. The owner has to invest in transport means, warehouses, information systems, and staff to manage and operate logistics activities. 1PL often makes companies too large and reduces their efficiency due to lack of experiences, special competencies to operate and manage all logistics activities.
	Only one logistics party exists who provides logistics services for itself.

2PL-Second party logistics Basic and particular logistics service provider	The 2PL is a service provider for one logistics activity in a supply chain such as transport, warehouse, customs formalities arrangement (clearance), payment… to respond to the needs of customer, the goods' owner. All these logistics activities are independent and not integrated.
	Short-term contract relationship concerning only one independent logistics activity.
3PL-Third party logistics Whole package logistics service provider	3PL of behalf of the goods' owner, the shipper (exporter), the receiver (importer) manages and carries out all logistics services. 3PL includes diverse services, coordinate closely the movement, the storing of goods, processes of information management and is integrated in the supply chain of customers.
	Medium-term contract relationship concerning management service of all logistics activities in the supply chain of customers.
4PL-fourth party logistics Integrative logistics management service provider	4PL is an integrator who connects all own resources, potentials, material and know-how bases with these of other organizations to design, build and operate solutions for supply chain. 4PL is responsible to manage logistics flows, deliver supply chain solutions, logistics planning and consultation, transport management… 4PL is directed to manage the whole logistics process such as receiving from manufacturers, export-import and distributing to the end-consumers.
	Strategic contract relationship, to integrate with customer's resource, structure, potential for the purpose of all-out integrated logistics service provision.
5PL-fifth party logistics Integrator of the whole supply chain	Together with development of e-business technology, 5PL is developing to serve e-commerce. 5PL are the 4PL and 3PL managing supply chain on the platform of e-commerce.
	Strategic partnership relationship to integrate not only customer's supply chain activities but also the whole supply chain of all customers.

Source: Own development

6.4.2 Third Party Logistics Development

In the past, third party providers of transportation services have traditionally included an array of middle men operating between carriers and shippers. The services provided by these intermediaries included several types of brokerage, forwarding, freight consolidation, warehousing, information processing services (including freight bill auditing and payment, tracking, EDI, transaction processing, reporting, etc.), and fleet operations (vehicle leasing and management, container control, inter-modal trailer operations, etc.). Each of these intermediaries was a specialist in a part of the business that the firm's manager did not have the time and resources to

manage in-house. For example, custom brokering requires detailed knowledge of complex domestic and foreign regulations and was therefore readily outsourced. An area that has routinely been outsourced is freight-bill auditing. The sheer volume of tariffs and their complexity made it uneconomical and no sense to handle in-house. Specialist firms were more suited to developing the necessary software and continuously updating the various tariffs and erratic contract rates. Information processing services also were outsourced, particularly in conjunction with other functions. Thus, many third parties provide tracing, reporting, and EDI as part of their services.

The last several years have witnessed the birth of a new breed of contract logistics providers. Many of these new companies originated from sophisticated logistics departments of the large, professional shippers. These departments found a business opportunity in providing logistics services to other shippers, as well as to their own parent company. The new breed of third parties can be divided into two main categories: those who own transportation assets and those who do not. Some providers invest in assets that are used to serve their parent company and then sell the extra capacity in the market place. As these companies grow, they invest in more assets and continue to expand their business in terms of selling available capacity.

Third party logistics companies (3PLs) can today look forward to increasing growth opportunities. The restructuring and integration of manufacturing and distribution activities within Europe will force companies to concentrate on their core competences and to seek improved performance in their logistics chains, using 3PLs. To be successful, the 3PLs need to provide more value added services beyond their basic services. They also need to take serious stance about being transnational and strengthen their services worldwide. The other major trend is for distributors and other shippers to form their own 3PLs. Companies who have built integrated warehousing and transportation infrastructure are jumping into the 3PL fray. Unlike 3PL who's traditional focus has been on the organization and management of assets such as facilities, vehicles, and inventory, the fourth party logistics companies' (4PLs) focus is on the collection, coordination, and management of information; leaving asset management for the 3PLs. The concept of Lead Logistics Providers (LLP/4PL) is also catching up very fast with the customers. A LLP/4PL could be a 3PL service provider currently used by the client, who is designated to manage certain aspects of the client's relationships with the other 3PL providers.

There is a visible shift from a mere asset-ownership based business model, to a new business model that seeks to meet the customer demands for

integrated end-to-end logistics solutions. The shift of market focus from national market to trans-European market is due to changes in the regulatory environment. The enlargement of European Union to the new states from Eastern and Central Europe furthers promises to make Europe the largest integrated economic region and logistics hub in the world, opening up new opportunities for 3PL players within Europe. The increased trend towards M&A (mergers and acquisitions) and strategic alliances results in greater synergies among them, thereby enabling greater transparency in pricing across the continent. There is an increasing preference among leading manufacturing companies towards the separation of their sales function from that of actual physical fulfillment. This leads to business process outsourcing, creating opportunities for logistics companies to act as Lead Logistics Providers (LLPs). Industries are realizing the need for outsourcing the management of entire logistics process to a single entity for greater visibility and optimization across the supply chain. This has led to the emergence of Lead Logistics Provider or 4PL players.

