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The course of lectures on discipline

LOGISTICS

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for the 3rd year students
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Зміст
(Content)

Preface

Logistics is key to the modern economy. From the steel factories of Pennsylvania to the port of Singapore, from the Nicaraguan banana fields to postal delivery and solid waste collection in any region of the world, almost every organization faces the problem of getting the right materials to the right place at the right time. Increasingly competitive markets are making it imperative to manage logistics systems more and more efficiently.

Introducing Logistics Systems

1.1 Introduction

Logistics deals with the planning and control of material flows and related information in organizations, both in the public and private sectors. Broadly speaking, its mission is to get the right materials to the right place at the right time, while optimizing a given performance measure (e.g. minimizing total operating costs) and satisfying a given set of constraints (e.g. a budget constraint). In the military context, logistics is concerned with the supply of troops with food, armaments, ammunitions and spare parts, as well as the transport of troops themselves. In civil organizations, logistics issues are encountered in firms producing and distributing physical goods. The key issue is to decide how and when raw materials, semi-finished and finished goods should be acquired, moved and stored. Logistics problems also arise in firms and public organizations producing services. This is the case of garbage collection, mail delivery, public utilities and after-sales service.

Significance of logistics. Logistics is one of the most important activities in modern societies. A few figures can be used to illustrate this assertion. It has been estimated that the total logistics cost incurred by USA organizations in 2007 was 862 billion dollars, corresponding to approximately 11% of the USA Gross Domestic Product (GDP). This cost is higher than the combined annual USA government expenditure in social security, health services and defence. These figures are similar to those observed for the other North America Free Trade Agreement (NAFTA) countries and for the European Union (EU) countries.

Logistics systems. A logistics system is made up of a set of *facilities* linked by *transportation services*. Facilities are sites where materials are processed, e.g. manufactured, stored, sorted, sold or consumed. They include manufacturing and assembly

centres, warehouses, distribution centres (DCs), transshipment points, transportation terminals, retail outlets, mail sorting centres, garbage incinerators, dump sites, etc.

Logistics has moved to center stage as a result of trading agreements such as Exxon Mobil Chemical is one of the largest petrochemical companies in the world. Its products include olefins, aromatics, synthetic rubber, polyethylene, polypropylene and oriented polypropylene packaging films. The company operates its 54 manufacturing plants in more than 20 countries and markets its products in more than 130 countries. The Pfizer Pharmaceuticals Group is the largest pharmaceutical corporation in the world. The company manufactures and distributes a broad assortment of pharmaceutical products meeting essential medical needs, a wide range of consumer products for self-care and well-being, and health products for livestock and pets. The Pfizer logistics system comprises 58 manufacturing sites in five continents producing medicines for more than 150 countries. Because manufacturing pharmaceutical products requires highly specialized and costly machines, each Pfizer plant produces a large amount of a limited number of pharmaceutical ingredients or medicines for an international market. This company are continued explosion of computer and information technology, the further development of global markets resulting in a larger number of companies with operations worldwide, and a corporate emphasis on quality and customer satisfaction.

Fundamentals of Logistics Management takes a marketing orientation and views the subject from a customer satisfaction perspective. While emphasizing the marketing aspects of logistics, it integrates all of the functional areas of the business as well as incorporating logistics into corporate strategy.

Logistics is big business. Its consumption of land, labor, capital, and information – coupled with its impact on the world's standard of living – is enormous. Curiously, it has only been within the past 40 years that the business community has taken a real interest in logistics. However, during that period logistics has increased in importance from a function that was perceived as barely necessary to (1) an activity where significant cost savings could be generated; (2) an activity that had enormous potential to impact customer satisfaction and hence increase sales; and (3) a marketing weapon that could be effectively utilized to gain a sustainable competitive advantage. The importance of logistics is being recognized all over the world.

Fundamentals of Logistics Management approaches the topic from a managerial perspective. Each chapter introduces basic logistics concepts in a format that is useful for management decision making. Of course, the basics – terms, concepts, and principles – are covered, but they are examined in light of how they interrelate and interface with other functions for the firm. In each chapter we have

included examples of corporate applications of these concepts to illustrate how logistics activities can be managed to properly implement the marketing concept. Each chapter contains examples of how logistics is being implemented globally, how technology is being used to improve logistics efficiency and effectiveness, and how businesses are creatively solving logistics problems.

This course includes a good balance of theory and practical application. All the traditional logistics functions such as customer service, transportation, warehousing, and inventory management, have been included. However, there are several important topics that are approached in a different way than in most texts. For example, the financial control of logistics is discussed in a separate chapter, as well as being interwoven throughout all chapters. We have purposely taken this approach because of the impact of logistics on the firm's profitability. Because logistics ultimately affects marketing's ability to generate and satisfy demand – and thus create customer satisfaction – the customer service activity is emphasized early in the book. Customer service can be considered the output of the logistics function.

A number of important topics not covered in many other logistics text are covered in this course: order processing and management information systems, materials flow, financial control of logistics performance, logistics organizations, global logistics, decision support systems, channels of distribution, and the strategic logistics plan. Other topics covered include partnerships, green marketing, computer technology, globalization of markets, warehouse location, strategic planning, and customer service. Given the importance of globalization, the global issues are not only included in a separate chapter but are incorporated in every chapter of the book. Our goal in covering these topics in addition to the traditional activities is to provide readers with a grasp of the total picture of the logistics process.

We have Suggested Readings at the end of each chapter and margin notes are used throughout the text. Terms included in the Subject Index are bolded in the text so that they can be located more easily. We believe that this course is readable for both the instructor and student.

Chapter 1. Part 1.

1.1 Introduction

Logistics is a broad, far-reaching function which has a major impact on a society's standard of living. In a modern society, we have come to expect excellent logistics services, and tend to notice logistics only when there is a problem. To understand some of the implications to consumers of logistics activity, consider:

• The difficulty in shopping for food, clothing, and other items if logistical systems do not conveniently bring all of those items together in one place, such as a single store or a shopping mall.

• The challenge in locating the proper size or style of an item if logistical systems do not provide for a wide mix of products, colors, sizes, and styles through the assortment process. This was a continual problem in the former Soviet Union.

• The frustration of going to a store to purchase an advertised item, only to find out the store's shipment is late in arriving.

These are only a few of the issues often taken for granted which illustrate how logistics touches many facets of our daily lives. Because of the magnitude of the impact of logistics on society and individuals, a macro approach is taken in this initial chapter.

This chapter focuses on how logistics has developed over time, explains the systems approach as it applies to logistics, explores the role of logistics in the economy and the firm, and examines the key interfaces of logistics with other marketing activities. This chapter also shows the relationship between the systems concept and the total cost of ownership perspective. The discussion closes with a summary of key trends and current issues in logistics management.

1.2 Definition of Logistics Management

Because logistics is the topic of this textbook, it is important to establish the meaning of the term. Logistics has been called by many names, including the following:

- Business logistics
- Channel management
- Distribution
- Industrial logistics

- Logistical management
- Materials management
- Physical distribution
- Quick-response systems
- Supply chain management
- Supply management

What these terms have in common is that they deal with the management of the flow of goods or materials from point of origin to point of consumption, and in some cases even to the point of disposal. The Council of Logistics Management (CLM), one of the leading professional organizations for logistics personnel, uses the term logistics management to describe:

the process of planning, implementing and controlling the efficient, effective flow and storage of goods, services, and related information from point of origin to point of consumption for the purpose of conforming to customer requirements.

Throughout this text, the CLM definition is used. This definition includes the flow of materials and services in both the manufacturing and service sectors. The service sector includes entities such as the government, hospitals, banks, retailers and wholesalers.[2] In addition, the ultimate disposal, recycling, and reuse of the products need to be considered because logistics is becoming increasingly responsible for issues such as removing packaging materials once a product is delivered and removing old equipment.

Logistics is not confined to manufacturing operations alone. It is relevant to all enter, including government, institutions such as hospitals and schools, and service organizations such as retailers, banks, and financial service organizations. Examples from these sectors will be used throughout the book to illustrate the relevance of logistics principles to a variety of operations.

Some of the many activities encompassed under the logistics umbrella are given in Figure 1-1, which illustrates that logistics is dependent upon natural, human, financial, and information resources for inputs. Suppliers provide raw materials which logistics manages in the form of raw materials, in-process inventory, and finished goods. Management actions provide the framework for logistics activities through the process of planning, implementation, and control. The outputs of the logistics system are competitive advantage, time and place utility, efficient movement to the customer, and providing a logistics service mix such that logistics becomes a proprietary asset of the organization.

1.3 Development of Logistics

Logistics activity is literally thousands of years old, dating back to the earliest forms of organized trade. As an area of study however, it first began to gain attention in the early 1900s in the distribution of farm products,[3] as a way to support the organization's business strategy,[4] and as a way of providing time and place utility.

Following the clear importance of the contribution of logistics toward the Allied victory in World War II, logistics began to receive increased recognition and emphasis. Just as in the Persian Gulf War in 1990-1991, the ability to efficiently and effectively distribute and store supplies and personnel were key factors in the success of the U.S. Armed Forces.[6]

The first dedicated logistics texts began to appear in the early 1960s,[7] which also is the time that Peter Drucker, a noted business expert, author, and consultant, stated that logistics was one of the last real frontiers of opportunity for organizations wishing to improve their corporate efficiency.[8] These factors combined to increase the interest in logistics.

To further fuel the focus on logistics, deregulation of the transportation industry in the late 1970s and early 1980s gave organizations many more options and increased the competition within and between transportation modes. As a result, carriers became more creative, flexible, customer-oriented, and competitive in order to succeed. Shippers are now faced with many more transportation options. They can focus on negotiation of rates, terms, and services, with their overall attention directed toward getting the best transportation buy.

With rising interest rates and increasing energy costs during the 1970s, logistics received more attention as a major cost driver. In addition, logistics costs became a more critical issue for many organizations because of the globalization of industry. This has affected logistics in two primary ways.

