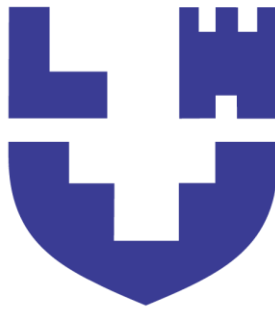


Міністерство освіти і науки України



SUPPLY CHAIN MANAGEMENT

конспект лекцій для здобувачів другого (магістерського) рівня вищої освіти

освітньої програми «Транспортно-логістичні системи автомобільних перевезень»

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У 67 **Supply Chain Management:** конспект лекцій для здобувачів другого (магістерського) рівня вищої освіти освітньої програми «Транспортно-логістичні системи автомобільних перевезень» галузі знань 7 Транспорт та послуги спеціальності 78 Автомобільний транспорт денної та заочної форм навчання / укладач: В. КОТЕНКО. – Луцьк: ЛНТУ, 2025. – 108 с.

Конспект лекцій з дисципліни «Supply Chain Management» спрямований на формування знань і практичних навичок з проектування, планування, управління та оцінювання ефективності ланцюгів постачання. Матеріал охоплює питання інтеграції та співпраці в ланцюгах постачання, прийняття управлінських рішень, управління транспортними процесами, оцінювання ефективності, інформаційних технологій, глобальних ланцюгів постачання та сучасних митних інновацій..

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1 Theoretical and methodological foundations of supply chain management

1. The essence of supply chain management.
2. Conditions for the development of supply chain management.
3. Evolution of the conceptual model of supply chain management.
4. The role of supply chain management in improving the efficiency of enterprises.

1.1. The essence of supply chain management

Supply Chain Management Term Origin: The term "supply chain management" emerged in the late 1980s and became widely used in the 1990s. Before that, terms like "logistics" and "operations management" were used.

Definitions of a Supply Chain:

1. **Lambert, Stock, and Ellram:** "A supply chain is the alignment of firms that bring products or services to market."
2. **Chopra and Meindl:** "A supply chain consists of all stages involved, directly or indirectly, in fulfilling a customer request, including manufacturers, suppliers, transporters, warehouses, retailers, and customers."
3. **Ganeshan and Harrison:** "A supply chain is a network of facilities and distribution options that performs procurement of materials, transformation into intermediate and finished products, and distribution of finished products to customers."

Definitions of Supply Chain Management:

1. **Mentzer et al.:** "The systemic, strategic coordination of traditional business functions and tactics within a company and across businesses in the supply chain to improve long-term performance."
2. **Key Concepts of Supply:** "The coordination of production, inventory, location, and transportation among supply chain participants to achieve the best mix of responsiveness and efficiency."

APICS

According to APICS, supply is the quantity of goods available for use or the planned replenishment of a product.

Supply chain is the process from raw material procurement to finished product consumption, linking across supplier-user companies or internal functions to enable the value chain.

Supply chain management means planning, organizing, and controlling supply chain activities from the customer to the customer.

Supply chains exist in both service and manufacturing organizations, with complexity varying across industries and firms.

The Association for Operations Management

Relationship between logistics and supply chain management (SCM)

There are four approaches to defining the relationship between logistics and supply chain management (SCM): traditionalist, re-labelling, unionist, and inter-sectionist.

1. The traditionalist approach considers SCM to be only a small part of logistics. Within this approach, supply chain management is presented as just one lecture in a logistics course or a chapter in a book dedicated to logistics.

2. The re-labelling approach considers SCM to be a new term that encompasses what was previously included in logistics. In other words, what was once logistics has become supply chain management.

3. The unionist approach to the relationship between logistics and supply chain management defines logistics as a component of SCM, fully encompassed within this concept.

4. The intersectionist approach, in turn, suggests that supply chain management (SCM) is NOT a combination of logistics, marketing, production management, procurement, and other functional areas, but it constantly intersects with them. The task of SCM is to coordinate the cross-functional activities of a large number of participants. Thus, supply chain management is not a tactical, but a strategic activity [23].

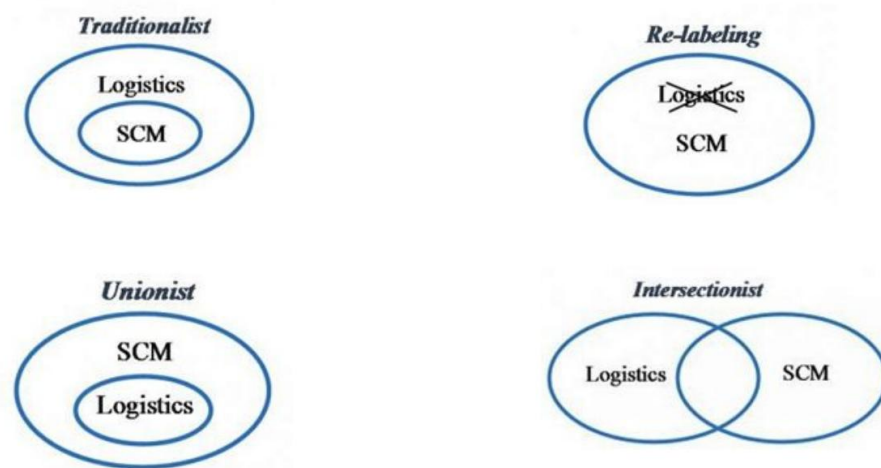


Figure 1.1 - Four approaches to defining the relationship between logistics and supply chain management (SCM)

A difference between the concept of supply chain management and the concept of logistics

There is a difference between the concept of supply chain management and the traditional concept of logistics. Logistics typically refers to activities that occur within the boundaries of a single organization and supply chains refer to networks of companies that work together and coordinate their actions to deliver a product to market. Traditional logistics focuses on activities such as procurement, distribution, maintenance, and inventory management. Supply chain management acknowledges all of traditional logistics and includes activities such as marketing, new product development, finance, and customer service [22].

1.2. Conditions for the development of supply chain management

Main Points:

- **Evolving Production and Logistics:** New concepts in organization and management of industrial and transport enterprises are emerging.
- **Market Shift:** Since the 1960s, there has been a shift from the "producer market" to the "consumer market" due to the increasing role of marketing.
- **Total Quality Management (TQM):** After initial market saturation, consumer demands for quality led to TQM, and the development of a customer-oriented business philosophy.
- **Impact on Production and Logistics:** Demand for shorter production cycles, low inventory levels, high reliability in meeting delivery deadlines, and flexibility in production and logistics.

- **Speed Effect:** In the 1990s, the development of Lean Production and Just-in-Time concepts emphasized the speed of response to market changes.
- **Synchronization Concepts:** In the 1980s, synchronization of distribution, production, and supply processes were developed, with Just-in-Time widely adopted.
- **Supply Chain Management (SCM):** SCM emerged for rational production capacity utilization and its understanding has evolved significantly.
- **1990s Trends:** Supply exceeding demand, market globalization, and the information society caused changes in business competitiveness and profitability strategies.

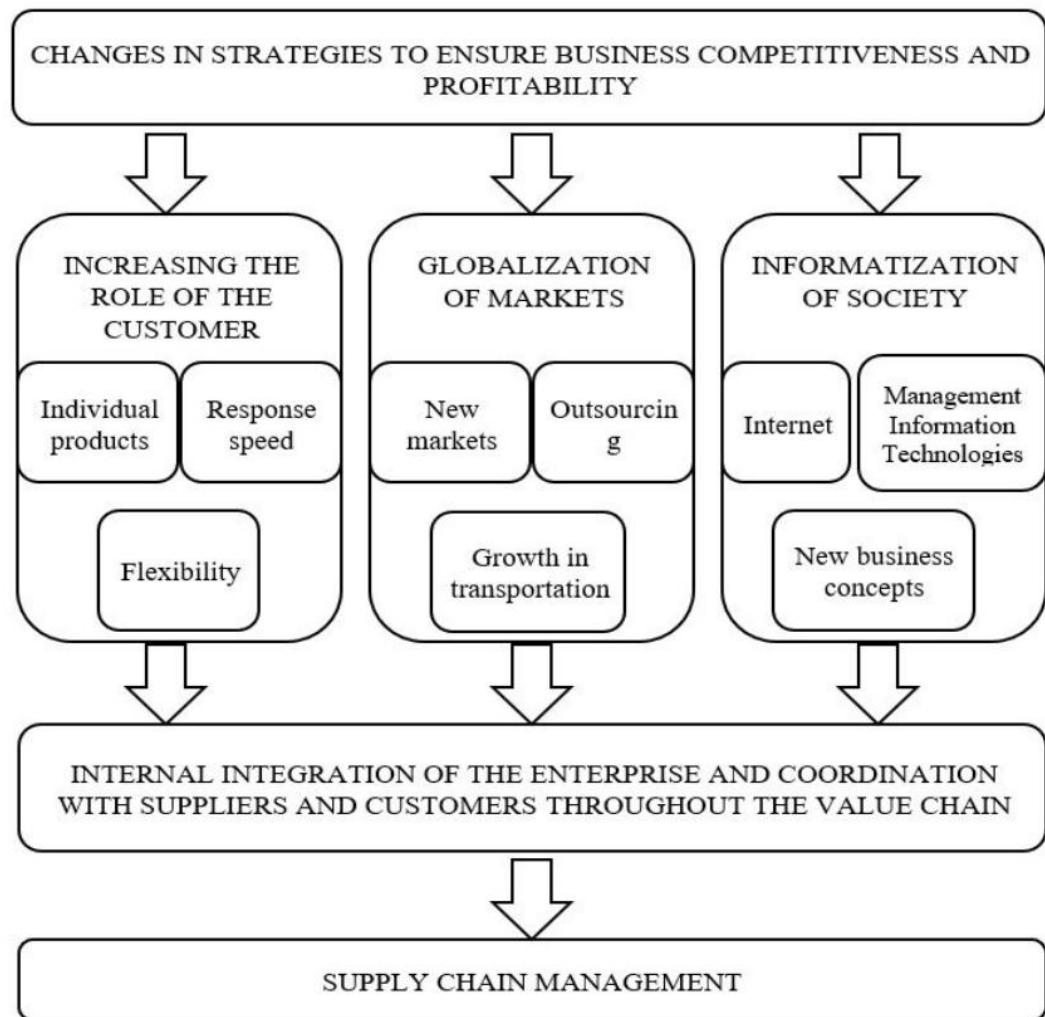


Figure 1.2 - Objective conditions for the development of supply chain management

To ensure competitiveness, companies were forced to individualize products and fully consider customer needs. In the 1990s, new markets in Southeast Asia, South America, Eastern Europe, and Russia began to be actively developed. Many companies relocated their production facilities to these regions. The volume of transportation, including intercontinental, began to increase rapidly.

The rapid development of information technology for business management and the emergence of the global information space of the internet provided fundamentally new opportunities for business management. This determined the development of supply chain management.

SCM practices proved the effectiveness of building and analyzing business from an integrated consideration of all segments and intersections of different stages of the value chain. In practice, SCM began to develop in the 1990s in the USA, Europe, and Japan in industries oriented

towards individual customers. The growing importance of SCM is associated with the development of outsourcing, increased competition, and the emergence of new forms of competition in the context of globalization and integration.

In the last decade, many companies have shifted their focus from internal restructuring of business processes to key competencies and inter-organizational interaction. This led to the spread of the outsourcing concept, involving third-party organizations to perform tasks that are not key competencies for a given company. While initial attention was focused on internal processes within organizations, in the 1990s, there was a transition to external integration of participants in the value chain (Value Chain Management) [2, 5].

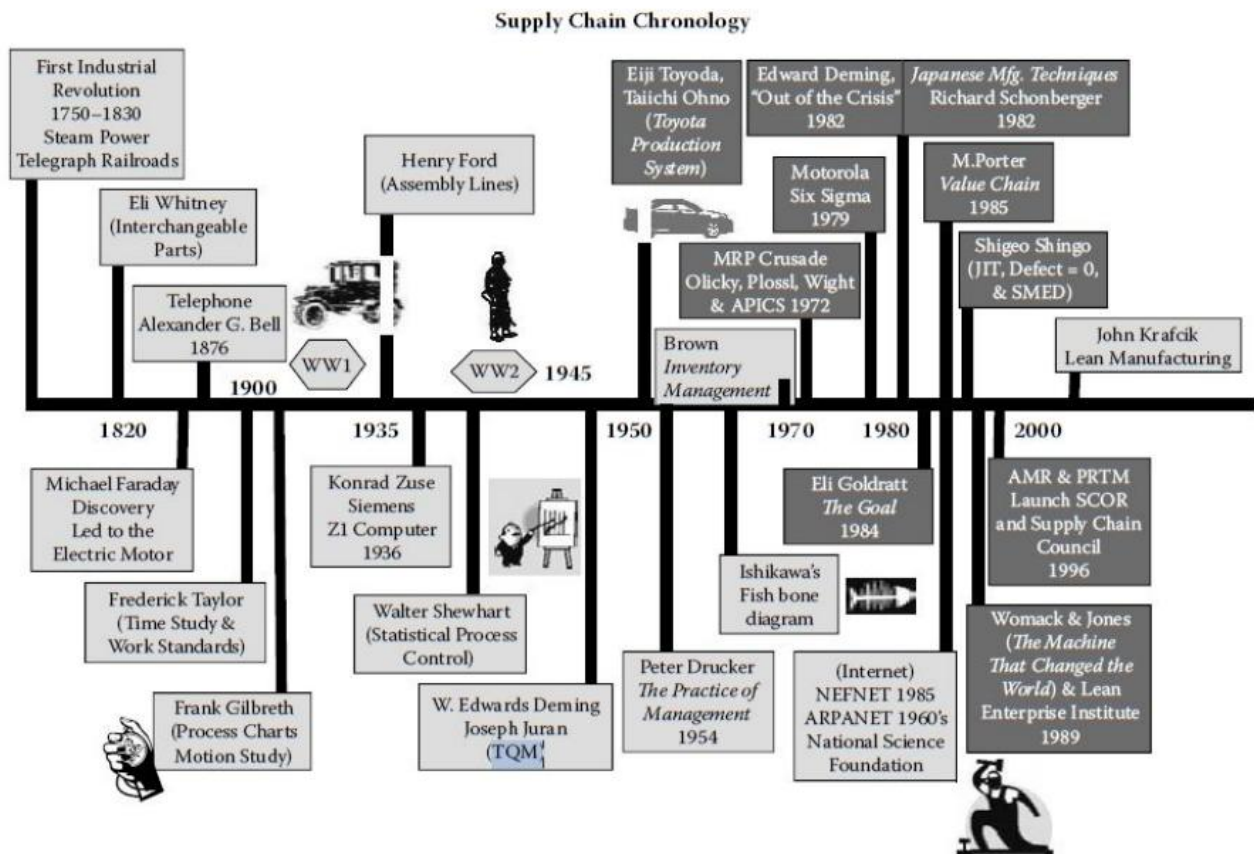


Figure 1.3 - Supply Chain Chronology

The modern level of industrial and logistics development is defined by competencies, virtuality, and interaction. Changes in production and logistics involve identifying key competencies, outsourcing non-core processes, and forming flexible tools. New forms of competition and increasing IT penetration drive changes in business organization. Modern products are developed and manufactured at multiple geographically distributed enterprises using internet technologies.

Sales, supply, and service stages impact enterprise economics.

Corporate information systems and internet technologies drive a new phase in SCM development.

Information technologies enable the coordination and synchronization of supply and demand in SCM [3].

Internal inter-firm integration and coordination distinguish SCM from traditional cooperation.

SCM is rapidly gaining significance for industrial, logistics, and trading enterprises.

SCM practices consider all segments and elements of the value creation process.

1.3. Evolution of the conceptual model of supply chain management

After the First Industrial Revolution (1750-1760), corporates followed a factory system with a fragmented supply chain approach. Every department was an isolated island with hostile relationships with other trading organizations. The scenario started changing after the Second Industrial Revolution with the Toyota Production System in Japan. The advent of MRP(manufacturing resource planning), MRP-II, and ERP systems accelerated this theme. The organization started evolving as one entity with a stronger internal supply chain. ERP systems aimed for tightly integrated organizations and partnerships with other organizations. This evolution resulted in supply chain management. The concept of the supply chain has existed for a long time, but the concept of supply chain management is new.

As discussed above, SCM function is the outgrowth of the unified evolution of manufacturing management and logistics management functions. The concept logistics management itself evolved from unified evolution of materials management and sales and distribution management. This is shown in Figure 4.

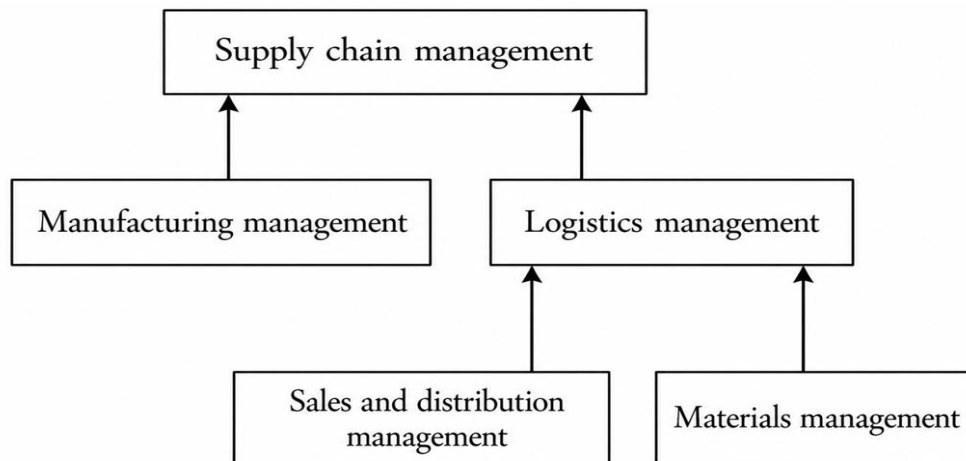


Figure 1.4 - Evolution of SCM

Traditional materials manager was responsible for supplier relationships, and the distribution manager for customer relations. The manufacturing function managed production and related services. Today, the supply chain manager oversees the entire material flow from demand planning to final dispatch to the consumer. All traditional functions are now part of the overall SCM strategy. SCM provides competitive and financial advantages by offering low-cost production with a variety of products. Implementing SCM involves techniques like CPFR, VMI, SRM, outsourcing partnerships, SMED, Pokayoke, TQM, TPM, TQC, TEI, Six Sigma, TPL, and optimizing systems.

Summarily, we can say that SCM works in demand driven situation, encourages flow-type production with small batches, reduces idle inventory and idle time in any business by improving overall customer centric approach.

Figure 5 shows the conceptual model of SCM. It is based on the five basic elements called Pillars of SCM. It includes:

- Multiparty net-logistics
- Multi-tier supplier partnerships
- Highly sophisticated IT systems
- Non-core outsourcing
- Make/Engineer to order philosophy [6]

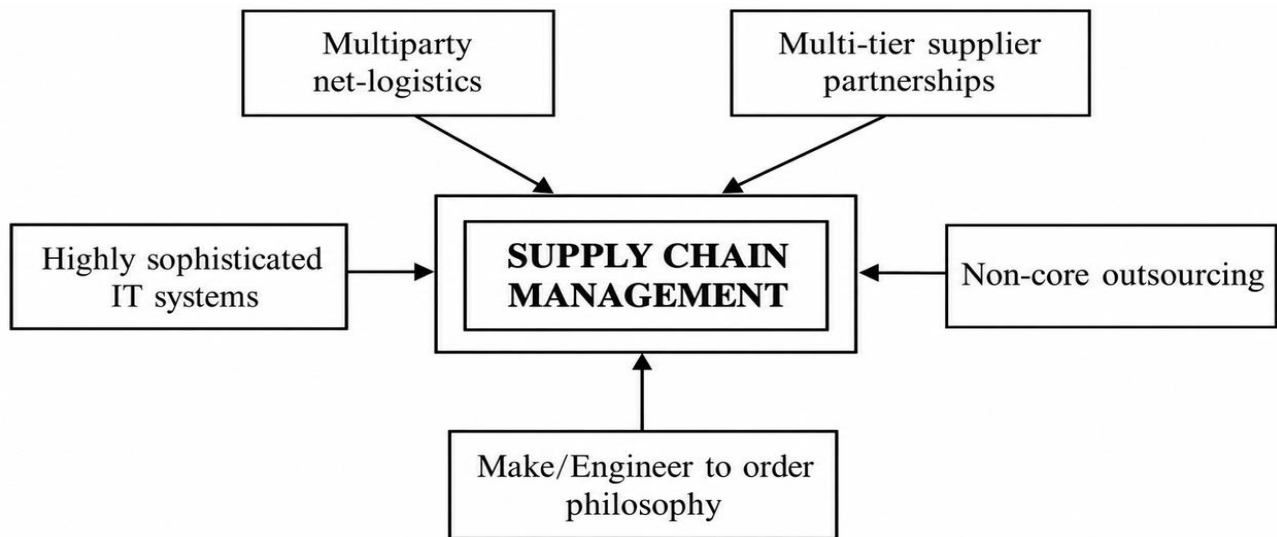


Figure 1.5 - Conceptual model of SCM

1.4. The role of supply chain management in improving the efficiency of enterprises

The key concept in logistics is the concept of flow. Flows, in turn, are formed by supplies. The entire history of inter-organizational interaction between different enterprises is associated with supplies. Along with the development of cooperation and specialization of enterprises, methods of supply management have also evolved.

In the 1990s, factors such as globalization, integration, increased market openness, information technologies, and the emergence of the global information space of the Internet began to significantly influence economic development. All of this contributed to the emergence of a new concept in supply management — Supply Chain Management (SCM).

Supply chain management (SCM) is the main concept of supply management in the modern economy. But it's more than that. SCM is more than just managing supplies from a logistical perspective.

Supply chain management (SCM) is an integrated business concept that combines advanced organizational principles and the capabilities of modern information technologies.

Supply chain management (SCM) is closely linked to business strategy. The scale of SCM development is such that experts are now talking about the shift of competition between enterprises to the realm of supply chain competition. Effective SCM is one of the decisive factors in maintaining and increasing income levels and competitiveness in current and future markets.

Supply chain management (SCM) is aimed at optimizing inter-organizational interaction based on the most advanced management methods and information technologies, as well as optimizing intra-firm logistics. The practice of implementing SCM in business suggests that this concept is fundamental in modern logistics and will continue to develop rapidly in the future [2].

SCM, on the one hand, is a part of logistics, and on the other hand, logistics is a part of SCM, because SCM integrates elements of logistics, production management, enterprise organization, marketing, and information science.

Statistics:

- Successful SCM projects can reduce overall supply chain costs by up to 60% and inventory levels by up to 60%.
- Manufacturing and delivery times can be reduced by up to 50%, and delivery accuracy can be improved by up to 60%.

- SCM enhances capacity utilization by up to 20% and increases profits by optimizing the value creation process and reducing transaction costs by up to 30%.
- Product quality can be improved by up to 30%, and turnover and market share can increase by improving supply chain response speed and flexibility by up to 55%.
- Up to 75% of operational costs in the value creation chain are associated with the supply chain, and up to 80% of the final product's cost depends on supply chain planning decisions.

Supply chain management (SCM) is aimed at achieving two main effects:

1. Increasing revenue from the sale of products/services by improving service levels, delivery accuracy, and reducing demand fluctuations.
2. Reducing costs by lowering inventory levels, reducing overhead and transactional costs in procurement, warehousing, and distribution, as well as improving the utilization of production and logistics capacities.

Increasing revenue from the sale of products/services by improving service levels, delivery accuracy, and reducing demand fluctuations.

Reducing costs by lowering inventory levels, reducing overhead and transactional costs in procurement, warehousing, and distribution, as well as improving the utilization of production and logistics capacities.

Figure 1.6 - Two main effects of supply chain management (SCM)

The main goal of supply chain management (SCM)

The solutions to these and many other tasks are aimed at achieving the main goal of supply chain management (SCM): increasing profit, expanding market share, and minimizing total supply chain costs to ensure long-term business stability and competitiveness. To achieve this goal, there is a whole set of various strategies, concepts, methods, and technologies, different combinations of which can significantly improve business efficiency in various sectors of the economy [3, 13].

Just a few years ago, the economy of an enterprise and its organizational structure were traditionally viewed through the lens of key functional management areas: marketing, product development, procurement, warehousing, production, distribution, management accounting, finance, and bookkeeping. Modern market trends suggest a somewhat different logic in the construction of an enterprise's economy.

The entire set of functional management areas of an enterprise mentioned above can be aggregated into four blocks:

- Finance management
- Product lifecycle management
- Logistics management
- Supply chain management



Figure 1.7 - Four blocks of enterprise management

Product lifecycle management combines all stages of product development, manufacturing, and usage. It accounts for about 25% of business success. Financial management integrates the functions of management accounting and financial flow management, contributing approximately 35% to overall business success. Logistics management is responsible for the physical transformation of material flows at specific (local) segments of the value creation chain. The effectiveness or ineffectiveness of logistics can determine about 10% of business success. Supply chain management (SCM) balances needs and supplies integrated across the entire value creation chain and determines about 30% of business success.

The basis of all considerations is added value and the aim to maximize it. Added value is created by the product, or more precisely, by all stages of obtaining the product from primary raw material sources to the end consumer (and in some cases, through the stages of product operation and disposal). The physical receipt of the product is based on local (but interdependent) processes of transformation (production) and material flow movement (logistics).

Five industry sectors can be identified where SCM is one of the main tools for enhancing business efficiency: aerospace, automotive, electronics, wholesale and retail trade, consumer goods, and pharmaceuticals.

To interact in order to remain competitive is one of the key principles for successful business operations in today's dynamic markets. This paradigm leads to significant changes in approaches to business organization and management. The emergence of new business concepts and information technologies opens up new opportunities for managing industrial and logistics enterprises (in this case, the thesis "technology defines organization" is valid). Information technologies, on one hand, act as a catalyst promoting the development of a fundamentally new level of enterprise interaction, and on the other hand, provide the infrastructure for new forms of industrial enterprise cooperation aimed at increasing the flexibility of response to market changes and product supply processes.

A promising approach to enhancing enterprise competitiveness and efficiency is developing methods, mechanisms, and tools for organizing and managing industrial economic entities through interproduction cooperation. This involves creating flexible organizational forms based on cooperation, coordination, and synchronization of key business processes. The planning and management models use unified information channels with suppliers and customers across the entire supply chain.

In the concepts of flexible organizational forms of interproduction cooperation, internet technologies are actively used for the rapid coordination of supply chains. Among the first companies to implement supply chain management technologies were Wal-Mart and Procter & Gamble in the trade sector, and Cisco, Toyota, and National Semiconductor.

SCM implementation in corporations like Hewlett-Packard, SpartanStores, Clariant Inc., and Ace Hardware has resulted in significant improvements:

- Inventory levels reduced by 40%.
- Service levels achieved 95-99%.
- Capacity utilization increased by 40%.
- Transportation costs reduced from 7% to 2.5% of product cost.

Organizing business based on SCM principles allows flexible responses to market changes and enables rapid supply chain formation to fulfill customer orders. Effective SCM is crucial for maintaining and increasing income levels and competitiveness in current and future markets.

The synergistic effect in supply chains

The four "driving forces" of an enterprise's economy—financial management, product lifecycle management, supply chain management, and logistics management—are closely

interconnected. Product lifecycle management links to supply chain management by involving suppliers and marketing early in product development. Synchronizing material and information flows positively impacts financial flows. Optimizing production and logistics processes and their connections enhances overall efficiency.

Supply chain management, alongside financial, product lifecycle, and logistics management, is crucial for business success. Integration and cooperation in supply chains create a synergistic effect, boosting logistics efficiency. The main goal of creating logistics chains is to achieve synergy, increasing the efficiency of logistics activities in enterprises.

Scientists consider the synergistic effect in supply chains as the effect of mutual reinforcement of the connections between its elements during their joint actions. The presence of an integrated system of flow processes in supply chains is considered an important condition for an industrial enterprise to create a "synergistic portfolio," which serves to mitigate the negative impacts of the external environment.

The synergistic effect in supply chains arises due to the reduction of internal and external uncertainties in supply chains by enhancing elasticity or flexibility, which depends on both its participants and the relationships between them.

The nature of connections in logistics chains is greatly influenced by logistics crossing points, due to the specialization of enterprise functions and segmentation of competence areas. This results in partial interests and dysfunctional conflicts.

It is appropriate to structure by supply chain participants, by key business processes in logistics chains, and by components of the synergistic effect.

Components of the synergistic effect:

- Sales synergy occurs when goods are supplied through the same distribution channels, and the sales process is managed from a single center;
- Operational synergy is the result of effective use of fixed assets and personnel, joint large-scale purchases, and distribution of overhead costs;
- Investment synergy results from the joint use of production capacities, common raw material stocks, equipment, transportation, research, and development of one product with another, and a common technological base;
- Management synergy arises when solving strategic, organizational, and operational problems as a positive effective result of company management.

Extra Materials: **Video**

1. What is the primary goal of supply chain management in today's fast-paced economy?
2. How has technology changed the traditional linear approach to supply chain management?
3. What are some benefits of effective supply chain management for businesses?

Key Questions

1. How is a supply chain defined, and which organisations and flows does it include?
2. How does supply chain management differ from logistics management?
3. What are the traditionalist, re-labelling, unionist and intersectionist approaches to the relationship between logistics and SCM?
4. Which market, technological and organisational conditions led to the development of SCM?
5. How did the shift from producer-oriented to customer-oriented markets influence supply chain management?
6. How has the conceptual model of SCM evolved from fragmented functions to integrated networks?
7. What are the five pillars of the conceptual model of SCM?

8. How can SCM improve service levels, inventory turnover, costs and enterprise competitiveness?
9. How do financial management, product lifecycle management, logistics management and SCM interact?
10. What is the synergistic effect in a supply chain, and how do sales, operational, investment and management synergy arise?

2 Conceptual Framework of Supply Chain and Its Management

1. Supply Chain: Definition, Functions, Structure
2. The mission of logistics management
3. Functional areas of supply chain management

2.1. Supply Chain: Definition, Functions, Structure

The supply chain embodies longstanding business planning concepts from logistics, strategic management, and operations research. Its growing importance stems from strategic relationships between shippers, carriers, manufacturers, suppliers, and distribution intermediaries, creating a complex interaction network.

R. Handfield notes: "The supply chain encompasses all organizations and activities related to moving and transforming goods from raw materials to finished products, along with information flows."

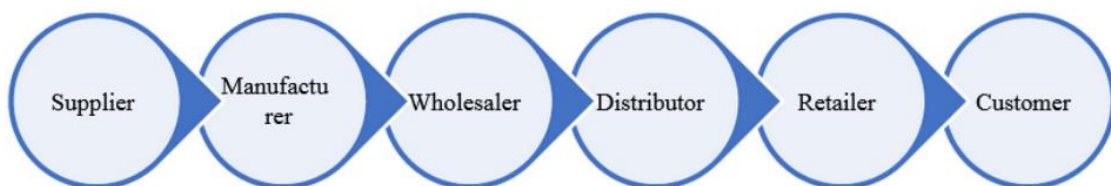


Figure 2.1 - Supply Chain Structure (Chopra and Meindl, 2003)

Table 2.1 - Levels of Supply Chain Complexity

Levels of Supply Chain Complexity	Types of Supply Chains	Supply Chain Structure
I	Direct	It consists of a focal (central) company (usually an industrial or trading firm), a supplier, and a buyer/consumer, who participate in the external and/or internal flow of products, services, finances, and/or information. Typically, the focal company determines the structure of the supply chain and manages relationships with business counterparts.
II	Extended	It additionally includes second-tier suppliers and consumers (suppliers of the supplier and consumers of the consumer).
III	Ultimate	It consists of the focal company and all its counterparts to the left (up to raw material and natural resource suppliers), which determine the resources of the focal company – on the "input" side, and the distribution network to the right – up to the end (individual) consumers, as well as logistic, institutional, and other intermediaries.

A direct supply chain consists of a central enterprise (production or commercial activity), first-tier suppliers, and first-tier consumers (those who work directly with the enterprise) who participate in managing flow processes.

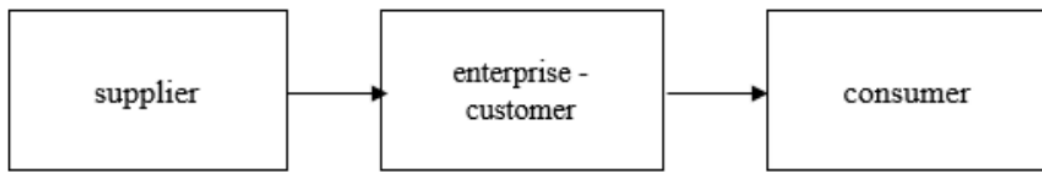


Figure 2.2 - Direct Supply Chain

An extended supply chain includes second-tier suppliers and consumers (those who work with the enterprise through first-tier suppliers and consumers).

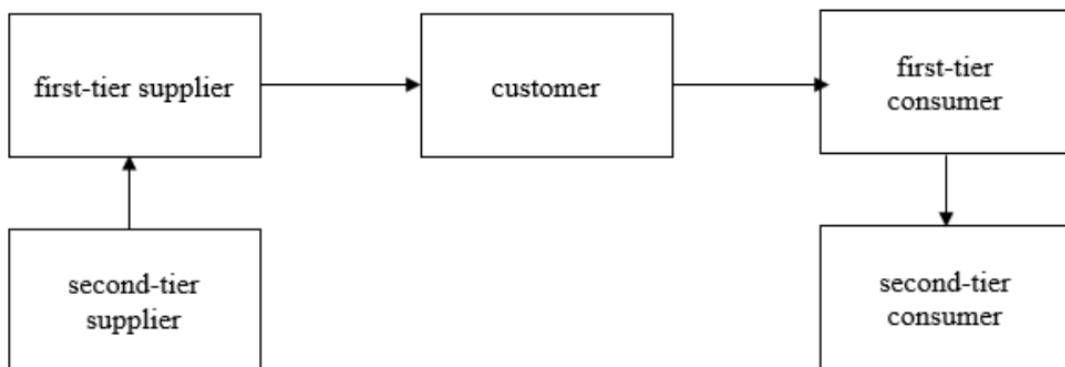


Figure 2.3 - Extended Supply Chain

The ultimate supply chain includes the central enterprise and all counterparts in the ascending and descending flows (up to the suppliers of primary material resources and the end (individual) consumers).

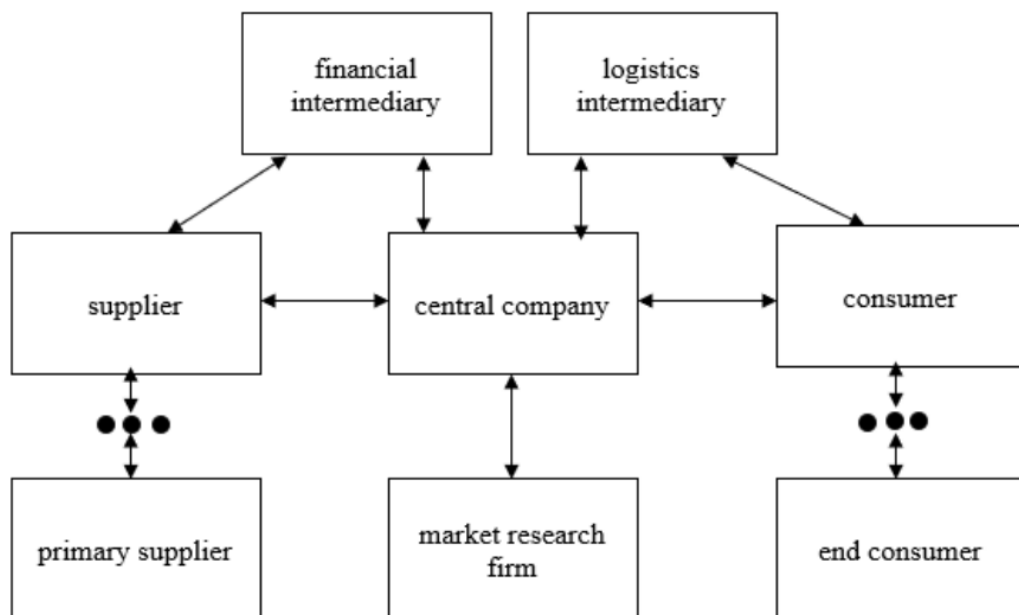


Figure 2.4 - Ultimate Supply Chain

There are two main approaches to considering a supply chain in terms of its structural components: object and process decomposition (table 2.2) [7, 10].