With the opening up and integration of the global market, Original Equipment Manufacturers (OEMs) in line with the trends in developed markets of North America and Europe are looking for the opportunities to outsource their manufacturing activities to highly competitive global contract manufacturers. Globalization has also translated into many selling opportunities for OEMs in services and finished products worldwide, including information technology, telecommunication, electronics, automobiles, pharmaceuticals etc., especially in the emerging markets. As market barriers and import tariff levels are further brought down under the impact of WTO regulations, the overall traded cargo volumes are likely to move up further, creating the need for new logistics pipelines.

Shrinking product life cycles and a high rate of technological obsolescence has increased the pressure on supply chain management, with the new emphasis on supply chain agility and the need to reduce non-value adding costs. 3PLs have come forward to provide the logistics resources and skills needed, thereby reducing the overall costs. An external 3PL may also overcome internal organizational inertia that often impedes companies making their own logistics process improvements. Meeting increasingly dynamic and ever changing customer specific orders, delivery schedules and service quality leads to new level of competitive pressures in several industries. Resorting to 3PL solutions or a lead logistics provider (LLP) is necessary both for survival and for maintaining the bottom line. A 3PL can be viewed as the vehicle to bring down conventional logistics cost structures

and induct improved process management through logistics and information technology. Outsourcing is increasingly becoming an acceptable business model for companies to implement, and manage their business activities. Several 3PL companies have realized this as a fast emerging opportunity and have been focusing on building required professional and vertical domain competencies in areas like information technology, electronics, automobiles, pharmaceutical outsourcing, etc. Transportation, warehousing and distribution services are traditionally managed like commodity service businesses. Margins in such asset-based basic services are declining and there is definitely more value to be realized in the value-added segments. Price is, and has been the key to sustaining bottom-line. Presently, revenues from basic services such as overland transportation constitute 50-80% of the sales revenues of 3PL companies. Most 3PL providers, including some of the larger operators, are limited in their ability to offer economies of scale to improve their cost structures. Incremental growth in business volume does not necessarily have desirable impacts on reducing operating costs. The 3PL solutions are now demanding additional investments to bring about network expansion and organizational growth to be capable to offer value-added solutions. For example, a firm that is going to provide an international 3PL service would look at business trends for the industry to be served, information technology needs, domestic and international sourcing, political stability of key countries and other factors that affect the growth of the 3PL market. This enables the potential 3PLs to understand the market and define the service segments against which the firm will have to compete. Firms outsource logistics to 3PL to gain expertise and leverage. Customers want value from their 3PL in four main dimensions of value:

- **Trust:** This is the strongest dimension value. Here firms are looking for reliable execution, objective assessment of execution, solid atmosphere of collaboration and orientation for solutions.
- **Information:** To keep customers in the loop in terms of accuracy, quality, timeliness, integration with customers' management information system (MIS).
- **Capital Utilization:** 3PL provides leverage to attain reduction of fixed assets (building and equipment) and reduction of inventory.
- **Expense Control:** Customers are looking for 3PL to help them reduce the supply chain costs, share cost savings, and promote innovativeness.

There are many advantages of outsourcing logistics operations to reliable 3PLs. Companies do that because of the following reasons.

- Cost Reduction-these costs can embrace labor cost, facility cost, system related cost, logistics cost, etc. Through engaging 3PLs for their services such costs can be reduced especially in the areas of inventory holding cost, warehousing, transportation, customs and duties, etc.
- Non-Core Business-if a company is a supplier of telecommunications product, it may not want to own a special department to manage its distribution, logistics, etc., as these are not a core business but rather support functions for its main business.
- Leverage on 3PL's Logistics Network-through business expansion, most 3PLs have representative offices and presence regionally and the bigger ones could have logistics network that span globally if not across a few regions.
- Cut down Asset Investment-most 3PLs have assets such as facility, trucks, information systems that can be offered as part of the services to customers. From the customers' standpoint these are non-core assets and there is no need to own them if 3PLs can provide such supports readily and cost effectively.
- Improve Customer Service-nowadays 3PLs can provide many value-added services such as packaging, labeling, palletizing, consolidation, deconsolidation, quality control, inspection, merge-in-transit, inventory management, etc.
- Short Lead-time-in terms of customer delivery, by leveraging on 3PL's extensive and excellent logistics infrastructure network, the lead-time for transportation and delivery can be improved.
- Flexibility of Business Expansion and Reduction-owing to 3PL's extensive and excellent logistics infrastructure network, customers can leverage on the 3PL's capacity to expand their business in times of increasing demands fairly quickly as well as cutting their business when demands are lower.
- Certainly, there are benefits to be reaped when companies outsource their logistics operations to 3PLs. However, there are many disadvantages and critical issues in terms of 3PL outsourcing (Sunil Chopra 2013, pp. 447-448):