First, the growth of world class competitors from other nations has caused organizations to look for new ways to differentiate their organizations and product offerings. Logistics is a logical place to look because domestic organizations should be able to provide much more reliable, responsive service to nearby markets than overseas competitors.

Second, as organizations increasingly buy and sell offshore, the supply chain between the organization and those it does business with becomes longer, more costly, and more complex. Excellent logistics management is needed to fully leverage global opportunities.

Another factor strongly contributing to the increased emphasis and importance of logistics is a continued and growing emphasis on cost control. A survey of chief

executive officers of Fortune 500 manufacturing firms and Fortune 500 service firms indicated that they believed that the most important way to improve company profitability was through cost cutting and cost control.[9] Thus, despite all the talk and emphasis on other issues, such as quality and customer service which CEOs rated as second and third in importance, cost cutting is still seen as the most important factor.

At about this same time, information technology really began to explode. This gave organi¬zations the ability to better monitor transaction intensive activities such as the ordering, movement, and storage of goods and materials. Combined with the availability of comput-erized quantitative models, this information increased the ability to manage flows and to optimize inventory levels and movements. Systems such as materials requirements planning (MRP, MRP II), distribution resource planning (DRP, DRPII), and just-in-time (JIT) allow organizations to link many materials management activities, from order processing to in¬ventory management, ordering from the supplier, forecasting and production scheduling.

Other factors contributing to the growing interest in logistics include advances in in¬formation systems technology, an increased emphasis on customer service, growing recognition of the systems approach and total cost concept, the profit leverage from logis¬tics, and the realization that logistics can be used as a strategic weapon in competing in the marketplace.

The shifting of channel power from manufacturers to retailers, wholesalers, and distributors has also had a profound impact on logistics. When competition rises in major consumer goods industries, there is a shakeout of many suppliers and manufacturers, so that a few leading competitors remain. Those remaining are intensely competitive and offer very high-quality products. In many cases, the consumer sees all of the leading brands as substitutes for each other. Lower brand-name loyalty decreases a manufacturer's power. This increases the retailer's power because sales are determined by what is in stock, not by what particular brands are offered.

The profit leverage effect of logistics illustrates that $1.00 saved in logistics costs has a much greater impact on the organization's profitability than a $1.00 increase in sales. In most organizations, sales revenue increases are more difficult to achieve than logistics cost reductions. This is particularly true in mature markets, where price cuts are often met by the competition, and revenue in the whole industry thus declines. The impact of the profit leverage effect is illustrated in Table 1.1.

There are many costs associated with a sale, such as the cost of goods sold and logistics-related costs. Thus, a $1.00 increase in sales does not result in a $1.00 increase in profit. If, for example, an organization's net profit margin (sales revenue

less costs) is 2 percent, the firm only receives a before tax profit of $0.02, from each sales dollar. Yet, any dollar saved in logistics does not require sales or other costs to generate the savings. Therefore, a dollar saved in logistics costs is a dollar increase in profit! As a result, logistics cost savings have much more leverage, dollar for dollar, than an increase in sales. Thus, the term, the "profit leverage effect of logistics," is relevant.

1.4 Systems Approach/Integration

The systems approach is a critical concept in logistics. Logistics is, in itself, a system; it is a network of related activities with the purpose of managing the orderly flow of material and personnel within the logistics channel. This is illustrated in Figure 1.2. It shows a simplified example of the network of relationships that logistics has to manage in a channel of distribution.

Table 1.1 Profit leverage provided by logistics cost reduction

If Net Profit on the Sales Dollar is 2.0 Percent, Then

A Saving of	*Is Equivalent to a Sales Increase of*
$ 0.02	% 1.00
2.00	100.00
200.00	10,000.00
2,000.00	100,000.00
20,000.00	1,000,000.00

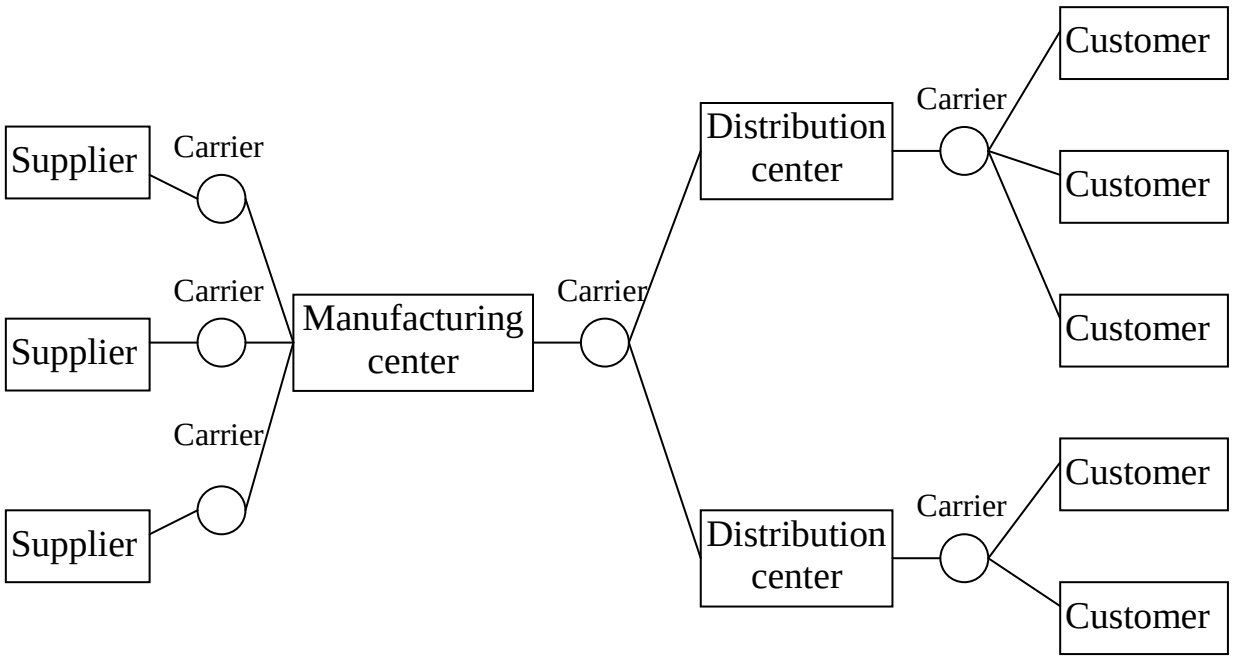


Figure 1.1 − Distribution channel: Logistics manages to flow through channel

While the flow is primarily left to right, logistics is also responsible for returns, or movements from right to left, hence the term *reverse logistics* has developed.

Global

Hewlett-Packard's Systems Approach to Inventory Management

Hewlett-Packard (HP) is a leading global supplier of computer printers, particularly the ink-jet and laser-jet variety. It has over $3 billion invested in inventory worldwide. HP has a division located in Vancouver, Washington, which manufactures and distributes the DeskJet Plus printer worldwide. It has three distribution centers, one each in North America. Europe, and Asia.

HP faced a situation where high inventories of printers, approximately seven weeks' worth, were required to meet their 98 percent service goal in Europe. High inventories were required in part because each country has unique power cord and transformer requirements, and needs the proper language manual. Initially, the "differentiation" of the printers to meet the needs of the local market was done at the Vancouver facility. HP apparently faced the prospect of high inventory costs or reduced customer service levels, neither of which was an acceptable option.

The management at the Vancouver site considered many options for reducing inventory while maintaining customer service. They first worked on improving the logistics system by reducing delivery variability. They considered faster shipping modes, such as air, to reduce transit inventory, and inventory held to cover lead times. That alternative proved too costly.

However, by looking at the entire system as a whole, HP was able to develop a better solution. It could delay the differentiation of printer power sources and manuals until firm orders were received. This allowed HP to reduce inventory to five weeks while maintaining 98 percent service levels. This saved over $30 million annually. In addition, transportation dropped by several million dollars because generic printers can be shipped in larger volumes than printers specific to a particular country. Because HP viewed the system as a whole and understood the interactions, they were able to develop this innovative logistical solution.

Source: Adapted from Tom Davis, "Effective Supply Chain Management," *Sloan Management Review*, 34, no. 4 (Summer 1993), pp. 35–46; and Corey Billington, "Strategic Supply Chain Management," *OR/MS Today* 21, no. 2 (Mar.-Apr. 1994), pp. 20–27.

Simplified example of the network of relationships that logistics has to manage in a channel of distribution.

The systems approach is a simplistic yet powerful paradigm for understanding interrelationships. The systems approach simply states that all functions or activities need to be understood in terms of how they affect, and are affected by, other elements and activities with which they interact. The idea is that if one looks at actions in isolation, he or she will not understand the big picture or how such actions affect, or are affected by, other activities. In essence, the sum, or outcome of a series of activities, is greater than its individual parts.

While it might be desirable to have high inventory levels in order to improve customer order fulfillment, high inventory levels increase storage costs as well as the risk of obsolescence. Those unfavorable factors must be "traded off" with the favorable aspects of a decision before arriving at a decision on inventory levels. Without considering the impact of decisions on the larger system, such as the firm or the distribution channel, sub-optimization often occurs. That means while the individual activities in that system appear to be operating well, the net result on the total system is relatively poor performance. To understand the opportunities for

improvement, and the implication of those opportunities, the system must be viewed as a whole.

Without understanding the channel wide implications of logistics decisions to improve service levels, excess inventory will begin to build up at the links along the supply chain. This excess inventory will tend to increase costs throughout the channel, but it serves as a buffer to protect against the uncertainty of how other channel members will behave. Thus, the system as a whole is less efficient than it could otherwise be. To get around that issue, organizations like Hewlett-Packard's DeskJet Division have taken a systems approach to managing channel inventories.

The systems approach is at the core of the next several topics discussed. The systems approach is key to understanding the role of logistics in the economy, its role in the organization, including its interface with marketing, the total cost concept, and logistics strategy.