Table 2.2 - Approaches to considering a supply chain in terms of its structural components

Type of Decomposition	Definition	Division of the Supply Chain
Object-oriented	It is a traditional approach to breaking down the holistic system into structural elements based on functional criteria; it involves dividing the supply chain (logistics system) into components: subsystems, links, elements, channels, chains, etc.	1) Logistic system – subsystem – element – link 2) Logistic system – network – channel – link
Process-oriented	It is an approach to effective supply chain management, where the supply chain (logistics system) is studied and designed as a sequence of flows and processes.	1) Logistic system – functional area – logistic function – logistic operation 2) Supply chain – key business process – logistic business process – logistic function – logistic operation

Depending on one's view, some of the functions listed here may be included within the supply chain and logistics organization:

Procurement: The acquisition of goods or services from an outside external source

Demand forecasting: Estimating the quantity of a product or service that customers will purchase

Customer service and order management: Tasks associated with fulfilling an order for goods or services placed by a customer

Inventory: Planning and management

Transportation: For hire and private

Warehousing: Public and private

Materials handling and packaging: Movement, protection, storage, and control of materials and products using manual, semi-automated, and automated equipment

Facility network: Location decision in an organization's supply chain network Supply chain management is also intertwined with operations management, which consists of activities that create value by transforming inputs (that is, raw materials) into outputs (that is, goods and services). Both activities support the manufacturing process.

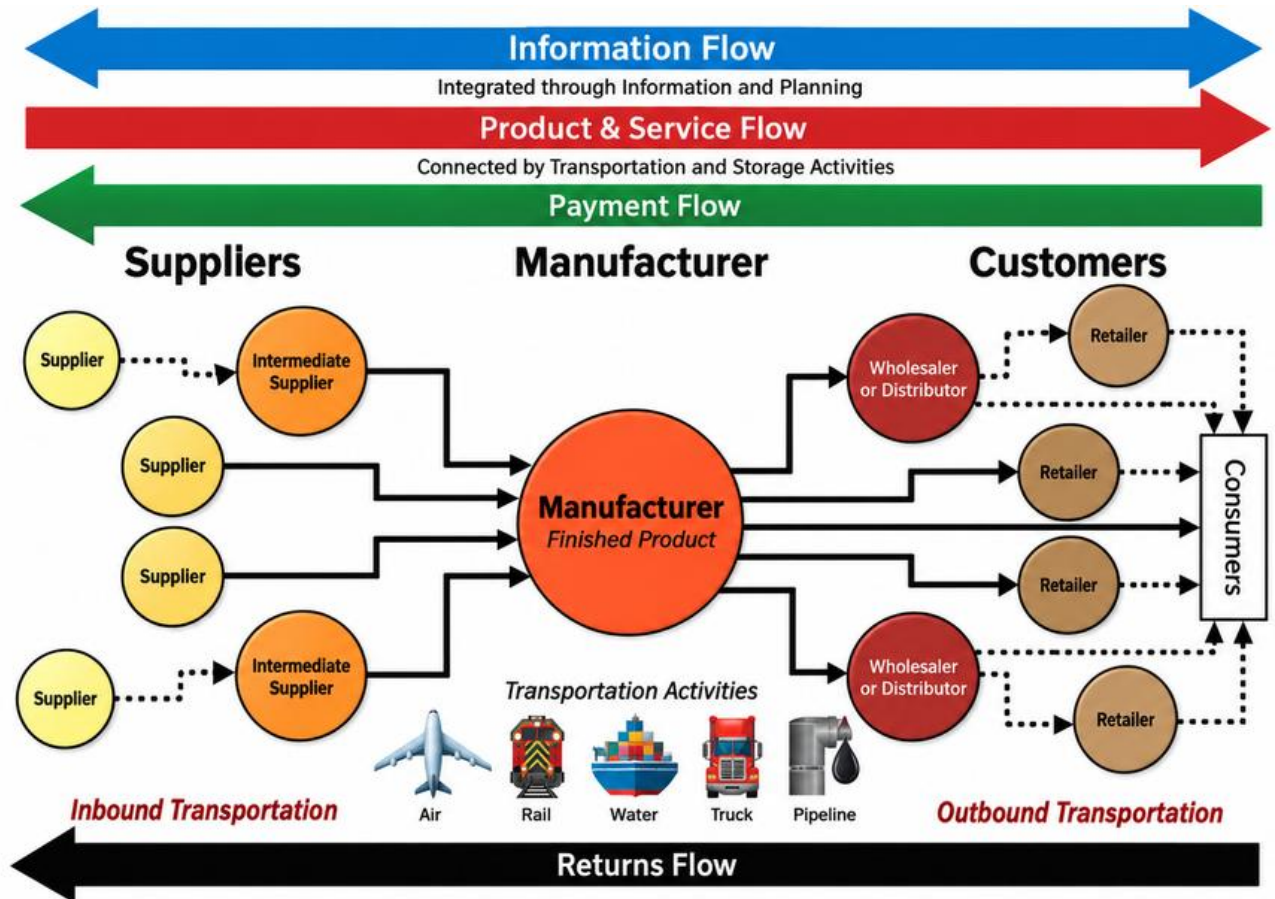


Figure 2.5 - Supply chain flows and participants [18]

Let's assume we are the manufacturer in the middle of the diagram producing a finished product. On the left side are suppliers and intermediate suppliers providing materials and services we need. Direct suppliers are Tier 1, while those supplying to our Tier 1 suppliers are Tier 2, and so on. Suppliers can occupy multiple tiers based on how they supply products.

To the right are customers: wholesalers, distributors, retailers, and consumers. Direct recipients are Tier 1 customers. Those receiving products through Tier 1 customers are Tier 2, and so forth. Like suppliers, customers can occupy multiple tiers.

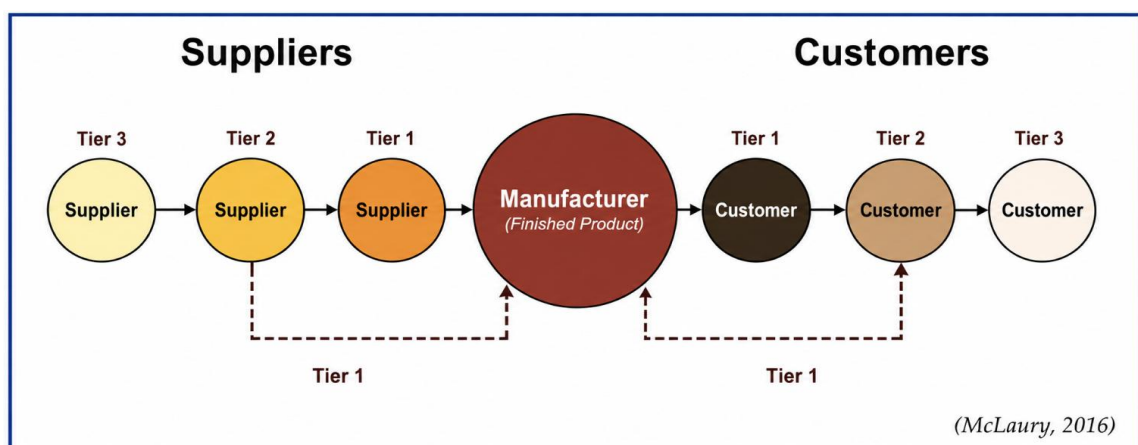


Figure 2.6 - Supplier and customer tiers in the supply chain

Arrows connecting the supply chain links indicate transportation activities, both inbound and outbound, using modes like rail, water, truck, air, and pipeline. Using multiple transportation modes for a single shipment is called intermodal.

Information such as forecasts, orders, confirmations, and invoices must flow both ways along the supply chain to facilitate the physical flow of products and materials.

The Payment Flow arrow indicates the flow of funds for products and services rendered.

Products usually flow from left to right, but reverse logistics (returns, recycling, rejected products) might occur, depicted by the Returns Flow arrow.

2.2. The mission of logistics management

It will be apparent from the previous comments that the mission of logistics management is to plan and coordinate all those activities necessary to achieve desired levels of delivered service and quality at lowest possible cost. Logistics must therefore be seen as the link between the marketplace and the supply base. The scope of logistics spans the organisation, from the management of raw materials through to the delivery of the final product.

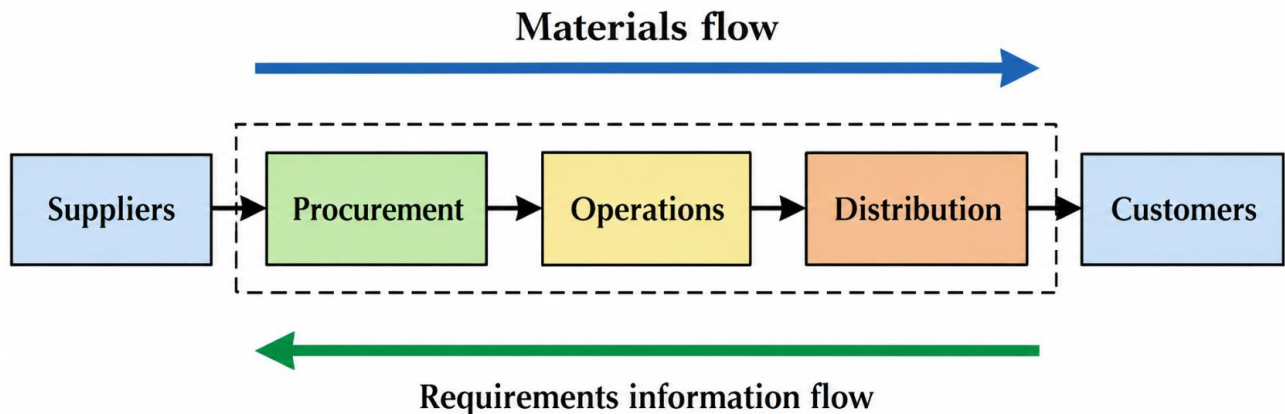


Figure 2.7 - Materials flow and requirements information flow in logistics management

As noted earlier, many people confuse supply chain management with logistics, and consider them interchangeable terms. Logistics is part of supply chain management, specifically the part involving warehousing, transportation, and reverse logistics activities.

Logistics is "that part of supply chain management that plans, implements and controls the efficient, effective flow and storage of goods, services and related information from the point of origin to the point of consumption in order to meet customer requirements," as per the Council of Supply Chain Management Professionals (CSCMP) official definition.

Logistics management coordinates materials and information flows to satisfy customer needs, integrating marketplace, firm operations, and suppliers. Achieving company-wide integration requires a different orientation than conventional organizations.

Traditionally, marketing and manufacturing were separate activities, often conflicting. In today's environment, manufacturing and marketing cannot act independently. Understanding and meeting customer requirements is essential for survival.

Manufacturing management has evolved with flexible manufacturing systems (FMS), materials requirements planning (MRP), just-in-time (JIT) methods, and total quality management (TQM).

Procurement plays a critical role in competitive advantage through integrated logistics.

Logistics is an integrative concept that develops a system-wide view of the firm, linking marketplace needs to manufacturing and procurement strategies. A "one-plan" mentality replaces separate plans for marketing, distribution, production, and procurement [8].

Additional definitions important in the context of supply chain management

Logistics Chain: A linearly ordered set of physical and legal entities (manufacturers, distributors, public warehouses, etc.) that perform logistics operations to move the material flow from one logistics system to another (for production and technical products) or to the final consumer.

Logistics Channel: A partially ordered set of intermediaries (dealers, freight forwarding companies, etc.) that move the material flow from a specific manufacturer to consumers. The logistics cycle is defined by the time from placing an order for delivery to the receipt of the product in the consumer's warehouse.

Logistics Infrastructure: A set of elements in the logistics system that perform specific logistics tasks in logistics processes. This includes buildings and structures with necessary equipment for storing products, transportation, and handling devices, packaging materials, and tools for collecting, processing, and transmitting logistics information. It is classified into transport and forwarding enterprises, warehouse enterprises, logistics centers, and other logistics service enterprises.

Logistics Centers: These are the latest advancements in logistics theory and practice that take on a significant portion of logistics operations (transportation, warehousing, packaging, commissioning, assembly, etc.) through the centralization of these functions in one enterprise, often transport and forwarding organizations.

Logistics Chain Formation: Based on cooperation between raw material suppliers, material suppliers, part suppliers, carriers, warehouse enterprises, intermediaries, manufacturers, subcontractors, distribution network enterprises and organizations, and consumers to coordinate their activities across space and time.

2.3. Functional areas of supply chain management

Operations Management

The operations management area involves managing internal resources: How am I determining my demand? How am I planning my supply? How am I running my operations? What equipment and people do I have? What is the level of quality I am producing? The major elements of operations management include forecasting and demand planning, planning systems, inventory management, and process management. In the SCOR model, the entire area of Make, where materials are converted into finished product, is part of the operations management area. Processes such MRP, MRP II, LEAN manufacturing, and Six Sigma are integral to managing operations efficiently and effectively. LEAN is an operating philosophy that focuses on eliminating wastes and improving efficiency. Six Sigma is an operating philosophy that focuses on reducing both defects and process variations. These are processes that complement one another.

Supply Management

The supply management area involves all the supplies and suppliers that you need to run your business. What materials do you need? How much of those materials do you need at a given time period in your operation? Who are your suppliers? What capabilities do they have? How well are they performing? The major elements of supply management include purchasing management, strategic sourcing, and supplier relationship management. You need to have great suppliers who can meet your requirements not only today, but also as your company grows and evolves in the future. What priority is your company in their business? How important are you as a customer to them? You must evaluate your suppliers, their capabilities, reputation, quality, pricing, and current customers. You may want to create a strategic partnership with them and qualify them as a certified supplier to your organization. Managing your suppliers is not only managing the physical supply but the entire supplier relationship, too.

Logistics Management

The logistics management area involves all the movement and storage of products and materials within the supply chain, whether the flow is forward or reverse. It is the planning and coordination of the physical movement aspects of a firm's operations such that a flow of raw

materials, parts, and finished goods is achieved in a manner that minimizes total costs for the levels of service desired. The major elements of logistics management include warehousing, distribution, transportation, international trade management, and customer relationship management.

Integration

The integration area involves all the enabling systems, software packages, processes, policies, procedures, performance standards and measures, information, and risk management necessary to facilitate the complete integration of the operations, supply, and logistics functions outlined above. Integration also involves collaborating with your trading partners to maximize total supply chain profits. Companies must integrate internally as well as externally to create a more efficient and cost-effective supply chain. Performance measurement is a critical element to determine if the supply chain is achieving its goals and delivering desired benefits. Performance measurement can also be used to identify areas for improvement and further integration [18, 28].

Key Questions

1. What are the key functions of a supply chain, and how do they contribute to business operations?
2. What are the main types of supply chain structures, and how do they differ?
3. How do object-oriented and process-oriented approaches to supply chain decomposition work?
4. What are the key functions within a supply chain and logistics organization?
5. What is the role of logistics management in connecting the marketplace and supply base?
6. What are the key components of logistics infrastructure within a supply chain?
7. How do organizations use forecasting and demand planning in supply chain operations?
8. What is the significance of supplier relationship management in modern supply chains?
9. How do companies balance cost efficiency and customer service in supply chain logistics?
10. How does supply chain management integrate logistics, strategic management, and operations research?
11. How do logistics centers contribute to the efficiency of supply chain operations?
12. What are the key elements of logistics management in the supply chain?

3 Supply Chain Planning and Design

- 3.1. Goals and objectives of supply chain planning.
- 3.2. Factors affecting the structure of the supply chain.
- 3.3. Main stages of supply chain design.
- 3.4. Supply Chain Network Structure.

3.1. Goals And Objectives of Supply Chain Planning

Supply chain planning is the element of supply chain management responsible for determining how best to satisfy the requirements created by the demand plan.

Its objective is to balance supply and demand in a way that realizes the financial and service objectives of the company. It is a combination of all the planning processes across the supply chain, including aggregate production planning, master production scheduling, materials requirement planning, and distribution requirements planning.

SUPPLY CHAIN PLANNING

Supply chain planning is hierarchical and can be divided into three broad categories:

- **LONG RANGE** (typically 1–3 years; can be as long as 10 years) Involves planning for major actions such as capital expenditures including the construction of facilities and major equipment purchase, and new product introduction plans (sales and operations planning and/or aggregate production planning). Example: Fictional Motor Company needs to increase manufacturing capacity to respond to an annual 5% increase in the demand for XL-150 pickup trucks over the next one to three years.
- **INTERMEDIATE RANGE** (typically 3–18 months) Involves planning the quantity and timing of end items—that is, specific make and model (master production scheduling). Includes sales planning; production planning; setting major resource levels such as manpower, inventory, contracting; and analyzing operating plans. Example: Fictional Motor Company plans to make 1,000 XL-150 pickup trucks per month for the next 3 to 18 months.
- **SHORT RANGE** Involves the detailed planning process for components and parts to support the master production schedule. Includes ordering and scheduling activities using information from the bill-of-materials, inventory system, purchasing system, and so forth (materials requirement planning). Example: Plan and order the components and materials needed for production of the XL-150 pickup trucks for delivery each week over the next 24 weeks (250 engines, 250 transmissions, seats, windows, etc.).

Planning Goals and Objectives

The first step in supply chain planning is for the top management at the company to establish the desired high-level planning goals and objectives. For example, meeting demand within the limits of the available resources at the lowest overall cost or obtaining the resources necessary to meet demand at the lowest overall cost.

The next step is to determine what is necessary to achieve these goals and objectives. Identify the specific action steps, such as building or acquiring a new facility, hiring more workers, and buying more equipment.

This is followed by setting start and completion dates for each action item identified. For instance, beginning to hire more workers in February and finishing hiring by April.

Responsibility for each action item should be formally assigned to the appropriate individual or department within the company to execute. For example, the action item of hiring more workers would be assigned to the human resource manager or department within the company.

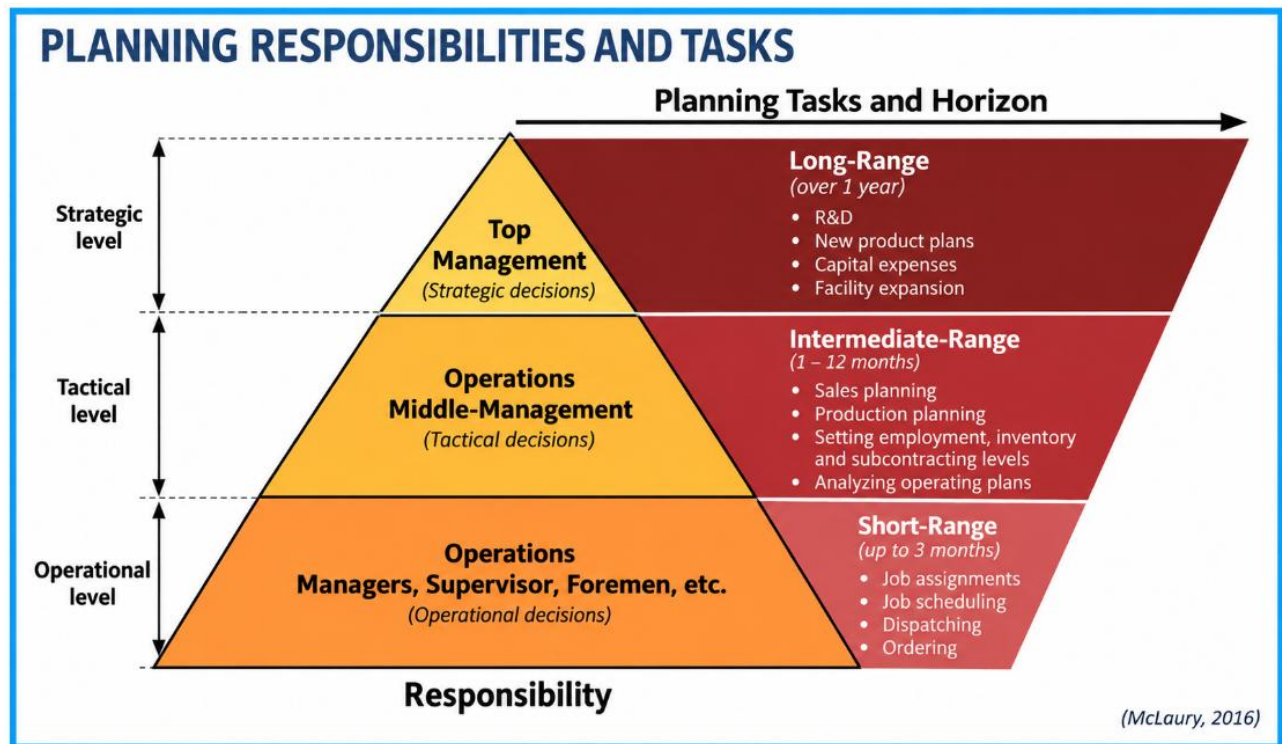


Figure 3.1 - Planning Responsibilities and Tasks

Responsibility for supply chain planning levels falls on different groups within a company:

- Long-range planning: Handled by top management. Involves strategic decisions and major resource control, setting the company's future direction.
- Intermediate-range planning: Managed by midlevel operations management. Translates long-range plans into executable plans and schedules, detailing specific products and resource allocation.
- Short-range planning: Managed by managers, supervisors, supply chain planners, and forepersons. Converts intermediate plans into detailed steps for immediate execution, involving materials procurement, production, and order fulfillment [18].

It should also be noted that the formation of the supply chain and its structure involves justifying its main characteristics: length, width, and capacity.

1. The length of the supply chain depends on the number of levels of suppliers and consumers. In other words, the length of the supply chain is determined by the number of intermediaries through which materials pass from the start of their production (extraction) to the final destination, that is, the end consumer. In practice, depending on the manufacturer's distribution policy, supply chains can be short or long.

2. The width of the supply chain is the number of parallel routes through which products can move. According to this characteristic, supply chains are classified as short or long. In turn, long supply chains are divided into narrow, moderately wide, and wide.

3. The capacity of the supply chain is the maximum volume of material flow that can pass through it in a given period. The overall capacity of the supply chain is determined by the part (the link) that has the lowest throughput capacity, that is, the lowest power. This link determines the "bottleneck" of the supply chain and is problematic in its operation. Thus, one way to increase the capacity of the supply chain is to increase the capacity at its "bottleneck." Adding resources elsewhere will not lead to anything but will only increase the idle time of fragments of the supply chain and decrease the utilization rate of the supply chain as a whole [3].

Let's consider the main phases of the logistic supply chain and their corresponding criteria.

I. Cooperation with Suppliers.

Choosing a supplier is a multi-criteria management task. The importance of choosing a supplier is explained by the fact that the supplier must be a reliable partner of the producer in implementing their strategic solutions. The criteria for evaluating and selecting suppliers of material resources depend on the requirements of the logistics system's consumers. There are usually 3-4 main criteria, but in some cases, their number can reach 50-60. The most important criteria for selecting a supplier are:

- Reliability of supply: Providing a diverse range of products.
- Quality of the supplied products: Returns are accepted.
- Acceptable price.
- Possibility of quantity discounts.
- Timeliness of material delivery.
- Creditworthiness and financial status of the supplier.
- Market image.
- Service level.
- Fast and simple order processing procedures.
- Evaluation of distribution capabilities.

II. Planning the Nomenclature of Material Resources.

Given that the nomenclature of enterprise materials includes thousands of items, and their share in all production costs is about 65%, the complexity of the task of ensuring material resources becomes apparent.

The correct selection of the nomenclature of material resources and their volumes affects the economic indicators of the supply chain. The information base for solving the task of optimal selection of the nomenclature of material resources, which achieves the maximum total quality indicator, includes the order portfolio, material reserves, material consumption for the production of products in value terms, quality indicators of interchangeable materials in the production of products and their components. The task of optimal planning of the nomenclature of material resources that meet the specified quality indicators and technical and economic parameters is presented as a model of discrete optimization.

III. Transportation.

A significant portion of logistical operations on the way of material flow from the primary source of raw materials to the end consumer is carried out using various transport modes. The costs of performing these operations can amount to up to 50% of the total logistics costs.

The following main factors influence the choice of transport mode: delivery time; frequency of shipments; reliability of schedule adherence; ability to transport various cargoes; ability to deliver cargo to any point of territory; transportation cost. When choosing transport, the primary factors considered are: reliability of schedule adherence; delivery time; transportation cost. Among many logistics procedures, the central place in decision-making on transportation is occupied by the procedure for selecting cargo carriers.

The algorithm for selecting carriers using ranked criteria systems involves comparing the total rating of carriers and choosing the best one based on the overall rating.

IV. Distribution.

The flow of resources moving from the primary source through the communication network to the end consumer continuously increases in value. According to global practice, over 70% of the cost of a product reaching the consumer is associated with promoting the product to the consumer and its service. An important task is to find the main principles for evaluating the efficiency of flow

promotion in the marketing distribution system, considering all endogenous and exogenous variables, all situations, and all possible scenarios.

The combined effect of applying the marketing service system includes the following components: market orientation of production through flexible response to consumer demand; establishing partnership relations with suppliers; reducing the time of goods passage; reducing losses through interdependent solutions to supply planning tasks; optimizing stocks at all distribution stages; reducing losses of material and financial resources.

Meeting the target consumers' requirements for service elements requires the channel participants to use the necessary resources (warehouses, special lines for electronic data exchange, information services, computer network, and so on). The allocation of the most important resources of the marketing channel involves choosing suitable partners to implement the channel's operating strategy. The choice and economic indicators of the channel partners are the main factors determining the success or failure of the marketing channel.

Criteria for Choosing Channel Partners.

The criteria for choosing channel partners are as follows: financial status (income, profit, and losses in dynamics); balance sheet; sales volume; number of sales agents; skills in sales and technical support of products; competing products; compatible products that complement the main products; reputation; authority; stability; level of professionalism; market coverage; number of sales points on the market; sectoral coverage; sales activity results; overall sales results; growth prospects; ability to attract new clients; effectiveness in covering target markets; after-sales service; advertising companies and sales promotion programs; technical and material base; transportation methods; stock levels; warehouse storage; order and payment procedures; installation and repair services; information service for clients.

Thus, the creation of a customer-oriented distribution system is directly linked to the management of an optimally organized marketing channel. To improve the efficiency and profitability of the channel, all participants need to use real mechanisms that improve coordination and harmonization of work.

Managing the order fulfillment time for consumers is one of the most important principles that provide a company with a competitive advantage in the market. Time-based competition is a principle according to which timely fulfillment of logistics chain tasks allows them to reach a new, higher level due to external and internal advantages. External advantages include: reducing the overall period of time and providing services in a shorter term; getting ahead of competitors. These advantages are particularly significant in the context of improving responsiveness to customer needs and a rapidly changing market environment.

3.2. Factors Influencing the Structure of The Supply Chain

The multiplicity and structure of supply chains depend on a large number of subjective and objective factors. Among them, the most influential are the type and kind of product and the general strategies of the organization. Each product has its own unique supply chain. When forming it, factors such as the cost of the product, its dimensional and weight characteristics, preservation of its qualities over time, availability, profitability, and others are taken into account. Depending on the above, a short or long supply chain, branched or "narrow," should be built.

Decisions regarding the structure of the supply chain are influenced by structural, commercial, operational, and functional factors (Figure 2).

Structural factors are factors that describe the quantity, location, and production capacity of enterprises, warehouses, and other objects in the logistics system.

Commercial Factors – Factors related to the company's supply strategies and subsequent distribution policies.

Operational Factors – Factors that affect the planning of material flow.

Functional Factors – Factors related to the management of transport resources, usually arising when selecting the type of transport vehicle, planning vehicle loading, and determining delivery routes.

Other factors influencing the structure of the supply chain include the type of consumer demand, the economic situation in the country, the availability of logistics services, the level of competition, market and financial capabilities of the organization, the pace of innovation implementation, and more [3].

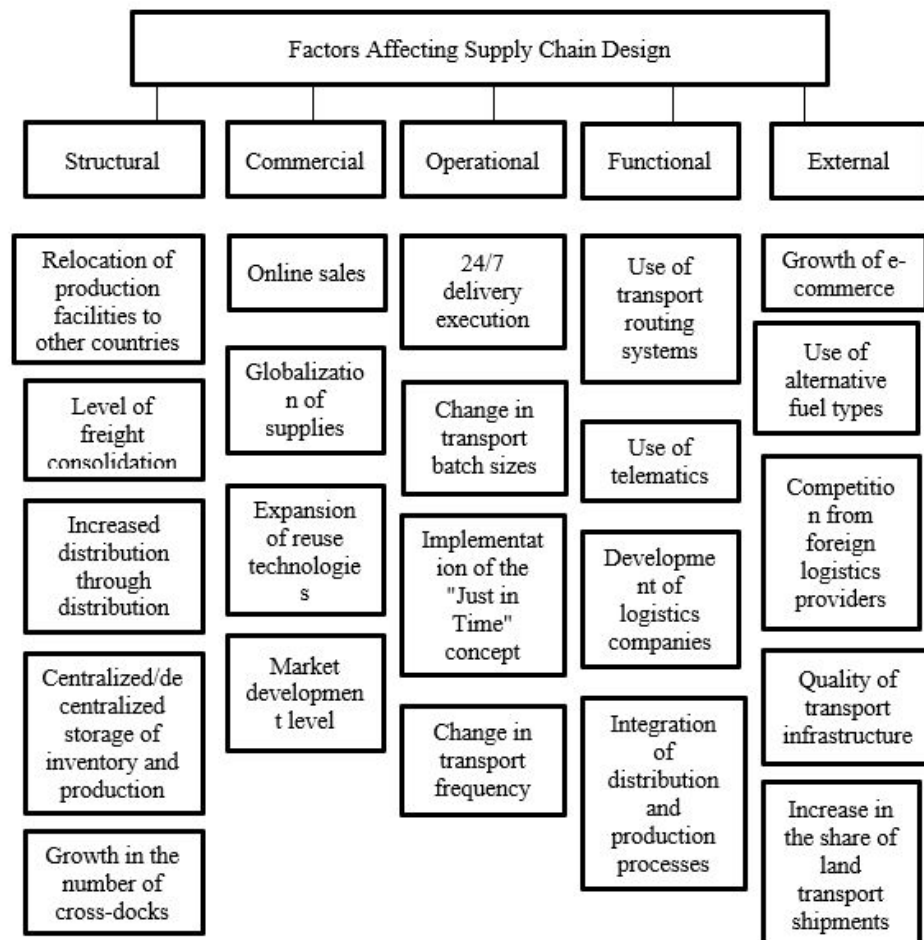


Figure 3.2 - Factors Influencing Supply Chain Design

3.3. Main Stages of Supply Chain Design

In the practice of logistics activities, two main approaches to supply chain design have emerged. The first approach, more general, involves describing the design process as a sequence of specific steps for creating the supply chain (Figure 3). This approach involves the formation of alternative supply chain structures, their evaluation, and the selection of the most optimal one.

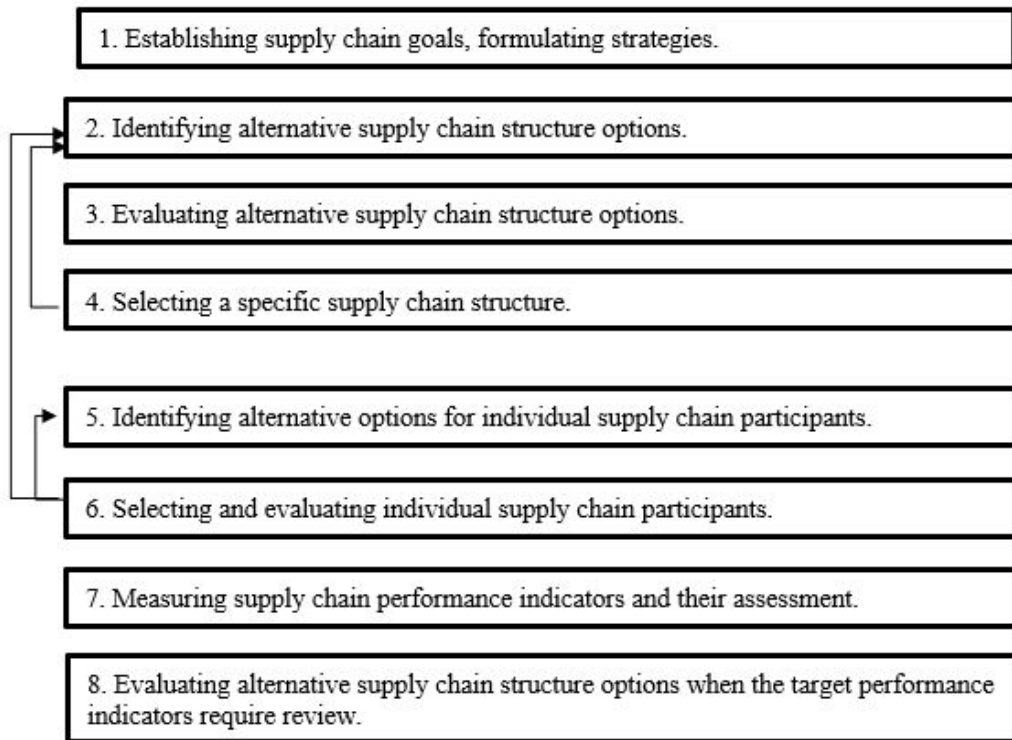


Figure 3.3 - Supply Chain Design Algorithm

The second approach is more specific.

The supply chain construction algorithm involves an iterative procedure, taking into account the interconnection and mutual influence of blocks of transportation, inventory management, and warehousing logistics. The iterative procedure means that the intermediate result obtained at each stage is, on the one hand, the starting point for the next stage in each block considered (transportation or inventory management and warehousing), and on the other hand, the starting point for solving tasks in the "neighboring" block (Figure 4) [3].