- Span of Control-although the market for contract logistics will continue to grow, the loss of control and service quality issues are the primary concerns to increased 3PL usage.
- Basic Services-the offering of value-added services and information management may be the keys to differentiation, but 3PL revenues continue to be still largely generated by basic services.
- Pricing-the price of services offered is an important issue in the choice of 3PL providers; lower cost is still the main driver for outsourcing.
- Confidential Information Sharing-due to close working relationship, secret operational information have to be shared with 3PL in order to support the business from time to time.
- System Integration-inadequate 3PL capabilities can result in strained relationship between 3PL and shipper if there is a need to integrate systems to allow information flow.
- Disparate Expectations-3PL and shipper can have different expectation in terms of service level requirements and measurements and such differences if not communicated properly can result in poor service by the 3PL.
- Implementation Timeline-when 3PL and shipper forged a partnership, there is a period for 3PL and shipper to involve in the implementation planning and execution. This period of time allow both 3PL and shipper to understand its operations regimes and sometime the implementation timeline can be relatively long especially if the scope of the agreement is more extensive.
- Others-Risks of engaging 3PL into the broken process; Underestimate the total cost of coordination; Reduced customer/supplier contact; Loss of internal capability at the expense of growth of third party power; Leakage of sensitive data and information; Ineffective contracts; Loss of supply chain visibility; Negative reputational impact.

In general, most 3PL service offerings include the following (more details will be presented in the table 15):

- **Inbound Logistics:** Includes raw material warehousing, customs clearance, airfreight, sea-freight forwarding, and transportation.
- **Outbound Logistics:** Includes inventory management, cross docking (i.e. the direct flow of goods from the receiving process to

the shipping process with the least additional handling and storage in between), sea freight, air freight forwarding, finished goods warehousing, and transportation.

- **Reverse Logistics:** Includes spare parts delivery, repairs and rework, replacement, technical support, after sales customer services.

IT Related Support and Service to Customers

- Shipment and Inventory Tracking
- Cross Dock Management
- Inventory and Warehouse Management
- Key Performance Indicators
- Customer Relationship Management
- Vendor/Supplier Management
- Return Material Authorization
- Transportation Planning and Scheduling
- Order Fulfillment
- Supply Chain Design and Planning

Table 15: Services Provided by 3PLs

Service Category	Basic Services	Specific Value Added Services
Transportation	Inbound, outbound by ship, truck, rail, air	Tendering, track/trace, mode conversion, dispatch, freight pay, contract management.
Warehousing	Storage, facilities management	Cross-dock, in-transit merge, pooling distribution across firms, pick/pack, kitting, inventory control, labeling, order fulfillment, home delivery of catalog orders.
Information technology	Provide and maintain advanced information systems	Transport management systems, warehousing management, network modeling and site selection, freight bill payment, automated broker interfaces, end-to-end matching, forecasting, EDI, worldwide track and trace, global visibility.
Reverse logistics	Handle reverse flows	Recycling, used asset disposition, customer returns, returnable container management, repair/refurbish.
Other 3PL services		Brokering, freight forwarding, purchase-order management, order taking, loss and damage

		claims, freight bill audits, consulting, time-definite delivery.
International		Customs brokering, port services, export crating, consolidation.
Special skills/handling		Hazardous materials, temperature controlled, package/parcel delivery, food-grade facilities/equipment, bulk.

Source: (Sunil Chopra 2013, p. 449)

Figure 23 presents us main functions of 3th party logistics providers and the tables 16 and 17 give us some insight into the largest 3PLs companies in the USA and in the world.

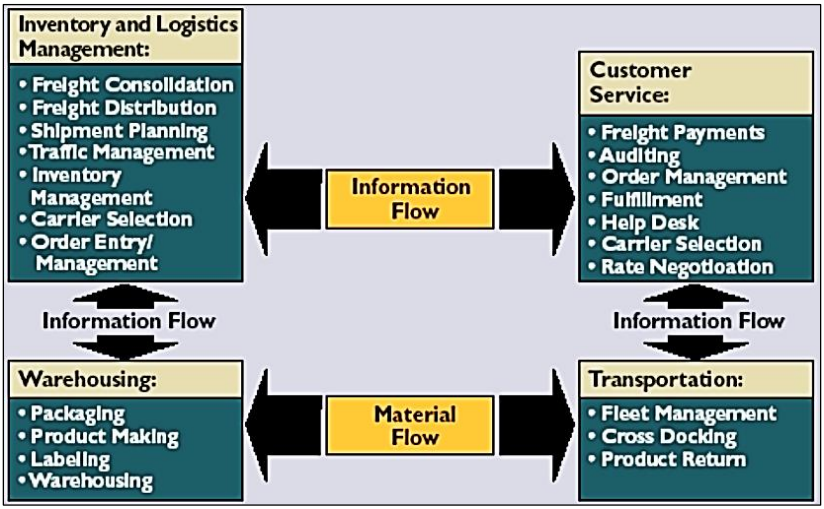

Fig 23: 3rd Party Logistics Functions

Source: (Vaidyanathan 2005)