1.5 The Role of Logistics in the Economy

Logistics plays a key role in the economy in two significant ways. First, logistics is one of the major expenditures for businesses, thereby affecting and being affected by other economic activities. In the United States, for example, logistics contributed approximately 10,5 percent of GDP in 1996 US industry spent approximately $451 billion on transportation of freight and about $311 billion on warehousing, storage, and carrying inventory. These and other logistics expenses added up to about $797 billion.[11]

In 1980, logistics expenditures accounted for around 17.2 percent of GDP. If logistics expenditures were still that high by 1996, an additional $510 billion would have been spent on logistics costs in the United States. This would translate into higher prices for consumers, lower profits for businesses, or both. The result could be a lower overall standard of living and/or a smaller tax base. Thus, by improving the efficiency of logistics operations, logistics makes an important contribution to the economy as a whole.

Second, logistics supports the movement and flow of many economic transactions; it is an important activity in facilitating the sale of virtually all goods and services. To understand this role from a systems perspective, consider that if goods do not arrive on time, customers cannot buy them. If goods do not arrive in the proper place, or in the proper condition, no sale can be made. Thus, all economic activity throughout the supply chain will suffer.

One of the fundamental ways that logistics adds value is by creating utility. From an economic standpoint, utility represents the value or usefulness that an item or service has in fulfilling a want or need. There are four types of utility: form, possession, time, and place. The later two, time and place utility, are intimately supported by logistics.

Form utility is the process of creating the good or service, or putting it in the proper form for the customer to use. When Honda of America Manufacturing transforms parts and raw materials into a car, form utility is created. This is generally part of the production or operations process.

Possession utility is the value added to a product or service because the customer is able to take actual possession. This is made possible by credit arrangements, loans, and so on. For example, when General Motors Acceptance Corporation extends a loan to a prospective auto purchaser, possession utility becomes possible.

While form and possession utility are not specifically related to logistics, neither would be possible without getting the right items needed for consumption or production to the right place at the right time and in the right condition at the right cost.[n] These "five rights of logistics," credited to E. Grosvenor Plowman, are the essence of the two utilities provided by logistics: time and place utility.

Time utility is the value added by having an item when it is needed. This could occur within the organization, as in having all the materials and parts that are needed for manufacturing, so that the production line does not have to shut down. This occurs when the logistics function at Pillsbury delivers flour from one of its mills to a production facility so that cake mix may be produced on schedule. Or it could occur in the marketplace, as in having an item available for a customer when the customer wants it. The item does the customer no good if it is not available when it is needed.

This is closely related to **place utility,** which means having the item or service available where it is needed. If a product desired by consumers is in transit, in a warehouse, or in another store, it does not create any place utility for them. Without both time and place utility, which logistics directly supports, a customer could not be satisfied.

1.6 The Role of Logistics in the Organization

The **marketing concept,** as mentioned above, is a "marketing management philosophy which holds that achieving organizational goals depends on determining the needs and wants of target markets and delivering the desired satisfactions more

effectively and efficiently than competitors."[13] Thus, the marketing concept is a "customer-driven" perspective which holds that a business exists to meet customer needs.

The "four P's" of the marketing mix require that for a firm to be successful, any marketing effort must integrate the ideas of having the right product, at the right price, publicized with the proper promotion, and available in the right place. Logistics plays a critical role particularly in support of getting the product to the right place. As discussed previously in conjunction with utility, a product or service provides customer satisfaction only if it is available to the customer when and where it is needed.

Also, it is important to understand that a central goal of an organization is to maximize long-term profitability or effective use of assets in the public or nonprofit sectors. One of the key ways to accomplish that is through examining trade-offs among alternatives, thereby reducing the overall total cost of activities within a system.

Product refers to the set of utilities/characteristics that a customer receives as a result of a purchase. In an effort to lower price, management may decide to reduce product quality, eliminate product features, reduce the breadth of product offerings, reduce customer service or warranty support, or increase the time between model changes. However, any of these actions may reduce the attraction of the product for consumers, creating a loss of customers and thereby a reduction in long-term profits. To avoid making poor decisions, management needs to understand the trade-off and interrelationships between logistics and other marketing activities.

Price is the amount of money that a customer pays for the product or service offering. Some of the items that should be factored into price include discounts for buying in quantities or for belonging to a certain class of customers, discounts for prompt payment, rebates, whether inventory is offered on consignment, and who pays delivery costs. A supplier may attempt to increase sales by reducing the price of its product, changing the terms or service offering. Unless the item in question is very price sensitive (i.e., sales change dramatically due to changes in price), such a strategy may create higher unit sales, but not enough to offset the lower price, yielding lower profit. This is particularly true in mature industries where customer demand is relatively fixed and the competition may follow the price decrease. The sales and the profitability of the entire industry suffer.

Promotion of a product or service encompasses both personal selling and advertising. Whereas increasing advertising expenditures or the size of the direct sales force can have a positive impact on sales, there is a point of diminishing returns.

A point exists where the extra money being spent does not yield sufficiently high increases in sales or profits to justify the added expense. It is important for organizations to understand when they reach that point, so that they can avoid misallocating funds. A more prudent idea may be to try to use those funds more effectively, perhaps training the sales force to provide more value-added services to the customer, or make the customer more aware of the value added it currently provides through superior logistics service.

Place is the key element of the marketing mix with which logistics interfaces directly. Place expenditures support the levels of customer service provided by the organization. This includes on-time delivery, high order fill rates, consistent transit times, and similar issues. Customer service is an output of the logistics system. On the other hand, when the organization performs well on all the elements of the marketing mix, customer satisfaction occurs.

For many organizations, customer service may be a key way to gain competitive advantage. By adjusting customer service levels to meet what the customer desires and is willing to pay, the organization may simultaneously improve service levels and reduce cost.

Chapter 1. Part 2.

2.1 Total cost concept

The total cost concept is the key to effectively managing logistics processes. The goal of the organization should be to reduce the *total* cost of logistics activities, rather than focusing on each activity in isolation. Reducing costs in one area, such as transportation, may drive up inventory carrying costs as more inventory is required to cover longer transit times, or to balance against greater uncertainty in transit times. National Semiconductor was actually able to reduce costs while improving logistics performance (see the Creative Solutions box at the end of this chapter) by taking a total cost approach.

Management should be concerned with the implications of decision making on all of the costs shown in Figure 2.1. These six major cost categories cover the 14 key logistics activities that will be discussed in this text.

2.2 Key logistics activities

Outlined below are the key activities required to facilitate the flow of a product from point of origin to point of consumption. All of these activities, listed alphabetically below, may be considered part of/the overall logistics process.

- Customer service
- Demand forecasting/planning
- Inventory management
- Logistics communications
- Material handling
- Traffic and transportation
- Warehousing and storage
- Order processing
- Packaging
- Parts and service support
- Plant and warehouse site selection
- Procurement
- Return goods handling
- Reverse logistics

Customer service has been defined as "a customer-oriented philosophy which integrates and manages all elements of the customer interface within a predetermined optimum cost-service mix." Customer service is the output of the logistics system. It involves getting the right product to the right customer at the right place, in the right condition and at the right time, at the lowest total cost possible. Good customer service supports customer satisfaction, which is the output of the entire marketing process. Customer service is the topic of the next chapter.

Demand forecasting/planning. There are many types of demand forecasts. Marketing forecasts customer demand based on promotions, pricing, competition, and so on. Manufacturing forecasts production requirements based on marketing's sales demand forecasts and current inventory levels. Logistics usually becomes involved in forecasting in terms of how much should be ordered from its suppliers (through purchasing), and how much of finished product should be transported or held in each market that the organization serves. In some organizations, logistics may even plan production. Thus, logistics needs to be linked to both marketing and manufacturing forecasting and planning.

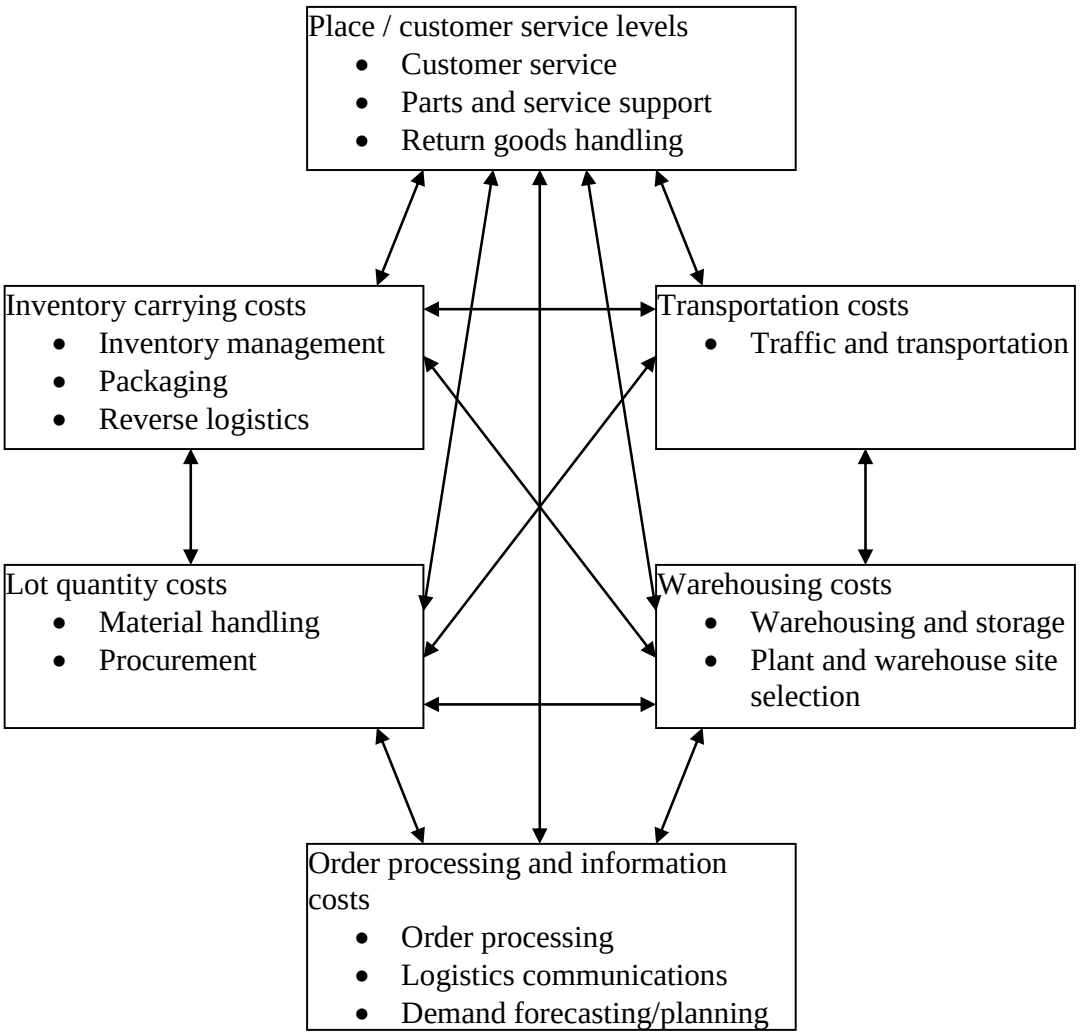


Figure 2.1 − How logistics activities drive logistics costs

Forecasting is a complex issue, with many interactions among functions and forecast variables. This topic will be explored in greater depth further.