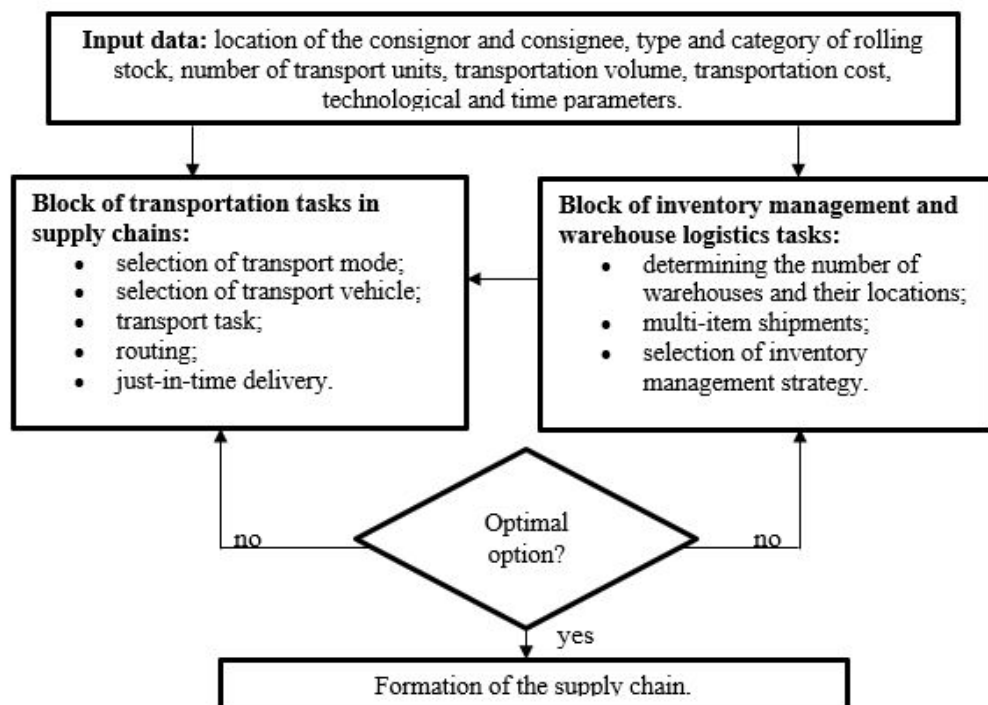
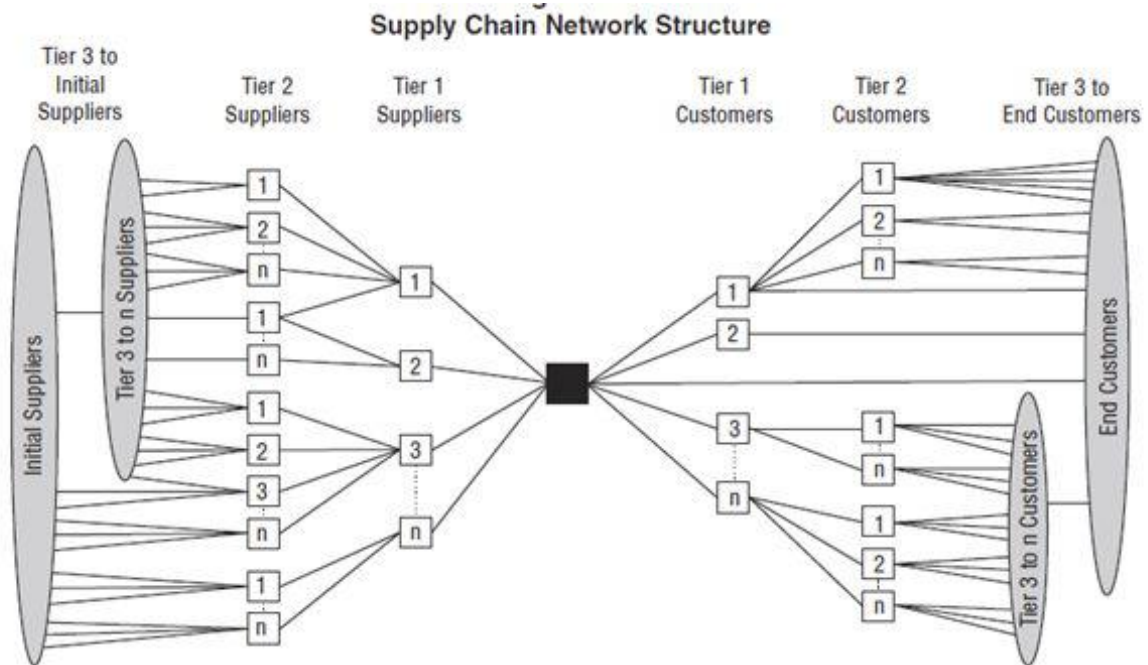


Figure 3.4 - Generalized Supply Chain Design Algorithm

3.4. Supply Chain Network Structure

Three key dimensions describe, analyze, and manage the supply chain:

1. Horizontal structure: Number of tiers across the supply chain (long or short).
2. Vertical structure: Number of suppliers/customers at each tier (narrow or wide).
3. Horizontal position: The focal company's position within the supply chain (initial supply, ultimate customer, or between).



Source: Adapted from Douglas M. Lambert, Martha C. Cooper and Janus D. Pagh, "Supply Chain Management: Implementation Issues and Research Opportunities," *The International Journal of Logistics Management*, Vol. 9, No. 2 (1998), p. 3.

Figure 3.5 - Supply Chain Network Structure

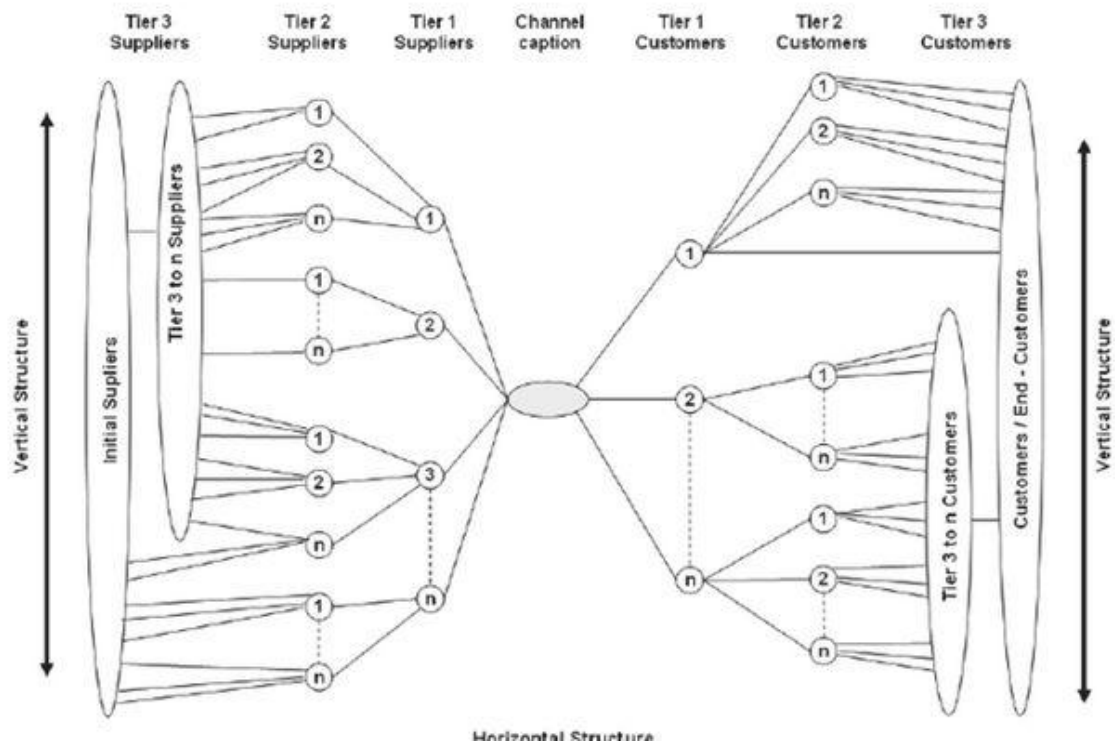


Figure 3.6 - Supply chain network structure (Adapted from: Lambert et al., 1998)

Example: A narrow and long supplier network combined with a wide and short customer network. Changes like switching to single-source suppliers or outsourcing activities can alter the supply chain's structure and the focal company's position.

Supply chains with many tier-1 customers/suppliers strain resources beyond tier 1. Companies with wide vertical structures usually manage only a few tiers. Some companies transfer small customers to distributors, a principle known as functional spin-off. Each company views its network differently but must understand interrelated roles for successful integration and management of business processes across boundaries.

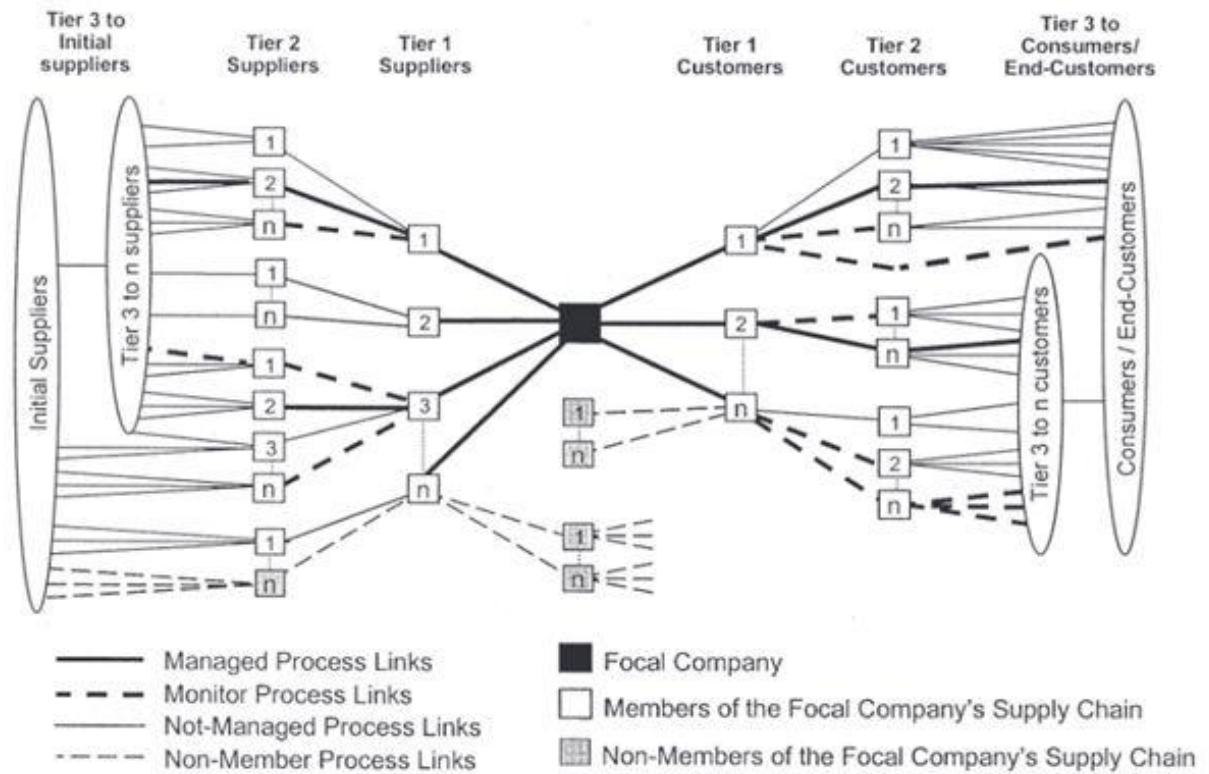


Figure 3.7 - Types of intercompany business process links [30]

There are four types of business process links: managed, monitored, not-managed, and non-member.

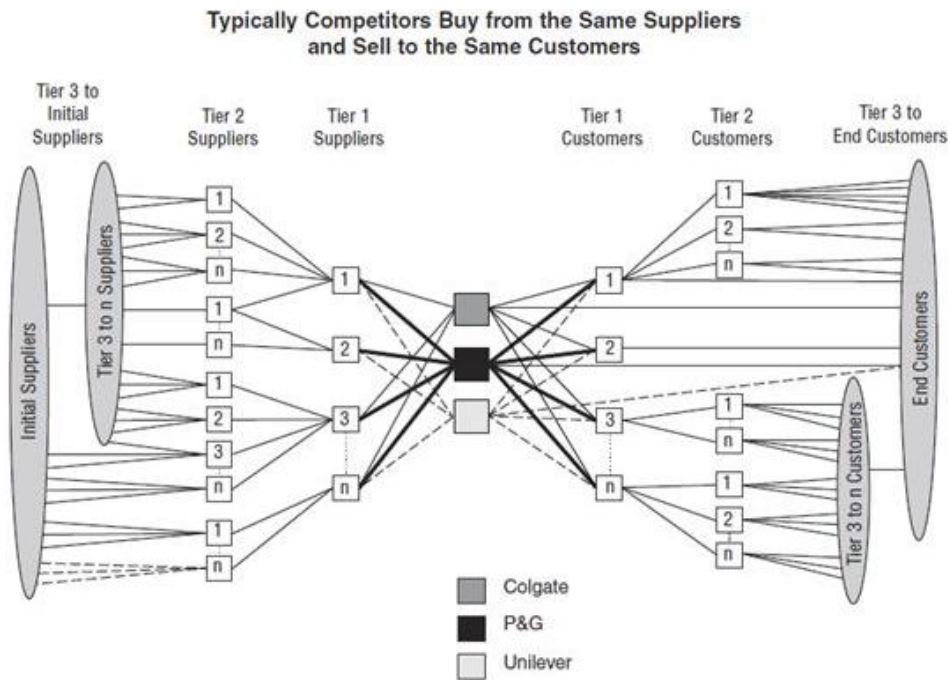
- **Managed links:** Focal company integrates and manages important links (indicated by thick solid lines in Figure 7).
- **Monitored links:** Less critical, but the company monitors them to ensure appropriate integration and management (thick dashed lines).
- **Not-managed links:** Focal company trusts other members to manage these links, or due to limited resources, leaves them unmonitored (thin solid lines).
- **Non-member links:** Connections between supply chain members and non-members, influencing performance (thin dashed lines).

Companies must understand these links for effective integration and management of their supply chains. For instance, a tomato ketchup manufacturer in New Zealand ensures high-quality output by negotiating contracts with suppliers for farmers to use, leading to better raw materials and lower costs. Similarly, identifying critical links, like a tier 2 supplier during shortages, is essential for maintaining the supply chain.

Managing the entire supply chain is challenging. Overseeing all suppliers and products/services from origin to consumption is overwhelming. For example, an organization with 225 tier 1 suppliers, each having 200 suppliers, could have 45,000 tier 2 suppliers. Executives

prefer managing supply chains to the point-of-consumption, as the relationship with the end-user holds power. Intel's "Intel inside" label strengthens its relationship with end-users, affecting computer manufacturers' supplier choices. Managing supplier networks can improve profits, as seen with Coca-Cola managing PET resin suppliers beyond tier 1 for better prices and availability.

While the idea of competition between supply chains is appealing, it's not technically accurate due to overlapping networks. For instance, Coca-Cola and PepsiCo share suppliers like Cargill and Graham Packaging Company. Effective supply chain management is about relationship management. Companies that manage supplier and customer relationships better will succeed. Supply chains are managed link-by-link, relationship-by-relationship [11, 30].



Source: Adapted from Douglas M. Lambert, Martha C. Cooper and Janus D. Pagh, "Supply Chain Management: Implementation Issues and Research Opportunities," *The International Journal of Logistics Management*, Vol. 9, No. 2 (1998), p. 3.

Figure 3.8 - Typically Competitors Buy from the Same Suppliers and Sell to the Same Customers

Questions

1. What are the main goals and objectives of supply chain planning?
2. How does supply chain planning balance supply and demand?
3. What are the three broad categories of supply chain planning based on time horizon?
4. What is the role of top management in long-range supply chain planning?
5. What are the key differences between intermediate-range and short-range planning in a supply chain?
6. What factors determine the length, width, and capacity of a supply chain?
7. Why is the "bottleneck" in a supply chain critical, and how can its capacity be increased?
8. What criteria are commonly used for evaluating and selecting suppliers in supply chain management?
9. Why is planning the nomenclature of material resources a complex task in supply chain management?
10. What factors influence the choice of transportation mode in supply chain logistics?
11. What is the significance of distribution in the supply chain, and how does it affect product cost?

12. What are the main factors that influence the structure of a supply chain?
13. What are the differences between structural, commercial, operational, and functional factors in supply chain design?
14. What are the three key dimensions of a supply chain network structure?
15. Why is relationship management critical in modern supply chain management, and how does it impact competition?

4 Integration and Collaboration in Supply Chains

4.1. Definition of Integration and Collaboration in Supply Chains

4.2. Organizational Forms of Integration

4.3. Models and Strategies for Collaboration in Supply Chains

4.1. Definition of Integration and Collaboration in Supply Chains

Collaborate to compete — this principle is one of the key factors for successful business operations in today's dynamic markets.

The term "integration" originates from the Latin word integer, meaning whole or restored. In supply chain management theory, integration can be seen as a process of interaction among supply chain participants, aimed at achieving common goals by expanding and deepening production and technological connections, through the joint use of resources, pooling of capital, and creating favorable partnerships for conducting joint economic activities.

Supply chain integration refers to the degree to which the firm can strategically collaborate with their supply chain partners and collaboratively manage the intra- and interorganization processes to achieve the effective and efficient flows of product and services, information, money, and decisions (Figure 1). The objective of this integration is to provide the maximum value to the customer at low cost and high speed [4, 7].

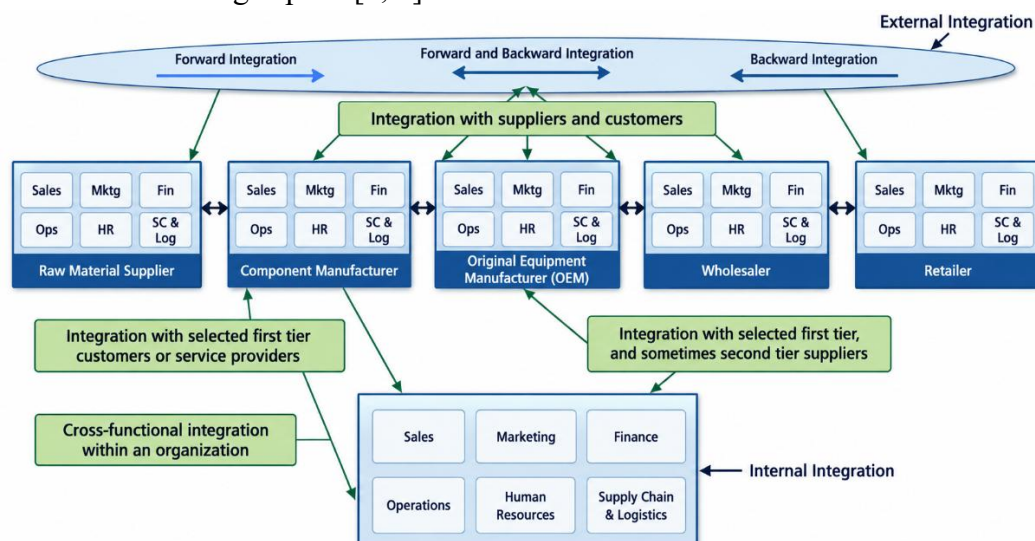


Figure 4.1 - Major types of integration

The term "partnership relations" encompasses a variety of collaboration styles, including cooperation, coordination, and joint activities. The characteristics of these relationships are presented in Table 1.

Among all forms of integration in partnership interactions, alliances stand out as having the most successful infrastructural effect. These types of partnerships allow companies to enhance their efficiency by eliminating unnecessary costs and redundancies within the supply chain.

Table 4.1 - Distinctive Features of Types of Partnership Relations

Types of Partnership Relations	Types of Activities	Term	Scope of Activities
Cooperation	Fewer contracts. Larger long-term contracts.	Short-term	A single function performed
Coordination	Information links. In-process links	Long-term	Several functions performed
Joint Activity	Electronic data interchange. Logistics chain integration. Joint planning and technology use	Long-term, without a fixed date	Companies view each other as an extension of their own enterprise

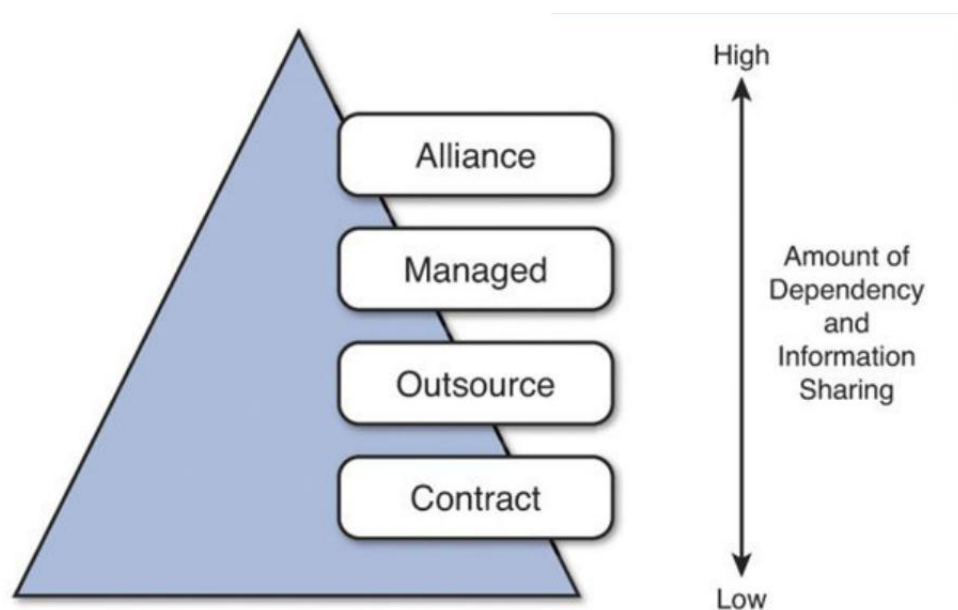


Figure 4.2 - Range of external supply chain relationships

Collaboration starts with contracting, adding a time dimension to buying and selling. Next is outsourcing, which involves performing a service rather than just supplying materials. Managed collaboration follows, where a dominant company directs a partner with limited information sharing and no fixed timeframe. The most advanced form is alliances in a just-in-time (JIT) environment, where partners integrate resources, engage in extensive joint planning, and anticipate long-term cooperation.

A well-run joint venture allows partners to learn, access new markets, and develop core competencies while achieving results unattainable alone. In today's economy, resource limitations, market volatility, and consumer focus make strategic alliances and joint ventures essential for survival.

Alliances have significant advantages that allow the companies involved to:

- Focus on their core competencies and key activities.
- Combine their core competencies, thus achieving a synergy effect.
- Reduce bureaucracy and simplify the organizational structure.
- Increase efficiency and reduce costs.
- Become more flexible and responsive.

The main effect of partnerships lies in utilizing resources and capacities with a synergistic effect of interaction among partner organizations. The primary goal is to build an integrated structure that can not only ensure the competitiveness and profitability of enterprises but also achieve a stable market position in the long term.

The choice of an alliance form depends on goals, risks, and partner qualifications. Companies often limit collaboration to specific areas to protect trade secrets and avoid partner withdrawal risks.

A notable example is Coca-Cola, which thrives on vertical alliances. Despite direct revenue of \$20 billion, Coca-Cola beverages generate over \$200 billion in sales. The company controls a vast network through cross-ownership, outsourcing production, bottling, sales, and distribution. This strategic approach maximizes profitability and influence over the consumer value chain, solidifying Coca-Cola as a key player in shaping product value.

Table 4.2 - The Largest European Vertical Alliances in Supply Chain Management

Company Alliances	The Goal of a Vertical Alliance
T&B and Carrefour	T&B strengthened its position in Europe by expanding its contract with Carrefour to gain access to a distribution center for large stores in Spain.
TNT Logistics and Arvil	Established a joint venture whereby TNT became the exclusive supplier for FIAT.
Danzas AEI and Roche Pharma Suisse	Extended their intercontinental supply chain control contract by adding air and sea transportation for Roche from Switzerland and Europe to Argentina, Brazil, and Mexico.
Exel Logistics and BIC UK	Consolidated their supply chain management agreements when Exel took over distribution control in Ireland and the United Kingdom from BIC.
TDG and Arjo Wiggins	Formed an alliance based on an interstate contract to meet the growing number of orders in Europe.
Gerodis and Philips Consumer Electronics	Signed a five-year supply chain management contract in Europe.
Norbert Dentressangle and Hewlett-Packard (HP)	Signed a partnership agreement for warehousing services and remanufacturing services.
T&B and Henkel	Entered into a seven-year contract under which T&B will handle the distribution of finished products in Poland, strengthening T&B's position in Central and Eastern Europe.
Danzas and Kellogg's	Danzas agreed to provide warehousing and distribution services globally for enterprises in Michigan (USA), Mexico, and the United Kingdom.

4.2. Organizational Forms of Integration

In the context of globalization, several fundamentally different forms of strategic partnerships in the supply chain may be appropriate.

Main Forms of Strategic Partnerships in the Supply Chain:

1. **Internalization (Interiorization):** From "interior" or "intro" meaning internal, inward-directed partnerships based on the concept of insourcing.
2. **Externalization (Exteriorization):** From "exterior" meaning external, outward-oriented partnerships based on the concept of outsourcing.
3. **Virtualization of Partner Activities:** This approach smooths out contradictions between internalization and externalization.

4. **Mixed Interaction Form in the Supply Chain:** Creation of so-called "brand companies."

5. **Competitive Form of Integration:** Not aimed at building long-term relationships due to the uncertainty of the external environment.

6. **Cooperative Interaction Strategy:** Focused on long-term cooperation in the areas of joint quality improvement of flows, business processes, and cost optimization.

Building a supply chain based on internalization (insourcing) involves combining related types of activities and distributing production functions within a single organization. This type of integration is characteristic of enterprises in the fuel and energy sectors, construction, and the agro-industrial complex.

Internal integration needs more than a system and proper organization. It also needs the following:

Shared goals: Which refers to the extent to which the manager of each key function (purchasing, operations, and logistics) is familiar with the strategic goals of each of the other two focal functions

Cooperation: Measured by the frequency of requests from other focal functions fulfilled by the members of each focal function

Collaboration: Defined as the frequency at which a member of a key function actively works on issues with members from the other key functions. Businesses aim to protect themselves from unfavorable market conditions by creating closed, self-sufficient structures.

The advantages of building supply chains based on internalization are:

- Increased control over system participants;
- Management of intra-company flow processes from a single logistics center, predominantly on a non-material basis;
- Ensuring the stability and reliability of business connections and supply.

The main disadvantage of integration based on internalization is the creation of large vertically integrated systems, known as the push type, which can ultimately lead to:

- Increased inventory levels in the supply chain;
- Reduced quality of flow processes and service levels;
- Increased number of auxiliary workers.

Externalization involves distributing production functions among different enterprises, followed by synchronizing their activities through partnership agreements (outsourcing). This approach is particularly common in the automotive industry, where most components are produced by outsourcing enterprises. The synergy of externalization results is strengthened through network integration with partners within corporate alliances. This form of strategic integration is considered a pull system, which tends to be loosely structured.

Table 4.3 - Advantages and Disadvantages of Externalization in Network Integration

Advantages of Externalization	Disadvantages of Externalization
Ability to focus on core competencies	Potential loss of control over suppliers of goods and services
Improved quality of supplied goods and services	Risk of commercial secrets being disclosed
Cost reduction	Dependence on the supplier of goods (services)
Access to the latest developments and know-how	

Due to the widespread development of information technologies, the ways in which businesses organize their activities are significantly changing through the virtualization of their operations, including procurement procedures.

A virtual enterprise represents a logistical system formed using an information network within the framework of a logistical agreement. The goal of virtualization is to reduce transaction costs. Consequently, the capabilities of the software should include a program for finding participants in the virtual enterprise and determining the optimal composition. From this definition, the concept of a "virtual logistical system" can be refined, which can be represented as an interdependent set of tools, methods, and control actions on modeled business processes and flows of goods (services), information, finances, etc., with the aim of improving the quality of service for counterparties and optimizing costs. Virtual enterprises operate based on this system.

The Internet has created numerous opportunities that improve supply chain performance, namely:

- Increased flexibility of the logistics system;
- Improved customer service quality in the supply chain through order information, product availability at the supplier, etc.;
- Complete and accurate information reduces the need for inventories and labor resources by decreasing uncertainty in counterparty operations.

However, a virtual organization also has a number of disadvantages, including the need for detailed study of the partner company and the high level of trust between counterparties, which is not always possible.

In addition to the listed forms of strategic partnership, another one is identified – import substitution of goods in the domestic market through the development of domestic production. This form of interaction is most often observed in the agricultural complex, light, and food industries. In modern conditions of globalization, there is a tendency for domestic producers to meet world standards in terms of the quality of their products, which undoubtedly leads to import substitution of goods in the domestic market.

A mixed form of interaction in the supply chain under modern conditions is the creation of so-called "brand companies" with small capital, which operate in close interaction with the external environment. The activities of these companies involve the development of a product (service) and the transfer of all components of the "supply – production – distribution" process to external counterparties: suppliers and consumers. The released capital of the brand companies is directed towards the development of new products. This integration in the supply chain is based on the externalization of key competencies and the virtualization of counterparty activities. Interaction of counterparties in this area creates specific networks of external structures around the brand companies, known as "value-added communities."

Dynamic and flexible interaction between adjacent networks of brand companies leads to the creation of meta-markets, which are characterized by a high capacity for rapid integration. The creation of value-added communities is observed in high-tech industries. For example, the corporation Microsoft acts as a system integrator of the supply chain, with its activities built on managed networks of external production structures. Another area where value-added communities are prevalent is the automotive industry.

Major automakers like General Motors and Ford increasingly outsource the production of parts and components, allowing them to focus on developing new models and expanding distribution and service networks. This creates new supplier-consumer structures and shifts production processes to external partners [3].

Supply chain integration relies heavily on the Internet and information technologies to connect different network elements. Due to market instability, companies often engage new counterparties, favoring competitive, short-term relationships over long-term partnerships.

At the same time, there is a trend toward cooperative strategies in supply chains, emphasizing joint cost reduction and faster response times. One example is Vendor Managed Inventory (VMI), where suppliers manage inventory based on real-time client data. Danone pioneered VMI using SAP ERP, improving supply chain efficiency through resource integration.

In summary, supply chains consist of dual relationships shaped by cooperative, competitive, or team strategies. While individual company goals may differ, integration requires alignment with common principles to achieve overall success.

Partnerships in business are a necessary condition for contractual relationships between several entrepreneurs, providing each of them the opportunity to profit from the exchange of activity results. Determining the effective form of partnership relations is possible only through a comparative analysis of cooperation options.

4.3. Models and strategies for collaboration in supply chains

Some of the types of supplier collaboration include the following:

Kanban: A signal-based replenishment process used in Lean or JIT production that uses cards or other visual signals such as a line on a wall to signal the need for replenishment of an item. Using collaborative technologies, the kanban process allows customers to electronically issue the kanban replenishment signals to their suppliers, who can then determine requirements and see exceptions.

Dynamic replenishment: This is a process that where suppliers compare customer forecasts or production schedules with their own production plans to match supply and demand. It allows suppliers to adjust to changes in customer requirements or supply shortages.

Invoicing processes: Automating invoicing and related processes gives the visibility to the vendor for the entire supply side, including purchase orders, releases, supplier-managed inventory, kanbans, and dynamic replenishment.

Outsourced manufacturer collaboration: When managing outsourced manufacturing relationships or contract manufacturers, you must shift your focus from owning and organizing assets to working collaboratively with partners. The collaborative efforts should help simplify processes such as product development and reduce manufacturing costs and improve reaction to response to customer demand.

Efforts to automate processes should support information sharing, collaboration, and monitoring to effectively manage relationships with contract manufacturers.

Customer collaboration involves receiving demand signals and automatically replenishing inventory based on actual demand, common in consumer goods and retail. These collaborative processes, like Quick Response (QR) and Efficient Consumer Response (ECR), are more responsive than forecast-based methods, providing visibility and faster reactions to out-of-stock situations.

Collaborative Planning, Forecasting, and Replenishment (CPFR) extends these ideas by integrating planning and fulfillment across trading partners to reduce supply chain costs and improve visibility and cooperation. Collaborative inventory models vary in complexity, with QR and ECR at basic levels, and CPFR representing more advanced integration.

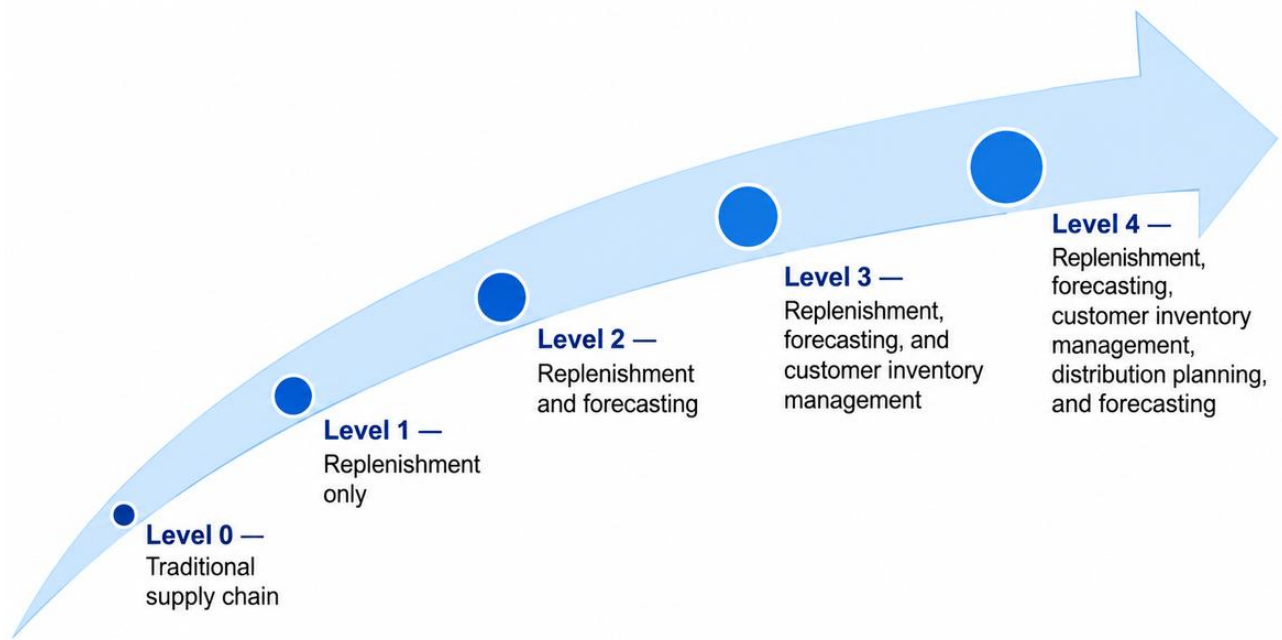


Figure 4.3 - Types of collaborative or vendor-managed inventory in supply chains

Sales & Operations Planning (S&OP), allows you to introduce collaborative information into the decision-making process, and when used as part of your collaborative efforts, it enables better communications between cross-functional groups and trading partners, both customers and suppliers.

Globalization and outsourcing generate a lot of information that can impact an organization's decision-making process externally to the enterprise. As a result of this, a comprehensive S&OP process is even more important. The S&OP process makes sure that your business is continually managed to meet organizational strategies, goals, and commitments, despite ongoing changes in your environment.

Quick Response Quick response (QR) was an apparel manufacturing initiative that started primarily in the United States during the mid-1980s. The main objective of QR was to drastically reduce lead times and setup costs to allow the postponement of ordering decisions until right before, or during, the retail selling season, when better demand information might be available. Implementation of QR is typically used in conjunction with information technologies such as electronic data interchange (EDI; a standardized format for businesses to exchange data electronically), barcodes, and RFID (the wireless use of radio frequency signals to transfer data to identify and track tags attached to objects).

A QR strategy can result in efficiencies such as maximized diversity of offering, quicker deliveries, faster inventory turns, fewer stock-outs, fewer markdowns, and lower inventory investment. This type of strategy can also reduce the time between the sale and replacement of goods on the retailer's shelf because it places an emphasis on flexibility and product velocity to meet the changing requirements of a highly competitive and dynamic marketplace.

Efficient Consumer Response Efficient Consumer Response (ECR), launched in 1984, is a grocery sector joint trade and industry organization with the goal of making the industry more responsive to consumer demand and to remove unnecessary costs from the supply chain.

The thinking is to improve the efficiency of a supply chain as a whole beyond the wall of retailers, wholesalers, and manufacturers, so that they can gain larger profits than each pursuing their own business goals. One of the main practices used in ECR is to place smaller orders more often to shorten lead times, improve inventory turns, and reduce stock outs (see Figure 4). ECR is similar to QR except that it is targeted toward the grocery industry, where the supplier takes

responsibility of monitoring and replenishing the retailer's distribution center inventories with approval of the retailer.