Table 16: Top 10 World 3PLs Companies

	Third party logistics providers	**2013 Gross logistics revenue (in USD millions)**
1.	DHL Supply Chain & Global Forwarding	31,432
2.	Kuehne + Nagel	22,587
3.	DB Schenker Logistics	19,732
4	Nippon Express	17,317
5.	C.H. Robinson Worldwide	12,752
6.	CEVA Logistics	8,517
7.	DSV	8,140
8.	Sinotrans	7,738

9.	Panalpina	7,293
10.	SDV (Bolloré Group)	7,263

Source: Armstrong and Associates

Table 17: Top USA 3PLs Companies

	Third party logistics providers	**2013 Gross logistics revenue (in USD millions)**
1.	C.H. Robinson Worldwide	12,752
2.	Expeditors International of Washington	6,080
3.	UPS Supply Chain Solutions	5,492
4.	J.B. Hunt (JBI, DCS & ICS)	5,224
5.	Kuehne + Nagel (The Americas)	5,046
6.	Exel (DHL Supply Chain-Americas)	4,600
7.	UTi Worldwide	4,441
8.	Unyson Logistic	3,374
9.	Burris Logistics	3,119
10.	Schneider Logistics & Dedicated	2,850

Source: Armstrong and Associates

6.5 Fourth Party Logistics

Fourth Party Logistics (4PL) is the evolution of supply chain outsourcing. The convergence of technology, the rapid acceleration of e-capabilities has heightened the need for an over-arching integrator for supply chain spanning activities. 4PL is the shared sourcing of supply chain spanning activity with a client and select teaming partner, under the direction of a 4PL integrator. The Fourth Party Logistics (4PL) provider is a supply chain integrator that assembles and manages the resources, capabilities, and technology of its own organization with those of complementary service providers to deliver a comprehensive supply chain solution. As conceptually illustrated and examined in the book, "Strategic Supply Chain Alignment" by John Gattorna (1998), supply chain evolution has occurred with organizations moving from insourcing through outsourcing to 4PL arrangements. According to Gattorna, while outsourcing to 3PLs is now an accepted business practice, 4PL is emerging as a breakthrough solution to modern supply chain challenges to provide maximum overall benefit. Central to the 4PL success is the best-of-breed approach to providing services to a client. The development of 4PL solutions leverages the capabilities of 3PLs, technology service providers, and business process managers to provide the client with greater cross-functional integration and broader operational autonomy. There are two key distinctions make the

concept of 4PL unique and set it apart from other supply chain outsourcing options available to the market today. Firstly, 4PL delivers a comprehensive supply chain solution; and secondly, 4PL delivers value through the ability to impact the entire supply chain. The term 4PL was actually coined by the Accenture consulting group, when it was still Andersen Consulting, which considered trademarking or copyrighting the term but never did so. In fact, they also hold the trademark to the name 4PL. Accenture defines 4PL as an integrator that assembles all the resources, capabilities, and technology of its own organization and other organizations to design, build and run comprehensive supply chain solutions.

A true 4PL organization would then build a set of activities focused around specific set of supply chain initiatives and goals, generally with the following attributes:

- Common Services (invoice management, call centers, warehouse and distribution facilities).
- Implementation Center (the business process analysis, development of all activities into an open systems framework).
- Products/Skills Centers (supply chain engineering).
- IT System Center (the pure IT selection for design, implementation and connectivity).
- Back Office (administration, quality, finance, legal issues).

Sitting above these functions would be a Controlling Interface, monitored by the hired 4PL party. This group would manage all the blocking and tackling issues related to daily business. The Controlling Interface would provide the customer with visibility, control, KPI/Metrics management, reporting, daily decision making and problem solving, etc. Additionally, surrounding these activity sets would be the following: Knowledge Transfer, Business Development, and Functional Support. From the center outward, there would be a series of concentric circles. In the center would be the 4PL. The next outer circle would be the strategic partners. The next outer circle would be the preferred service provider, following by the largest outward circle which covers the project partners (see Figure 24).