Inventory management involves trading off the level of inventory held to achieve high customer service levels with the cost of holding inventory, including capital tied up in inventory, variable storage costs, and obsolescence. These costs can range from 14 to over 50 percent of the value of inventory on an annual basis! With high costs for items such as high-tech merchandise, automobiles, and seasonal items that rapidly become obsolete, many organizations, including Hewlett-Packard, Xerox, and Sears, are giving inventory management much more attention. These issues will be explored in next Chapters.

Logistics communications. Communications are becoming increasingly automated, complex, and rapid. Logistics interfaces with a wide array of functions and organizations in its communication processes. Communication must occur between:

1. The organization and its suppliers and customers.

2. The major functions within the organization, such as logistics, engineering, accounting, marketing, and production.
3. The various logistics activities listed previously.
4. The various aspects of each logistics activity, such as coordinating warehousing of material, work in process, and finished goods.
5. Various members of the supply chain, such as intermediaries and secondary customers or suppliers who may not be directly linked to the firm.

Communication is key to the efficient functioning of any system, whether it be the distribution system of an organization or the wider supply chain. Excellent communications within a system can be a key source of competitive advantage. Part of Wal-Mart's success can be attributed to computerized advance communications systems which link their suppliers to their actual customer sales on a regular basis, so that the suppliers can plan based on up-to-date demand information, and provide timely and adequate replenishment to Wal-Mart stores. This is presented in more depth in another Chapter, which describes information systems.

Materials handling is a broad area that encompasses virtually all aspects of all movements of raw materials, work in process, or finished goods within a plant or warehouse. Because an organization incurs costs without adding value each time an item moves or is handled, a primary objective of materials management is to eliminate handling wherever possible. That includes minimizing travel distance, bottlenecks, inventory levels, and loss due to waste, mishandling, pilferage, and damage. Thus, by carefully analyzing material flows, materials management can save the organization significant amounts of money.

Order processing entails the systems that an organization has for getting orders from customers, checking on the status of orders and communicating to customers about them, and actually filling the order and making it available to the customer. Part of the order processing includes checking inventory status, customer credit, invoicing, and accounts receivable. Thus, order processing is a broad, highly automated area. Because the order processing cycle is a key area of customer interface with the organization, it can have a big impact on a customer's perception of service and, therefore, satisfaction. In creasingly, organizations today are turning to advanced order-processing methods such as electronic data interchange (EDI) and electronic funds transfer (EFT) to speed the process and improve accuracy and efficiency.

Packaging is valuable both as a form of advertising/marketing, and for protection and storage from a logistical perspective. Packaging can convey important information to inform the consumer. Aesthetically pleasing packaging also can attract

the consumer's attention. Logistically, packaging provides protection during storage and transport. This is especially important for long distances over multiple transportation modes such as international shipping. Packaging can ease movement and storage by being properly designed for the warehouse configuration and materials handling equipment.

Parts and Service Support. In addition to supporting production through the movement of materials, work in process, and finished goods, logistics also is responsible for providing after-sale service support. This may include delivery of repair parts to dealers, stocking adequate spares, picking up defective or malfunctioning products from customers, and responding quickly to demands for repairs. Downtime can be extremely costly to industrial customers who may have to stop or delay production while awaiting repairs!

Plant and Warehouse Site Selection. Determining the location of the company's plant(s) and warehouse(s) is a strategic decision that affects not only the costs of transporting raw materials inbound and finished goods outbound, but also customer service levels and speed of response. This topic is overviewed in Chapter 8. Issues to consider include the location of customers, suppliers, transportation services, availability and wage rates of qualified employees, governmental cooperation, and so on. In recent times, there has been a great deal of competition for new manufacturing facilities. An example of this is Intel Corporation's decision regarding where to locate a semiconductor facility. It received bids from a number of major cities, including Portland, Oregon; Austin, Texas; and Chandler, Arizona, a suburb of Phoenix. Ultimately, Intel chose Chandler because it already had a facility there, the Phoenix area was growing and had an attractive labor force, and the company had a good relationship with and was provided attractive incentives by the local government.

In recent times, there has been a great deal of competition for new manufacturing facilities. An example of this is Intel Corporation's decision regarding where to locate a semiconductor facility. It received bids from a number of major cities, including Portland, Oregon; Austin, Texas; and Chandler, Arizona, a suburb of Phoenix. Ultimately, Intel chose Chandler because it already had a facility there, the Phoenix area was growing and had an attractive labor force, and the company had a good relationship with and was provided attractive incentives by the local government.

Return Goods Handling. Returns may take place because of a problem with the performance of the item or simply because the customer changed his or her mind. Return goods handling is complex because it involves moving small quantities of

goods back from the customer rather than to the customer as the firm is accustomed. Many logistics systems have a difficult time han-, dling this type of movement. Costs tend to be very high. The cost of moving a product backward through the channel from the consumer to the producer may be as much as nine times as high as moving the same product forward from the producer to the customer. Thus, this significant cost and service area is beginning to receive more attention.

Reverse logistics. Logistics is also involved in removal and disposal of waste materials left over from the production, distribution, or packaging processes. There could be temporary storage followed by transportation to the disposal, reuse, reprocessing, or recycling location. As the concern for recycling and reusable packaging grows, this issue will increase in importance. This is of particular concern in Europe, which has very strict regulations regarding removal of packaging materials and even obsolete product due in part to limited landfill space.

Traffic and Transportation. A key logistics activity is to actually provide for the movement of materials and goods from point of origin to point of consumption, and perhaps to its ultimate point of disposal as well. Transportation involves selection of the mode (e.g., air, rail, water, truck, or pipeline), the routing of the shipment, assuring of compliance with regulations in the region of the country where shipment is occurring, and selection of the carrier. It is frequently the largest single cost among logistics activities. Transportation issues are covered in one of the next Chapter.

Warehousing and Storage. Warehousing supports time and place utility by allowing an item to be produced and held for later consumption. It can be held near the location where it will be needed, or transported later. Warehousing and storage activities relate to warehouse layout, design, ownership, automation, training of employees, and related issues.

2.3 The Relationship of Logistics Activities to Logistics Costs

Logistics costs are driven or created by the activities that support the logistics process. Each of the major cost categories – customer service, transportation, warehousing, order processing and information, lot quantity and inventory carrying – are discussed below.

Customer Service Levels. The key cost trade-off associated with varying levels of customer service is the cost of lost sales. Monies that are spent to support customer service include the costs associated with order fulfillment, parts, and service support. They also include the costs of return goods handling, which has a major

impact on a customer's perception of the organization's service as well as the ultimate level of customer satisfaction.

The cost of lost sales includes not only the lost contribution of the current sale, but also potential future sales from the customer and from other customers due to word-of-mouth negative publicity from former customers. A recent estimate indicated that every disgruntled customer tells an average of nine others about his or her dissatisfaction with the product or service. It is no wonder that it is extremely difficult to measure the true cost of customer service!

Thus, the best approach is to determine desired levels of customer service based on customer needs, and how those needs are affected by expenditures on other areas of the marketing mix. The idea is to minimize the total cost, given the customer service objectives. Because each of the other five major logistics cost elements work together to support customer service, good data are needed regarding expenditures in each category.

Transportation Costs. The activity of transporting goods drives transportation costs. Expenditures that support transportation can be viewed in many different ways, depending on the unit of analysis. Costs can be categorized by customer, product line, type of channel such as inbound versus outbound, and so on. Costs vary considerably with volume of shipment (cube), weight of shipment, distance, and point of origin and destination. Costs and service also vary considerably with the mode of transportation chosen.

Warehousing Costs. Warehousing costs are created by warehousing and storage activities, and by the plant and warehouse site selection process. Included are all of the costs that vary due to a change in the number or location of warehouses.

Order Processing/Information Systems Costs. This category includes costs related to activities such as order processing, distribution communications, and forecasting demand. Order processing and information costs are an extremely important investment to support good customer service levels and control costs. Order processing costs include such costs as order transmittal, order entry, processing the order, and related internal and external costs such as notifying carriers and customers of shipping information and product availability. Shippers and carriers have invested a great deal in improving their information systems, to include technology such as electronic data interchange (EDI), satellite data transmission, and bar coding and scanning shipments and sales. There also has been a growth in more sophisticated information technology, such as decision support systems, artificial intelligence (AI), and expert systems.

Lot Quantity Costs. The major logistics lot quantity costs are due to procurement and production quantities. Lot quantity costs are purchasing- or production-related costs that vary with changes in order size or frequency and include:

1. Setup costs.
    a. Time required to set up a line or locate a supplier and place an order.
    b. Scrap due to setting up the production line.
    c. Operating inefficiency as the line begins to run, or as a new supplier is brought on board.
2. Capacity lost due to downtime during changeover of line or changeover to a new supplier.
3. Materials handling, scheduling, and expediting.
4. Price differentials due to buying in different quantities.
5. Order costs associated with order placement and handling.