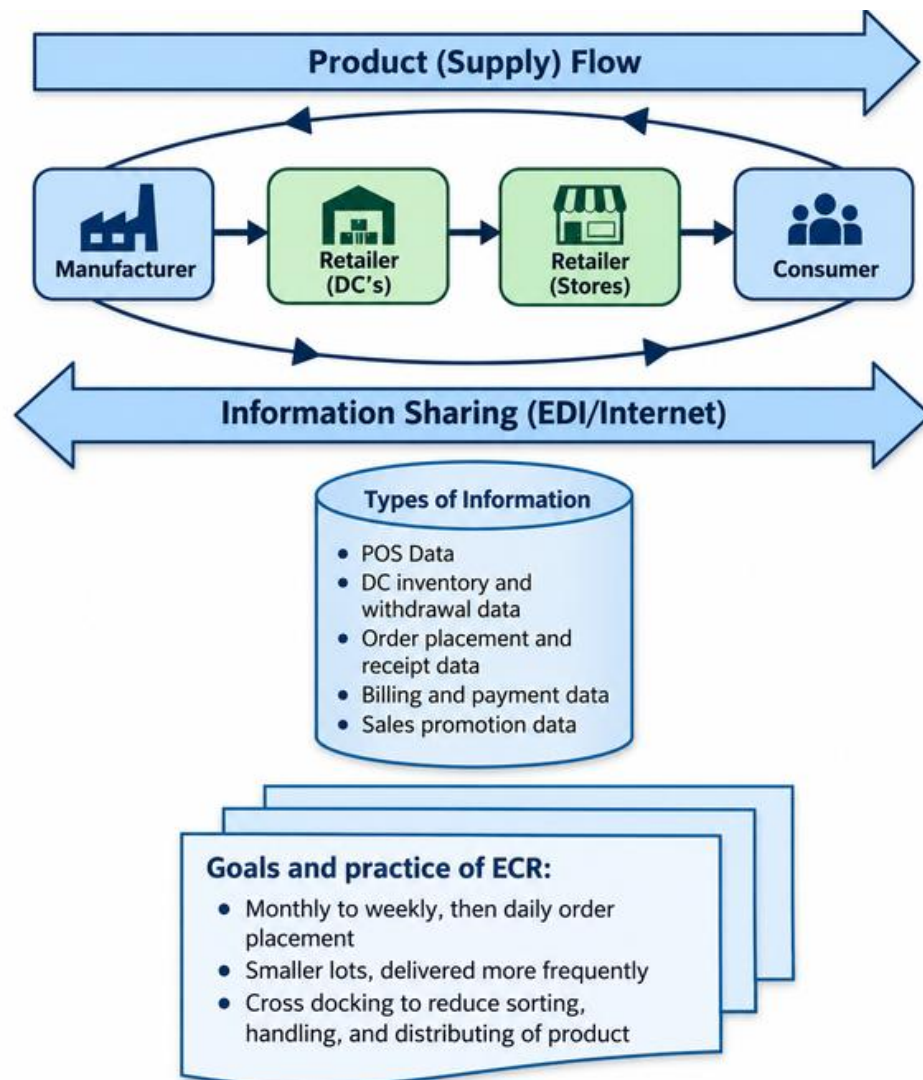


Figure 4.4 - Efficient consumer response

Like QR, ECR is highly dependent on technology, using tools such as EDI, forecasting, and distribution requirements planning (DRP) software and point-of-sale (POS) data to manage the process.

The use of sophisticated technology like this as well as the lack of capabilities (both skill and technology related), the resistance of wholesalers, retailers, and manufacturers toward collaboration, and the attitudes of company personnel can all be barriers to a successful implementation of an ECR (or QR) type of program. It is well worth the effort, though, and can prove to be a win-win for all involved, because forecast accuracy tends to improve for the manufacturer and the retailer is relieved of managing the replenishment of some of its over 50,000+ stock keeping units (SKUs) while reducing stock-outs and inventory and ordering costs.

CPFR has its roots in efficient consumer response (ECR) and is an attempt to improve marketing, production, and replenishment functions, resulting in increased value to the consumer while at the same time improving supply chain performance for producers and retailers.

The Voluntary Inter-industry Commerce Solutions (VICS) association has defined both a framework and guidelines for CPFR, including elements for strategy and planning used for the development of joint business plans and the forms of collaboration, supply chain management focusing on forecasting and order planning, execution for the fulfillment of replenishment orders, and analysis for exceptions and performance metrics. The benefits of CPFR can include the

following: Improved forecast accuracy Smoother ordering patterns Increased sales revenues Higher order-fill rates Decrease in safety stock inventory levels Reduction in cost of goods sold (COGS) as a result of improved visibility of end-consumer demand, more accurate forecasts, and more stable production schedules Similarly to QR and ECR, CPFR requires the use of technology, which can be shared technology, for planning, execution, and measurement. As in most cases of intercompany integration and collaboration, besides having sophisticated supply chain processes and technology, the key is to have the proper organization alignment and training (see Figure 5).



Figure 4.5 - CPFR teams

On the supplier side, there will need to be CPFR teams made up of supply chain, sales, and customer service employees. On the customer side, which can be either the distributor or retailer, representatives from the purchasing, marketing, and merchandising functions will also need to be organized into a focused CPFR team [7].

Key Questions

1. What do integration and collaboration mean in a supply chain?
2. How do internal integration and integration between supply chain partners differ?
3. What types of partnership relationships can be established between supply chain participants?
4. How does collaboration generate a synergistic effect across the supply chain?
5. What are the main differences between internalisation, externalisation and virtualisation?
6. Which factors should a company consider when choosing an organisational form of integration?
7. How do competitive integration and cooperative interaction influence relationships between partners?
8. How do Quick Response (QR), Efficient Consumer Response (ECR) and Collaborative Planning, Forecasting and Replenishment (CPFR) differ?
9. Why are information sharing, trust and organisational alignment necessary for successful collaboration?
10. Which indicators can be used to evaluate the benefits and risks of a collaboration programme?

5 Decision-Making in Supply Chain Management

5.1. Methods of Justifying Management Decisions

5.2. Decision-Making in Supply Chain Management Under Uncertainty

5.3. Overview of Decision Support Methodologies

5.1. Methods of Justifying Management Decisions

Modern decision theory literature offers various approaches to classifying methods for justifying managerial decisions. One of the most common approaches divides all methods into two categories: quantitative and qualitative.

Quantitative methods (or operations research methods) are applied when the factors influencing a decision can be measured and evaluated numerically.

Qualitative methods are used when these factors cannot be quantified or are entirely resistant to numerical measurement. Qualitative methods mainly include expert assessments.

Quantitative methods can be further divided based on the type of information available to the decision-maker:

1. Methods under certainty — when complete information about the decision-making situation is available (analytical methods and some mathematical programming methods).

2. Methods under probabilistic certainty — when probabilistic information is available (statistical methods and some mathematical programming methods).

3. Methods under uncertainty — when information is incomplete or unknown (game theory and statistical decision theory, depending on whether the uncertainty is caused by objective conditions or conscious adversarial actions).

General Characteristics of Key Methods

Analytical methods determine functional relationships between the problem conditions (factors) and outcomes (decisions). These include various economic analysis methods, such as breakeven analysis.

Statistical methods rely on collecting and processing statistical data. They account for random effects and deviations and include: correlation-regression analysis, variance analysis, factor analysis, cluster analysis, and statistical quality and reliability control.

Mathematical programming involves solving constrained optimization problems. These methods are used to optimize product mix, routing, inventory, and production scheduling.

Statistical decision theory is applied when uncertainty arises from unknown or random factors.

Game theory is used when uncertainty is due to deliberate actions of rational opponents.

Common Practical Tools

Forecasting is a reasoned statement about the future state of an object or alternative paths to achieving it. It precedes planning and aims to produce scientifically grounded development scenarios. Forecasting methods can be:

- Quantitative: normative, parametric, extrapolation, and index methods.
- Qualitative: expert judgment, functional methods, and technical strategy evaluation.

Payoff matrix method evaluates each alternative as a function of possible outcomes. Conditions for use:

- Multiple alternatives.
- Multiple possible scenarios for each alternative.
- Outcomes can be measured quantitatively.

The expected payoff is calculated by multiplying each possible outcome by its probability and summing the results. Accurate probability estimates are critical for this method.

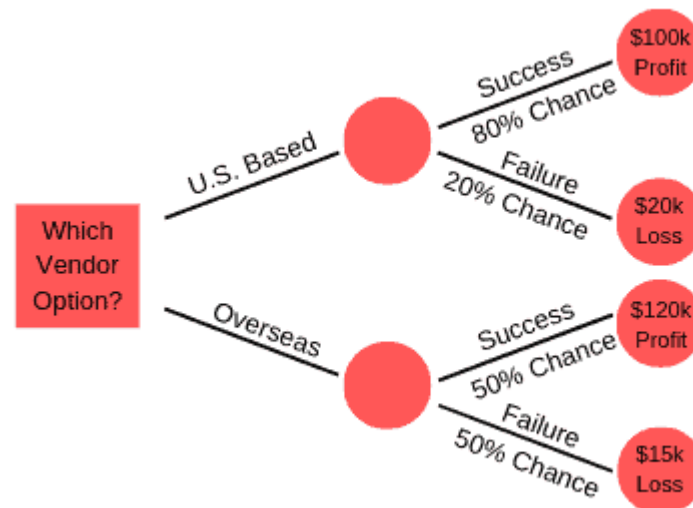


Figure 5.1 - Decision tree method

Decision tree method visually maps potential decisions and outcomes. The diagram includes:

- Action fields (alternative decisions).
- Event fields (possible scenarios and their probabilities).
- Outcome fields (expected results).

Components:

- Decision node (rectangle): where a decision is made.
- Chance node (circle): possible outcomes of actions.
- Branches: paths from decision to outcomes.

This method involves calculating expected payoffs from right to left and selecting the optimal alternative [31].

Game-theoretic methods apply when decisions must be made with incomplete and imprecise information. These methods include:

1. Statistical decision theory (games against nature).
2. Classical game theory (games against intelligent opponents).

5.2. Decision-Making in Supply Chain Management Under Uncertainty [12]

5.2.1. Concept of Managing Resilient/Viable Supply Chains

The current shift in supply chains toward recognizing the interests of end users as the primary focus of supply chain management is driven by two major factors.

First, changes in consumption patterns — including growing consumer awareness, increasing variability of their interests, and greater (both explicit and implicit) involvement in product creation.

Second, the expanding capabilities of modern information technologies to collect and analyze consumer data, conduct joint development processes, and design products.

To emphasize the decisive role of consumers in the supply chain, a new term has been introduced: Demand Chain Management (DCM).

The value creation chain can be roughly divided into DCM and SCM, highlighting the fact that consumer needs are the starting point for supply chain governance. Most SCM definitions describe a complex chain of business partners, from raw material suppliers to end consumers. Therefore, identifying DCM as a distinct phase of value creation does not oppose DCM and SCM but underscores the primacy of consumer interests as the key source of coordination.

Today, the concept of sustainable/viable supply chain management (SSCM) is evolving. This concept expands SCM by introducing social responsibility and ethical business practices. SSCM considers supply chain relationships as mutual influences among all participants and their impact on the environment, society, employees, shareholders, etc. In other words, SSCM concerns not only business-to-business relations, as in classical SCM, but also relationships with the external world [16].

The logic of SSCM is that environmental and social issues cannot be solved by one company alone — they must be addressed collectively by all supply chain participants, jointly forming long-term strategies for business and societal development.

Examples of SSCM processes include:

- reverse logistics,
- development, production, procurement, or use of materials/products that reduce or prevent environmental pollution,
- recycling, replacement, reuse, disposal, repair, and recovery of products.

These may also include:

- implementation of ethical standards, labor norms, employee rights and responsibilities,
- community engagement practices.

SSCM processes not only coordinate interactions between business partners to improve overall supply chain efficiency, but also foster social satisfaction and protection of workers, local communities, and the environment.

Thus, the formation and evolution of SCM as a concept respond to the growing need to coordinate and regulate activities among business partners in a dynamic and complex business environment. As a result, SCM has become a practical business tool in most developed economies, enabling:

- cost reduction, contractual discipline, and improved governance through transformation of linear supply chains into responsive supply networks;
- improved product quality and customer service across the entire chain by integrating development, supply, production, and distribution processes;
- customer-oriented, knowledge-sharing, and transparent business processes;
- faster time-to-market and avoidance of costly mistakes via close cooperation in planning, organization, motivation, and control across the network;
- increased corporate social responsibility, with attention to environmental and social challenges.

5.2.2. Security of Material Supply Chains

The transformation of market relations in Ukraine has made the issue of economic security particularly relevant — a relatively new term increasingly used by Ukrainian economists. Experts note that the security of any economic system is characterized by many indicators of the internal and external environment that affect its development, stability, resilience, and progress.

On one hand, there are factors that threaten economic functionality and the system's ability to fulfill its mission and objectives. On the other hand, economic security refers to the system's capacity to resist destructive factors regardless of their source.

Economic security is not only about threat mitigation — it is the system's ability to guarantee stable growth and the achievement of its development goals.

Security concerns are especially critical in logistics systems like supply chains. Logistics and SCM represent new types of production and business relations among manufacturers, suppliers, and consumers, based on modern IT tools.

The modern economy eliminates geographical, sectoral, and corporate barriers through system integration, which ensures technological, economic, and informational security.

In SCM, the goal (e.g., service level, profitability) represents potential efficiency. Actual efficiency depends on resilience. Therefore, economic efficiency and resilience are both essential in supply chain design.

The strength and invulnerability of a supply chain depend on every link, since a failure in one element affects the entire system [15].

Supply chains are high-risk zones due to:

- numerous participants with different ownership types,
- dependence on external factors and partner reliability,
- differing strategies, policies, production capacity, technologies, and resource quality,
- diverse equipment, materials, and labor,
- highly mobile and universal transportation and handling infrastructure.

Transparency is the key to resilience, especially to balance supply and demand across the chain. For example:

- inventory losses in retail reach 6% of sales,
- over 50% of trucks are underloaded, empty, or deliver spoiled or wrong goods, incurring high costs.

Another challenge is achieving maximum accuracy in supply chain management. Despite advanced IT systems, many processes still require human input — for managing inventory, perishable goods, tracking regulated items, and fulfilling retailer or distributor-specific demands. These challenges are compounded by product spoilage, fraud, poor storage, and safety issues.

Risk in supply chains is defined as the quantifiable probability of adverse events. It includes potential negative outcomes (losses) and sometimes positive results (unexpected gains). These outcomes arise from various causes and conditions.

Risk identification must be carried out at every level of the supply chain.

To enhance resilience, ISO 28002:2011 was developed — “Security Management Systems for the Supply Chain – Resilience in the Supply Chain – Requirements and Guidelines.”

Organizations worldwide increasingly use risk management procedures to reduce uncertainty and ensure business continuity. ISO 28002 provides a full system for:

- disruption prevention,
- protection and preparation,
- impact mitigation and recovery.

It uses PDCA (Plan–Do–Check–Act) cycles and outlines:

- criteria for audit and monitoring,
- risk identification and response planning,
- personnel behavior modeling under scenarios to guide protection actions.

Notable ISO-certified organizations:

- DP World – first to certify maritime terminals across 31 countries;
- Port of Houston – one of the first port authorities with certification;
- YCH Group (Singapore and India) – certified logistics partner for Dell, Canon, Moët Hennessy, Motorola, etc.;

- TNT Express (Asia) and Asian Terminals (Philippines);
- CTS Logistics China – certified for electronics and IT/telecom distribution.

The next step in supply chain development is integrating risk management models — including tools for risk identification, assessment, and monitoring — to increase resource efficiency and enhance supply chain resilience [12, 19].

5.3. Overview of Decision Support Methodologies

Lean Manufacturing

Lean manufacturing is a business strategy focused on systematically reducing waste across all areas of production. The main principle is to cut costs early in the design stage by selecting efficient materials and processes, rather than familiar but expensive ones. This reduces risk and improves profitability.

At the system engineering level, lean involves reviewing requirements to eliminate unnecessary elements, use shared modules, and reassign responsibilities to the lowest-cost disciplines. In mechanical and electrical engineering, this may mean combining parts, using inexpensive components, and replacing mechanical with electronic solutions.

Software engineering contributes by minimizing system complexity and customizing only where necessary. The overall goal is to increase efficiency, lower production costs, and ensure high quality by avoiding waste throughout the process.

Agile Manufacturing

Lean manufacturing is very good at doing the things that can be controlled. Agile manufacturing deals with the things which can not be controlled. Agility is the ability to thrive and prosper in an environment of constant and unpredictable change. Agility is not only to accommodate change but to relish the opportunities inherent within a turbulent environment. Some of the reasons for the fact that the manufacturing paradigm is changing from mass production to agile manufacturing are: [6]

- Global competition is intensifying.
- Mass markets are fragmenting into niche markets.
- Cooperation among companies is becoming necessary, including companies who are in direct competition with each other.
- Customers expect low volume, high quality, custom products.
- Very short product life cycles, development time and production lead times are required.
- Customers want to be treated as individuals.

Rapid Prototyping (RP)

Rapid prototyping is a relatively new class of technology used for building physical models and prototype parts from 3D computer-aided design (CAD) data. Unlike milling machines (which are subtractive in nature), RP systems join together liquid, powder and sheet materials to form complex parts. Layer by layer, RP machines fabricate plastic, wood, ceramic and metal objects based on thin horizontal cross sections taken from a computer model.

Rapid Tooling

Rapid tooling falls into two categories: (i) advanced methods of making tools using RP technology, and additive processes and (ii) advanced methods of making tools using milling technology, a subtractive process. Both are driven from a digital database, which is the key to making it rapid. RP-driven RT accelerates the tool-making process using RP masters that are, in turn, used to produce moulds.

Reverse Engineering

Reverse engineering encompasses a variety of approaches to reproducing a physical object with the aid of drawings, documentation, or computer model data. In the broadest sense, reverse engineering is whatever it takes—manual or under computer control—to reproduce something.

Quick Response Manufacturing (QRM)

In today's world of competitive environment, one of the key success factors for manufacturing firms is speed—not only speed of delivery, but of concept, design and production. New opportunities open for those manufacturing firms, who can get products to market before the competition and success hinges on the ability to move quickly.

Quick response manufacturing (QRM) is a companywide strategy to cut lead times in all phases of manufacturing and office operations. It can bring the manufacturing firm's products to market more quickly and secure its business prospects by helping to compete in a rapidly changing manufacturing arena.

QRM will not only make the manufacturing firm more attractive to potential customers; it will also increase profitability by reducing non-value-added time, cutting inventory and increasing return on investment.

Benefits of QRM for the manufacturing firm:

- Decreases the manufacturing cost
- Increases the market share
- Fills customer orders faster
- Boosts product quality
- Introduces new products rapidly
- Eliminates waste and inefficiency
- Secures the manufacturing future of the firm

New Inventory and Purchasing Paradigms

Traditional inventory methods (pre-1965) were replaced by modern systems like MRP, JIT, and Kanban, reshaping materials management. Later innovations included integrated materials management, VMI, self-certified vendors, and ERP-driven purchasing roles (e.g., JIT-II, ship-to-line, green channel suppliers).

Today, terms like SRM and multi-tier supplier partnerships reflect a shift toward strategic supplier integration. The core idea is that inventory is a liability, and the best approach is to avoid holding it until truly needed.

With advanced IT tools and 3PL services, inventory is now often replaced by real-time information and efficient transportation.

MATERIAL REQUIREMENTS PLANNING (MRP)

This technique originated way back in 1962–65. The basic theme of MRP is so useful that today also it is very popular and used across industries. It is basically applied to balance supply with demand, automate the creation of new supply/work orders, and regulate the inventory levels.

MRP is used to plan the materials that are required to produce or procure in definite quantities and at determined time, based on the specification in the master production schedule. In fact, its basic model works backwards from MPS to determine requirements for components. It uses mainly inputs like master production schedule, bill of materials, and inventory database.

MRP has following types of run:

- Full regeneration run
- Net change run

Order policies supported are:

- Fixed order quantity
- Lot for lot

- Fixed period of supply
- Reorder point

JUST IN TIME (JIT)

JIT is a Japanese management philosophy, which has been applied in practice since the early 1970s in many Japanese manufacturing organizations. It was first developed and perfected within the Toyota manufacturing plants by Taiichi Ohno as a means of meeting consumer demands with minimum delays. Taiichi Ohno is frequently referred to as the father of JIT.

Toyota was able to meet the increasing challenges for survival through an approach that focused on people, plants and systems. Toyota realized that JIT would only be successful if every individual within the organisation was involved and committed to it, if the plant and processes were arranged for maximum output and efficiency, and if quality and production programs were scheduled to meet demands exactly.

JIT manufacturing has the capacity, when properly adapted to the organisation, to strengthen the organisation's competitiveness in the marketplace substantially by reducing wastes and improving product quality and efficiency of production.

Seven types of waste in JIT:

- Waste from overproduction
- Waste of waiting time
- Transportation waste
- Processing waste
- Inventory waste
- Waste of motion
- Waste from product defects

Elements of JIT System:

- Continuous improvement
- Attacking fundamental problems
- Devise systems to identify problems
- Striving for simplicity
- Product-oriented layout
- Quality control at source
- Poka-yoke
- Total productive maintenance
- Good housekeeping
- Set up time reduction
- Ideal batch size = 1
- Multi-process handling
- Levelled/mixed production
- Kanbans
- Jidoka
- Andon

Benefits of JIT Systems:

- Reduced levels of in-process inventories, purchased goods, and finished goods
- Reduced space requirements
- Increased product quality and reduced scrap and rework
- Reduced manufacturing lead times
- Greater flexibility in changing the production mix
- Smoother production flow with fewer disruptions

- Worker participation in problem solving
- Pressure to build good relationships with vendors
- Increased productivity levels and utilisation of equipment

It can be said in summary that JIT is the management philosophy, which emphasises on the waste elimination as well as vendor integration to create certainty in the material planning process, which ultimately results into no inventory; and hence inventory control means to follow JIT.

Vendor Managed Inventory (VMI)

VMI is an inventory strategy where the supplier, not the retailer, is responsible for managing and replenishing stock using electronic data interchange (EDI). The retailer shares sales and inventory data, and the supplier uses it to forecast and generate purchase orders, enabling automatic replenishment.

Originally used in the grocery sector (e.g., Procter & Gamble and Wal-Mart), VMI ensures just-in-time stock availability, reduces inventory levels, improves planning, and enhances responsiveness.

Conventional vs. VMI Models:

Conventional: The retailer forecasts demand, creates orders, and handles payment and invoice matching.

VMI: The supplier handles forecasting, ordering, and invoicing. The retailer simply receives shipments, lowering workload and excess inventory.

Benefits:

- Better visibility across the supply chain
- Lower inventory and stockouts
- Improved production planning and customer service
- Streamlined transactions via EDI and automated fund transfers

Benefits of VMI

Dual Benefits

1. Data entry errors are reduced due to computer-to-computer communications. Speed of the processing is also improved.

2. Both parties are interested in giving better service to the end customer. Having the correct item in stock when the end customer needs it, benefits all parties involved.

3. A true partnership is formed between the manufacturer and the distributor. They work closer together and strengthen their ties.

Supplier Benefits

Reduced Inventory: This is the most obvious benefit of VMI. Using the VMI process, the supplier is able to control the lead time component of order point better than a customer with thousands of suppliers they have to deal with. Additionally, the supplier takes on a greater responsibility to have the product available when needed, thereby lowering the need for safety stock. Also, the supplier reviews the information on a more frequent basis, lowering the safety stock component.

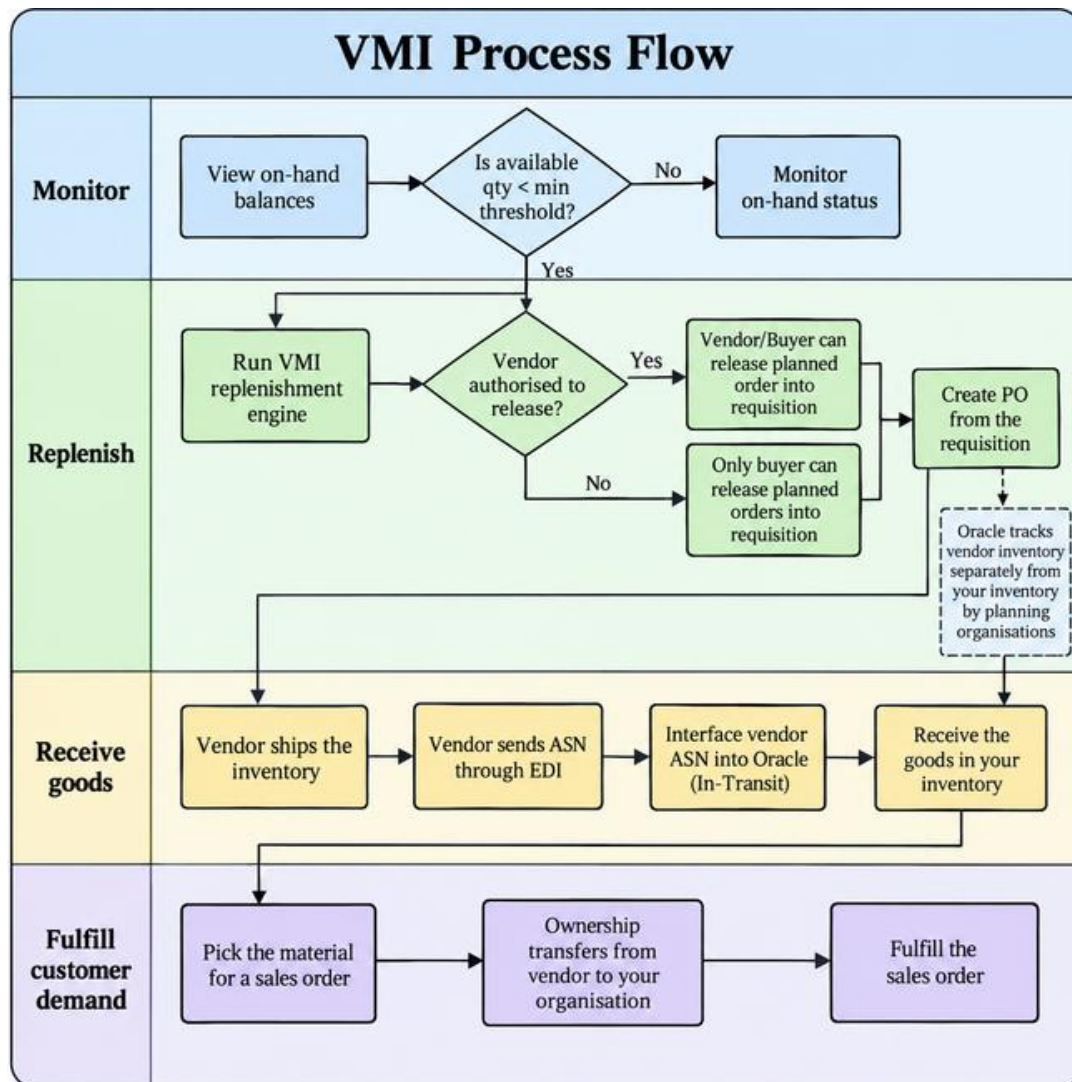


Figure 5.2 - A Typical VMI Process

These factors contribute to significantly lower inventories.

1. Reduced stockouts: The supplier keeps track of inventory movement and takes over responsibility of product availability resulting in a reduction of stockouts, thereby increasing end-customer satisfaction.
2. Reduced forecasting and purchasing activities: As the supplier does the forecasting and creating orders based on the demand information sent by the retailer, the retailer can reduce the costs on forecasting and purchasing activities.
3. Increase in sales: Due to less stockout situations, customers will find the right product at right time. Customers will come to the store again and again, thereby reflecting an increase in sales.
4. Planning and ordering cost will decrease due to the responsibility being shifted to the manufacturer.
5. The overall service level is improved by having the right product at the right time.
6. The manufacturer is more focused than ever in providing great service.

Table 5.1 - Vendor-Managed Inventory Transaction Cost Reduction

Purchasing	Inventory Management	Receiving	Error Reduction
Speeds transactions	Delivery as needed cuts storage	Advance Ship Notice speeds up receiving	Data entry mistakes are avoided
Streamlines communication between customer and supplier	Helps you reduce inventory levels	Bar Coding cuts warehousing costs	Information flow is continuous
Eliminates paper-to-computer data entry	Reduces inventory obsolescence		
Improves data accuracy	Improves inventory turns		
Frees up staff to work on more productive activities	Improves fill rates		
	Decreases lost sales		

Manufacturers Benefits

1. Improved visibility results in better forecasting: Without the VMI process, suppliers do not exactly know how their customers are going to place orders. To satisfy the demand, suppliers usually have to maintain large amounts of safety stocks. With the VMI process, the retailer sends the POS data directly to the vendor, which improves the visibility and results in better forecasting.

2. Reduces PO errors and potential returns: As the supplier forecasts and creates the orders, mistakes, which could otherwise lead to a return, will come down.

3. Improvement in SLA: Vendor can see the potential need for the item before it is actually ordered and right product is supplied to retailer at right time improving service level agreements between retailer and supplier.

4. Encourages supply chain cooperation: Partnerships and collaborations are formed that smooth the supply chain pipeline. Visibility to the distributors' point of sale data makes forecasting easier.

5. Payments can be more easily processed through integration with retailer systems.

6. A reduction in distributor ordering errors (which in the past would probably lead to a return).

7. Visibility to stock levels helps to identify priorities. Before VMI, a manufacturer has no visibility to the quantity and the products that are ordered. With VMI, the manufacturer can see the potential need for an item before the item is ordered.

Challenges and Limitations of VMI

1. The VMI approach has its own set of challenges and limitations:
2. Some companies continue to manufacture to stock without leveraging customer-specific data effectively for production planning.
3. In order to provide priority service to VMI partners, some vendors reserve inventory resulting in shortages to other customers.
4. Insufficient level of system integration results in incomplete visibility.
5. High expectations from retailers.
6. Resistance from sales forces due to concerns of losing control, affecting sales based incentive programs.
7. Lack of trust and skepticism from employees.

8. The overall level of collaboration is limited.
9. The level of detail for planning is still generally high.

Third-Party Logistics (3PL)

3PL involves outsourcing logistics and distribution to specialized providers so companies can focus on core functions like product development and marketing. This helps reduce logistics ($\approx 5\%$) and inventory costs ($\approx 15\%$) of total product cost.

Why Companies Use 3PL:

- Focus on core activities and improve customer satisfaction
- Reduce costs (15–30% in inventory management)
- Expand into new markets and channels quickly
- Access expert logistics solutions
- Improve service levels and response time
- Optimize inventory and working capital
- Gain flexibility without heavy internal investments

Beyond transportation and warehousing, 3PLs offer services like:

- Fund collection
- Tracking and data services
- Consumer analytics
- Packaging, assembling, and reverse logistics
- 3PLs serve as strategic partners in enhancing supply chain efficiency and scalability.

The Infrastructure Required for a 3PL

The 3PL should have adequate infrastructure for servicing its customer requirements. The following type of infrastructure is a prerequisite for a good 3PL:

1. Warehouse
2. Fleet of vehicles
3. Hardware and software to take care of information needs
4. Advanced material handling capabilities
5. Good team of consultants
6. Trained manpower
7. Reach in terms of geography

Selecting a 3PL Service Provider

Though manufacturing or even service companies stand to gain a lot from outsourcing their logistics activities to 3PLs, the returns from such a relationship have not been commensurate with the expected returns. This makes many critics to question the validity of using a 3PL service provider, in turn making the process of selection and evaluating the 3PL all the more important.

Steps While Considering a 3PL Service Provider

The unique challenges posed by the company when they outsource to a 3PL makes it worthwhile for companies to answer a few questions for making their relationship with the 3PL a success. The manufacturing company should consider the following points:

Knowing where to go: Companies should define their logistics management goals and attempt to visualise their organisation status after they have outsourced their logistics activities. Many companies even employ outside consultants to gauge whether there is a need of a 3PL alliance. The consultants help the company to narrow down to a list of 3PLs and identify their would-be partners.

Knowing the needs and objectives: The manufacturing company should know clearly its objectives for outsourcing their logistical activities and then attempt to visualise the organisation after it has outsourced their logistical activities. Knowing the needs also helps the companies in

selecting a 3PL that best fits in to their requirements. Setting objectives of the outsourcing function should be a cross functional activity with participation of key personnel from all critical departments of the company such as information systems, finance, marketing, production, field staff, human resources and supply chain department.

Measuring and Evaluating Performance

After the whole structure has been put in place the manufacturing firm needs to realise that the service provider is an integral part of their business process and commit its resources to invest in long-term relationship. However, at the same time it must also realise that it needs to review the performance of the service provider as it does with any business unit within the organisation.

The manufacturing company should review the performance of the 3PL based on the metrics of performance decided initially in the contract. The following are the metrics of evaluating a 3PL:

Transportation

On-time shipment: Percentage of shipments that leave on the designated time/date as against the total number of deliveries.

On-time delivery: Percentage of shipments that reach the customer location on the designated date as against the total number of shipments.

Transportation cost per mile: How much it cost to transport a unit per mile against the previous in-house process or against industry standards.

Warehousing

- Percentage of orders that the 3PL ships in exact quantity as against specified on the shipping order.
- Per unit cost of warehousing.
- Cost of warehousing including the overheads.
- Ability of moving the goods from one dock to another within specified time period.
- Number of cases handled per hour or per employee.
- Picking accuracy: Percentage of lines with errors vs. total number of lines.
- Order fulfillment.
- Item Fulfillment.
- Inventory accuracy: Number of errors in reporting inventory in warehouses.
- Loss and damage: Loss and damage resulting from contractor negligence.

Cost

Service costs: The number of times the service provider meets the targeted reduction in costs.

Cost reductions: Service provider initiatives to cut costs quarter to quarter.

Quality

Reports: Ability of service provider to supply reports to manufacturing firm with the required information.

Process improvement: Initiatives jointly developed by the manufacturing firm and the 3PL to improve process performance.

Availability

- Customer satisfaction: Customer satisfaction surveys for the customers serviced by the 3PL.
- Handling routing: Excess/shortage of inventory in the warehouse indicating improper warehousing.
- In addition to these quantifiable metrics there are some other factors that should also be considered while evaluating the 3PL. Some of these are listed below:
- Flexibility: Ability of the 3PL to make changes in the processes according to the requirements of the manufacturing company.

- Support of top management: The top management of the service provider plays a crucial role in making a commitment to a long-term relationship.
- Investments in infrastructure: The 3PL should also make considerable investments on the Information Technology and communication front.
- Financial stability: A 3PL contract calls for major investments by the service provider in the initial years for warehouses, fleets etc. and hence may not realize any gains in the first one or two years. Hence, the financial stability of the service provider is also crucial to the success of the alliance.

Fourth-Party Logistics (4PL)

4PL is a concept introduced by Accenture in the 1990s after research showed that 3PL models often favored providers while shifting risks to clients. Rising outsourcing costs led to the need for a more balanced, strategic model.

Definition: A 4PL is an integrator that brings together its own and others' capabilities, technology, and resources to design and manage end-to-end supply chain solutions.

To qualify as a 4PL, a firm must manage multiple 3PLs and possess strong infrastructure and strategic expertise.

Many 3PLs mislabel themselves as 4PLs by simply offering extra services, rather than acting as true integrators.

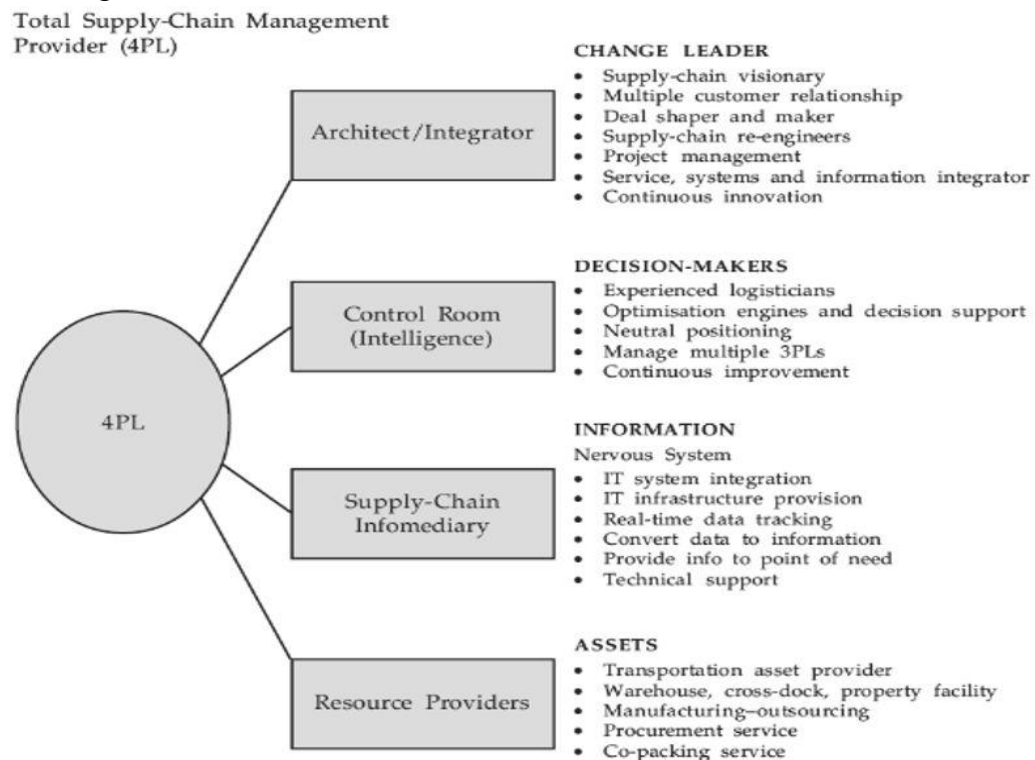


Figure 5.3 - Role of the 4PL in SCM

TECHNOLOGY COMPONENT OF 4PL

Though technology is not the only component of a 4PL provider, it is one of the key components of disseminating information for being responsive to changes. And being dynamic is one of the most important challenges of a 4PL service provider.