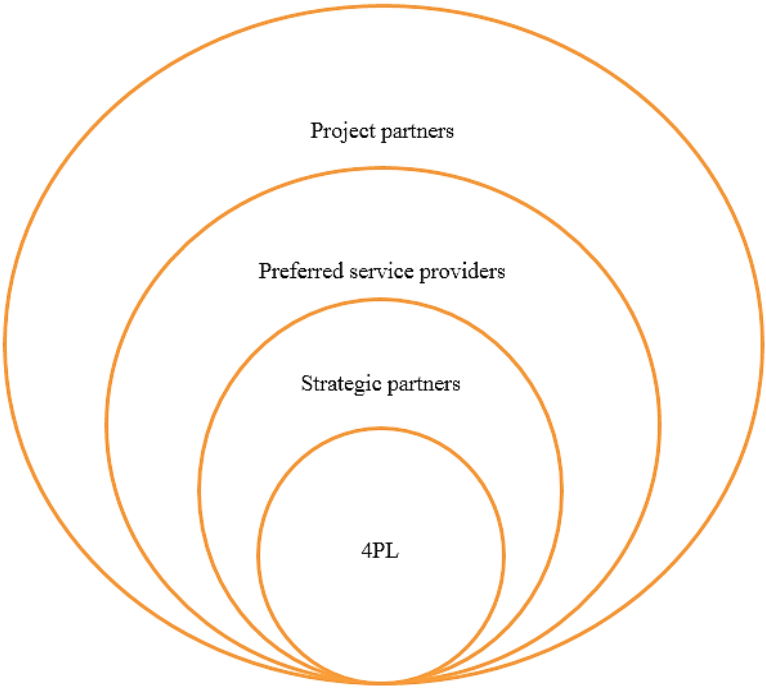

Fig 24: 4PL Platform

Source: Own development

Most companies do use 3PLs to leverage their capabilities to improve the performance of their supply chain by outsourcing portions of its transportation and warehousing functions. The third-party management allows companies to focus on its core competencies, to provide a differentiated level of customer service, and to take advantage of greater operational flexibility. This type of management also provides companies with the opportunity to improve their financial position by reducing some operating and capital expenses. However, in practice, 3PLs lack the strategic expertise required to operate across the entire supply chain and the technologies to truly integrate the related supply chain processes. Although some 3PLs provide minor assembly and kitting operations, they still concentrate primarily on their core strengths such as transportation and warehousing. While third-party management provides solid one-time reductions, it does not deliver the continuous on-going savings and management that a 4PL can provide.

It can be quite confusing to differentiate between 4PL, LLP and Logistics Integrator. Whilst the traditional focal point has been on the

organization of assets such as facilities, vehicles, and inventory, the shift for 4PL and Logistics Integrators is toward the collection, coordination, and management of information leaving asset management for the 3PLs. Under this business model, the fourth party would not have to be a third party logistics company, but could be a consulting firm or an information technology company. In contrast, an LLP provider would be a 3PL service provider currently used by the client, who is designated to manage certain aspects of the client's relationships with the other 3PL providers. 4PL providers become a partner to their clients and must continue to add value. Frequently, the process of implementing supply chain solutions involves changing culture within a company, and has to be tackled in stages.

A 4PL solution leverages the combined capabilities of both management consulting and third party logistics providers. More importantly, the design, implementation and execution of a leading edge, client-optimized, uniform technology plan that will meet the needs of the 4PL client is ensured by leveraging the technology capabilities of consultancies, technology providers and third party logistics providers. A 4PL implements recommendations including business process realignment, systems integration of technology across the client organizations and service providers, and transition of operations to the 4PL delivery team. Careful attention is paid to organizational change, recognizing that the human factor is a critical driver of success in the transition to the 4PL arrangement. The goal is to avoid the common, ineffective implementation of well-designed strategies and business processes that have limited the effectiveness of solutions and the delivery of projected results. A 4PL provider takes on operational responsibility for multiple supply chain functions and processes. The scope goes well beyond traditional third party transportation and warehouse operations to include: manufacturing, procurement, supply chain information technology, demand forecasting, network management, customer service management, inventory management, and administration. While an organization can outsource the entire range of its supply chain activities to a 4PL provider, a 4PL solution will more likely be a subset of critical path of supply chain functions or processes. Companies offering 4PL, or lead logistics services, include Schneider Logistics, Excel, UPS Logistics and Ryder Logistics. Others are: Accenture, XPO Logistics, 4PL Insights, Geodis Wilson, Deloitte, Global 4PL Supply Chain Services, 4PL Group, Logistics Plus 4PL. More 3PLs are planning to enter the 4PL field and consulting firms also are interested.

The 4PL provider needs to possess a comprehensive set of skills to effectively deliver a 4PL solution. The depth of skills and knowledge will be

critical to the success of the arrangement. We have identified the following criteria to evaluate a 4PL provider:

- Adequate number of trained and competent supply chain professionals including management staff.
- Global and regional capability in terms of geographical presence, resources, and technology.
- Ability to manage multiple service providers.
- Ability to provide transition of customer's staff and other assets smoothly to the new 4PL organization.
- Strong program management skill, people relationship and teamwork skills.
- Ability to deliver of world class supply chain strategy formulation and business process redesign.
- Substantial experience in integrating supply chain technologies and outsourcing capabilities.
- Understanding and management of organizational changes, issues and challenges.
- Ability to anticipate and prepare customers for future supply chain developments, trends and standards.