These costs must not be viewed in isolation because they also may affect many other costs. For example, a consumer goods manufacturer that produces large production runs may get good prices from suppliers and have long efficient production runs, but requires more storage space to handle large runs. Customer service levels may suffer as order fulfillment declines because products are produced infrequently, in large batches, and with inventory going to zero and creating stock out situations in between runs. This may increase information and order processing costs, as customers frequently call to check on availability of back-ordered products, and cancel back orders.

Transportation costs also may rise as customers are sent partial or split shipments. Inventory carrying costs will rise as large quantities of inventory are held until depleted, due to large batch sizes. The implication of one cost upon another must be explicitly considered.

Inventory Carrying Costs. The logistics activities that make up inventory carrying costs include inventory control, packaging, and salvage and scrap disposal. Inventory carrying costs are made up of many elements. For decision-making purposes, the only relevant inventory costs to consider are those that vary with the amount of inventory stored.

These costs will be explored in detail in Chapter 4. The four major categories of inventory cost are:

1. Capital cost, or opportunity cost, which is the return that the company could make on the money that it has tied up in inventory.

2. Inventory service cost, which includes insurance and taxes on inventory.
3. Storage space cost, which includes those warehousing space-related costs which change with the level of inventory.
4. Inventory risk cost, including obsolescence, pilferage, relocation within the inventory system, and damage.

2.4 Developing Logistics Strategy

Understanding the organization's overall strategy and the key trade-offs in that organization are important to developing logistics strategy. The primary goal of logistics in any organization is to support the organization's customer service goals in an effective and efficient manner. To do that, the logistics function and the organization's management need to know:

1. What do customers desire in terms of customer service levels and capabilities?
2. How is the competition performing in terms of customer service?
3. How is the organization performing today compared with the competition and, particularly, on those areas that the customer perceives as important?

Logistics costs also are an important aspect of analyzing alternative logistics service offerings. The next section provides an overview of some of the key issues in developing logistics strategy.

Answering questions one and two above can be accomplished through a marketing and logistics audit of the external environment.

Based on this analysis, an organization can identify its own strengths and weaknesses, and what may be potential opportunities and hazards in the marketplace. Objectives or goals for the logistics function are thus formulated. Based on the objectives, alternative strategies or plans of action need to be developed in support of those objectives. The analysis should include the implications of each alternative on other functions and performance parameters, as well as an analysis of the total cost of each alternative. Thus, a systems approach is required.

Once a decision has been made concerning logistics strategy, the organization must ensure that its current logistics structure is adequate to achieve that strategy, or adjust the channel structure accordingly. Proper channel design is an important concern for logistics professionals. The next section addresses some additional future

challenges facing logistics professionals, and highlights some key areas for logistics performance improvement

Chapter 1. Part 3.

Future Challenges and Areas for Logistics Performance Improvement

This section presents some of the key challenges and issues that logistics faces today and will continue to face in the future. These themes will be integrated throughout this text to provide continuity and an understanding of how these issues affect the performance and perceived importance of various logistics activities.

As the role of logistics grows and takes on greater importance in achieving the overall goals of the organization, logistics needs to meet the challenge and improve its performance to support those goals. Some areas of opportunity include:

- Greater participation in setting organizational strategy and the strategic planning process.
- Total quality management (TQM).
- Identification of opportunities for using logistics as a competitive weapon/marketing strength.
- Just-in-time (JIT) logistics.
- The use of quick response (QR) and efficient consumer response (ECR) techniques.
- Improved understanding of and accounting for logistics costs.
- Better understanding of global logistics issues and improved logistics information systems.
- Greater participation of logistics professionals on work teams.
- Appropriate understanding and use of outsourcing, partnerships, and strategic alliances.
- Greater understanding and appropriate application of technology.
- Green marketing.

Each of these issues is explored below.

Strategic Planning and Participation. Activities such as logistics budgeting and control, inventory planning and positioning, and customer service have become important parts of the organization's strategic planning process. A study supported by the Council of Logistics Management illustrates that strategic planning is performed by the majority of logistics organizations studied. Bergen **Strategic Planning at**

Brunswig, a multibillion dollar drug wholesaler, reports that logistics participation in **Bergen Brunswig** strategic planning is critical, with the vice president of Logistics attending corporate strategy meetings and serving on the task force which thinks strategically about the future.

Table 3.1 − Strategic Planning by Departments

	Planning Level				
	Corporate	***Marketing***	***Manufacturing***	***Logistics (Staff)***	***Logistics (Function)***
Is strategic planning done at this level?	**97%**	**93%**	**86%**	**82%**	**70%**
Is there a formal written plan at this level?	**90%**	**85%**	**75%**	**65%**	**55%**
How many years has this formal system existed?	**8**	**8**	**5**	**4**	**3**
How many people are involved?	**11**	**10**	**10**	**5**	**5**

Total quality management (TQM) is a philosophy that should be embedded in all aspects of logistics operations. Going beyond simple "quality control," which monitors for problems in actual performance after the fact, TQM is a philosophy that is integrated in designing logistics systems to achieve desired results, performing logistics activities, and monitoring results. Total quality management involves being proactive in performing the right activity the right way the first time, and continuing to perform it to the required level. In logistics, that could translate into short, predictable transit times, certain levels of in-stock availability, and certain fill rates on customer orders.

One reason that logistics has received more attention as a strategic function is the growing recognition given to it in the **Malcolm Baldrige National Quality Award.** This award, administered by the U.S. Department of Commerce, was designed to recognize organizations that have achieved an outstanding level of quality and competitive excellence in the global marketplace. Many organizations are using the award criteria to evaluate and improve their quality procedures, even if they do not intend to apply for the award.

Twenty-five percent of the points used in judging applicants for awards are based on customer satisfaction. The "customer focus and satisfaction" category rates the company's knowledge of the customer, responsiveness, overall customer service

systems, and ability to meet requirements and expectations. Thus, an organization must have a good logistics system and include logistics in its strategic planning process to score well in this major area.

Scoring the Balridge Award, 1996 criteria

1.0 Leadership (90 points)
- 1.1 Senior executive leadership (45)
- 1.2 Leadership system and organization (25)
- 1.3 Public responsibility and corporate citizenship (20)

2.0 Information and analysis (75 points)
- 2.1 Marketing of information and data (20)
- 2.2 Competitive comparisons and benchmarks (15)
- 2.3 Analysis and use of company-level data (40)

3.0 Strategic planning (55 points)
- 3.1 Strategy development (35)
- 3.2 Strategy deployment (20)

4.0 Human resources development and management (140)
- 4.1 Human resource planning and evaluation (20)
- 4.2 High-performance work systems (45)
- 4.3 Employee education, training, and development (50)
- 4.4 Employee well-being and satisfaction (25)

5.0 Process management (140)
- 5.1 Design and introduction of products and services (40)
- 5.2 Process management: Product and service production and delivery (40)
- 5.3 Process management: Support services (30)
- 5.4 Management of supplier performance (30)

6.0 Business results (250)
- 6.1 Product and service quality results (75)
- 6.2 Company operational and financial results (130)
- 6.3 Supplier performance results (45)

7.0 Customer focus and satisfaction (250 points)
- 7.1 Customer and market knowledge (30)
- 7.2 Customer relationship management (30)
- 7.3 Customer satisfaction determination (30)
- 7.4 Customer satisfaction results (100)

7.5 Customer satisfaction comparison (60)

Total points = 1,000

The **ISO 9000** (International Organization for Standardization) series is an internationally recognized certification program whereby the quality processes of firms are audited to verify whether they have well-documented and effective quality processes in place. It was bora in Europe in 1987 in an effort to support trade between countries and companies.

Just-in-time (JIT) is an inventory management philosophy aimed at reducing waste and redundant inventory by delivering products, components, or materials just when an organization needs them. As will be discussed in next lectures, JIT has profound implications on logistics systems. JIT requires close coordination of demand needs among logistics, carriers, suppliers, and manufacturing. JIT also represents a tremendous opportunity for the logistics function to contribute to the organization's success by reducing inventory while simultaneously maintaining or improving customer service levels. Thus, JIT represents an important trend in inventory management that will be discussed throughout this text. Applications of JIT principles to the retail and grocery sectors are discussed below in relation to quick response and efficient consumer response.

Quick response (QR) is a retail sector strategy which combines a number of tactics to improve inventory management and efficiency, while speeding inventory flows. Most QR is between manufacturer and retailer only. When fully implemented, QR applies JIT principles throughout the entire supply chain, from raw material suppliers through ultimate customer demand.

The concept works by combining electronic data interchange (EDI) with bar coding technology, so that the customer sales are tracked immediately. This information can be passed on to the manufacturer, who can then notify its raw material suppliers, and schedule production and deliveries as required to meet replenishment needs. This allows inventory reductions while speeding response time, lowering the number of out-of-stock products, and reducing handling and obsolescence. While QR began in the textile and apparel industry, it is now being applied by many industries in the retail sector. The grocery industry has begun an adaptation of this approach, called efficient consumer response, as discussed in the next section.

QR has had a major impact on distribution operations. Rather than "warehousing" product, distribution centers are now charged with "moving" the product through quickly.

This frequently entails **cross-docking,** whereby the inbound product is unloaded, sorted by store, and reloaded onto trucks destined for a particular store, without ever being warehoused. As a result of QR, Mercantile Stores has reduced the number of distribution centers it owns from 12 to 8.

To further improve retail efficiency, some suppliers are shipping goods prehung and preticketed. This concept, known as "floor-ready merchandise," is growing in popularity. As noted by Randy Burnette, director of QR for Mercantile, "Our strategy and goal is to maximize the portion of business that is floor ready." One retail executive commented that mer-

chandise routinely spends an additional three days in the distribution center (DC) if it does not have retail price tickets and the proper hangers. Floor-ready merchandise may lead to a reduction in the number of DCs, and processing time can be greatly reduced.