GPS Technology

GPS, global positioning system, is the only technology that can be used for determining the position of any object on Earth, with a high amount of accuracy and in any weather.

Key Components of GPS

GPS uses 3 main elements — space segment, user segment and the control segment.

GPS uses 24 satellites that orbit in space 11,000 nautical miles above the earth, which comprises the space segment. The user segment consists of receivers, which can be hand held or mount on a car. The control segment consists of five ground stations, located around the world, which ensures the proper working of the satellites.

Space Segment

The space segment of GPS includes 24 satellites orbiting ~11,000 nautical miles above Earth, each completing a full orbit every 12 hours. At any time, signals from at least six satellites can reach any point on Earth.

These satellites use ultra-precise clocks (accurate within three nanoseconds) to ensure accurate positioning. The system began with a test satellite in 1978, and the full 24-satellite constellation was completed in 1994.

Ground Control Stations

The GPS control or ground segment consists of unmanned monitor stations located around the world; a master ground control station at Falcon Air Force Base in Colorado and four large ground antenna stations that transmit signal to the satellites.

GPS Receivers

GPS receivers can be hand-held or can be mounted on vehicles. These vehicles detect, decode and process GPS satellite signals. The typical size of a GPS receiver is same as that of a cell phone.

Quality Management & Improvement Techniques:

Six Sigma

The use of six sigma methodology can be a powerful way to reduce variability in supply chain processes (see box).

Reducing process variability through six sigma methodology Conventional approaches to quality management were typically based upon 'inspection'. In other words, a sample of the output of a process would be taken on a periodic basis and if non-standard outputs were detected then remedial action would be taken. Not surprisingly, inspection-based quality management has proved to be less than satisfactory. Often non-conforming items would 'slip through the net' and, in any case, inspection is 'after the event'. Today, our thinking on quality management has changed. Now the recognition is that if we seek consistency in the quality of the output then the only way to achieve this is to ensure that the process that produces those outputs is under control.

Thus process control becomes the means by which variation in output is identified. Variation in any process is the problem. If everything in life or in business was totally constant or even predictable, then there would be few problems. The challenges arise because of variations. Hence it follows that if variation can be reduced then the consistency (and, by definition, the reliability) of the output can almost be guaranteed.

The six sigma way

The six sigma route to quality control emerged in the 1980s as Motorola searched for a robust quantitative approach that would drive variability out of manufacturing processes and thus guarantee the reliability of their products. The term 'six sigma' is largely symbolic, referring to a methodology and a culture for continuous quality improvement, as well as referring to the statistical goal, six sigma. The term 'sigma' (σ) is used in statistics to measure variation from the mean; in a business context the higher the value of sigma the more capable the process of delivering an output within customer specifications. The diagram below illustrates the difference between two processes: one with a low capability and the other with six sigma capability. The six sigma goal (which in many cases is an aspirational one) is to squeeze out process variability until the process produces just 3.4 defects per million activities or 'opportunities'; this reduces waste and hence saves money

whilst improving customer satisfaction. Whilst six sigma performance may be unattainable in many cases, it is used as a target.

Six sigma is a data-driven continuous improvement methodology that seeks to bring processes under control and to improve process capability.

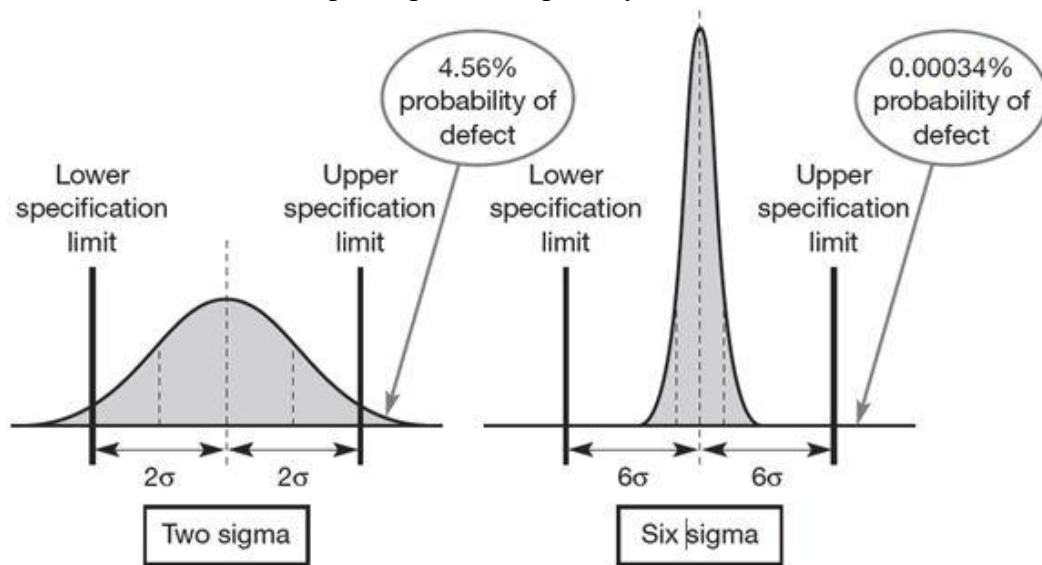


Figure 5.4 - Two sigma VS Six Sigma

The methodology itself follows the five-stage DMAIC cycle:

Define: What is it we are seeking to improve?

Measure: What is the current capability of the process? What averages, what variability in process output is evident? analyse: Map the process, use cause and effect analysis (Ishikawa) and prioritise for action.

Improve: Re-engineer the process, simplify.

Control: Improve visibility of the process. Use statistical process control and monitor performance.

Six sigma tools and techniques enable the proper execution of the DMAIC cycle and ensure that decisions are based on hard quantitative evidence [8].



Figure 5.5 - DMAIC cycle

Six Sigma

There are three main foundational aspects of Six Sigma:

1. Quality is defined by the customer: Customers expect performance, reliability, competitive prices, on-time delivery, good service, clear and correct transaction processing, and more. It is vital to provide what the customers need to achieve customer satisfaction.

2. Use of technical tools: Six Sigma provides a statistical approach for solving any problem and thereby improves the quality level of the product as well as the company. All employees should be trained to use technical tools (e.g., statistical quality control and the seven tools of quality). Six Sigma is concerned with the permanent fix to quality problems and seeks to identify and correct the root cause of the problem.

3. People involvement: Six Sigma follows a structured methodology, and has defined roles for the participants. A company must involve all its employees in the Six Sigma program, and provide opportunities and incentives for them to focus their talents and ability to satisfy customers. All employees are responsible to identify quality problems. It is important that all Six Sigma team members have a well-defined role with measurable objectives. Under Six Sigma, the members of an organization are assigned specific “roles” as follows:

Senior Leader: Defines the goals and objectives in the Six Sigma initiative.

Implementation Leader: Supervises the Six Sigma initiative.

Coach: Six Sigma expert or consultant who sets a schedule, defines result of a project, and mediates conflict or deals with resistance to the program.

Sponsor: High-level individual within the company that acts as a problem solver for the Six Sigma initiative.

Team Leader: Oversees the work of the Six Sigma team and acts as a liaison between the sponsor and the team members.

Team Member: Executes specific Six Sigma assignments.

Process Owner: Takes responsibility for a process after the Six Sigma team has completed its work.

TOTAL QUALITY MANAGEMENT (TQM)

Total Quality Management (TQM) is a management philosophy based on the principle that every employee must be committed to maintaining high standards of work in every aspect of a company’s operations, focused on meeting customer needs and organizational objectives. TQM is a combination of quality and management tools designed to increase business and reduce losses resulting from wasteful practices.

When implemented, Six Sigma is an integral part of TQM. Its key principles are as follows:

- Management Commitment
- Employee Empowerment
- Fact-Based Decision Making
- Continuous Improvement
- Customer Focus



Figure 5.6 - Total Quality Management (TQM) methodology

There is no single academic formalization of total quality, but noted quality gurus W. Edwards Deming, Philip Crosby, Joseph Juran, and Kaoru Ishikawa, among others, contributed to the basic framework:

This discipline and philosophy of management institutionalizes planned and continuous improvement.

Quality is the outcome of all activities that take place within an organization.

All functions and all employees must participate in the improvement process.

Organizations need both quality systems and a quality culture.

Key Questions

1. How do quantitative and qualitative methods support the justification of management decisions?
2. How does the information available to a decision-maker affect the choice of a decision method?
3. How can a decision tree be used to compare supply chain alternatives?
4. How do decision-making under certainty, risk and uncertainty differ?
5. How can expert assessment, forecasting and game theory support decisions under uncertainty?
6. What makes a supply chain resilient or viable, and how can these qualities influence decision-making?
7. Which measures can improve the security and reliability of material supply chains?
8. How do lean manufacturing, agile manufacturing and QRM address different operating conditions?
9. How do MRP, JIT and VMI influence inventory and replenishment decisions?
10. When should a company use 3PL or 4PL services, and what decision criteria should it apply?
11. How do Six Sigma, the DMAIC cycle and TQM support continuous improvement?
12. How should managers balance cost, service, quality and risk when selecting a decision support methodology?

6 Fundamentals of Transport Process Management

Agenda

- 6.1. Place in the Supply Chain
- 6.2. Transportation Cost Factors and Elements
- 6.3. Transport Operations in Consolidation, Break Bulk, and Cross-Docking Warehousing
- 6.4. Technology and trends in transportation

6.1. Place in the Supply Chain

Definition: Transportation in a simple language can be defined as a means through which goods are transferred from one place to another. Given the facility and information capabilities, transportation is the operational area of logistics that geographically positions inventory. It is fundamentally important function and has the most visible cost, hence there is a lot of importance given to transportation in the logistics process and hence, demands due attention and time of the manager responsible for transportation [18, 29].

Place in the Supply Chain:

To understand the functions of transportation, let us understand where it occurs in the entire supply chain.

Figure 1 illustrates the major part of the supply chain. As it can be seen, transportation occurs between almost all two steps up and down the value chain. However, the internal transportation can and should be avoided as far as possible by getting the manufacturing process physically closer. The major challenge lies in handling the external transportation.

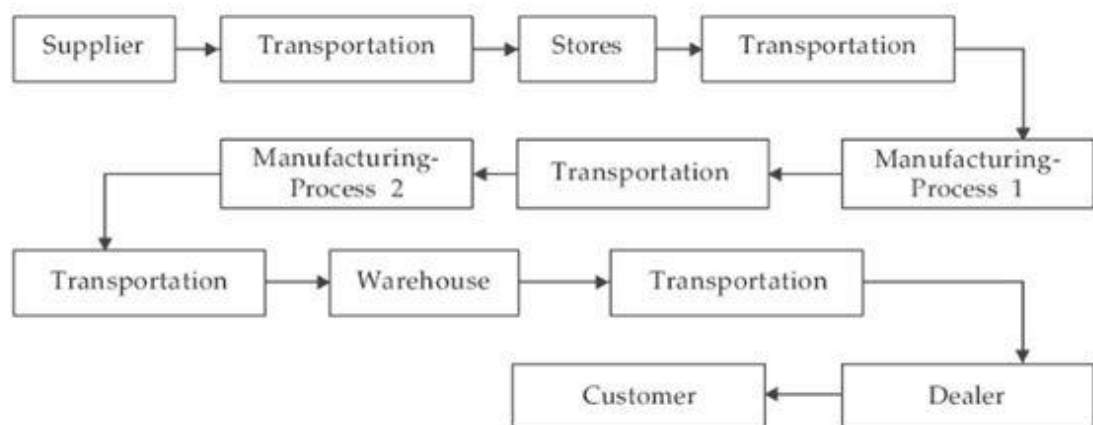


Figure 6.1 - Role of transportation in supply chain process

Functionality

Transportation provides two basic functions:

- 1. Product Movement
- 2. Product Storage

Product Movement

This is the primary transportation function. It involves moving the product up and down the value chain. Whether the product is in the form of materials, components, assemblies, work-in-progress, or finished goods, transportation is essential to shift it to the next stage of the manufacturing process or distribution.

However, during transportation of the product, there could be some loss on account of damage or product loss. Also, the product is inaccessible for use when it is in transit. There could also be environmental hazards due to use of polluting fuels. Hence, for a transportation decision-

making, the costs of the temporal, financial and environmental resources have to be considered. These will be further elaborated upon in the later part.

Product Storage

This is a less common function of transportation. This is because vehicles make rather expensive storage facilities. However, it makes sense to use it as a storage facility in the following few instances:

- When the in-transit product requires to be moved shortly and the cost of unloading and reloading the goods will be more than the charge of storage in the vehicle. To put it simply in a mathematical form.
- When the origin and destination warehouse space is limited. In such circumstances when warehouse space is limited a circuitous route is taken to increase the transit time that is greater than it would be in case of a direct route.

Cost of Storage in Vehicle < Cost of Unloading + Cost of Reloading + Cost of Warehouse

Decision Factors

The three fundamental factors to transportation performance are:

- Cost
- Speed
- Consistency

These factors help in selecting the transportation mode.

Cost It includes the direct cost i.e. the payment for movement between two geographical locations and expenses related to the administration and indirect cost of maintaining in-transit inventory. Hence for deciding the transportation, the least expensive transportation is not always resulting in the lowest cost of movement.

Speed It is the time required to complete a specific movement of goods from one place to another. Speed and cost are related in two ways. On one hand, greater the speed of transportation higher is the transportation charges, but on the other hand greater speed would result in lesser time of inventory in-transit being unavailable. Hence the trade-off is required to be made and balance has to be struck.

Consistency Consistency refers to the variations in time required to perform a specific movement. Consistency is the reflection of dependability of the transport. This is a very important factor as inconsistent transportation, i.e. if a given movement takes 2 days once and 6 days the next time, can create serious logistical and operational problems. If there is inconsistency then it would require safety stock which would mean higher costs and also chances of obsolescence in some industries where specifications change frequently.

Other Factors Apart from the factors discussed above, there are other factors to be considered while deciding for the transport of a good.

Distance Distance is the major influence on transportation cost since it directly contributes to the variable cost, such as labour, fuel and maintenance. The following curve (Figure 2) illustrates the relationship between the cost and distance.

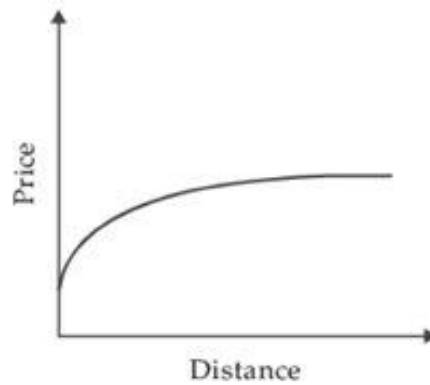


Figure 6.2 - Relationship between cost and distance

The cost curve starts above the origin due to fixed shipment pickup and delivery costs. While total costs rise with distance, the cost per unit decreases as fuel and labor become more efficient over longer distances.

Volume: Larger loads reduce the cost per weight unit by spreading fixed costs over more volume, though this is limited by vehicle capacity.

Density: Higher product density maximizes vehicle space usage, as transportation costs are space-constrained rather than weight-constrained.

Storability: Efficient vehicle space usage depends on product shape. Rectangular items stow better than irregular shapes.

Handling: Fragile materials require minimal handling, making roadways a better option than railways or waterways for reduced intermediary handling.

6.2. Transportation Cost Factors and Elements

The primary transportation modes are truck/motor carrier, rail, air, water, intermodal, and pipeline. Their differences lie in operating costs and flexibility.

Transportation Costs: Fixed costs (buildings, equipment, land) don't depend on volume, while variable costs (fuel, maintenance, wages) do. Costs arise in ways (roads, water, air), terminals (loading/unloading, administration), and vehicles (capital investment, fuel, labor).

Ways: Goods move over land, water, or air—owned by operators (e.g., railroads), governments (roads), or nature (oceans).

Terminals: Used for sorting, loading/unloading, connecting modes, dispatching, and administration.

Vehicles: Owned or leased, with fixed (capital) and variable (fuel, labor) costs.

Modes: Trucks dominate U.S. freight (71%), mainly higher-value goods. Rail and trucks share ton-miles (39% each), while air transport handles longest shipments (average 1,304 miles).

Rail: Rail is slow, inflexible, and low-cost, suited for bulky goods over long distances. Railroads have high fixed costs due to owning ways, terminals, and vehicles but low variable costs. They include:

- **Class I Railroads:** Operate 350+ miles or earn \$272M+ annually, covering 70% of mileage and handling long-haul, high-density traffic.
- **Regional & Local Line Haul:** Regional railroads serve regions across multiple states with revenue between \$40M-\$272M. Local railroads focus on point-to-point service within one state and operate shorter distances.
- **Switching & Terminal Railroads:** Handle pickup and delivery within specific areas.

Motor Carriers: Dominant in domestic supply chains, motor carriers ship small goods directly to multiple locations. They have low fixed costs and high variable costs, paying for infrastructure through taxes/tolls. Types include:

- Full-Truckload Carriers: Provide point-to-point service with one customer's freight, minimizing overhead.
- Less-Than-Truckload (LTL) & Small-Package Carriers: Require terminal networks for sorting and mixing, increasing infrastructure and rates. Examples are Con-way Freight, Old Dominion, and UPS.

Air Carriers: Fast and expensive, air cargo carriers specialize in high-value, low-volume, time-sensitive goods. They have low fixed costs (government terminals) and high variable costs (fuel). Operators include UPS, FedEx, DHL, and divisions of passenger airlines.

Water Carriers: Among the oldest transport methods, divided into domestic and international (deepwater). They have moderate fixed costs (terminals, ships) and low operating costs, suited for low-value bulk goods. Containerization has revolutionized global trade, handling 81% of international freight.

Intermodal Carriers: Combine multiple transport modes using standardized containers, improving speed, security, and efficiency. Popular systems include trailers on flatcars (TOFC) and containers on flatcars (COFC), essential for global trade.

Pipeline: Pipelines transport high-volume liquids and gases, such as crude oil and natural gas, using fixed infrastructure. Key operators include the Trans-Alaska Pipeline System (TAPS). Pipelines support inland production and offshore deliveries, relying on interstate systems for natural gas supplies.

Intermodal

Intermodal is sometimes referred to as the sixth mode of transportation, but it is really the use of multiple modes of transportation to execute a single transport shipment. Intermodal is growing substantially because it is fairly cost efficient and cost effective.

Some of the more common examples include:

- Rail and Motor Carriers: Offer point-to-point pickup and delivery service known as trailer-on-flatcar (TOFC).
- Rail and Water Carriers: Offer point-to-point pickup and delivery service known as container-on-flatcar (COFC) [18].
- Water and Motor Carriers: Offer point-to-point pickup and delivery service for overseas manufacturers.
- Roll-On/Roll-Off (RO/RO) Ship: This is one of the most successful types of cargo ships operating today and its flexibility, ability to integrate with other transport systems, and speed of operation have made it extremely popular on many shipping routes. A RO/RO ship is specifically designed to carry wheeled and tracked vehicles as all or most of its cargo. Vehicles are driven or towed on and off the ship by means of either the ship's own ramps or shore-based ramps. Because it is designed to accommodate cargo that cannot be stacked.

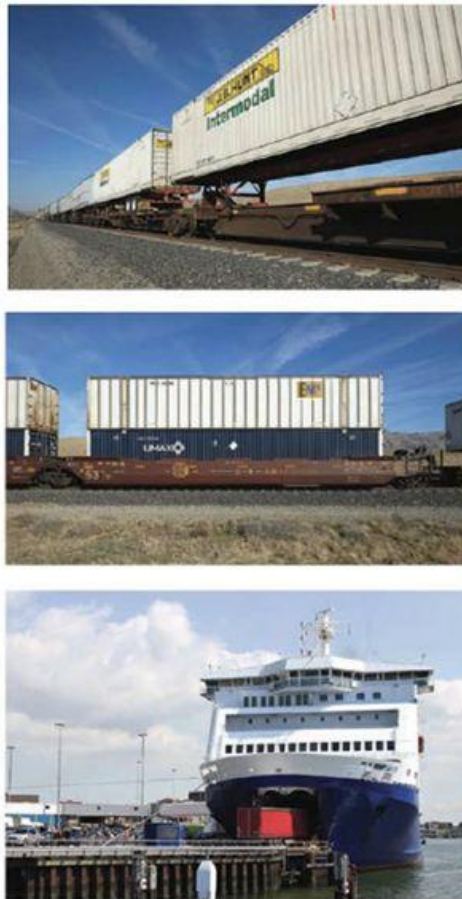


Figure 6.3 - Examples of intermodal transportation

6.3. Transport Operations in Consolidation, Break Bulk, and Cross-Docking Warehousing

Consolidation Warehousing

A consolidation warehouse receives products from suppliers, sorts them, and then combines them with similar shipments from other suppliers into larger, more economical, shipping loads for further distribution. In other words, small flexible shipments in, and large economical shipments out. The goal is maximizing transportation utilization while minimizing costs [26].

The concept is similar to carpooling where several individuals in the same area come together and meet at one place, and then take one car to work instead of taking several different cars. The cost to each person is significantly less than it would have been if they went separately. Consolidation of freight shipments works in basically the same way.

Consolidation warehouses are typically established at a strategic location between suppliers and customers. Ideally, in order to minimize the total transportation costs, the consolidation warehouse should be located closer to the supply base so that the smaller LTL shipments travel the shorter distance and can be consolidated more quickly into the larger FTL shipments traveling the longer distance to the customer. Usually, a third-party logistics (3PL) provider manages and maintains the warehouse and the information system needed to run it, and these operations can either be client-dedicated or multiple-user facilities.

Figure 4 provides an example of the flow of products through a consolidation warehouse. Products are shipped from three separate plants or suppliers into the consolidation warehouse, usually in less-than-truckload (LTL) shipments. At the warehouse, the products are received and combined together to be shipped out to a customer in a larger full truckload (FTL) shipment.

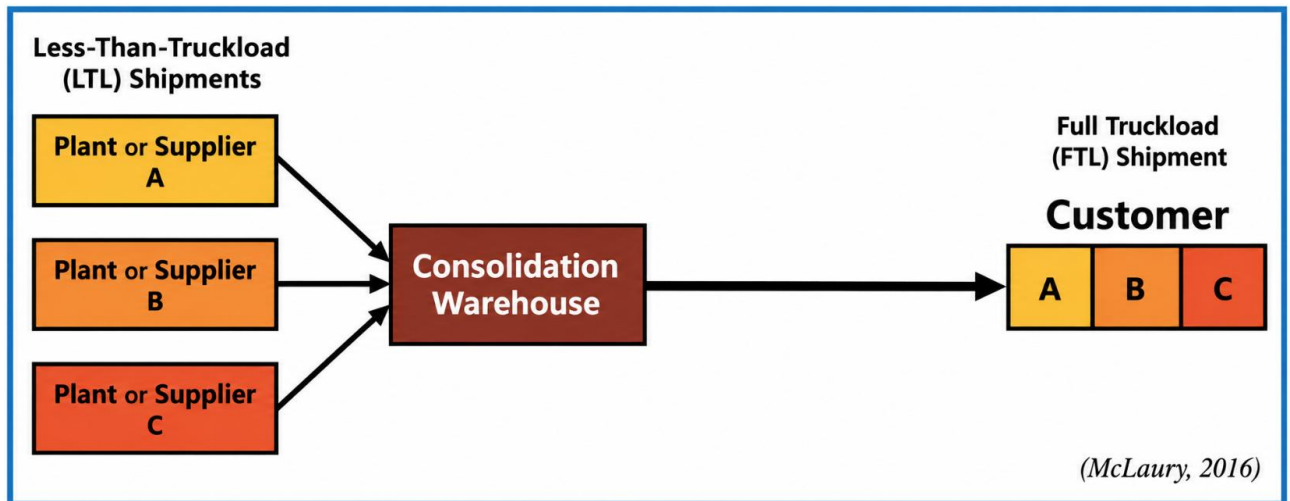


Figure 6.4 - Consolidation warehouse

Break Bulk Warehousing

A break bulk warehouse is similar to a consolidation warehouse except that the incoming shipments are generally truckloads of homogeneous items from a single plant or supplier. The break bulk warehouse sorts or splits the items into individual orders or shipments and arranges for local delivery.

Similar to consolidation warehouses, break bulk warehouses are also typically established at a strategic location between suppliers and customers. In contrast to the consolidation warehouse location, in order to minimize total transportation costs, the break bulk warehouse should be located closer to the customer base so that the smaller LTL shipments travel the shorter distance to the customers, while the larger FTL shipments from the single supply source travel the longer distance before arriving at the break bulk warehouse.

Figure 5 provides an example of the flow of products through a break bulk warehouse. Products are shipped from a single plant or supplier into the break bulk warehouse, usually in FTL shipments. At the warehouse, the products are received and sorted or split into individual orders to be shipped out to customers in LTL shipments.

In both consolidation warehousing and break bulk warehousing, a 3PL provider frequently manages the warehouse and the information system(s) needed to run it. These operations can either be client-dedicated or multiple-user facilities.

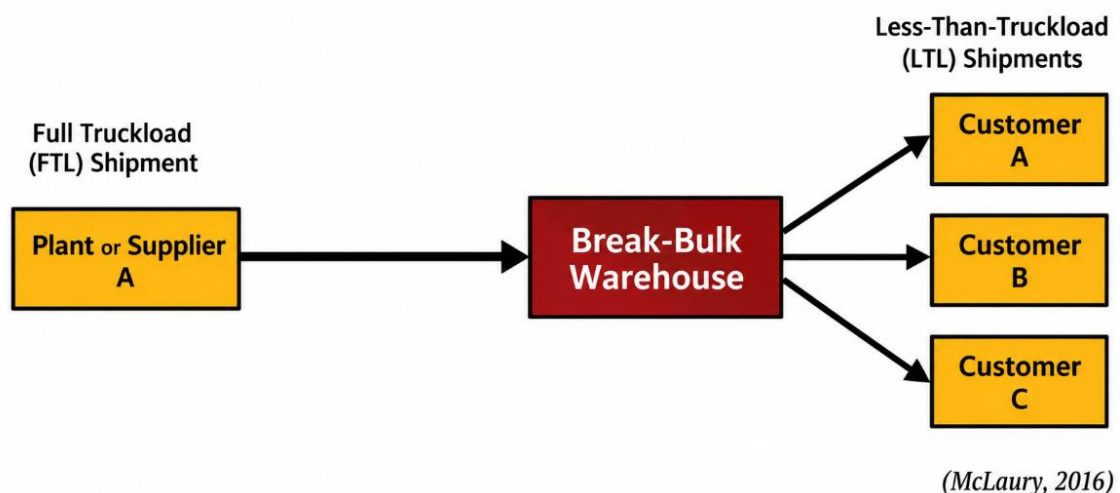


Figure 6.5 - Break Bulk Warehousing

Cross-Docking Warehouse

Cross docking is the logistics practice of unloading materials from an incoming truck or railcar and loading these materials directly onto outbound trucks or railcars, with little or no storage in between. This is a type of consolidation and/or break bulk warehouse. The advantages of cross docking are to speed throughput times, reduce inventory investment, and reduce storage space requirements.

Cross docking takes place in a distribution terminal usually consisting of dock doors on two sides (inbound and outbound) with minimal storage space on site. The name cross docking refers to receiving products through an inbound dock and then transferring them across to the outbound dock. Once the inbound shipment has been received, the products can be moved either directly or indirectly to the outbound destinations. Products can be unloaded, sorted and screened to identify their end destinations, and then moved to the other end of the cross-dock terminal via materials handling equipment such as a forklift, conveyor belt, or pallet truck. When the outbound transportation has been loaded, the products can then be shipped out to customers [18].

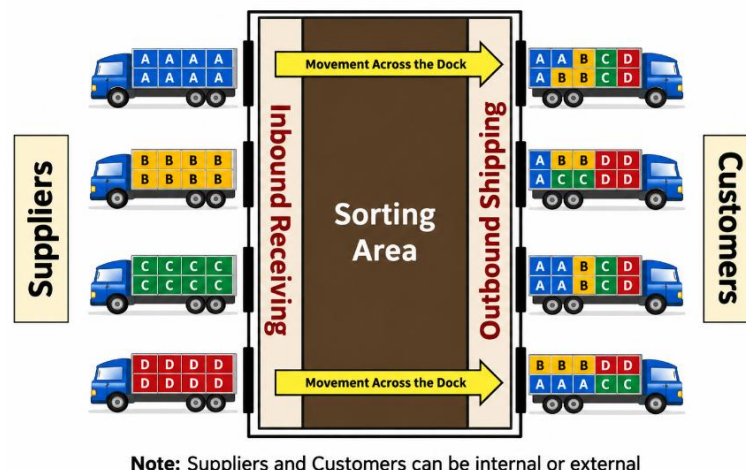
The main reasons that cross docking is implemented are as follows:

- To provide a central site for products to be sorted and similar products combined to be delivered to multiple destinations in the most productive and fastest method possible.
- To combine numerous smaller product loads into one method of transport to save on transportation costs (i.e., consolidation).
- To break down large product loads into smaller loads for transportation to create an easier delivery process to the customer (i.e., deconsolidation or break bulk).

Cross-Docking Provides Certain Advantages:

- **OPERATIONAL EFFICIENCY:** As the material does not have to be stored at the warehouse, and directly moves from the receiving docks to the shipping docks, the warehouse operations are more efficient.
- **INVENTORY EFFICIENCY:** As the inventory moves directly from the receiving to shipping docks, there is no storage at the warehouses, and that reduces the total system inventory in the supply chain.

Figure 6 illustrates a cross-docking warehouse operation. On the left side of the diagram are inbound shipments of products from four suppliers. Once these products are received and unloaded, they can be sorted, reconfigured, and moved across the dock to ship outbound to the four customers, as shown on the right side of the diagram. Notice that each customer is being shipped a different configuration of the four products.



Note: Suppliers and Customers can be internal or external

(McLaury 2016)

Figure 6.6 - Cross-docking warehouse operation

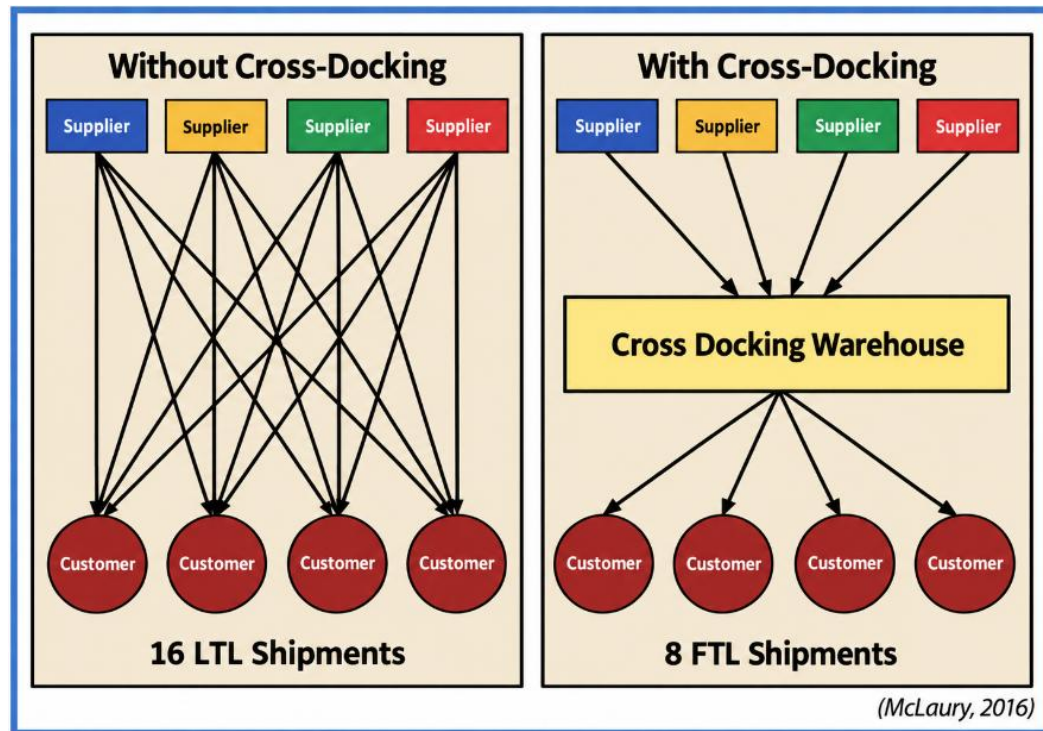


Figure 6.7 - The difference with and without a cross-docking warehouse operation

6.4. Technology and trends in transportation

Transportation Management Systems (TMSs): Initially add-ons to ERP or legacy systems, TMSs can now be installed as resident software or accessed online. They enhance auditing, operations, and visibility while planning, scheduling, and controlling transportation. Key functionalities include:

- Planning & Decision Making: Optimizing transport schemes (cost, time, stops) and selecting modes, providers, loads, and routes.
- Execution: Implementing plans, including carrier dispatch and EDI.
- Follow-Up: Tracking operations, customs, invoices, and alerts.
- Measurement: Controlling costs and reporting KPIs.

TMSs connect supply chain links (transportation) and nodes (facilities). Next focus: warehouse management.

Transportation Pricing and Considerations

Since deregulation in the transportation industry, the negotiating of transportation prices is common. The main transportation schemes are as follows:

- **COST OF SERVICE PRICING:** The setting of a price for a service based on the costs incurred in providing it. The carrier estimates the cost of providing the service and then adds on a percent profit margin. Commonly used for pricing transportation of low value goods or in highly competitive situations.
- **VALUE OF SERVICE PRICING:** A pricing strategy that sets prices primarily, but not exclusively, in the value, perceived or estimated, to the customer rather than on the cost of the product or historical prices (i.e., "priced at what the market will bear"). Depends on the value of the goods being shipped. Used for high value goods or when no competition exists.
- **COMBINATION PRICING:** Price setting at a value between cost-of-service minimum and value-of-service maximum. Most carriers use some form of combination pricing. Common in highly volatile markets and changing competitive situations.

- **NET-RATE PRICING:** Established discounts and accessorial charges are rolled into one all-inclusive price. Pricing is tailored to the individual customer's needs.

Terms of Sale

The delivery and payment terms agreed between a buyer and a seller. In international trade, terms of sale also set out the rights and obligations of buyers and sellers as applicable in the transportation of goods.

EXAMPLES:

F.O.B. Origin:

- Seller states price at point of origin and agrees to load a carrier.
- Buyer selects the carrier and pays for the transportation.
- Title passes to the buyer when the shipment originates.

F.O.B. Destination:

- Seller arranges for transportation and adds charges to the sales invoice.
- Seller assumes the risk for in-transit loss or damage.
- Title does not pass to the buyer until delivery is completed.

Transportation Rate Categories Price charged by transportation carrier for moving an item or commodity from point A to point B. Actual amount charged varies based on weight of object being moved, type of commodity being moved, and distance traveled. Classified as line haul rates, class rates, exception rates, commodity rates, and miscellaneous rates.

TECHNOLOGY AND TRENDS IN TRANSPORTATION

As technology has continued to evolve in the trucking sector, it is now essential for companies to remain current with trends. According to a recent report from the American Journal of Transportation, technological trends have disrupted the trucking industry to the extent that early adopters are set to become the most effective and efficient operators.

Everything from driver staffing and recruiting, to driver monitoring and traffic coordination, to safety and communications are now driven exclusively through technology for many companies.