Upon reviewing the above, it seems to appear a true 4PL providers must be totally self-governing and cannot own assets such as warehouses or vehicles. The 4PL provider has to manage the outcome of the supply chain by utilizing the best and most appropriate resources available.

Table 18: Characteristics and Fundamentals of 4PL

Characteristics and Fundamentals of the 4PL	
1.	Neutrality
2.	Branch specific know-how
3.	Extensive IT competence
4.	Management capacity
5.	Task of designing, coordinating and controlling supply networks
6.	Delivering comprehensive supply chain solutions
7.	Managing an integrated material and information flow
8.	Taking over operative responsibility for the clients
9.	Offering a portfolio of different service modules by coordinating with other service providers

Source: Own development

A 4PL role can vary depending on what it is required to perform according to the customer's requirements. In general, the following are usually the requirements for logistics companies with 4PL role:

Supply Chain Visibility

This includes order visibility, shipment visibility and inventory visibility. 4PL may be required to deploy their own visibility systems or to integrate their systems to the customer's internal systems so as to provide a comprehensive information visibility to customers. The 4PL will be required to capture critical milestones in the logistics and warehousing process from all 3PLs and carriers within a geographical region and match them with customer order feeds to enable real-time order status for customer. This will allow customer to better manage the execution of deliveries within the geographical region as well as material shipments from global supply nodes.

Logistics Processes

4PL may be required to oversee the management of logistics processes including inbound logistics material, outbound logistics material, reverse logistics material, etc. 4PL is expected to manage most of these processes simultaneously and this multitasking management is what separates a 4PL from 3PL. 4PL is expected to manage their customer's 3PLs and must be in a leadership position to drive performance and measure performance of all the 3PLs. 4PL may access to computer systems to assimilate metrics from each of the logistics process owners to assess the overall performance of the 3PLs for a particular region. The logistics contract management process is defined as where the 4PL is required to balance existing customer's contracts and the 4PL's logistics provider network. Over time, 4PL will control and be responsible for all carrier contracts and for carrier selection, 3PL selection, contract negotiation, performance monitoring and measurement, etc. The reverse logistics process is defined as the return of material from an end destination based upon a Return Material Authorization (RMA). This RMA process may be initiated by customer, 3PL, or supplier that has been empowered to allow the return. As the authorization is entered into a database, this event triggers the appropriate system to alert the 4PL to manage the reverse logistics process. The warehousing and distribution process is defined as activities pertaining to receiving, short-term storing, accounting, preparation and shipment of material. This function will be used as a means of consolidating multiple shipments from multiple sources and staging the material in preparation for delivery. The supply chain network optimization is defined as the core group of logistics activities that the 4PL oversees as a regional or macro view. The network optimization scope could

include shipment optimization, shipment consolidation, regional and local geographic logistics loops (milk run), merge-in-transit, freight forwarders and customs broker management. The 4PL should demonstrate systems, procedures and capabilities to initiate and manage a Vendor Managed Inventory (VMI) hub for inbound raw materials and components into the customer's manufacturers or customer's Executive Management System (EMS). With VMI, the manufacturers or supplier is responsible for all decisions regarding product inventories. As a result, the control of the replenishment decision moves to the manufacturer to allow it to make inventory replenishment decision. VMI can allow a manufacturer to increase its profits for the entire supply chain by mitigating some of the effects of double marginalization. 4PL is therefore required to manage a VMI program on behalf of its customer.

The 4PL concept brings about the following benefits for the supply chain members:

- Revenue Growth-Revenue growth will be driven by enhanced product quality, product availability and improvement of customer service. Experience has shown that customer service measures, such as stock outs and ship complete, can be improved by getting 4PL focusing on the entire supply chain and not just the efficiency associated with warehousing or lowest cost transportation.
- Reduction of Supply Chain Cost-Operating cost reduction can be driven through operational efficiencies, process enhancements and procurement savings. Savings will be achieved through the complete outsourcing of the supply chain function.
- Reduction in Working Capital Requirements-Working capital reductions can be realized through inventory reductions and reduced order-to-cash cycle times. The proactive use of technology to manage order and SKU movement throughout the pipeline will minimize the amount of inventory required, as well as increase item availability to reduce cycle times.
- Supply Chain related Capital Reduction-Fixed capital reductions will result from capital asset transfer and enhanced asset utilization. The 4PL's logistics service providers can take ownership of physical assets, thus freeing up assets. This will allow the client organization to invest in its core competencies, i.e. research and design, product development, sales and marketing, impacting the balance sheet and bringing about broad level change.

- Leveraging Technology in a 4PL Solution-As the management of information becomes increasingly critical shippers need to develop a strategy for addressing information technology. To be truly effective, the information technology strategy must encompass systems at all levels such as ERP, Decision Support System, Transactional, and Functional if it is to enhance supply chain performance.