Efficient consumer response (ECR) combines several logistics strategies in an effort to improve the competitiveness of the grocery industry by cutting waste in the supply chain. It is the grocery industry's answer to QR.[33] ECR includes the following strategies:

1. Widespread implementation of electronic data interchange up and down the supply chain, both between suppliers and manufacturers, manufacturers and distributors, and distributors and customers.
2. Greater use of point-of-sale data obtained by greater and more accurate use of bar coding.
3. Cooperative relationships between manufacturers, distributors, suppliers, and customers.
4. Continuous replenishment of inventory and flow through distribution.
5. Improved product management and promotions.

By applying the fourth point, continuous replenishment and flow through distribution, inventory is managed on a just-in-time basis, rather than stockpiled in warehouses and distribution centers. Product is cross-docked, whereby it is unloaded at one dock, broken down into store-sized shipments, and reloaded on trucks to go directly to the stores. Thus, cooperation and coordination are very important to ensure proper sequencing of truck loading and unloading, as well as the proper product mix. The belief is that the potential exists to reduce pipeline inventory by up to 40 percent.

A key feature of ECR that distinguishes it from QR is the emphasis on moving away from the grocery industry's "deal mentality." Cooperation is required among industry participants to move away from the heavy use of promotional strategies. Such strategies encourage grocers to "stockpile" or forward buy product due to

promotions such as a temporary low price or "buy two, get one free" deals. This creates excessive inventory in the supply chain, and reduces the number of times inventory turns over each year.

The ECR strategy was developed to offset some of the pressure on the grocery industry by mass merchandisers like Wal-Mart, and Warehouse clubs. It will be referred to throughout the text.

Logistics as a Competitive Weapon. Logistics may be the best source of competitive advantage for a firm because it is less easily duplicated than other elements of the marketing mix: product, price, and promotions consider for example, forming close, ongoing relationships with carriers or logistics service providers can help give the firm a distinct competitive advantage in speed to the customer, reliability, availability, or other customer service factors.

The power of logistics in achieving an organization's customer service goals and supporting customer satisfaction has received an increased amount of attention in the press. Companies that understand and utilize the potential of logistics as a competitive weapon include logistics as a key component of their strategic planning process. In recognition of the key role of logistics in supporting strategic customer service initiatives, the logistics function of Levi Strauss and Company began reporting to marketing rather than operations in 1990. To support this, logistics began formal strategic planning for 1990.

Questions and Problems

1. How do improvements in logistics productivity affect the economy as a whole, as well as the position of individual consumers?
2. How is logistics related to the marketing effort? Be sure to discuss customer service/ customer satisfaction, integration of efforts, and cost and performance outputs.
3. What are the different types of utility? How does logistics directly or indirectly affect each one?
4. Why has logistics recently been receiving more attention as a strategic function of the organization?
5. What is meant by the profit leverage affect of logistics? What are the greatest cost savings opportunities for logistics?
6. Based on the examples shown in the text, what is the profit leverage effect of logistics in a firm with pretax profit of 5%? Of 10%? How could you use this information to get favorable attention for a logistics cost-saving effort?

7. Discuss the key challenges facing logistics today. What do you see as the greatest area of opportunity for logistics? Why?
8. How has the role and performance of logistics been enhanced by the growth of technology, particularly information technology? What do you see as key trends in the future?
9. Of the 14 areas of logistics responsibility, which do you believe will experience the most change in the next five years or so? Why?

Chapter 2.

Meaning and the functional structure of the logistics of enterprise.

Basing on the definition of the system as the set of the elements, which are related with each other and form some integrity that provides emergent features of the system, we can allocate few features of the system (including logistics system), such as:

- system is always subdivided to the appropriate elements;
- elements of the system in the specific moment are ordered some way;
- such organization of elements of the system determines the meaning of relationships and communications;
- system as the entire organization of elements, forms the new emergent features as the features of entire system not inherent to any particular element;
- beside that, logistics system is characterized by availability and priority of the processes of material and informational flows.

Specific integrity of logistics system not like the other systems is in it's through- and general nature at the same level as finances and personnel etc.

The main objective of functioning of logistics system at the micro-level is in delivering of industrial-technically intended goods, or the consumer goods of needed quantity and assortment at the maximum possible stage of its readiness to using or consumption at the place which customer needs ("The right product at the right time and, the right place") along with defined level of logistics costs. Presented objective of logistics of enterprise starts in the logistics approach to the material flows management in individual functional branches (supply, production, distribution), afterwards this theory and practice naturally integrates this approach regarding to the common-enterprise goals, and finally, the modern development stage describes the upper level of integration – the combination with strategic management. (E.g.

regarding to construction of the product, new technology development, collaboration with environment, etc.)

According to this processes dynamics, practice was often ahead the theory, transforming into the appropriate system decisions. As for functional branches of supply, production and distribution, the logistics approach has formed few effective system decisions. The “MOB problem” (“make-or-buy problem”) deserves the attention paid to it. In the narrow view it is decision between individual producing of the goods needed, or buying it from the other producer. In the wider view, beside said before, it is making decision about using of individual transport or common transport, individual warehouses or common ones, etc. Formalization of the decision making process allows to create unified methodical instrument, but there are also completely opposite points of view of leading specialists in the management branch on the optimal level of vertical integration (production depth), because high level of vertical integration reduces enterprises dependence from market fluctuations but can also cause rising of production cost, while the low level means switching to so-called “screwdriver technology” which makes the enterprise hardly dependent from suppliers, market fluctuations, causes the persona loss.

“Just in Time” system is the system of production and delivery of details, spare parts in needed quantity and time. System provides production’s adaptation to the changes, caused by “violations” in the technologic lines, and in case of it’s using in the scale of entire enterprise and main suppliers the rhythm of producing is provided, the stocks are hardly reduced. Using of this system makes the realization of “production with zero stock” conception possible. The most completely the principles of “Just in Time” are implemented in the Canban system.

The system with two fixed levels of stock without constant frequency of orders is the system of the stock status control, in which stock is refilling when its level reaches the order level. The system with two fixed levels of stock and the fixed order frequency, unlike the previous, besides rationing upper and lower levels, sets the period between orders.

The system with fixed orders frequency is the system of the stock level control, in which the period between orders is at constant value. In the end of every period the stock level is checked, and depended of this, the size of delivery batch is formed. Unlike the previous system with fixed order size, the stock level is regulated by changing the delivery interval with constant size of delivery batch. (Optimal delivery batch).

The PRM (Physical Resource Management) system is the system of management of technical service of fixed assets based on integrated approach to the

different elements, including gathering and procession of information, giving the repair manuals, control of the spare parts supply, etc. The higher control in this area is the SRP (Service Requirement Planning) system – the automated system of management of technical service of production equipment, which provides optimization of prophylactics and repair service, reducing of the additional materials stock, spare parts (up to 20%), rise of the equipment efficiency (up to 10%). RMP system can function as the subsystem or to be isolated.

In the production branch two types of material resources management systems are distinguished: the first are called "push systems" what means the production organization system in which details and semis are given from previous technological operation to the next according to earlier formed schedule. The same system in the distribution branch means outgoing (as for the demand) forming of the stock in wholesale and retail commercial enterprises. The second, "pull systems" – are the production organization systems in which details and semis are given from previous technological operation to the next as necessary, without any strict schedule. In the distribution branch these systems mean outgoing (as for the stock forming) stimulation of customer's demand. In other words, typical for the first type systems is providing the plan to each structural subdivision, and for the second type – to the distribution subdivision only.

The DRP (Distribution Requirements Planning) system is the distribution management system, it is the "push" system, it performs the important functions of the stock quality control, forming of the production relations with distribution and supply. Modern DRP system has transformed into MRP system as the production organization system and material-technical supply (MTS). In this system at the first stage the planning is implemented using forecasts and facts about actual orders. At the second stage the production schedule is formed, the plan is structured for the specific dates, quantity of hardware goods, and ready products. At the third stage the calculation of demand of material resources and production capacities is implemented. DRP system can serve as the base of integrated planning of logistics and marketing functions, it allows forecasting market conjuncture, to optimize logistics costs, to plan the deliveries and stocks at the different levels. The important function of DRP is the transport planning, including transport-expedition service, transport schedules, demand in transportation.

Canban system is the organization of production and MTS, which allows implementing the principle "Just in Time" better, is the "pull" class system. It is developed and the first used by "Toyota" company (Japan) in the end of 60^{th}–early 70^{th}. Nowadays the Canban system is widely used by a lot of industrial enterprises in

USA, Europe as in the updated form, as in combination with other well-known systems of organization of production and MTS (MRP, MRP-2, etc). According to Canban system, the department-producer does not have finished plan-schedule, but is strictly guided by concrete orders of department-consumer, and optimizes its work inside this order. That's why production is always at stage of "superstructure". Fluctuations of demand and market conditions have its limits, behind which Canban system begins to fail. The limit of system's efficiency is 7-10 % difference from general plan. The specific approach to choice of suppliers is based on the collaboration with narrow circle leading by principle of long-term connections, which are capable to work "Just in Time".

Canban system means using systems and methods of the products quality control management, close collaboration with supplier and assisting him, and all of these give the Japanese enterprises huge economical effect. Nowadays this technology is used by such firms as: "General Motors", "Renault". Analysis shows, that Canban system makes possible the reduction of production stock up to 50%, goods – up to 8% with respectable speeding up current asset flow.

MRP (Material Requirements Planning) system is the system of organization of production and MTS, which is the "push" system. MRP-1 system has been developed in 60^{th}. Its creation matched in time with the spread of computing. Due to development of precious computing complexes, the opportunity has appeared to coordinate and correct plans and actions of supply, producing, and distribution branches in real time. Formalization of decisions made in MRP system is executing with different methods of investigation of operations. Based on the mathematical models, informational and program software, there is an opportunity to solve the problems of calculating demand of raw, materials, to form the schedules of producing and distribution etc. At the end of 80^{th} in USA it was used by the most of enterprises with the sales over 15 million dollars a year, In Great Britain – every third enterprise. The disadvantages of MRP system are: large costs of forming the database, inability to consideration a lot of important factors of producing process, which forced the development of the new system MRP-2

MRP-2 (Manufacturing Resources Planning) system is the system of production organization and MTS, which is different from MRP system not by the technology level, but by management flexibility and content of functions. MRP-2 includes few new functions (automatic design, management of technical processes, etc.). Investigations made in USA signed, that using MRP-2 technology reduces the stock size for 17%, the raw purchasing costs for 7.