Following are some of the most prominent ways in which companies are now leveraging technologies to improve their operations and logistics:

- **Driver Monitoring**

With the onset of data sharing technology in the trucking sector, companies are able to keep track of driver and vehicle progress. Mileage, distance routes, and all other behaviors can be monitored remotely now, which gives companies the ability to make real-time changes and improvements.

- **Traffic Coordination**

With the ability to communicate and access fleet information remotely, companies and drivers are now able to improve delivery times. This is achieved by coordinating driving patterns, delivering real-time traffic reports, updating information on surrounding areas, and even telling a driver about something in his or her blind spot. Traffic coordination technology has resolved many road transport issues for truckers as a result.

- **Safety Technology**

Safety technology has perhaps been the most significant disrupter in the trucking industry. This facet of the sector is constantly experiencing changes with:

- Stability control
- Antilock braking systems
- Collision avoidance systems
- Lane departure warning
- Interior cameras

- Rearview cameras
- Blind spot warning devices
- Side monitor cameras and sensors

Investments in safety technology not only reduce accidents, injuries, and fatalities, but they have been shown to cut costs as well. For instance, according to research cited by TruckingInfo.com, it costs between \$100,000 and \$200,000 in payouts for property damage, up to \$455,000 for accidents with injuries and close to \$885,000 and \$1.3 million for accidents that end in fatalities. The high costs of accidents have prompted many companies to adapt to new technologies.

The same research showed that just on the adoption of lane departure warning systems alone, there is significant return on investment. The average cost is around \$800, which means it generates an ROI of somewhere between \$1.37 and \$6.55 for each dollar spent (ProDrivers, 2016).

Platooning

Vehicle-to-vehicle communication is tackling two of the trucking industry's largest problems—fuel and safety. By using radar sensors, intelligent braking, video screens, and a wireless link, vehicle-to-vehicle communication makes it possible for two trucks to connect in a “platoon,” or “closer together than would normally be safe.”

The two trucks are able to get as close as 20 feet from each other while platooning in order to take advantage of fuel-saving aerodynamics. The industry reports fuel savings of 10% for the second truck and 4.5% for the lead truck in a platoon. The trucks are able to get this close thanks to an active safety system that wirelessly links the trucks. The wireless link controls the truck's acceleration and braking, while radar detects potential dangers up ahead. The linked trucks react within a “fraction of a second” whereas a truck driver needs up to two seconds to react to changes in conditions. While the wireless link controls acceleration and braking, drivers still have complete control of the truck (Goldwasser, 2015).

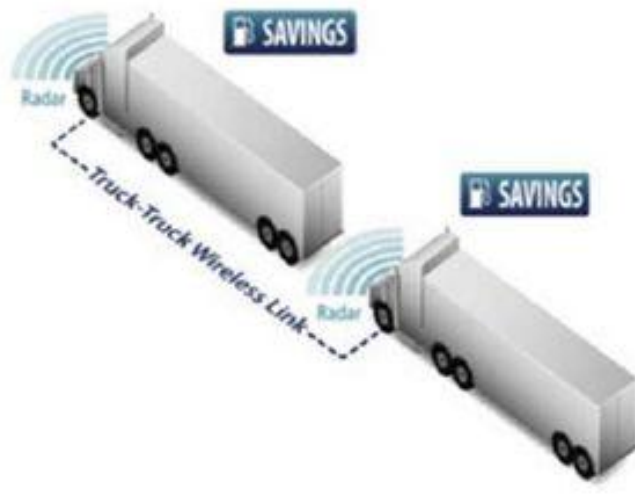


Figure 6.8 - Platooning

Advanced Vehicle Experience—New Concept Trucking

A collaboration between Peterbilt, Capstone Turbine, and Great Dane Trailer has created a new concept truck—the Walmart Advanced Vehicle Experience, or W.A.V.E. W.A.V.E. is a means to shake up the way things are done in the trucking industry as it combines many revolutionary ideas in tractor and trailer design. The advanced concept tractor has a streamlined, aerodynamic body, thanks to the driver's seat placed in the center of the cab. Furthermore, the tractor has a microturbine-powered series hybrid electric drivetrain, programmed to find the most efficient balance between its turbine and electric drivetrains.

The trailer is equally as advanced, made almost entirely of carbon fiber, and weighing 4,000 pounds less than a normal trailer. The sidewalls and roof are single, 53-foot-long pieces, held together with advanced adhesives, eliminating the need for rivets. Finally, the trailer has a convex nose that maintains cargo capacity and improves aerodynamics. While the W.A.V.E. is still a prototype, Walmart is not only attempting to improve its own fleet efficiency, but also advance the future of the entire trucking industry with this application transportation technology (Goldwasser, 2015).



Figure 6.9 - Advanced Vehicle Experience—New Concept Trucking

Vertically Folding Shipping Containers

For decades, empty cargo containers have led to inefficiencies at ports. A new innovation hopes to bring a sustainable alternative to normal, rigid cargo containers through vertically folding, retrofitted containers. The goal is to reduce the number of container ship movements as well as intrastate truck movements at ports related to empty containers.

These foldable containers will reduce the cost and inefficiencies involved in moving empty intermodal containers. The containers are folded vertically by collapsing the doors of the container and pushing the outer walls of the container in toward each other. With this method, five empty, collapsed containers can fit into the same space as one normal, nonfolding container. Retrofitting old containers to be collapsible rather than designing and building completely new containers is another hallmark of this initiative. With an idea as simple as folding containers, you don't have to build intricate software or design new trucks to have a huge impact on the logistics industry (Goldwasser, 2015).



Figure 6.10 - Vertically Folding Shipping Containers

Driverless Trucks

According to the American Trucking Association, there are some 3.5 million truck drivers in the United States alone. That's 3.5 million people who may be impacted once driverless trucks hit the roads in full force. A convoy of these trucks recently drove across Europe and arrived without incident at their destination at the Port of Rotterdam for 75% cheaper than it would have cost had human beings been driving them.

A large part of the economic efficiency boost will include the fact that driverless trucks never get tired and can drive for 24 hours straight, non-stop, whereas humans obviously need to eat, take breaks, and sleep. Drivers are restricted by law from driving more than 11 hours a day and are required to take breaks each day. That means the technology would effectively double the output of the U.S. transportation network at 25% of the cost. In addition, truck drivers drive faster because they are paid by the mile and they're trying to get more done, a situation that throws fuel efficiency out the window in a way that won't happen with robotrucks, which will drive at a steady, set pace the entire trip (Dykes, 2016) [18].

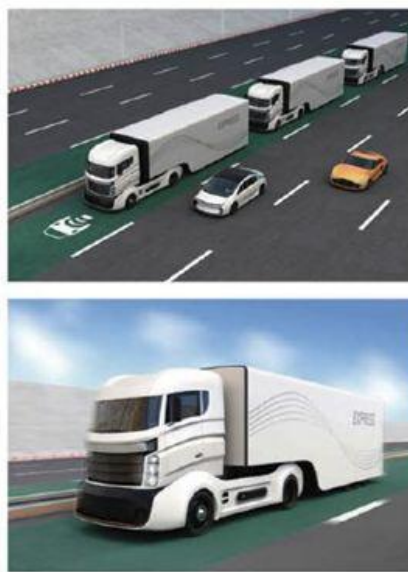


Figure 6.11 - Driverless Trucks

Key Questions for Discussion

1. What role does transportation play at different stages of the supply chain?
2. How does transportation influence inventory, customer service and total logistics cost?
3. Which factors and cost elements determine transportation costs?
4. How do distance, shipment size and freight characteristics affect transportation cost?
5. How do the main transport modes differ in cost, speed, reliability and capacity?
6. When can intermodal transportation offer advantages over a single transport mode?
7. How do consolidation, break bulk and cross-docking operations differ?
8. How can warehouse and transportation decisions be coordinated to improve material flow?
9. How do real-time tracking and automation support transport process management?
10. Which operational, economic and environmental criteria should be used to assess a new transportation technology?

7 Monitoring the Economic Efficiency of Supply Chain Management

Agenda

- 7.1. Methods of Monitoring and Performance Analysis
- 7.2. The Value Chain as a Competitive Advantage
- 7.3. Supply Chain Performance Indicators

7.1. Methods of Monitoring and Performance Analysis

Metrics and Measures

The saying “If you don’t measure it, you can’t manage it” holds especially true in supply chain and logistics. Effective performance measurement aligns with a company’s strategy, influences behavior, and helps balance key trade-offs like cost vs. service [7, 9].

Measuring supply chain performance supports:

- Meeting customer expectations
- Enhancing capability and asset use
- Motivating employees
- Delivering returns to stakeholders

With today’s vast data availability, it’s crucial to focus on the right metrics to avoid "paralysis by analysis" and use results meaningfully.

Data Analytics

Data analytics involves examining raw data to gain insights and support decision-making. In supply chains, it's known as supply chain analytics and helps improve efficiency, predict trends, and solve problems.

Types of Analytics:

- Descriptive: Analyzes past data to understand demand patterns, product flow, and delays (also called Business Intelligence).
- Diagnostic: Identifies causes of problems (e.g., missing parts, late shipments).
- Predictive: Forecasts future trends like demand or pricing using statistical methods.
- Prescriptive: Recommends optimal decisions (e.g., inventory levels, facility locations, production schedules).

Measurement and Control Methods

To manage performance, companies must define clear metrics. These serve as benchmarks and guide behavior. Poorly chosen metrics can drive the wrong actions. Supply chain cost metrics should reflect the entire network, not just isolated functions.

The Evolution of Metrics

- Pre-1970s: Focused mainly on manufacturing costs
- 1970s: Expanded to include transportation
- 1980s–90s: Broadened to logistics and customer service indicators (e.g., delivery rate, order fulfillment)
- 2000s–Present: Globalization, ERP systems, and analytics have enabled broader, real-time measurement

Modern challenges like rising costs, global disruptions, and higher customer demands require advanced analytics to eliminate waste and improve supply chain responsiveness.

Measurement Methods

Several modern methods help measure supply chain performance effectively:

- **Balanced Scorecard:** Aligns activities with strategy, combining financial and non-financial metrics for a complete performance view.
- **SCOR Model:** Provides standardized metrics for evaluating and prioritizing supply chain performance.
- **Activity-Based Costing (ABC):** Assigns costs to products/services based on actual resource usage.
- **Economic Value Analysis (EVA):** Measures value created beyond capital costs—useful for overall enterprise value, less so for supply chain detail.

Regardless of the method, metrics should:

- Align with strategy and customer needs
- Be process-focused (not function-focused)
- Be consistent and transparent across the supply chain
- Use accurate cost data to track improvements

Technology can support detailed and aggregated measurement for better decision-making.

Measurement Categories

Key supply chain metrics should cover time, quality, and cost:

- **Time:** On-time delivery, order cycle time, response time, and variability.
- **Quality:** Customer satisfaction, order accuracy, damage-free delivery, invoicing, forecasting, and scheduling precision.
- **Cost:** Inventory turns, order-to-cash cycle, and total delivered cost (including transportation, handling, and carrying costs).

Metrics can also be grouped by organizational level:

- **Strategic:** Lead times vs. industry norms, cost-saving efforts, supplier pricing.
- **Tactical:** PO cycle efficiency, cash flow, quality methods, capacity flexibility.
- **Operational:** Schedule adherence, complaint avoidance, defect-free delivery.

Balanced Scorecard Approach

The balanced scorecard evaluates supply chain performance from four key perspectives:

- **Customer:** How do customers perceive us?
- **Internal Processes:** What must we do well?
- **Financial:** How do we appear to shareholders?
- **Innovation & Learning:** Can we keep improving and adding value?

These perspectives should align with organizational goals and link to supply chain metrics in customer service, operations, and finance.

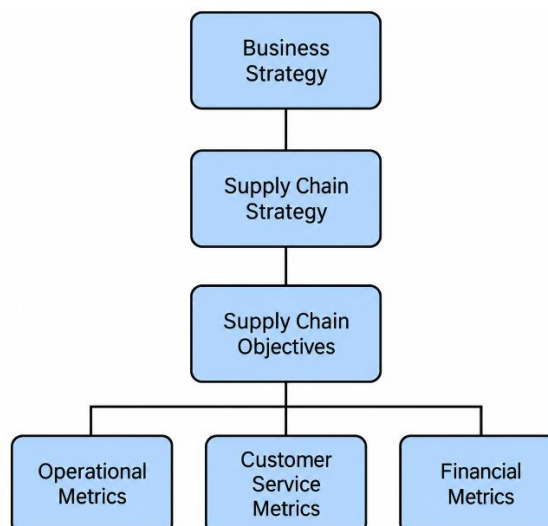


Figure 7.1 - Supply chain metrics framework

Customer Service Metrics

Customer service metrics indicate a company's ability to satisfy the needs of customers by meeting customer's needs on a timely basis and creating exceptional values to the customers (see Table 1).

Table 7.1 - Customer Service Supply Chain Metrics

Goals	Measures
Flexible response	Number of choices and average response time
Product/service innovation	Customer contact points and product finalization points
Customer satisfaction	Order-fulfillment rate
Customer value	Customer profitability
Delivery performance	Delivery speed and reliability

Operational Metrics

Operational metrics come from internal processes, decisions, and actions needed to meet or exceed customer expectations. They are drivers of future financial performance (see Table 2).

Table 7.2 - Operational Supply Chain Metrics

Goals	Measures
Waste reduction	Supply chain cost of ownership
Time compression	Supply chain cycle efficiency
Unit cost reduction	Percentage of supply chain target cost achieved
Product/process innovation	Product finalization point
Inventory management	Inventory turns and days of inventory
Supplier performance	Supplier evaluations

Financial Metrics

Financial metrics indicate whether the company's strategy, implementation, and execution create value for the shareholders by contributing to improvements in profitability (see Table 3).

Table 7.3 - Financial Supply Chain Metrics

Goals	Measures
Profit margins	Profit margin by supply chain partners
Cash flows	Cash-to-cash cycle on receivables and payables
Revenue growth	Customer growth and profitability
Return on assets	Return on supply chain asset
Return on equity	Return on supply chain equity

SCOR Model

Another, relatively newer approach to measuring the supply chain is the SCOR model that was discussed in Chapter 1. To recap, the SCOR model was designed to help companies to communicate, compare, and learn from competitors and companies both within and outside of their industry. It measures an organization's supply chain performance and the effectiveness of and supply chain improvements and can also help to test and plan future process improvements.

The SCOR model contains over 200 process elements, 550 metrics, and 500 best practices, including risk and environmental management, and is organized around the 5 primary management processes of plan, source, make, deliver, and return (see Figure 2).

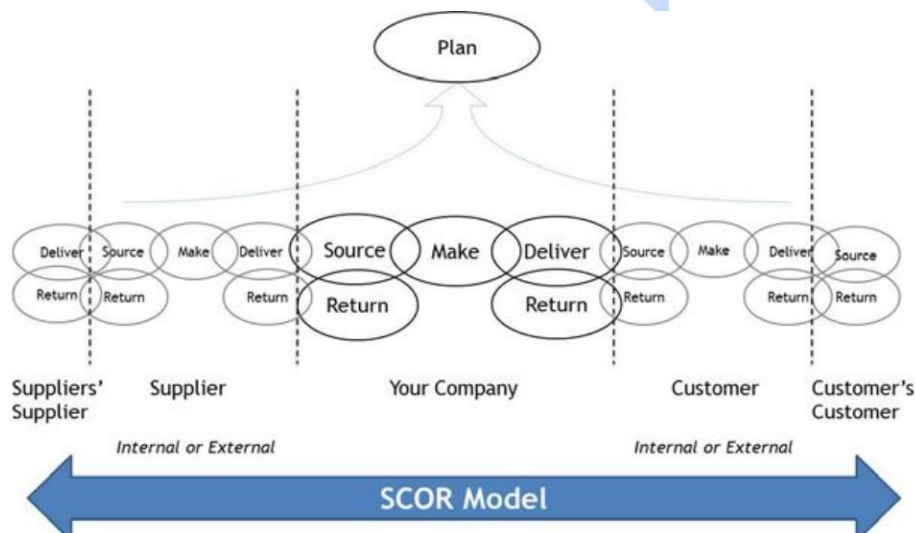


Figure 7.2 - The SCOR Model

The model is based on three major pillars:

- **Process modeling:**

To describe supply chains that are very simple or very complex using a common set of definitions, SCOR provides three levels of process detail.

- Level 1: Scope
- Level 2: Configuration or type of supply chain
- Level 3: Process element details (e.g., performance attributes)

Below level 3, companies decompose process elements and start implementing specific supply chain management practices. At this stage, practices are defined to achieve competitive advantage and adapt to changing conditions.

- **Performance measurements:**

SCOR metrics are organized in a hierarchical structure:

- Level 1 metrics: Most aggregated, used by top decision makers to assess overall supply chain performance
- Level 2 metrics: are primary, high-level measures that may cross multiple SCOR processes.

Best practices:

Once the performance of the supply chain operations has been measured and performance gaps identified, it becomes important to identify what activities should be performed to close those gaps. More than 430 executable practices derived from the experience of Supply Chain Council (SCC) members are available.

SCOR Levels :

- Level 1. Scope: Defines business lines, business strategy, and complete supply chains
- Level 2. Configuration: Defines specific planning models such as make to order (MTO) or make to stock (MTS), which are process strategies
- Level 3. Activity: Specifies tasks within the supply chain, describing what people actually do
- Level 4. Workflow: Includes best practices, job details, or workflow of an activity
- Level 5. Transaction: Specific detail transactions to perform a job step

SCOR: Five Key Strategic Performance Attributes

All SCOR metrics have five key strategic performance attributes. These attributes are not measurable themselves but are used to express and set strategic direction:

- **Reliability:** Ability to deliver on-time, complete, in the right condition and packaging, with correct documentation to the right customer

- Responsiveness: Speed at which products and services are provided
- Agility: Ability to change the supply chain to support changing (market) conditions
- Cost: Cost associated with operating the supply chain
- Assets: The effectiveness in managing assets in support of demand satisfaction

Table 7.4 - SCOR Model Strategic Metrics

Performance Attribute	Sample Metric	Calculation
Supply chain reliability	Perfect order fulfillment	Total perfect orders / Total number of orders
Supply chain responsiveness	Average order-fulfillment cycle time	Sum of actual cycle times for all orders delivered / Total number of orders delivered
Supply chain agility	Upside supply chain flexibility	Time required to achieve an unplanned X% increase in delivered quantities
Supply chain costs	Supply chain management costs	Cost to plan + Cost to source + Cost to deliver + Cost to return
Supply chain asset management	Cash-to-cash cycle time	Inventory days of supply + Days of receivables outstanding – Days of payables outstanding

Supply Chain Dashboard and KPIs

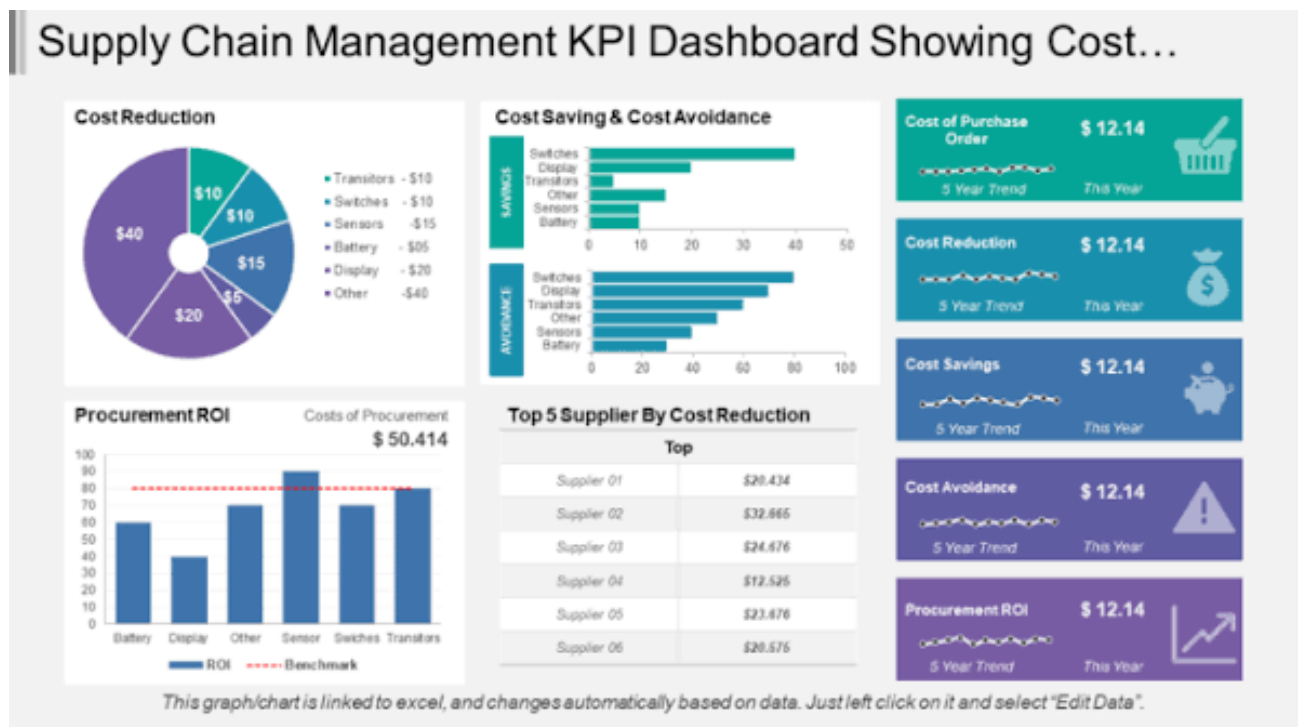


Figure 7.3 - Supply Chain Dashboard and KPIs [25]

Indicators

Metrics used in performance dashboards are typically called key performance indicators (KPIs). Having a standardized set of KPIs allows you to review supply chain operations efficiently across regions, business units, and plants (and even brands and channels).

KPIs usually fall into one of three categories:

- Leading indicators: Have a significant impact on future performance by measuring either current state activities (for example, the number of items produced today) or future activities (for example, the number of items scheduled for production this week).
- Lagging indicators: Measures of past performance, such as various financial measurements, or in the case of the supply chain, measurements in areas such as cost, quality, and delivery.
- Diagnostic: Areas that may not fit under lead or lagging indicators but indicate the general health of an organization (Myerson, 2012).

Benchmarking

After you have established what KPIs to measure, you need to determine how to gauge yourself against them. This is known as benchmarking, which is the process of comparing one's business processes and performance metrics to industry bests or best practices from other companies. The dimensions that are typically measured are quality, time, and cost. There is both internal and external benchmarking.

Internal benchmarking can be used when the organization is large enough and data is fairly accessible. For example, a company like General Electric with over 100 business units can compare some KPIs across businesses.

External benchmarking is a process where management identifies the best firms in their industry, or in another industry where similar processes exist, comparing the results and processes of those target companies to their own results and processes. This allows them to learn how well the targets perform and, more importantly, the best practice business processes that help to explain why these firms are successful.

The process of selecting best practices to use as a standard for performance involves the following general steps:

1. Determine what to benchmark. What processes are most important to measuring the success of your supply chain? Can be based on your company's overall and supply chain strategies, goals, and objectives. In some cases, you may want to be best in class, and in others, being average may be just fine.
2. Form a benchmark team. Select those with some skin in the game.
3. Identify benchmarking partners. Should be a combination of those involved in the day-to-day processes as well as those affected and management (can also include customers and suppliers).
4. Collect and analyze benchmarking information. There are many sources of best practice metrics. In many cases, companies can pay for this information from consultants or through associations that they belong to.
5. Take action to match or exceed the benchmark. This involves process improvement, the topic of the next chapter.

7.2. The Value Chain as a Competitive Advantage

Of the many changes that have taken place in management thinking over the last 30 years or so perhaps the most significant has been the emphasis placed upon the search for strategies that will provide superior value in the eyes of the customer. To a large extent the credit for this must go to Michael Porter, the Harvard Business School professor, who through his research and writing has alerted managers and strategists to the central importance of competitive relativities in achieving success in the marketplace.

One concept in particular that Michael Porter has brought to a wider audience is the 'value chain': competitive advantage cannot be understood by looking at a firm as a whole. It stems from the many discrete activities a firm performs in designing, producing, marketing, delivering, and supporting its product. Each of these activities can contribute to a firm's relative cost position and

create a basis for differentiation ... The value chain disaggregates a firm into its strategically relevant activities in order to understand the behaviour of costs and the existing and potential sources of differentiation. A firm gains competitive advantage by performing these strategically important activities more cheaply or better than its competitors.

Value chain activities (shown in Figure 4) can be categorised into two types – primary activities (inbound logistics, operations, outbound logistics, marketing and sales, and service) and support activities (infrastructure, human resource management, technology development and procurement). These activities are integrating functions that cut across the traditional functions of the firm.

Competitive advantage is derived from the way in which firms organise and perform these activities within the value chain. To gain competitive advantage over its rivals, a firm must deliver value to its customers by performing these activities more efficiently than its competitors or by performing the activities in a unique way that creates greater differentiation.

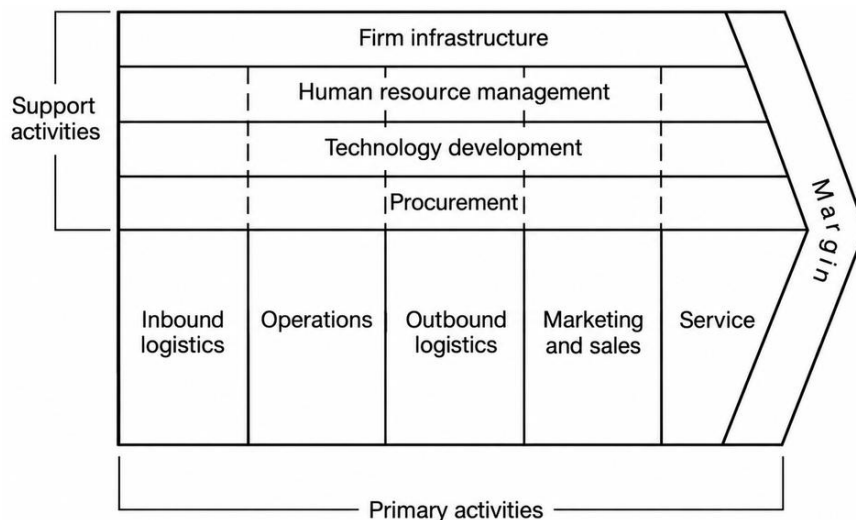


Figure 7.4 - The Value Chain

Michael Porter's thesis suggests that companies should evaluate each value chain activity and outsource those where they lack competitive advantage. This widely accepted idea has fueled the rise of outsourcing across industries.

While outsourcing can offer cost or value benefits, it increases supply chain complexity due to added interfaces. This requires stronger relationship management, as the value chain now extends beyond the company [8, 27].

In this "extended enterprise," value and cost are co-created by all partners in the network—making the supply chain itself a key source of competitive advantage or risk.

7.3. Supply Chain Performance Indicators

Evaluation of Supply Chain Quality

Evaluating the quality of a supply chain involves identifying and assessing the characteristics that determine how well, fast, and cost-effectively the supply chain can meet customer needs. A performance measurement system for supply chain management is typically structured into two main groups of indicators.

The first group includes target performance indicators of the supply chain. These indicators describe the intended purpose of the supply chain. At the core of these target performance indicators lie the metrics introduced by Eliyahu Goldratt's Theory of Constraints (TOC). The target indicators and their calculation methods are shown in Table 5.

Revenue generated is defined as the income the organization receives (usually through selling goods or services). This indicator represents the amount of new money that enters and remains in the supply chain — that is, the added value generated as a result of the supply chain's functioning.

Investments are defined as the money the organization spends on items it intends to sell later. These are typically tied-up resources of the system — they cannot easily be converted to cash and are used to generate income.

These investment indicators are divided into two groups:

1. Investments in inventories of materials, components, and products within the supply chain.
2. Investments in fixed assets required for the supply chain to operate.

Table 7.5 - Target Supply Chain Performance Indicators

№	Indicator Name	Calculation Method
1	Revenue generated in the supply chain, UAH	$T = \text{Sales Profit} - \text{Variable Costs}$
2	Capital investment needed for operation	$I = \text{Fixed Assets} + \text{Working Capital}$
3	Operating expenses, incl. inventory maintenance	$OE = \text{Inventory holding costs} = \text{Operating Expenses}$
4	Inventory turnover period in the supply chain, days	$D^0 = K^0 / I^d$ Where D^0 = number of days needed for full inventory turnover K^0 = average inventory I^d = average daily cost of inventory used in the chain

OE is often defined as the cost of resources that leave the system. This includes large fixed (overhead) expenses. The inventory turnover period reflects the speed of the supply chain and affects its efficiency — the shorter it is, the more flexible and effective the supply chain becomes.

Timeliness is extremely important for business. It can take different forms, but generally, the trend is toward constant or significantly reduced timing.

Four of the indicators are internally focused for evaluating supply chain performance, as they are resource-related and allow linking local operational decisions with the financial well-being of the company. They also reflect how the supply chain performs at a given point in time — better, faster, and cheaper.

The second group consists of key operational indicators (see Table 6) — a group of metrics that describe not the quantitative, but the qualitative achievement of supply chain goals at the operational level.

Main supply chain performance criteria:

1. Total number of days inventory stays in the average supply chain, days
2. Level of material stock delivered, %
3. Order cycle time, days
4. Inventory turnover at a supply chain participant's warehouse
5. Utilization of capacity (workload), %
6. Percentage of orders fulfilled "on time and in full," %
7. Share of transportation costs in sales, %
8. Percentage of cargo losses or damages, %

9. Supply chain revenue, UAH
10. Supply chain profit, UAH
11. Product cost consistency within the supply chain, UAH/unit

Thus, supply chain quality assessment is performed using an evaluation system based on key performance indicators, which represent a breakdown of metrics from top-level goal-based indicators to key operational indicators and individual employee performance criteria.

Moreover, the presented system is not overloaded with too many parameters, which is achieved by focusing only on those metrics that can actually influence and truly reflect the efficiency of supply chain performance.

The third financial dimension to decision making is resource utilisation and specifically the use of fixed and working capital. The pressure in most organisations is to improve the productivity of capital – ‘to make the assets sweat’. In this regard it is usual to utilise the concept of return on investment (ROI). Return on investment is the ratio between the net profit and the capital that was employed to produce that profit, thus:

$$\text{ROI} = \text{Profit} / \text{Capital employed}$$

This ratio can be further expanded:

$$\text{ROI} = \text{Profit} / \text{Sales} \times \text{Sales} / \text{Capital employed}$$

It will be seen that ROI is the product of two ratios: the first, profit/sales, being commonly referred to as the margin and the second, sales/capital employed, termed capital turnover or asset turn. Thus to gain improvement on ROI one or both of these ratios must increase. Typically many companies will focus their main attention on the margin in their attempt to drive up ROI, yet it can often be more effective to use the leverage of improved capital turnover to boost ROI.

For example, many successful retailers have long since recognised that very small net margins can lead to excellent ROI if the productivity of capital is high, e.g. limited inventory, high sales per square foot, premises that are leased rather than owned and so on [8].

Figure 5 illustrates the opportunities that exist for boosting ROI through either achieving better margins or higher assets turns or both. Each ‘iso-curve’ reflects the different ways the same ROI can be achieved through specific margin/asset turn combination. The challenge to logistics management is to find ways of moving the iso-curve to the right.

The ways in which logistics management can impact on ROI are many and varied. Figure 6 highlights the major elements determining ROI and the potential for improvement through more effective logistics management.

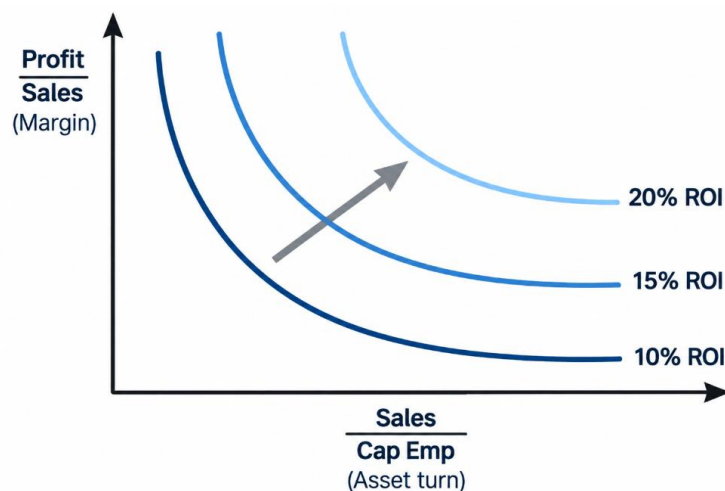


Figure 7.5 - The impact of margin and asset turn on ROI

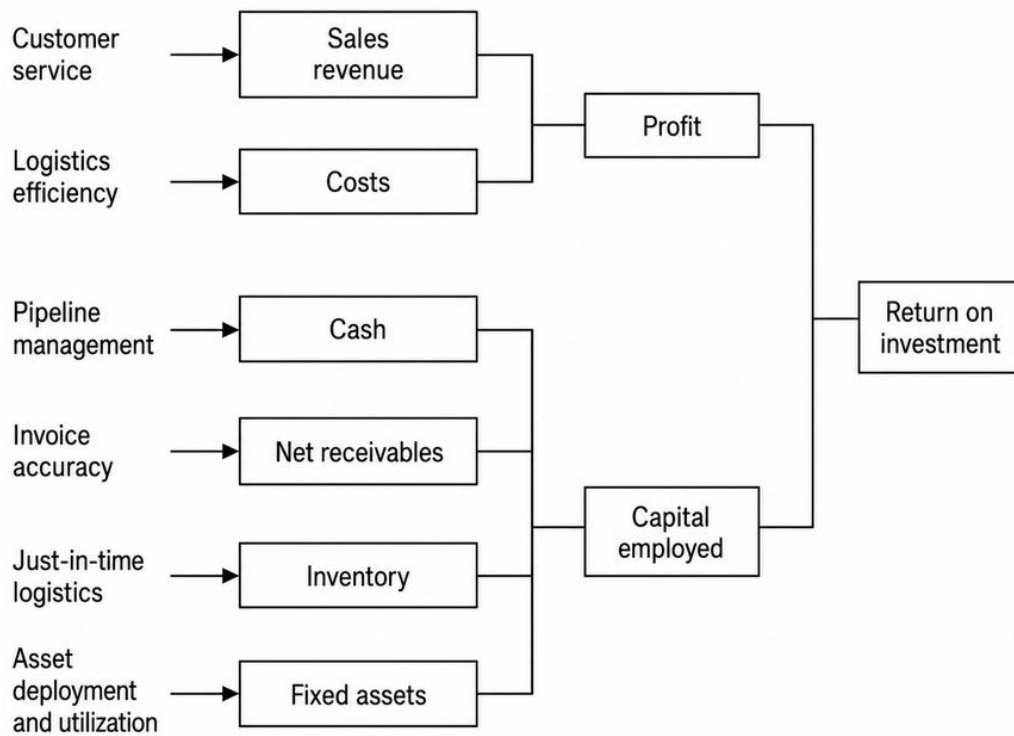


Figure 7.6 - Logistics impact of ROI

Direct product profitability

An application of logistics cost analysis that has gained widespread acceptance, particularly in the retail industry, is a technique known as direct product profitability – or more simply ‘DPP’. In essence it is somewhat analogous to customer profitability analysis in that it attempts to identify all the costs that attach to a product or an order as it moves through the distribution channel.

The idea behind DPP is that in many transactions the customer will incur costs other than the immediate purchase price of the product. Often this is termed the total cost of ownership. Sometimes these costs will be hidden and often they can be substantial – certainly big enough to reduce or even eliminate net profit on a particular item. To be a low-cost supplier is clearly influenced by the costs that are incurred as that product moves through their logistics system. Similarly, as distributors and retailers are now very much more conscious of an item’s DPP, it is to the advantage of the supplier equally to understand the cost drivers that impact upon DPP so as to seek to influence it favourably.