Recent advances in supply chain technology can provide a supply chain participant with a comprehensive real-time visibility of the entire supply chain. Technology has expanded to include product flow visibility, event management, and performance management, all of which enhance the corporation's competitive position. This technology provides real time information allowing a corporation to redirect product flow, if necessary, and forecasting inbound and outbound volumes. It also allows the user to quantify performance data and track performance accountability at all levels within the supply chain, while monitoring continuous performance improvement opportunities. Virtual businesses can be supported by entire end-to-end supply chain systems that will operated by virtual logistics outsourcer. These new technologies will enable a 4PL to provide an integrated solution across its service providers, as well as the client and its supply chain partners.

Beside the mentioned benefits, there are some challenges and issues to cope with in the 4PL environment (see table 19).

Table 19: Challenges and Issues within 4PL Environment

	Challenges and Issues within 4PL Environment
1.	Enterprises do not outsource controlling tasks
2.	Individual enterprises are not in the position to conduct comprehensive 4PL research
3.	Lack of clear cost allocation in outsourcing projects
4.	Slow reaction of logistics service providers on industrial requirements
5.	Inadequate developed supply networks
6.	4PL concepts and their benefits especially in their implementation phase are not well known
7.	Fragmented implementation of 4PL concepts along supply chains
8.	Insufficient definitions of interfaces between different processes
9.	Insufficient definition of tasks and responsibilities

Source: Own development

As cited by Dow N. Bauknight and John R. Miller (2009), there is no one single 4PL model for any companies. It all depends what does each

company want their 4PL to do but the bottom line is for 4PL to reduce cost, provide one-stop-shop service, consultancy, and value-added services, among others. Below are some generic 4PL models:

Synergy Plus Model

A synergy plus operating model relies on a working relationship between the 4PL organization and a 3PL. In this model, a 4PL and 3PL partner work together to market supply chain solutions which capitalize on the capabilities and market reach of both organizations. The 4PL could provide a broad range of services to the 3PL including technology, supply chain strategy skills, capability to go to market, and program management expertise.

Solution Integrator

A 4PL can act as a solution integrator. In this operating model, the 4PL operates and manages a comprehensive supply chain solution for a single client. The solution integrator arrangement will encompass the resources, capabilities, and technology of the 4PL with complementary service providers to provide a comprehensive integrated supply chain solution that delivers value throughout a single client organization's supply chain components.

Industry Innovator

In this model, a 4PL organization develops and runs a supply chain solution for multiple industry players with a focus on synchronization and collaboration. The formation of industry solutions will provide the greatest benefits, however it is complex and can challenge the most competent organizations.

Reference

1. Ballou Ronald H., Samir K. Srivastava (2007): Business Logistics/Supply Chain Management (Fifth Edition) Published by Pearson Education,
2. Bowman R. J. (2001). From cash to cash-the ultimate supply chain measurement tool, Global Logistics and Supply Chain Strategies, Vol. 5, No 6, Jun 2001, p. 47.
3. Bowman R. J. (2001). E-tail distribution: making it a two-way street, Global Logistics and Supply Chain Strategies, Vol. 5, No 2, February 2001, pp. 44-48.
4. Bucklin Luis. (1965), Postponement, speculation and the structure of distribution channels. Journal of marketing Research. Vol 2, No 1, pp. 26-31.
5. Canon slashes chargebacks by underscoring accountability, Chargebacks Solutions Monitor, Vol. 4, No. 4, February 2001, p. 3.
6. Contractor F. J., P. Lorange (ed), Cooperative strategies in international business. Lexington Book, Lexington 1988, p. 205.
7. Cook, S. 1995. Practical Benchmarking: A Manager's Guide to Creating a Competitive Advantage. London: Kogan Page.
8. Cygler J. (2002). Strategic alliances. Diffin, Warsaw, 2002.
9. Dale S. Rogers, Ronald S Tibben-Lembke (1998), Going backwards: reverse logistics trends and practices, University of Nevada, Reno, Center for Logistics Management, Reverse Logistics Executive Council.
10. Dana Dubbs (2001), many (unhappy) returns, Operation & Fulfillment, Vol. 9, No. 3, March 2001.
11. David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi (2000), Designing and managing the supply chain-concepts, strategies and case studies, 3th international edition, The McGraw-Hill.
12. Donald J. Bowersox, David J. Closs (1996), Logistical management: the integrated supply chain process, McGraw-Hill, 1996.
13. Donald J. Bowersox, David J. Closs, M. Bixby Cooper (2002), Supply chain logistics management, McGraw-Hill, 2002.
14. Donald W. Dobler, David N. Burt (1996), Purchasing and supply management: text and cases, The McGraw-Hill, US.

15. Douglas M. Lambert, James R. Stock, Lisa M. Ellram (1998). Fundamentals of logistics management. Boston: Irwin/McGraw-Hill, 1998.