Modern achievements in logistics have found their display in the following systems. System LRP (Logistics Requirements Planning) – the system of control of incoming, inner, and output flows at the enterprise level. LRP system is also known as "Supply Chain Management". LRP provides the integrated approach to: the stock management in the channels of circulation sphere, production and goods stock, incomplete production; forecasting the demand in transportation, demand for the products of enterprise; definition of the optimal content of logistics chains etc. In LRP systems the applications of MRP and DRP are widely used.

OPT system (Optimized Production Technology) is the system of organization of production and supply, made by Israel and American scientists at the beginning of 80^{th}. In the western European literature OPT system is known as "Israel Canban" and is the "pull" class system. OPT is the computerized Canban with the difference in fact, that OPT makes the appearance of "the bottlenecks" in the "supply-production-sales" chain impossible, and Canban allows to effectively remove "the bottlenecks". The main principle of OPT system is detection of "bottlenecks", according to the terminology of its creators – critical resources, which can be the stock of raw and materials, machines and equipment, technological processes, personnel. The effect of OPT system is in the increasing of output of completed products, reduction of the producing and transport spending and the stock of incomplete products, reduction of production cycle and demand in warehouses and production areas, improvement of the delivery frequency to the consumer. CALS system (Computer – aided Acquisitions & Logistic Support) is the automated system of control and management of developments in the branch of military technology, organization of its production, technical support, providing the spare parts. The CALS system has been developed by USA Defense Department since 1985, introducing step-by-step since 1988-1989. In the CALS system the complex of standards of automated data transmission is provided between consumer, supplier, and also departments which produce and use military technology. Introduction of CALS makes possible the reducing of time of the military technologies development, mastering its production, quality improvements, reducing of logistics cycles.

CONTROL QUESTIONS

1. Describe the features of logistics system and its particular properties comparing with other systems.

2. Characterize the main goal of logistics systems at the micro-level.

3. Show the examples of logistics solutions in particular branches (supply, production, distribution etc.)

4. Characterize the systems of organization and management of production, which “push” (DRP, MRP)

5. Characterize the systems of organization and management of production, which “pull” (DRP-2, MRP-2)

6. Characterize the sense of the management systems LRP, OPT, CALS.

Chapter 3.

The concept and functions of logistics.

The entering point for the solving the logistics problems nowadays are the problem of market requirements, strategy and structure of production. The main aspects of material-technical supply are the objects of increased interest for the investigators. The reason was the increasing competition with the South-Eastern Asia countries, especially Japan, and US, where the attention to production activity of the enterprises has been increased. In the most cases the previous production, excluding the demand factors (what? where? when? in what form? with what characteristics?), could exist only because it worked for the stable market. However, the modern market conjuncture talks about the following changes: reduction of the markets stability; desire of the product’s differentiation on the late stage of production; desire of the production of the variable products basing on the most similar components; using the advantages of mass production not at the stage of assembling, but at the stage of components producing; desire of the maximum meeting of the customer’s demands at the stage of choice of the product to produce. All of this demands the production flexibility at the department level, what can be developed as by the expansion of equipment re-adjustment abilities, as by using the methods of production organization aimed for the stock minimization – the “Just in Time” system, Canban system.

In general, we see the priority changes between the different types of economic activity in favor of the material flow management. On practice this also means shift in emphasis to the side of forming the necessary information or appropriate production organization instead of expensive reserve stock. So, the main idea of logistical view is based on the optimization of producing-economic activity by effective material flow management, and is the concept of logistics. The modern meaning of it is dynamically complementing by the problems of strategic plan, marketing problems, etc.

During the recent years, European industry is quiet strong influenced by the new philosophies and concepts, which are generally based and developed on the Japan enterprises. Among them the main place takes the concept of the line production, which is characterized by following:

- maximum decentralization of the tasks and the direct responsibility of workers;
- the products quality increase;
- applying of the developed level of automation;
- obtaining the sufficient communicative and information experience.

The analysis of the weak sides of the logistics system shows that the reasons of most problems depend of employee behavior, that is:

- significant difficulty of processes, which cannot be learned by worker;
- bad information communications between separate departments and enterprises with the information available;
- poor discipline in the logistics chain using the data procession system;
- poor personnel qualification;
- missing the information about the results of wrong behavior of employees;
- poor motivation for the cooperation between the separate departments.

These problems cause the tendencies to the simple, unramified, organizational forms and systems, and on the other hand, show the fact that no patent recipes and standard solving do exist. That's why during the forming of logistics concepts the specific features of enterprises must be considered.

While choosing the logistics concepts, should clearly determine the goals of logistics organization, for example:

- integrated review of the general logistics chain;
- high maneuverability of available recourses;
- creation of differentiable wages and providing the encouragements;
- reduction of the production cycles by system optimization of the processes;
- realization of precautionary measures against bad production;
- reduction of the idle time and time of plantation, adjustment, preparation of production;
- parallelism of material and information flows;
- reduction of the process complexity;
- reduction of the intermediary management branches number;

- optimization of the technology and technique of stocking, transportation, packaging;
- management of the general logistics costs in order to minimize them;
- introduction of integrated logistics-marketing and logistics-management;
- introduction of the logistics service system;

Achievements, connected with the logistics projects realization of the recent years, confirm the rising interdependence of production and logistics. Production depends of the intense implementation of logistics, because its necessity here is considered not only from the technical or economic-organizational point of view, but also taking into account the social sphere.

As the applied logistics instrument, the following solving, concepts and systems should be used:

- global logistics strategy (Global Sourcing);
- production-synchronous supply;
- Make-or-Buy decisions;
- Just in Time production
- ABC/XYZ analysis;
- modular production;
- production segmentation;
- Canban system;
- lean production.

3.1. The pyramid and the goal conflict in the logistics of enterprise

Pursuing the main objective of implementing the theory of logistics decisions into the management, forming the logistics decisions and projects include appropriate structuring of logistics objectives. Next to the general logistics, logistics management meets the numerous goals of partial or subject nature, which somehow “support” the common goal, because they are in some hierarchy for it.

The result of logistics goals structuring is formed primarily under the influence of the order nature. The order can de the finished product, which is in the production program, modified product, which is also in the production program, and the product which has to be created (new one).

Depending of the order nature, the different profiles of regulation form in the logistics management. The first one, diminished profile of regulation, concerning the production of mastered products, does not demand including to the process such functional branches as development of the product and technologic preparation, and

applies only to supply, producing, sales, control, and transport. The second one, expanded profile of regulation, demands the additional inclusion of functional branches of products development and technologic preparation, because that's concerned with the new products emission.

Considering the above, is appropriate to show the hierarch of the entrepreneurship goals, structured by levels from the logistics position. It is shown in the form of pyramid. (Figure 1)

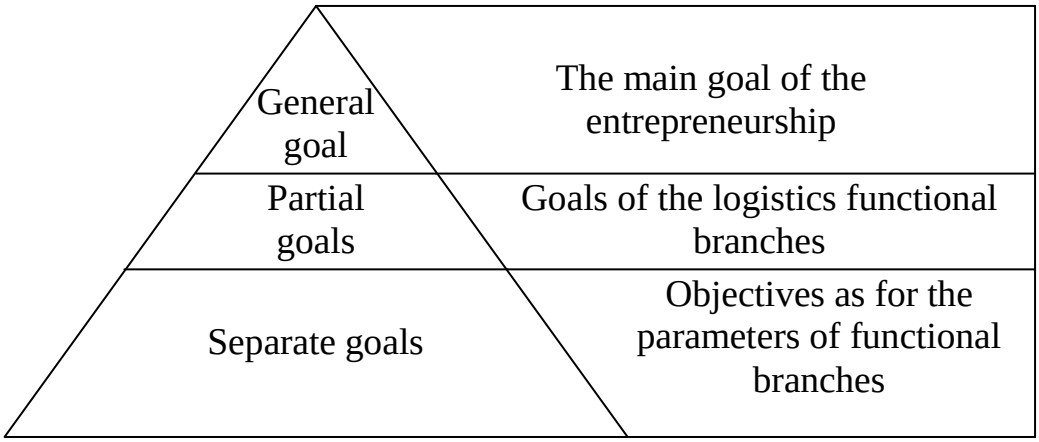


Figure 1 - Pyramid of the entrepreneurship goals and its meaning.

The main goal of the producing enterprise can be formulated this way: the acceleration of material and non-material flows and the costs minimization, starting from the order accept to the delivery to the customer. It is clearly that the main goal will initiate some reactions concerning to reduction of innovation cycles, technologies, production and transport processes,

The goals of functional logistics branches are in the full execution of program tasks with the minimum costs. We should mark, that specifics of the partial logistics goals does not require the local time optimization, because it is provided in the main goal. Based on the principle of emergency, it becomes unreal to combine local and global time optimization in case of simultaneous local costs minimization. The well-known dilemma "win at time, lose at money" occurs in the transportation, in the supply, in the production and sale.

The separate goals of the products development logistics can include the creation of block products for the accelerated reaction on the modifications, technology unification, the spare parts standardization, the products ability to repair, stocking unification, packaging and transport, etc.

The separate goals of the technical preparation logistics provide the setting of optimal depth of the own production, applying the resource-saving technologies, simplification of production processes, providing proportion of production process.

The separate goals of logistics of supply, sale, recycling, production and transport can be formulated the same way. This can occur some separate goal conflicts, as a result of realization of logistics decisions. Goal conflicts of the first type appear as a contradiction between executing the separate functional branch goal and the realization of the main goal of enterprise. Thus, providing the permanent guarantee of continuous material production requires the increased material stock from the supply sphere, and this causes the costs increase in general for the enterprise. The same way, request of accelerating the reaction to the customers' orders leads to the increasing of total costs of the enterprise. That's why these conflicts can be removed only by the logistics planning and management. We should say that enterprise logistics makes possible the rational increasing of the total costs, if it is followed by the high profit increase.