Direct product profit (DPP)

The net profit contribution from the sales of a product after allowances are added and all costs that can be rationally allocated or assigned to an individual product are subtracted = direct product profit

Sales – Cost of goods sold = Gross margin

- Allowances and discounts = Adjusted gross margin – Warehouse costs
- Labour (labour model – case, cube, weight)
- Occupancy (space and cube)
- Inventory (average inventory) – Transportation costs (cube) – Retail costs
- Stocking labour
- Front end labour
- Occupancy
- Inventory = Direct product profit

The importance to the supplier of DPP is based on the proposition that a key objective of customer service strategy is ‘to reduce the customer’s costs of ownership’. In other words the

supplier should be looking at his products and asking the question: ‘How can I favourably influence the DPP of my customers by changing either the characteristics of the products I sell, or the way I distribute them?’ From pack design onwards there are a number of elements that the manufacturer or supplier may be able to vary in order to influence DPP/square metre in a positive way, for example, changing the case size, increasing the delivery frequency, direct store deliveries, etc [8].

Extra Materials [Video](#)

1. What are the main components of the SCOR model in supply chain management?
2. How does the SCOR model help organizations improve their supply chain performance?
3. What are the five key processes defined in the SCOR framework?
4. How can companies use the SCOR model to identify inefficiencies in their supply chain?
5. What is the relationship between metrics and processes in the SCOR model?

Key Questions

1. Why should supply chain performance measures be linked to a company's strategy?
2. How do customer service, operational and financial performance indicators differ?
3. How can managers use benchmarking and dashboards to identify performance gaps?
4. How does a value chain differ from a supply chain?
5. How do primary and support activities contribute to value creation?
6. How can coordination of value chain activities create a competitive advantage?
7. Which indicators reveal trade-offs between cost, service, responsiveness and asset utilisation?
8. How do profit margin and asset turnover affect return on investment (ROI)?
9. How can logistics decisions influence working capital and the cash-to-cash cycle?
10. What is direct product profitability (DPP), and how can it support product and distribution decisions?

8 Information Technologies in Supply Chain Management

- 8.1. Supply Chain Information Technology
- 8.2. Supply Chain Software Market and Its Functions
- 8.3. Short-Term Supply Chain Technology Trends

8.1. Supply Chain Information Technology

There really isn't any aspect of supply chain and logistics that isn't touched by technology in today's world. Thanks to both advances in software and hardware technologies and the Internet, companies of all sizes can automate and integrate internal processes and connect with customers and suppliers with ease [17].

Up to this point, we have briefly discussed technology applications in various aspects of supply chain and logistics management, including forecasting, inventory planning, production scheduling, and beyond. In this chapter, we go into a bit more depth in terms of understanding both the information flows and the systems used to make decisions at all levels of an organization, from longer-term decisions such as where to locate plants and warehouses, down to short-term decisions such as how many cases of product to ship to an individual warehouse on a given day.

Supply Chain Information

First, it should be made clear that there are subtle differences between data and information. Data are the facts from which information is derived to make decisions. Pieces of data are rarely useful alone; for data to become information, it needs to be put into context. That is the purpose of information systems.

According to Simatupang and Sridharan (2001): An interactive view of information enables people to define the level of information they need to solve problems or make decisions. Depending on the decisions, some people can use data to answer the questions, but others need to extract information from the same data to solve their problems. This interactive view also enables people to trace the source of knowledge from the available data, or to specify the required data based on their explicit knowledge (see Figure 1).

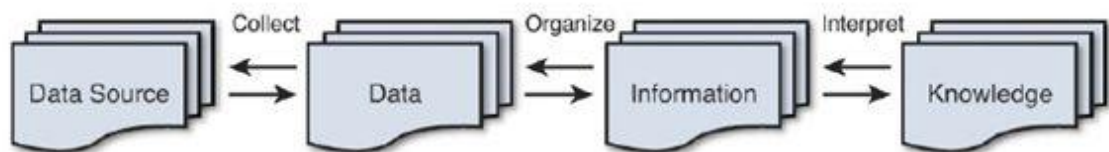


Figure 8.1 - Interactive view of information

An information system is used to collect, process, and disseminate information to make it available for decision makers at the right time. Traditionally, an information system deals with transferable data through plain media of communication such as EDI and the Internet. The recent advance of information technology offers a rich variety of media such as video conferencing and online decision support systems that enable decision-makers to convert tacit knowledge into explicit knowledge and to share explicit knowledge.

An organization's information requirements in general are that it needs to be easy to access, relevant to them, accurate, and timely. Thus, the information technology used will have a direct impact on a company's performance, both internal and external through integration, which will enable collaboration (see Figure 2).

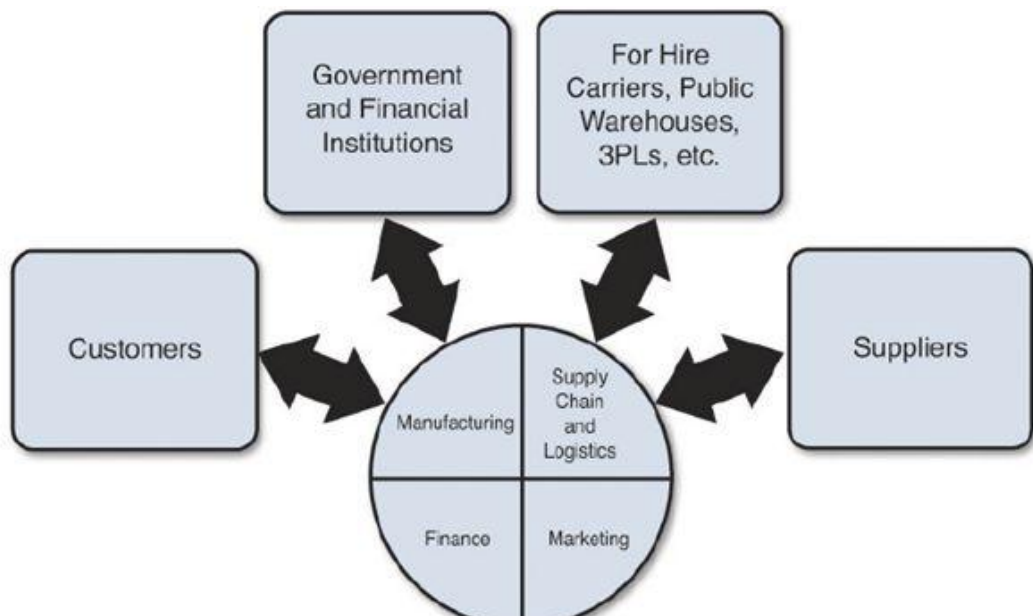


Figure 8.2 - Internal and external supply chain information flows

The bullwhip effect often results from poor supply chain information management, leading to excess inventory. Improved demand visibility can help reduce inventory levels by substituting information for stock through information systems.

McDonnell, Sweeney, and Kenny (2004) outlined four IT solution categories:

- Point solutions (e.g., WMS) support a single part of the chain.
- Best of breed solutions integrate multiple standalone systems using middleware.
- Enterprise solutions (e.g., ERP) unify functions across the company into one system.
- Extended enterprise solutions (XES) enable partners to share information and processes through ERP-based platforms.

Since the 1990s, there has been a shift toward integrated enterprise solutions, supported by technologies like EDI and the Internet, which help reduce the bullwhip effect by enabling decisions based on real demand.

Supply Chain Information Needs

SCM information systems use technology to more effectively manage supply chains. Because there are so many applications in today's global supply chain, it is best to look at the technology from strategic, tactical, and execution viewpoints, as suggested by Bozarth and Handfield (2008). The viewpoints are as follows:

Strategic: Develop long-term decisions that help to meet the organization's mission and focus on strategic plans for meeting such as new products or markets as well as facility capacity decisions.

Tactical: Develop plans that coordinate the actions of key supply chain areas customers and suppliers across the tactical time horizon. They focus on tactical decisions, such as inventory or workforce levels. They plan, but don't carry out, the actual physical flows.

Routine: Support rules-based decision making. Usually in short time frames, where accuracy and timeliness are important to the user.

Execution: Typically, more transactional oriented, where they record and retrieve transaction processing data and execute control physical and financial information flow. These systems usually have very short time frames, are highly automated, and use standardized business practices.

All these types of supply chain systems may also link both downstream with customers and upstream with suppliers [7].

8.2. Supply Chain Software Market and Its Functions

Most companies today use some form of supply chain system, such as warehouse management or forecasting. The greatest benefits come from integrated, extended supply chain approaches.

SCM software is increasingly supported by:

- SRM (Supplier Relationship Management): Streamlines procurement and payment processes.
- CRM (Customer Relationship Management): Originally for sales and service, now often integrated with ERP.
- PLM (Product Lifecycle Management): Manages the product lifecycle from design to disposal, incorporating tools like CAD, CAM, CAE, and PDM.

In 2012, the SCM software market reached \$8.3 billion (Gartner), driven by global competition, regulations, and risk reduction. The market is fragmented, with SAP and Oracle holding 38% of the share.

SCM software includes:

- SCP (Supply Chain Planning): Uses algorithms to forecast and balance supply and demand.
- SCE (Supply Chain Execution): Tracks goods movement, material flow, and related financial data [7].

8.2.1 Supply Chain Planning

SCP software vendors address short- to long-term planning and focus on demand, supply, and the balance of demand and supply together usually in the form of a sales & operational planning (S&OP) process described in more detail later:

Demand management: There are three main functions of demand management software, which are 1) predicting demand, 2) using “what-if” analysis to create sales plans, and 3) using what-if analysis to shape demand. Forecasts are typically a rolling 24–36 months. Modern supply chain systems have moved toward a demand “pull”-driven model, so demand management has moved from a purely forecasting tool to one that optimizes and shapes demand to some extent.

Supply management: This area helps meet demand with minimal resources at the lowest cost. Software functionality typically found in this area includes supply network planning or optimization (SNP), production scheduling (sometimes referred to as advanced planning systems or APS), distribution requirements planning (DRP), replenishment, and procurement.

Sales & operational planning: S&OP, as mentioned earlier in this book, facilitates monthly executive planning meetings to tie together sales, operation, and financial plans, along with the related tasks. Input is collected from demand, capacity, and financial plans, culminating in a consolidated sales and operational plan [7].

8.2.2 Supply Chain Execution (SCE)

Supply Chain Execution (SCE) systems support real-time operations in supply chains, focusing on planning, scheduling, optimization, tracking, and performance monitoring. The main components are:

- **Warehouse Management Systems (WMS):**

WMS controls the movement and storage of goods in a warehouse. It handles inbound/outbound shipments, interfaces with material handling equipment, and supports functions like EDI transactions, resource management, and performance tracking.

- **Transportation Management Systems (TMS):**

TMS manages global transportation across all modes (air, sea, ground), covering planning, scheduling, and shipment optimization. It also tracks vehicles, manages exceptions and constraints, collaborates with partners, and includes features like cost allocation, freight auditing, and payment processing.

- **Enterprise Resource Planning Systems (ERP):**

Though broader in scope, ERPs include extensive supply chain and logistics functionality. Evolving from MRP systems, ERP integrates internal processes (finance, HR, inventory, production, sales) with supplier and customer operations. ERPs enable automation, real-time data sharing, and coordination from supplier evaluation to customer invoicing.

E-businesses often enhance ERP systems with web access to track inventory, part costs, and delivery timelines.

While ERPs offer improved efficiency, accuracy, and reduced transaction costs, they can be expensive and complex to implement [7].

8.2.3. Other Supply Chain Technologies

Other categories of software are also often used in the supply chain, including the following:

Supply chain event management: These are software applications that enable companies to track orders across the supply chain in real time between trading partners, providing managers with a clear picture of how their supply chain is performing. The information provided by these systems allows a company to sense and respond to unanticipated changes to planned supply chain operations. This breed of systems conveys information regarding supply chain processes at a specific event level, such as a handoff from one supply chain entity to another, the commitment of a

product to an order, the movement of a shipment between two logistics network nodes, or the placement of a product into storage.

Business intelligence (BI): This category is made up of applications, infrastructure, tools, and best practices, providing analysis of information to improve and optimize decisions and performance. BI tools help to sort through the vast amount of data that has become available through the continuing adoption of SCM technologies. In addition, there are related tools for supply chain collaboration, data synchronization, and spreadsheets and database software. In fact, many smaller companies today still operate their primary planning functions using spreadsheets and run their day-to-day operations with accounting systems such as Quick-Books and Peachtree rather than spend the resources on a full-blown ERP system [7].

8.2.4 SCM System Costs and Options

The total cost of supply chain management (SCM) software is often 3 to 5 times the software license price due to planning, implementation, training, customization, hardware, and ongoing support. Vendors typically charge an annual maintenance fee of 15–20%.

An alternative is cloud-based SCM software (SaaS), which offers subscription pricing and eliminates large upfront costs, installation, and maintenance. While security is a concern for some, SaaS is the fastest-growing segment in enterprise software. Gartner (2013) reported 13% growth in SaaS SCM vs. 3.5% for traditional licenses.

Best-in-Class vs. Integrated Solutions

- Best-in-class software (e.g., forecasting, optimization) offers deep functionality but may require more complex integration and higher implementation costs.
- Integrated solutions (offered by vendors like SAP and Oracle) provide a unified system with a single interface, contact point, and architecture.
- Enterprise Application Integration (EAI) tools can help reduce integration costs when using multiple vendors.

Types of Consultants in SCM Projects

1. SCM or management consultants – Focus on planning and supply chain modeling
2. Vendor consultants – Experts in the specific software product
3. IT consultants – Support infrastructure, customization, and interfaces

The mix and number of consultants vary by project size and scope.

Current and Emerging Trends

As technology rapidly evolves, SCM software continues to adapt. It's crucial to stay informed about short-term and emerging trends in supply chain systems to maintain competitive advantage [7, 14].

8.3. Short-Term Supply Chain Technology Trends

Gartner Supply Chain Study Insights

A 2010 Gartner study (updated in 2013) explored the adoption of supply chain applications. Excluding ERP, the most fully implemented systems were:

- Warehouse Management Systems (WMS) – 39%
- Supply Chain Planning (SCP) – 32%
- Sales & Operations Planning (S&OP) – 29%
- Transportation Management Systems (TMS) – 28%

Top obstacles to achieving supply chain goals:

- Demand variability/forecast inaccuracy (59%)
- Network complexity (42%)

- Lack of cross-functional collaboration and visibility (39%)

Investment priorities:

- Improving planning processes (20%)
- Aligning supply chain and corporate strategy (11%)
- Enhancing visibility (11%)

By 2013, driving business growth through the supply chain became the top focus, with customer service a close second, though obstacles remained largely unchanged.

Emerging Trends

While the types of supply chain software may remain consistent, data collection, application usage, and sharing methods are rapidly evolving with advancing technology.

Major areas of innovation most recently include the following:

- Cloud computing: As mentioned previously, this method, also referred to as software-as-a-service or SaaS, delivers a single application through the browser to thousands of customers “on demand,” thus avoiding costly licensing, implementation, and maintenance costs. It allows companies to focus on their core competencies while allowing a third party to manage technical elements. Salesforce.com is probably the best-known example among enterprise applications, but it is also common for HR and ERP applications as well as some “desktop” applications such as Google Apps.
- Mobile computing: Supply chain execution and event management is becoming more mobile with basic visibility and traceability available on smartphones and other mobile devices.

Third-party logistics providers (3PLs) providing technology: Cost is a big driver of this because 3PLs can offer economies of scale, especially for small and mid-size companies.

Radio frequency identification (RFID): An automatic identification method using electronic tags with an embedded microchip and antenna. RFIDs can be utilized in a variety of forms within the supply chain (for example, they can be embedded in between the cardboard layers in a carton or product packaging).

To become more widespread (the 2010 Gartner study showed 51% of the companies surveyed not doing anything with RFID), RFID costs will need to continue to decline to make it more economically feasible. There are also equipment issues that will need to improve, such as reader range, sensitivity, and durability.

An example of the use of RFIDs is with Intel (Harrington, 2007), the global semiconductor manufacturer that needs to know where its product is at all times. They are embarking on a joint effort with DHL, utilizing sensors to monitor the condition of containers as they move around the world. Intel has another project, in Costa Rica, using RFID technology to minimize handheld scanning of inbound and outbound shipments. They have achieved labor savings of 18+% as a result of faster processing and have also eliminated steps in these processes (Harrington, 2007).

Extra materials:

Automatic Cluster Detection

While searching for records with similar data, cluster detection is most appropriate. This technique enables to discover clusters of records that contain similar information. Sometimes data records contain so much information that it's difficult to discern any pattern. Clustering allows to group similar records and makes it easier to search the groups of records for patterns.

Clustering is an unsupervised operation. It is used to find groupings of similar records in the data without any preconditions as to what that similarity may involve. Clustering is used to identify interesting groups in a customer base that may not have been recognised before. For example, it can be used to identify similarities in customers' telephone usage, in order to devise and market new call services. Clustering is often undertaken as an exploratory exercise before doing further data

mining using a classification technique. For this reason, good visualisation support is a helpful adjunct to clustering: it enables to ‘play’ with the clusters in order to see if the clusters identified make sense and are useful in a business context.

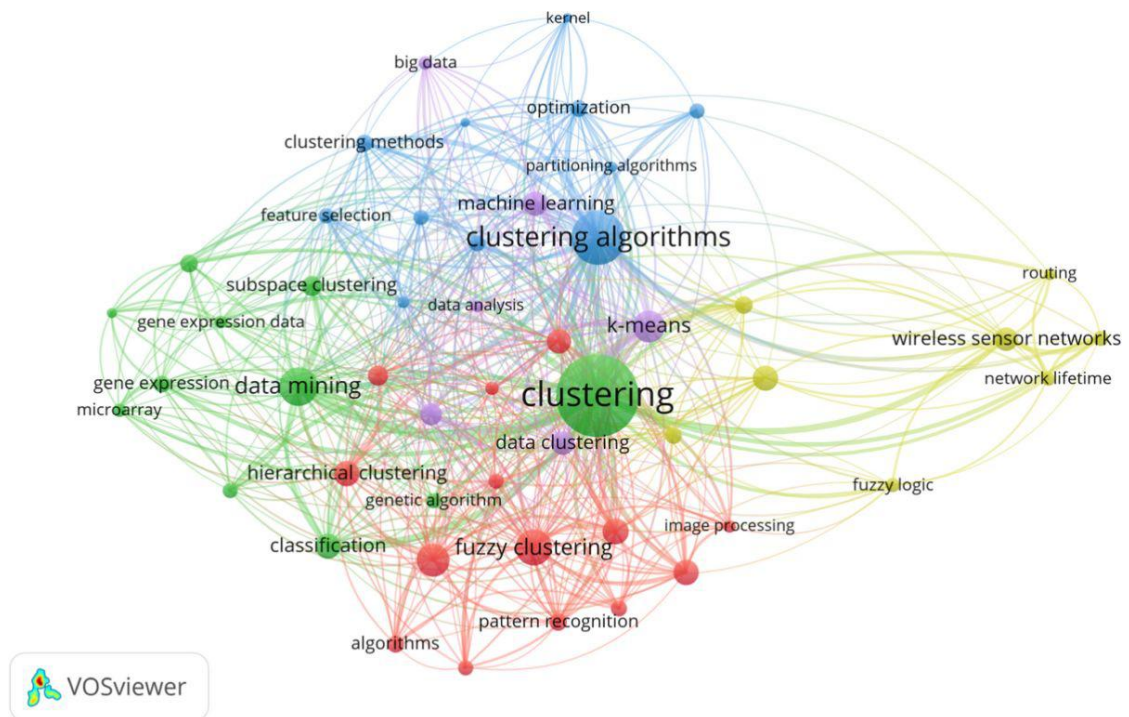


Figure 8.3 - Automatic Cluster Detection

Decision Trees

Decision trees are not useful for finding patterns in data. Rather, they split records into individual, predefined categories for further data mining use. A decision tree is the best approach to use when having specific, broad categories in mind before beginning a data mining search. The decision tree will split records based on the categories that have been defined. Decision trees are one of the most common data mining technique and are by far the most popular in tools aimed at the business user. They are easy to set up, their results are understandable by an end-user, they can address a wide range of classification problems, they are robust in the face of different data distributions and formats, and they are effective in analysing large numbers of fields.

A decision tree algorithm works by splitting a data set in order to build a model that successfully classifies each record in terms of a target field or variable. An example is a decision tree which classifies a data set according to whether customers did or did not buy a particular product [7, 21].

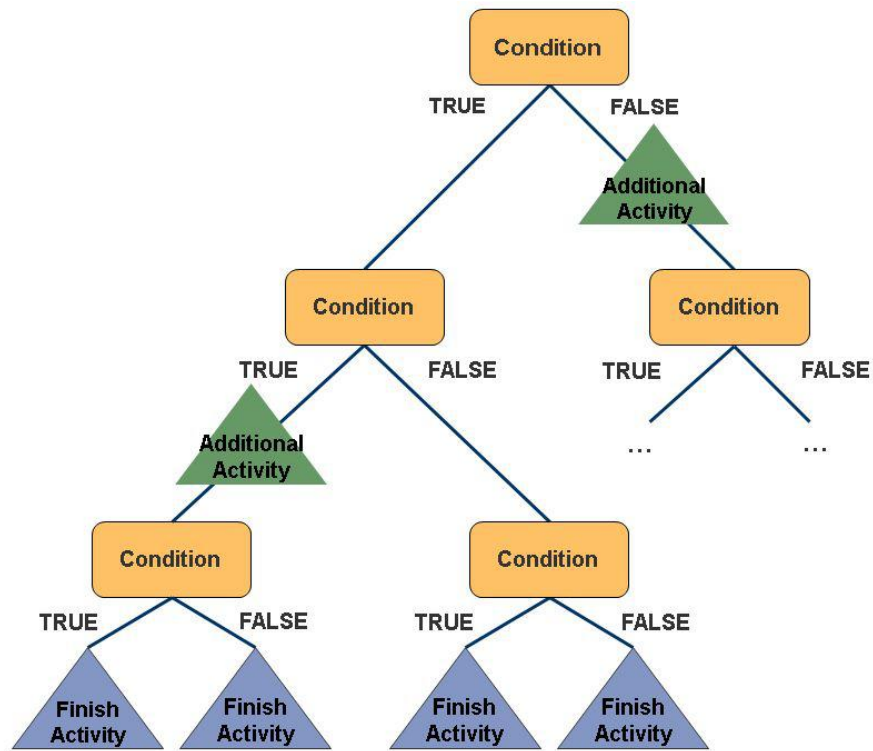


Figure 8.4 - Decision Trees

Neural Networks

The third data mining technique involves neural networks, which often are used in conjunction with decision trees. When using a neural network, there are no expectations for finding patterns. The data is not easily analysed, so a more thorough data mining approach is required. Neural networks are used best in small subcategories of records. Decision trees split the information and neural networks pick it apart to provide classification and prediction models.

Neural networks cannot explain the results they provide, but they offer insightful predictions. They are best used when detailed predictions are required without creating any predetermined sets of information.

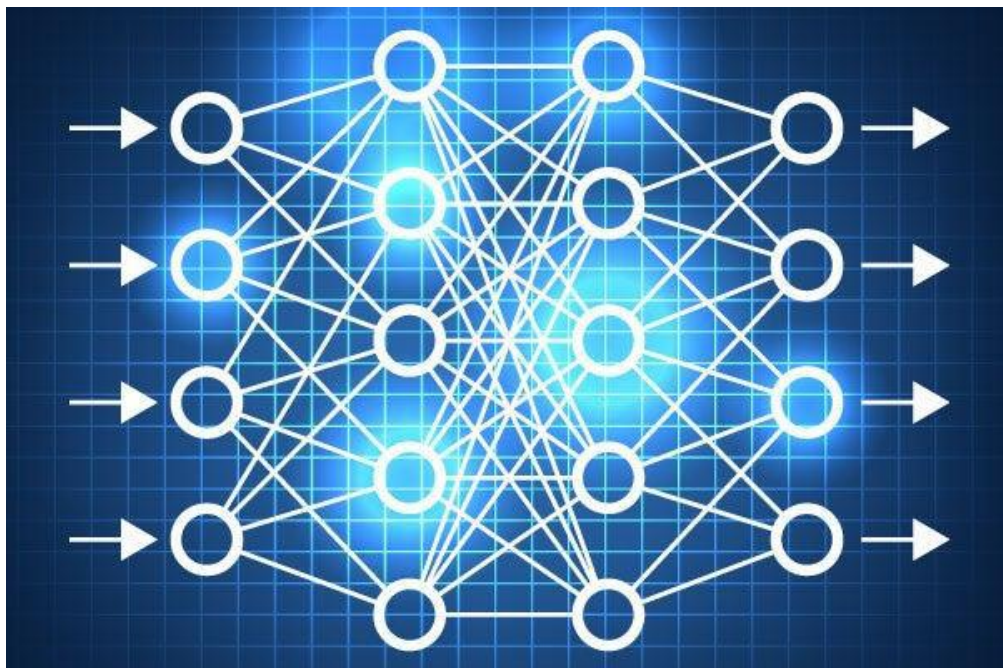


Figure 8.5 - Neural Networks

The next generation ERP System like SAP S/4 HANA (Ver 1610 and later) redesigned the entire ERP offering with modular suite of integrated solutions that include advanced supply chain capabilities that used to require separate, disparate installations. This simplified landscape allows new companies to explore brand-new planning and analytics functionality. Thus the areas of warehouse management, production planning, scheduling and order promising, all of which are critical for supply chain enabled within ERP itself to digitize the supply chain planning and execution. Thus, new generation ERP like SAP S/4HANA started addressing new supply chain challenges with faster, more accurate planning cycles, dynamic sourcing and procurement processes, and a simplified logistics data model that enables an omni-channel strategy, ensuring a competitive advantage in an increasingly crowded marketplace.

Thus, the next generation ERP brought in revolution with below aspects:

- ERP system moved on from hardware centric on-premise design to Cloud based and consumption based services
- ERP System became smart with advanced analytics, alerts, predictive insights and primarily any device. It means one can now access and take decisions on her mobile or tablet
- Traditional standalone manufacturing scheduling & optimization system, transportation optimization system and warehousing system became part of ERP System itself with choice of enablement
- ERP system now compliant with block chain, robotics, big data and also equipped with Scenario Planning and Simulations functionality

SAP's Digital Supply Chain Solution Strategy is presented below:

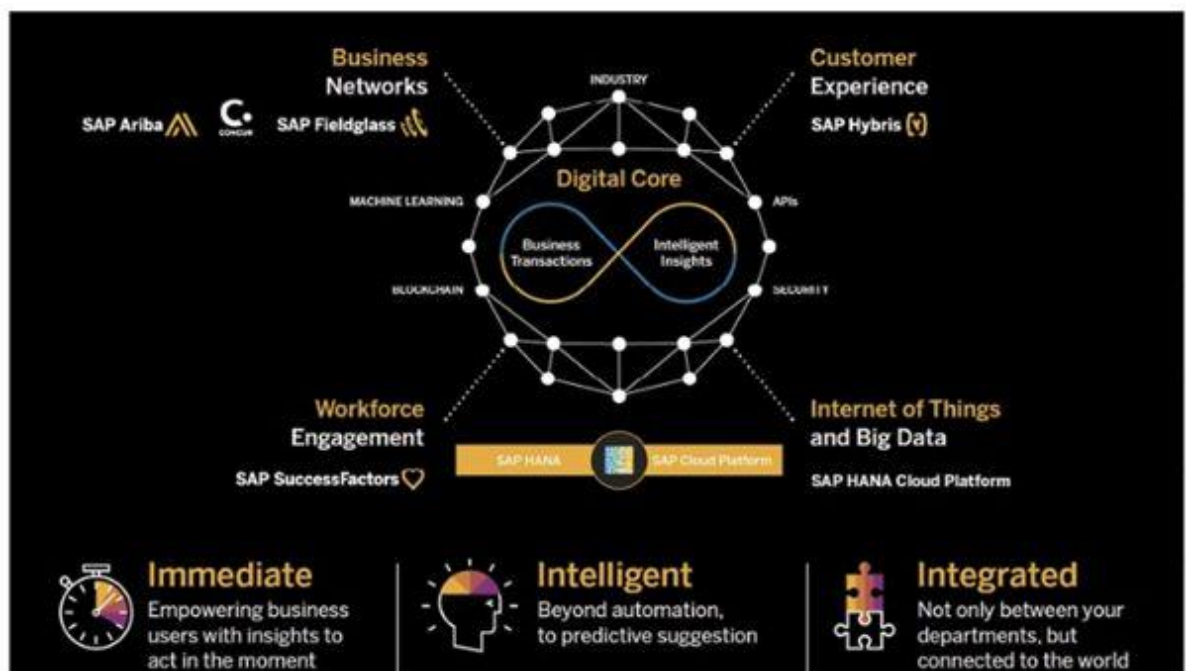


Figure 8.6 - SAP's Digital Supply Chain Solution Strategy

Synchronizing Demand Planning with Fulfilment Execution

SAP leverages a single logistics data model across manufacturing, inventory, sales, and the material ledger that simplifies data consumption and enables better integration. Incoming sales order and financial data in ERP can be seamlessly rolled up into Supply Chain Planning System, which improves planning, forecasting, and what-if simulation analysis. This simpler setup eliminates the complicated integrations across siloed solutions required in the past, and users no longer have to struggle with spreadsheets and batch processing to get the information they need. Downstream material requirements planning (MRP), production planning, and order fulfillment are

also improved in SAP ERP, because the close integration with SAP's Planning System allows forecast plans for sales and operations planning (S&OP) and demand planning to be used downstream. This reduces the time between receiving a customer order and making a final delivery and frees up resources to better respond to sudden shifts in customer demand.

Enhancing Digital Supply Chain Visibility with the Internet of Things

The Internet of Things (IoT) is a major technological breakthrough in the supply chain space, providing real-time data around everything from machine part wear and tear to package tracking and weather conditions. SAP's IoT strategy and solution portfolio integrates into the SAP S/4HANA value chain from engineering to delivery, providing companies with data across devices, applications, and assets as well as the vision to act on it. SAP Digital System tracks everything from cold-chain condition tracking—temperature points along critical points in the supply chain for perishable goods, such as ice cream or vegetables—to detailed component traceability, so life sciences companies can carefully monitor all elements of the supply chain to avoid contamination of a pharmaceutical or chemical. This functionality also helps logistics organizations track packages and delivery processes, benefits they can then extend to their customers with end-to-end visibility. In addition to tracking processes, system allows companies to monitor their IoT-connected devices by making digital twins of machines developed for manufacturing use. By embedding sensors, companies can recreate in the solution a visual image of each asset and properly monitor its state and condition in real-time to determine if it needs maintenance or is overcapacity, for example. In many cases, the digital twin will have a longer lifespan than its physical counterpart, enabling companies to not only perform preventive maintenance and optimize use of the asset, but also understand how future assets can be improved. This is an important benefit for manufacturers that have changed from operating as machine providers to becoming service providers—if they can innovate machines that they sell to customers as a service, they can gain greater efficiencies and revenue by running these machines optimally [32].

Providing Real-Time Forecast Changes to Suppliers

Speed is critical in digital world to establish a stable and fast supply chain. Traditionally, the supply chain changes, like supply delays and shortages required heavy manual communication leading to slow and error prone decisions thus affecting the ability to respond to demand fluctuation. Today, the Digital system of one company is connected directly to the digital systems of supply chain partners, allowing enterprises to quickly react to market disruptions in real-time. If a new product launch is seeing unexpectedly high demand, for example, suppliers can learn this more quickly through manufacturers and retailers and adjust their production schedule to meet the new forecasted demand. Integration between these Digital Network Systems also benefits members of the finance team, including treasury and accounts payable, through dynamic discounting. It also allows these users to have real-time views into the payment terms and supplier contracts throughout their supply chain network, enabling them to identify situations where early payment could provide discounts to the company, whether they are using their own funds or the capabilities provided within Digital Financial Supply Chain. Dynamic discounting capitalizes on real-time information to improve the visibility of the finance organization and give a short-term benefit to working capital and liquidity.

Bringing Omnichannel to Retail and FMCG Companies

When it comes to retail and consumer packaged goods (CPG), it's not enough to consider only the trade distribution parts of a company's supply chain. In today's competitive marketplace, customers have more access to multi-channels than ever, and it's essential that companies have a complete view to deliver the best service at every touchpoint on every channel. Digital System provides the required decision making functionality across the organization including sales, finance,

customer service, or in the warehouse to have the information they need at their fingertips. These system uses the customer data to help marketers better segment and target their audience. The solution captures leads during a campaign and shares that data with SAP Hybris Cloud for Sales so salespeople can follow up on the leads using the complete set of customer data from SAP S/4HANA. The same principle is true for customers placing orders: Data from SAP S/4HANA is immediately available within order management and warehouse management components, making for better shipping and billing processes.

Key Questions

1. What information is required to plan, coordinate and control a supply chain?
2. How do internal and external information flows support integration between supply chain participants?
3. How do supply chain planning and supply chain execution systems differ?
4. What roles do ERP, warehouse management and transportation management systems perform?
5. Which factors should a company consider when selecting and implementing SCM software?
6. How do system costs, integration requirements and deployment options affect an IT investment decision?
7. How can cloud and mobile technologies support supply chain decision-making?
8. How do RFID and IoT improve visibility and traceability?
9. How can data mining, decision trees and neural networks support planning and risk identification?
10. What is a digital twin, and how can it support asset monitoring and maintenance?
11. How does digital integration help synchronise demand planning, fulfilment and supplier responses?
12. What data quality, cybersecurity and organisational challenges arise when implementing digital supply chain systems?

9 Global Supply Chain Management

- 9.1. The trend towards globalisation in the supply chain
- 9.2. Global logistics intermediaries and its role
- 9.3. Global SCM factors
- 9.4. Key global supply chain challenges

9.1. The trend towards globalisation in the supply chain

In the late 1980s, a considerable number of companies began to integrate global sources into their core business, establishing global systems of supplier relationships and expansion of their supply chains across national boundaries and into other continents around the globe.

The globalization of supply chain management in organizations had the goals of increasing their competitive advantage, adding value to the customer, and reducing costs through global sourcing. In addition to sourcing globally, many companies sell globally or compete with other companies that do.

Ultimately, global supply chain management is about sourcing, manufacturing, transporting, and distributing products outside of your native country. It ensures that customers get products and

services that they need and want faster, better, and more cost-effectively either locally or from around the world.

Therefore, we can define global supply chains as worldwide networks of suppliers, manufacturers, warehouses, distribution centers, and retailers through which raw materials are acquired, transformed, and delivered to customers. Global brands and companies now dominate most markets. Over the last two decades there has been a steady trend towards the worldwide marketing of products under a common brand umbrella – whether it be Coca-Cola or Marlborough, IBM or Toyota. At the same time the global company has revised its previously localised focus, manufacturing and marketing its products in individual countries, and now instead will typically source on a worldwide basis for global production and distribution.



Figure 9.1 - Global supply chain network

The logic of the global company is clear: it seeks to grow its business by extending its markets whilst at the same time seeking cost reduction through scale economies in purchasing and production and through focused manufacturing and/or assembly operations.

However, whilst the logic of globalisation is strong, we must recognise that it also presents certain challenges. Firstly, world markets are not homogeneous, there is still a requirement for local variation in many product categories. Secondly, unless there is a high level of coordination the complex logistics of managing global supply chains may result in higher costs and extended lead times. These two challenges are related: on the one hand, how to offer local markets the variety they seek whilst still gaining the advantage of standardised global production and, on the other, how to manage the links in the global chain from sources of supply through to end user. There is a danger that some global companies in their search for cost advantage may take too narrow a view of cost and only see the purchasing or manufacturing cost reduction that may be achieved through using low-cost supply sources. In reality it is a total cost trade-off where the costs of longer supply pipelines may outweigh the production cost saving [8].

Figure 2 illustrates some of the potential cost trade-offs to be considered in establishing the extent to which a global strategy for logistics will be cost-justified. Clearly a key component of the decision to go global must be the service needs of the marketplace. There is a danger that

companies might run the risk of sacrificing service on the altar of cost reduction through a failure to fully understand the service needs of individual markets.