16. Dow N. Bauknight, J. R. Miller (2009): Fourth Party Logistics™: The Evolution of Supply Chain Outsourcing.

17. Ernst F. Bolten (1997), Managing Time and Space in the modern warehouse, New York, 1997.

18. Garrette B., DDussage P. (1996), Strategic alliance in the market. Poltext, Warsaw 1996.

19. Gattorna J. (1998),"Strategic Supply Chain Alignment. Best Practices in Supply Chain Management", 1998.

20. Jacobs F. R., R. B. Chase (2014). Operations and supply chain management. McGraw-Hill Irwin.

21. James S. Keebler... [et al.] (1999). Keeping score: measuring the business value of logistics in the supply chain. Oak Brook, Ill.: Council of Logistics Management, 1999.

22. James R. Stock (1993). Development and implementation of reverse logistics programs, Oak Brook, Illinois, Council of Logistics Management.

23. Jenkins, Creed H., Complete guide to modern warehouse management, Prentice Hall (1990)

24. Jennifer S. Kuhel (2001), Reversal of fortune, Supply Chain Technology News, Vol. 3, No. 5, May 2001, pp. 40-45.

25. John J. Coyle, C. John Langley Jr., Brian J. Gibson, Robert A. Novack, Edward J. Bardi (2008), Supply chain management: a logistics perspective, Southern-Western Cengage Learning, 2008.

26. Kaplan, R. S. and D.P. Norton (2001) the Strategy-Focused Organization: How Balanced Scorecard Companies Thrive in the New Competitive Environment, Boston: HBS Press.

27. Kaplan, R.S. and D.P. Norton (2000) the Strategy-Focused Organization: How Balanced Scorecard Companies Thrive in the New Business Environment, Harvard Business School Press

28. Kaplan, R. S. and D.P. Norton (1996a) the Balanced Scorecard: Translating Strategy into Action, Boston: HBS Press.

29. Kaplan, R. S. and D.P. Norton (1996b) Using the Balanced Scorecard as a Strategic Management System," Harvard Business Review (January-February):75-85.

30. Kaplan, R. S. and D.P. Norton (1993) Putting the Balanced Scorecard to Work, Harvard Business Review (September-October).

31. Kaplan, R. S. and D.P. Norton (1992) the Balanced Scorecard: Measures that Drive Performance, Harvard Business Review, (January-February): 71-79.

32. Ken Ackerman, Warehousing profitably, Ackerman's publication (1994)

33. Ken Ackerman, Practical Handbook of Warehousing, London: Chapman & Hall (1997)

34. Larry Lapide, 'What about Measuring Supply Chain Performance', AMR Research.

35. Leslie Hansen Harps (2001). Getting a good return, inbound logistics, Vol 21, No 1, January 2001, pp. 185-194.

36. Levi Strauss (2000), Presentation by at annual conference of Council of Logistics Management, September 2000.

37. LPI report (www.worldbank.org/lpi)

38. Martin Christopher (1998), Logistics and supply chain management: strategies for reducing cost and improving service, Prentice Hall publisher (an imprint of Pearson Education), London.

39. McKeon, Joseph, "Strike Up Logistics Alliances," Transportation and Distribution, Vol. 39, Issue. 11, November 1988, pp. 38-39.

40. Muller Max (2003), Essentials of inventory management, AMCOM, 2003.

41. Nguyen Hoang Tien (2017), Global strategic marketing management. Ementon publisher, Warsaw.

42. Parcel carriers are helping e-tailers handle returns. Logistics Management & Distribution Report, Vol. 39, No. 11, November 2000, pp. 24-27.

43. Porter M. E. (1990), the competitive advantage of nations. The Free Press, New York 1990, pp. 65-67.

44. Rhodes Ed, Warren James P., Carter Ruth (2006), Supply chain and total product systems. Reader Blackwell, 2006.

45. Schmitz J. M., R. Frankel, and D.J. Frayer (1995), "ECR Alliances: A Best Practice Model" Joint Industry Project on Efficient Consumer Response, 1995.

46. Starr, M. K. (1966). Planning Models, Management Science, 13(4) B115– B141.

47. Sunil Chopra, Peter Meindl (2013): Supply chain management-strategy, planning and operation, 5th edition, global edition. Pearson publisher

48. Supply Chain Operations Reference Model-Overview of SCOR version 5.0. Supply Chain Council.

49. Supply chain and logistics terms and glossary, CSCMP.

50. Vaidyanathan G. (2005) "A framework for evaluating 3rd party logistics". Communications of the ACM, Vol. 48 No. 1, Pages 89-94

51. Vietnam Logistics Institute's internal teaching materials, SCM module.

52. Walters Donald (2003), Logistics: an introduction to supply chain management, Palgrave McMillan, 2003.

53. Zinn Walter, Donald J. Bowerbox (1988): Planning physical distribution with the principle of postponement. Journal of Business Logistics, Vol 9, No 2, pp. 117-136.

Website

1. https://www.knowthis.com/managing-product-movement/modes-of-transportation-comparison

2. http://www.geocities.ws/liame_/Warehousing.htm