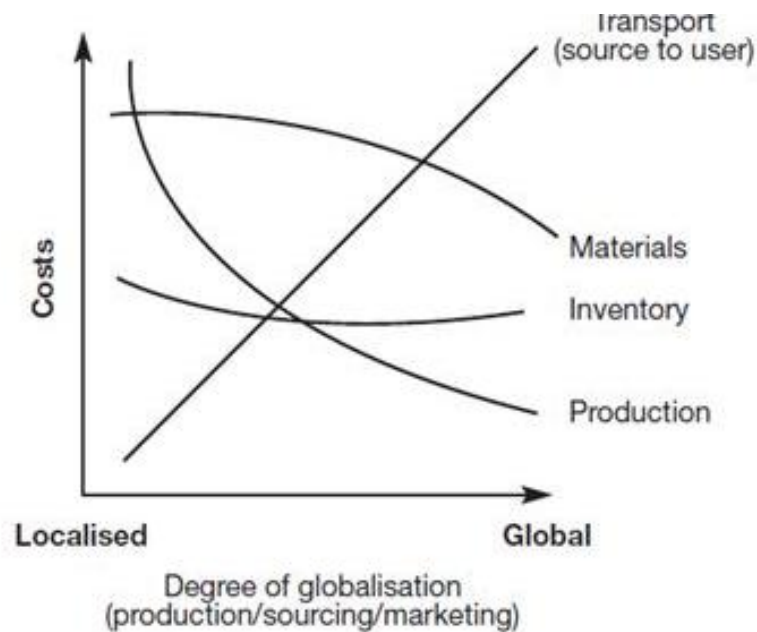


Figure 9.2 - Trade-offs in global logistics

The trend towards global organisation of both manufacturing and marketing is highlighting the critical importance of logistics and supply chain management as the keys to profitability. The complexity of the logistics task appears to be increasing exponentially, influenced by such factors as the increasing range of products, shorter product life cycles, marketplace growth and the number of supply/market channels.

There is no doubting that the globalisation of industrial activity has become a major issue in business. Articles in the business press, seminars and academic symposia have all focused upon the emerging global trend. The competitive pressures and challenges that have led to this upsurge of interest have been well documented. What are less well understood are the implications of globalisation for operations management in general and specifically for logistics management.

At the outset it is important that we define the global business and recognise its distinctiveness from an international or a multinational business. A global business is one that does more than simply export. The global business will typically source its materials and components in more than one country. Similarly it will often have multiple assembly or manufacturing locations geographically dispersed. It will subsequently market its products worldwide. A classic example is provided by Nike – the US-based sportswear company. The company outsources virtually 100 per cent of its shoe production, for example, only retaining in-house manufacturing in the US of a few key components of its patented Nike Air System. Nike's basketball shoe, for example, is designed in the USA but manufactured in South Korea and Indonesia from over 70 components supplied by companies in Japan, South Korea, Taiwan, Indonesia and the United States. The finished products are sold around the world. The trend towards globalisation and offshore sourcing has been growing rapidly for several decades. There has been a transformation from a world where most markets used to be served from local sources to one where there is a growing worldwide interdependence of suppliers, manufacturers and customers in what has truly become a 'global village'.

Early commentators like Levitt saw the growth of global brands and talked in terms of the growing convergence of customer preferences that would enable standardised products to be marketed in similar fashion around the world. However, the reality of global marketing is often different, with quite substantial differences in local requirements still very much in evidence. Thus,

whilst the brand may be global, the product may need certain customisation to meet specific country needs, whether it be left- or right-hand-drive cars or different TV transmission standards or local tastes. A good example is Nescafé, the instant coffee made by Nestlé, which has over 200 slightly different formulations to cater for preferences in taste country by country.

Factors Influencing Globalization

Some key factors influence the growth of globalization, including the following:

Improvements in transportation: Larger container ships mean that the cost of transporting goods between countries has decreased. Economies of scale are found as the cost per item can reduce when operating on a larger scale. Transportation improvements also mean that both goods and people can travel more quickly.

Freedom of trade: There are a number of organizations like the World Trade Organization (WTO) that promote free trade between countries, helping to remove barriers between countries.

Improvements of communications: The Internet and mobile technology has allowed greater communication between people in different countries.

Labor availability and skills: Less-developed nations in Asia and elsewhere have lower labor costs and, in some cases, also high skill levels. Labor-intensive industries such as clothing can take advantage of cheaper labor costs and reduced legal restrictions in these less developed countries.

Transnational corporations: Globalization has resulted in many businesses setting up or buying operations in other countries. When a foreign company invests in a country, by building a factory or a shop, this is sometimes called inward investment. Companies that operate in several countries are often referred to as multinational corporations (MNCs) or transnational corporations (TNCs). The U.S. fast-food chain McDonald's is a large MNC, having nearly 30,000 restaurants in 119 countries. Many multinational corporations not only invest in other economically developed countries but also invest in less-developed countries as well. (For example, Ford Motor Company makes a large numbers of cars in the United Kingdom and in India.) [7]

9.2. Global logistics intermediaries and its role

The following are a few key global logistics intermediaries that companies may interact with to execute international trade activities.

Customs Broker

“Customs Brokers are private individuals, partnerships, associations or corporations licensed, regulated and empowered by U.S. Customs and Border Protection (CBP) to assist importers and exporters in meeting Federal requirements governing imports and exports.”

Customs brokers are also described as “[a] person who manages the paperwork required for international shipping and tracks and moves the shipments through the proper channels.”

A customs broker is typically the importer's only point of contact with the CBP, and advises the importer of record about the requirements for importing, including preparing and filing entry documents, obtaining the necessary bonds, handling import duties, tracking shipments, securing release of the goods, and arranging delivery to the importer's facility. The broker often consults with CBP to determine the proper rate of duty.

Export Management Companies

Export management companies (EMCs) are agents for domestic companies in foreign markets. An EMC provides a manufacturer immediate access to foreign market knowledge and export know-how. They act as the exclusive export sales department for a manufacturer, and

function in foreign markets just like a sales representative functions for a manufacturer in a domestic market.

International Freight Forwarder

An international freight forwarder provides the expert know-how and experience needed to arrange for the movement of cargo from domestic points of origin to foreign destinations with maximum speed and efficiency. They have detailed knowledge of international transportation possibilities and limitations.

As an agent of the exporter, the international freight forwarder advises the exporter about the regulations affecting foreign trade, as well as the import rules of various foreign countries. They prepare shipping documents, arrange for space on ocean vessels, arrange transportation of cargo to shipside, arrange for cargo insurance, and generally orchestrate the entire movement of goods from point of origin to destination in the most cost-efficient manner.

Non-Vessel-Operating Common Carrier (NVOCC)

A non-vessel-operating common carrier (NVOCC) is a “carrier that uses ocean liners and works similarly to freight forwarders.” An NVOCC does not own or operate any ocean vessels, but they are a shipper in relation to the ocean carrier involved. However, they do function as a common carrier by issuing their own bills of lading and assuming responsibility for the shipments they arrange. NVOCCs specialize in less-than-container load (LCL) shipments and perform many of the same functions as freight forwarders.

Trading Company

“A company that introduces foreign buyers and sellers and arranges all product export/import details, documentation, and transportation.” In a strict definition, trading companies purchase and take ownership of products in one country and export these products to sell in another country [18, 20].

9.3. Global SCM factors

Global location factors are used to compare and contrast one potential location against another when making global location decisions. The most common location factors are:

- Access and Proximity to Markets
- Access to Suppliers and Cost
- Business Clusters
- Competitiveness
- Currency Stability
- Environmental Considerations
- Labor Availability and Cost
- Land Availability and Cost
- Quality of Life Factors
- Taxes and Incentives
- Trade Agreements
- Utility Availability and Cost

Access and Proximity to Markets

The company's ability to deliver its products and services to customers in a timely and cost-effective manner is not only a goal or objective, but also absolutely critical to the company's long-term survival. When choosing a global location from which to establish operations, the proximity to customers and the access to the markets being served are vitally important, and may be the deciding factors when making the final location selection.

There are some markets around the world that are restrictive, and to be granted access to sell products in those markets, companies may be required to establish local operations within those countries.

Because logistics timelines and costs are significant concerns, the trend in manufacturing is to locate within delivery proximity of your customers. This also reinforces the business cluster concept discussed later in the chapter, where manufacturers, suppliers, customers, and service providers locate near one another generally in places that offer lower cost labor, tax breaks, and lower real estate prices.

In the service industry, proximity to customers is even more critical. A company can't easily or cost-effectively service a piece of equipment that they sold to a customer if the technician is thousands of miles away.

Access to Suppliers and Cost

The company's ability to receive materials and services from suppliers in a timely and cost-effective manner is also critical to the company both short and long term. If the company wants to source materials and services locally, are those materials and services available, and are they priced competitively in the global locations being considered?

When choosing a global location from which to establish operations, the proximity to suppliers and the ability suppliers have to deliver materials and services to the company will be major factors in determining the effectiveness of the supply chain, and may therefore be deciding factors when making the final location selection.

Business Clusters

A business cluster is a network of manufacturers, suppliers, service organizations, and related businesses and institutions connected to one another within an industry, all located in the same geographical area. These industry concentrations are believed to provide a benefit to all of the co-located businesses and institutions whether they are partners or competitors. The proximity to one another provides easy access to talent, knowledge, services, supplies, technology, and even competitive information. Companies located in these business clusters are often able to increase their efficiency and productivity, making them more competitive. Research parks and special economic/industrial zones can serve as magnets for business clusters. Examples include:

- Silicon Valley (technology)
- Research Triangle Park (research & development)
- Wall Street (financial)
- New Jersey (pharmaceuticals)
- Singapore (high-tech manufacturing)
- India (software)

Reasons for success of business clusters include:

- Innovation and competition can be geographically concentrated
- There is close cooperation, coordination, and trust among clustered companies
- Companies recruit from local skilled workers

Competitiveness

The World Economic Forum defines competitiveness as the "set of institutions, policies, and factors that determine the level of productivity of a country" and identifies 12 Pillars of Competitiveness in their Global Competitiveness Report 2014–2015.

These pillars are used to rank and compare country locations. In general, countries that have a higher overall ranking potentially provide a more favorable business environment.

The 12 Pillars of Competitiveness:

1. Institutions: Property rights, transparency, public administration, judiciary, physical security, corporate governance
2. Infrastructure: Transport, electricity, communication quality and availability
3. Macroeconomic Stability: Fiscal and monetary indicators, savings, debt rating
4. Health and Primary Education: State of health, basic education quality
5. Higher Education and Training: Quantity and quality of higher education and training
6. Goods Market Efficiency: Domestic/foreign competition, demand conditions
7. Labor Market Efficiency: Flexibility, meritocracy, gender parity
8. Financial Market Sophistication: Stability and trustworthiness of financial system
9. Technological Readiness: Adoption of technology by individuals/businesses
10. Market Size: Domestic/export market size
11. Business Sophistication: Efficiency and sophistication of business processes
12. Innovation: Capacity and commitment to innovation

Currency Stability and Environmental Considerations

Currency Stability

Any decision about locating operations must consider currency stability. Fluctuation in exchange rates is a reality in global business. An unstable currency market affects cost determination, pricing, purchasing power, inventory value, labor, and material costs. Example: Brazil once had 1,000% annual inflation – it became nearly impossible to set prices or determine costs.

Environmental Considerations

Companies may have assess:

- Environmental impact on operations and employees
- Local regulations, emissions, air/water quality, waste disposal

These factors can affect cost and restrict operations.

Labor Availability and Cost vs Land Availability and Costs

Labor Availability and Cost

Key factors for companies:

- Availability of skilled/unskilled labor
- Labor productivity
- Unemployment and underemployment rates
- Turnover and wage rates
- Labor laws and forecasted changes

In the U.S., right to work laws mean employees can't be required to join a union as a condition of employment.

Land Availability and Costs

A company considering various global locations may also be considering building a new facility or buying an existing one. In either situation, the availability and cost of land could potentially be an issue, and must be a consideration in the location decision. Many popular areas around the globe have scarce land resources available and/or the land prices are extremely high. Companies have expanded their focus beyond the major cities to include some of the more suburban and rural areas where land may be more readily available and at a lower cost, while still being close enough to the urban areas where suppliers, customers, and service providers are located.

Quality-of-Life Factors

A higher quality of life in the workplace and also in the surrounding environment leads to higher employee morale, satisfaction, and retention. Companies that establish facilities in various global locations will need people to work at these locations. Some of the workforce will likely be local, and some personnel may transfer from other locations either from inside or from outside the company. In all cases, the quality of life in each global location will be a factor in attracting and retaining skilled and unskilled workers to that location. Companies should therefore understand and evaluate the following quality of life factors in terms of maturity, sophistication, robustness, and so forth, in each location before making a location decision:

1. Culture
2. Economy
3. Education
4. Government / Politics
5. Healthcare
6. Mobility
7. Natural Environment
8. Public Safety
9. Recreation
10. Social Environment

Taxes and Incentives

Taxes and governmental incentives are significant considerations when comparing potential global locations. From a tax perspective, multiple levels of government must be considered as there may be federal, state/region, and/or local community taxes, any or all of which could impact the business and influence the location decision. Import tariffs, which are designed to generate revenue and/or protect local businesses, may also be imposed in various countries. Countries with high tariffs encourage multinational corporations to produce locally, and discourage importing goods into the country.

Countries may provide tax incentives (e.g., reductions or deferments) to attract businesses to locate operations within their borders. These incentives may also be tied to the volume of business done within the country, how many local labors are employed, whether materials are purchased from local suppliers or not, among others.

Trade Agreements

Regional trade agreements impact global location decisions. A location may be more favorably viewed if there is one or more trade agreements in place providing a financial incentive and a better business environment than another country location. The following are a few examples of regional trade agreements:

- European Union (EU): – [1950] Following WWII, consists of 27 members countries in Europe
- North American Free Trade Agreement (NAFTA): – [1994] Removed most barriers to trade and investment among United States, Canada, and Mexico
- Southern Common Market (MERCOSUR): – [1991] Argentina, Brazil, Paraguay, and Uruguay
- Association of Southeast Asian Nations (ASEAN): – [1967] 10 member countries in SE Asia
- Common Market of Eastern and Southern Africa (COMESA): – [1993] 19 member countries in East and South Africa

World Trade Organization

These regional trade agreements, and many more, are monitored by the World Trade Organization (WTO).

“The World Trade Organization (WTO) deals with the global rules of trade between nations. Its main goal is to ensure that trade flows as smoothly, predictably and as freely as possible.” The WTO was established in 1995, and is headquartered in Geneva, Switzerland. There are currently 164 member countries (as of July 2016) that use the WTO to facilitate and resolve trade issues with each other.

WTO functions include:

- Administering WTO trade agreements
- Forum for trade negotiations
- Handling trade disputes
- Monitoring national trade policies
- Technical assistance and training for developing countries
- Cooperation with other international organizations



Figure 9.3 - World Trade Organization

Utility Availability and Cost

The cost and availability of utilities such as water, electricity, natural gas, and telecommunications could be an important consideration for companies making location decisions. The availability of all utilities on a consistent basis, as well as the cost of those utilities, are critical considerations, particularly for companies producing or supplying heavy industrial products such as iron, coal, oil, ships, and machinery. In some parts of the world, the supply of various utilities is not reliable in general, and also not able to meet the demand of local business growth. This has been an issue particularly in emerging markets, where some of the lower cost labor and materials are centered [18].

9.4. Key global supply chain challenges

According to a survey by PRTM consultants for Supply Chain Digest (SCDigest Editorial Staff, 2010), key global supply chain challenges include the following:

Supply chain volatility and uncertainty have permanently increased: Market transparency and greater price sensitivity have led to lower customer loyalty. Product commoditization reduces true differentiation in both the consumer and business-to-business (B2B) environments.

Securing growth requires truly global customer and supplier networks: Future market growth depends on international customers and customized products. Increased supply chain globalization and complexity need to be managed effectively.

Market dynamics demand regional, cost-optimized supply chain configurations: Customer requirements and competitors necessitate regionally tailored supply chains and product offerings. End-to-end supply chain cost optimization will be critical.

Risk management involves the end-to-end supply chain: Risk and opportunity management should span the entire supply chain—from demand planning to expansion of manufacturing capacity—and should include the supply chains of key partners.

Existing supply chain organizations are not truly integrated and empowered: The supply chain organization needs to be treated as a single integrated organization. To be effective, significant improvements require support across all supply chain functions.

Global location decision challenge

Generally, when a company considers various global locations for its operations there is a hierarchy or step-wise approach to narrowing down the possibilities. Companies will first start by dividing the globe into regions, and then hone in on countries that align with the company's vision, mission, and business strategy. From there, the company can begin to look at specific areas within countries, and then finally down to specific communities or sites to evaluate.

Some of the decision factors outlined in this chapter are federally controlled or related to the country as a whole, such as competitiveness, currency stability, federal taxes and incentives, and trade agreements. Some of the decision factors are locally controlled or related to the local community or specific site selected, such as land availability and costs, and local taxes and incentives. The balance of the decision factors are related to, or influenced by, all levels (i.e., federal, regional, local) within the country.

Weighted-Factor Rating Model

One method of evaluating the potential global locations is the weighted-factor rating model, which compares the attractiveness of several locations against some or all of the location factors described in this chapter. The process involves:

- Identifying the factors to be considered/evaluated
- Assigning a weight to each factor:
 - The individual factor weights must sum to 1.
 - Equal weight can be applied to all factors, or different individual weights can be applied to factors, with some factors weighing more than others in the decision-making model. This determination is made by companies based on how they value each factor, and it is company specific.
- Determining a score for each factor at each location
- Multiplying the factor score by the weight, and then calculating the sum of the weighted scores
- The location with the highest total weighted score is the recommended location [7, 18].



Extra Materials [Video](#)

1. Who are the eight key participants in global supply chain management as discussed in the video?

2. What role does a freight forwarder play in the global supply chain?

3. How do customs brokers facilitate international trade within the supply chain?

4. What is the significance of export management companies in global supply chain operations?

5. How do international freight forwarders assist exporters in navigating foreign trade regulations?

Let's discuss Boeing Case



Digitalization Takes Off at The Boeing Company: Building a Next Generation Supply Chain (Figure 9.5) [33]

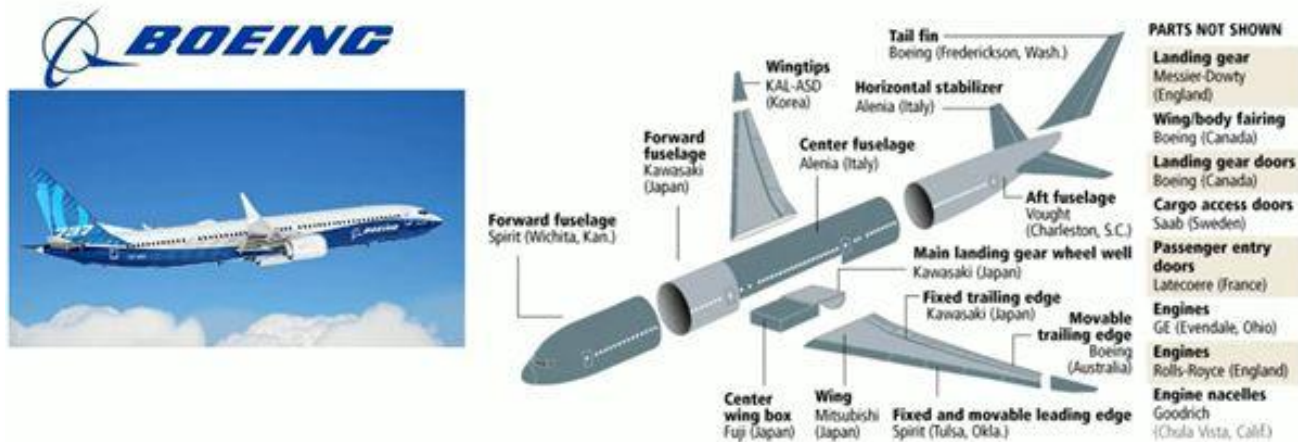


Figure 9.4 - Digitalization Takes Off at The Boeing Company: Building a Next Generation Supply Chain

Key Questions

1. Which transport, communication and trade developments have encouraged the globalisation of supply chains?
2. What benefits and trade-offs arise when a company moves from a domestic to a global supply chain?
3. How do multinational corporations and international investment influence the configuration of global supply networks?
4. Which economic, infrastructure, labour and institutional factors influence global supply chain location decisions?
5. How do tariffs, trade agreements and customs requirements affect sourcing and distribution choices?
6. Why should location decisions consider market access, logistics capabilities and the social environment together?
7. What operational and coordination challenges arise in geographically dispersed supply chains?
8. How can companies balance cost advantages against uncertainty, longer lead times and disruption exposure?
9. How does the weighted-factor location method work, and how can the choice of weights affect the recommended location?

10 Innovations in the State Customs Service of Ukraine and Their Impact on Supply Chain Efficiency

- 10.1. Global development trends and their impact on Ukraine's development.
- 10.2. Implementation of the New Computerized Transit System (NCTS).
- 10.3. Introduction of the Authorized Economic Operators (AEO) institute.
- 10.4. Use of customs digital products ("Single Window for International Trade," Business Intelligence, and others).

10.1. Global development trends and their impact on Ukraine's development

The 2008–2010 crisis, paradoxically, intensified globalization processes and accelerated systemic changes in the global economy – a convergence is taking place between the largest developed countries and developing nations. New integration formations are emerging and strengthening, and the configuration and influence of transnational corporations is changing. Research of analytical reports presented at recent Davos forums gives grounds to draw conclusions about the main long-term global development trends that will have a decisive impact on the development of countries, including Ukraine, in the near future. These must be taken into account when forming national development strategies.

Key long-term global development trends include:

- Increased competition for limited natural resources (energy, water) and food;
- Capital flow from the West to the East, from the North to the South (particularly from North American and European markets to new growth centers in Asia, Latin America, South Africa);
- Growth in the share of urban population;
- Growth in the elderly population;
- Expansion of intellectual services and the role of education;
- Strengthening the role and importance of international institutions;
- Expansion of public-private partnerships and the role of non-governmental actors (NGOs, big business, religious organizations, etc.).

Ukraine's development strategy must respond to these global challenges by adjusting national priorities to make the best use of its natural and resource potential. One promising direction could be the development of a logistics strategy aimed at realizing Ukraine's transit potential [1].

Among the success factors of global companies:

- Strengthening the role of large metropolises as ideal environments for TNCs and transnational capital hubs. Residents of big cities form a new transnational subculture, consuming the same global media, raised with unified standards of education and behavior. Paradoxically, a resident of New York or London may have more in common with someone from Kyiv than with fellow citizens from a small town.
- Identifying a target audience that reacts to marketing actions regardless of country – the so-called “Y generation” (born in the 1980s) in Ukraine is very similar to peers in Japan, the USA, or Germany: they grew up under market economy conditions, liberalization, globalization, and information technologies. In Ukraine, this group (about 7.3 million or 15.2% of the population) significantly influences markets for music, sports, and tech products.
- Recognizing current societal trends that blur national differences. Faith Popcorn's trend list includes “cocooning” (making the home as comfortable and protected as possible), “rejuvenation” (people over 40 seeking youthfulness – hence demand for wrinkle creams, Jaguars, plastic surgery), and “simplification of life” (moving to simpler lives in small towns) [34].

10.2. Implementation of the New Computerized Transit System (NCTS)

The Convention on a Common Transit Procedure forms the basis for transit movements between its contracting parties, including EU Member States, EFTA countries and Ukraine. The New Computerized Transit System (NCTS) is the electronic system used to implement the Convention.

Ukraine is reforming its customs system in accordance with EU standards. The common transit system is one of the key elements of economic integration between the EU and Ukraine. Ukraine fulfilled its commitment to join the Convention, which entered into force for Ukraine on 1 October 2022.

Ukraine implemented NCTS through successive stages. Pilot application began on 16 November 2020, followed by national application on 17 March 2021 and international application on 1 October 2022:

- Pilot project (completed in 2021),
- National application (launched on 17 March 2021),
- International application (launched on 1 October 2022).

Ukraine moved to NCTS Phase 5 on 22 April 2024 and to NCTS Phase 6 on 22 June 2026. Phase 6 supports further alignment with EU transit procedures and the use of security and safety data within common transit. These are completed implementation milestones, rather than planned accession dates [36].

The Convention on Common Transit Procedure serves as the foundation for the transit movement of goods between its signatory countries. Its provisions ensure proper control over transit goods and help prevent fraud involving accompanying documentation.

In particular, the use of a single transit declaration for the delivery of goods from one country to another under the common transit procedure reduces the cost and time of customs procedures—therefore decreasing border queues and enabling a faster flow of goods.

NCTS connects the customs services of the Convention's contracting parties and enables the exchange of customs data. Ukraine participates in this exchange. A single transit document in the system allows customs authorities to control the goods at each stage of the movement.

Features of the Common Transit System

Since the Convention entered into force for Ukraine on 1 October 2022, common rules govern transit operations between Ukraine and the other contracting parties.

Thus, the transit of goods will be carried out under a single transit procedure, from the customs office of departure in one country to the customs office of destination in another country:

- (i) using one transit declaration,
- (ii) secured by one financial guarantee, valid across the entire territory of the Convention's member countries.

Under common transit, guarantees and customs identification measures secure the movement of goods in accordance with the applicable rules. Guarantees cover the potential customs debt; seals protect the integrity of the consignment and are recognised by the contracting parties. Authorised simplifications may include a reduced comprehensive guarantee or a guarantee waiver.

Traders can use individual or comprehensive guarantees, subject to the applicable conditions.

The Convention also provides for a range of special transit simplifications, such as:

- the use of comprehensive guarantees, including the possibility of reducing the basic guarantee amount down to 0% (i.e., exemption from guarantees),
- the ability to independently apply seals to cargo,
- the possibility to dispatch or receive goods without presenting them to customs (as an "authorized consignor" or "authorized consignee").

Traders may obtain authorizations for multiple simplifications simultaneously.

Ukrainian businesses can apply for common transit simplifications under the current authorisation procedures. Continued use of a simplification depends on the conditions of the authorisation and compliance with the applicable requirements.

Before the introduction of NCTS, Ukraine used a national cargo delivery control system based on EE customs declarations. T1UA declarations were used during the national implementation stage preceding international common transit.

During the pilot project, participating businesses filled out both EE and T1UA declarations. National application began in March 2021. International common transit has operated since October 2022; the declaration type and electronic submission process must correspond to the procedure and system version used for the movement.

The early implementation material described a gradual transition from national procedures towards common transit. In current practice, the choice of procedure must be based on the applicable Customs Code, the Convention and the conditions of the movement, rather than on a forecast that the national system will automatically be phased out.

The EU supported Ukraine's accession to the Convention through EU4PFM and the Reform Support Team. Lithuania provided NCTS software, which was localised with EU support. Cooperation with EU institutions and experts also supported the legal framework and subsequent development of NCTS Phases 5 and 6.

Current NCTS guidance

State Customs Service of Ukraine. Common Transit (NCTS): <https://customs.gov.ua/rezhim-spilnogo-tranzitu-ncts>

10.3. Introduction of the Authorized Economic Operators (AEO) institute.

Historical foundation: Resolution No. 665 of 29 July 2020 approved the following elements of the initial AEO framework:

1. The application form for enterprises requesting AEO authorization;
2. The self-assessment questionnaire for enterprises;
3. The procedure for customs authorities to carry out (re)assessment of the enterprise's compliance with AEO criteria;
4. The procedure for confirming the qualifications of the company employee responsible for customs matters;
5. The normative values of financial solvency (financial stability) and liquidity ratios, based on annual (interim) financial statements;
6. The report template on the results of the assessment (reassessment) of the enterprise's compliance with AEO criteria;
7. The template for the conclusion on the enterprise's compliance (or non-compliance) with AEO criteria;
8. The action plan template for monitoring the enterprise's compliance with the Authorized Economic Operator criteria;
9. The procedure for planning and conducting compliance monitoring by customs authorities regarding the AEO criteria.

Resolution No. 665 formed part of the initial implementation framework. Current AEO applications, self-assessment forms and assessment procedures are governed by the Customs Code and Cabinet of Ministers Resolution No. 1092 of 27 September 2022, as amended.

Obtaining AEO authorisation requires thorough preparation. Preliminary review normally takes up to 30 days, and the compliance assessment up to 120 days, with possible extensions under the prescribed conditions. The assessment may be shorter when relevant criteria have already been assessed for another authorisation.

During the initial implementation period, Law No. 141-IX limited the number of applications reviewed simultaneously to 20 before 7 November 2021 and to 30 before 7 November

2022. These dates describe historical transitional arrangements rather than current application quotas.

On March 18, 2021, the State Customs Service, following the completion of a compliance assessment, made the decision to grant AEO status to an enterprise. The first company to receive AEO authorization in Ukraine was the public joint-stock company JT International Ukraine (based in Kremenchuk).

Current guidance, forms and frequently asked questions about AEO are available on the State Customs Service website.

Electronic submission is available through the Single Window for International Trade portal. The State Customs Service recommends the route Business / My Applications / Application for AEO Authorisation for submitting the application and self-assessment questionnaire electronically.

Ukraine offers AEO authorisation for customs simplifications (AEO-C) and for security and safety (AEO-B); an enterprise may hold both. Authorisation confirms compliance with the relevant criteria and supports more predictable customs interaction. Benefits abroad depend on applicable mutual recognition agreements [24].

Historical regulatory acts underpinning the initial AEO programme:

1. Law of Ukraine dated 02.10.2019 No. 141-IX “On Amendments to the Customs Code of Ukraine Regarding Certain Aspects of the Functioning of Authorized Economic Operators.” <https://zakon.rada.gov.ua/laws/show/141-IX#Text>

2. Cabinet of Ministers Resolution dated 29.07.2020 No. 665 “On Certain Issues Regarding the Functioning of Authorized Economic Operators.” <https://zakon.rada.gov.ua/laws/show/665-2020-%D0%BF#Text>

3. Cabinet of Ministers Resolution dated 27.01.2021 No. 50 “On Approval of the Procedure for Maintaining the Unified State Register of Authorized Economic Operators.” <https://zakon.rada.gov.ua/laws/show/50-2021-%D0%BF#Text>

4. Cabinet of Ministers Resolution dated 03.02.2021 No. 70 “On Approval of the Form, Description, and Rules for the Use of the National AEO Logo and AEO Certificate Template.” <https://zakon.rada.gov.ua/laws/show/70-2021-%D0%BF#Text>

5. Cabinet of Ministers Resolution dated 24.02.2021 No. 139 “On Approval of Application Forms for Permits to Apply Special Simplifications.” <https://www.kmu.gov.ua/npas/pro-zatverdzhennya-form-zayavi-pid-a139>

10.4. Use of Customs Digital Products ("Single Window for International Trade", Business Intelligence, and Others)

The IT transformation of the State Customs Service was a priority of customs reform support under EU4PFM in 2019–2022 and remains part of Ukraine's alignment with EU customs procedures. The following paragraphs describe the initial development stage as reported in June 2021; the subsequent status update summarises later developments.

The initial implementation status was discussed during the monthly online Customs Coordination Meeting held on 10 June 2021, attended by representatives of the Ministry of Finance, the State Customs Service, EU4PFM and the Reform Support Team.

"The key objective of the Programme in the customs area is to assist Ukraine in improving customs processes and increasing efficiency. This includes transforming current procedures and implementing new ones in line with the EU-Ukraine Association Agreement. The work is focused on two main directions: developing a regulatory framework and designing IT solutions. In this

context, IT tools are essential for enabling these changes," — stated Vytianis Alishauskas, EU4PFM international customs expert.

According to Yevhenii Yentis, Deputy Head of the State Customs Service for Digital Development and Transformation, by June 10, 2021, two core systems were completed and undergoing pilot operation:

- Automated Risk Management System 2.0 (ASUR 2.0), and
- Customs Audit System.

At that stage in 2021, the first phase of the new Automated Customs Clearance System 2.0 (ASMO 2.0) was nearing completion. ASMO was designed to handle internal service functions and integration with internal modules and external data sources. Registers for sea and road border crossing points had also been developed for the initial launch.

In the 2021 implementation programme, the updated Single Window for International Trade platform, also known as the Customs Interaction Cabinet, was intended to reduce time, cost and corruption risks. Initial functionality included administrative services and an Intellectual Property Rights (IPR) Registry for online interaction between rights holders and customs.

At the June 2021 reporting date, further functionality was under development, including:

- clearance for international shipments, vehicles, and export declarations,
- online payments,
- customs accounting,
- AEO support modules,
- electronic forms for interaction with customs,
- integration with other executive bodies.

The 2021 implementation report also identified the following operational online services:

- Customer Support Service (beta version),
- Complaints System.

The initial implementation report described the Open Customs Data Portal as providing downloadable customs declaration data for analysis. It also listed the Business Intelligence portal, Customs Car Valuation Calculator and Customs Infrastructure Map as digital tools.

The initial implementation report described the integration of NCTS with ASUR 2.0 and ASMO 2.0.

The 2021 programme scheduled three further components for launch: automated processing of international shipments, automated vehicle clearance and an updated Trader's Portal. This was the implementation timetable reported at that stage.

"There are around 50–60 million international shipments annually in Ukraine. We understand how much senders and recipients are waiting for this service. We're already working with postal operators to ensure accessibility and speed," — said Yentis.

The 2021 programme envisaged replacement of the previous IT ecosystem by 2022. That timetable is a historical plan; it does not establish that all components were fully replaced by that date.

The system is based on microservice architecture, where complex modules are built from small, independent, self-contained services, each responsible for a specific function. This approach allows for: flexible updates, independent module improvements, quick integration of changes.

This architecture is widely used by major tech platforms like Google, Amazon, Booking.com, Netflix, Facebook, and others [35].

The DataBus information system is the foundation of this architecture, enabling data exchange across internal and external systems, databases, and registers

The reform of the State Customs Service aims to modernize customs processes through new IT solutions. The IT transformation focuses on six main directions:

1. Customs Interaction Cabinet,
2. Customs Control and Clearance,
3. Public Reporting and Analytics,
4. Smart Border Crossing,
5. Cybersecurity,
6. EU Harmonization.

These are all components of [the “e-Customs” project](#), one of the key digitalization initiatives under a Cabinet of Ministers resolution.

Key Customs Digital Products:

- Online Map of Customs Infrastructure
- Interactive Import/Export Business Intelligence Module
- Personal Account on the “Single Window for International Trade” Portal
- QD Professional and/or MD Declarations
- Unified State Web Portal “Single Window for International Trade”

Digital customs developments

The Single Window for International Trade portal provides an operational channel for electronic interaction with customs, including AEO applications. The customs website provides current NCTS guidance and Trader's Portal instructions. Digital procedures therefore need to be assessed through the services and requirements in operation, rather than the launch forecasts published in 2021.

On 7 February 2025, the State Customs Service reported the integration of Business Intelligence and generative AI into its risk management system. BI clusters customs data to identify risk patterns; AI adds targeted analysis. The report described the first risk profile based on the combined approach as being in test operation. This illustrates how analytics can support targeted controls and improve risk identification [37].

For supply chain management, the relevant outcomes are more predictable clearance, better information exchange and reduced administrative effort. These outcomes should be evaluated through clearance time, variability of border delays, document errors, compliance and total logistics cost.

State Customs Service of Ukraine. BI and AI integration in risk management, 7 February 2025:

<https://customs.gov.ua/news/it-transformatsiia-62/post/derzhmitsluzhba-integruvala-shi-ta-bi-v-asur-dlia-pidvishchennia-efektivnosti-upravlinnia-rizikami-2016>

Single Window for International Trade: <https://cabinet.customs.gov.ua/>

Key Questions for Discussion

1. How do global development trends influence the organisation of supply chains in Ukraine?
2. What is the relationship between the Convention on a Common Transit Procedure and NCTS?
3. What were the main milestones in Ukraine's transition to international common transit and NCTS Phases 5 and 6?
4. How can a single transit declaration and guarantee reduce administrative effort and improve shipment predictability?
5. Which common transit simplifications are available, and what role do authorisations play?
6. How do AEO authorisations for customs simplifications and for security and safety differ?
7. Which documents and internal procedures should an enterprise prepare before applying for AEO authorisation?

8. How can the Single Window for International Trade support interaction between businesses and customs authorities?
9. How can Business Intelligence and risk management systems improve the targeting of customs controls?
10. Which indicators should a company use to assess the effect of customs digitalisation on lead time, cost, reliability and compliance?

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