For example of the goal conflicts coordination, let's take the typical situation of business in market economy. Conducted marketing researches showed: there was a unsatisfied demand for the products, which didn't meet the profile of enterprise. In this case the market expansion will require reduction of the goods supply time from the moment of receiving the order. And this is important, because there is the adequate reaction of the competitors. But, the development time reduction is followed by the rise of organization, supply, selling, and transport costs.

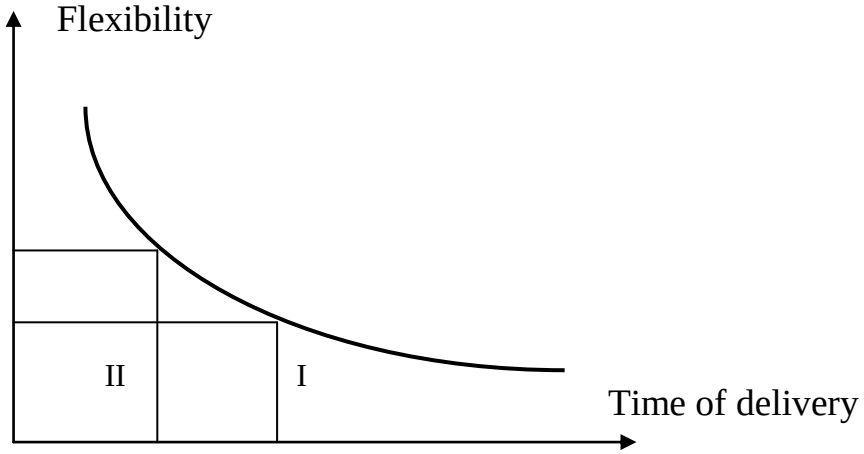


Figure 2 The flexibility dynamics of the enterprise

The shown curve illustrates the hyperbolic dependence of enterprise flexibility from the delivery time of the products. At the moment of receiving the order production can be at the different stages: in stock, under production, or not to be inside the enterprise. The extreme phases show in accordance its maximum and minimum flexibility. However, the appropriate funds at the separate phases may change the dynamics of enterprise flexibility.

The goal conflicts of the second type concerning the contradictions between the logistics goals of separate functional branches. The availability of large material stock allows reducing the reaction time in material production in case of making the decision of its increasing. That means the extra spending for holding extra stock, but the production area can react more quickly. From the other hand, holding the small stock can cause higher transport spending in supply.

The goal conflicts can be also found in the production logistics referring to the depth, seriality of production, in the sales logistics, transport logistics, etc. Their removal requires the appropriate compromise in every single case, which is forming the optimality of decisions. The shown argues the significant role of the logistics theory for the effective development of business activity in a market economy.

Control questions

1. Characterize the subject and the objects of logistics.
2. What is the concept of logistics?
3. Tell the goals of implementing the logistics in the economy practice.
4. Describe the meaning of logistics functions and their integration in the system of management.
5. Characterize the applied logistics tools.
6. Describe the functional structure of logistics of enterprise.
7. Show the pyramid and characterize the goal conflict in the logistics of enterprise.

Chapter 4

Designing of logistics decision of choose of the materials, parts, and nodes.

Choose of materials, parts and nodes for the own production or external supply as the object of logistics decision is the key element in the system of logistics planning and goods flow management in the sphere of production and circulation. More complicated the product is, more questions stands for the producer, such as:

– can all the parts be produced on the own powers, and is it necessary;

– if it’s not, is the existent production depth optimal;

– what organization and stocking problems do appear with the multi-nomenclature stocking of materials and parts;

– what economic impacts do appear with the major part of the own production, in other words with the complex system of division of labor;

– can the enterprise react quite quickly to the customers wishes, depending of the division of labor level.

The answer of this and other questions is necessary for the decision making, which touch the following:

– obtaining the rational division of labor level (production depth) in future;

– forming the stock economy and the supply system;

– investment activity in the expanding of production or introduction of the new activity direction (re-specialization);

– expanding or changing the sphere of using the increased or new product;

Based on the written above, the first stage of optimization have the next goals:

– the principle division of materials, parts and nodes into three groups: the own production, the third-party production, supply by demand (synchronously, “Just in Time”, etc);

– the balancing of using the production powers.

Note, that in this optimization calculation, we does not set the task to spot the demand in materials, parts, and nodes, moreover, its forecasting. For this task there are the well-known instruments of forecast rating (statistic, factor analysis, etc).

The methods of optimization calculation include the next steps, showed in the form of block-scheme:

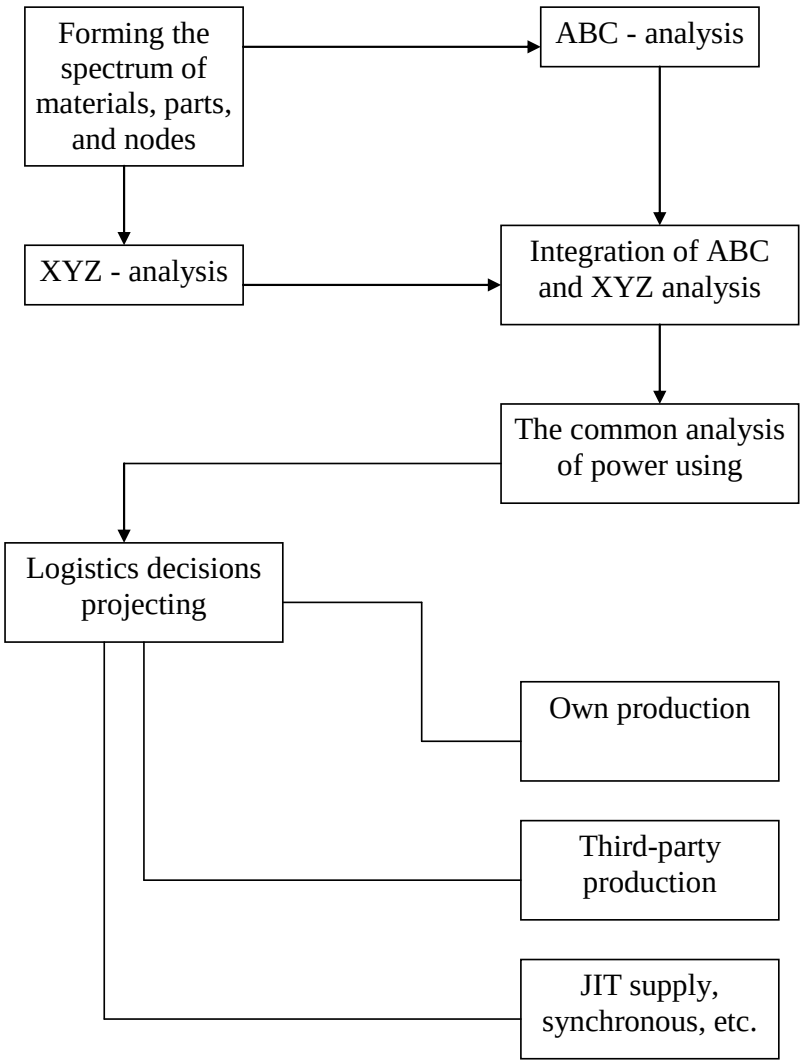


Figure 4.1. The block-scheme of the choose optimization of materials, parts, and nodes.

The block of material, parts, and nodes spectrum (assortment) forming includes their list, monthly amount by quantity and value and the group ratings of their consumption permanence. Value ratings are the base of ABC-analysis, and the group values – the base of XYZ-analysis.

The meaning of the second block (ABC-analysis) is in the following: the necessary assortment of materials, parts, and nodes in the chosen period, is table-like placed in order of decreasing of value ratings, which allows to calculate the summed value ratings and their percentage in the next column. Simultaneously the structure ratings of quantity position and their percentage are calculated. This allows comparing the summed sizes of structure concerning the value and quantity ratings and fundamentally dividing the assortment into three groups: A, B, and C. Group A because of the high value quite strong affects the capital costs in supply, stocking, i.e. the general capital costs. Group C because of the relatively low value barely affects

the size of advance funds. Group B has the intermediate position. For example, the graphic interpretation of those groups looks like following:

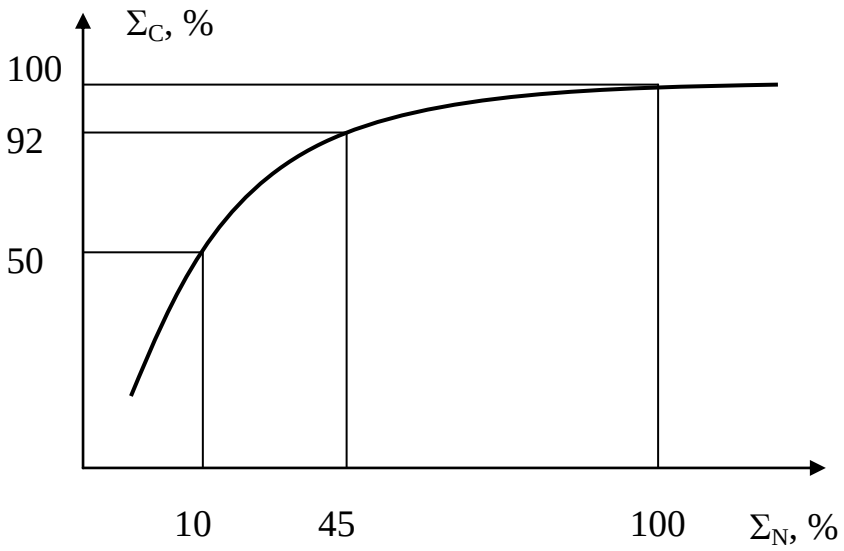


Figure 4.2. Graphic interpretation of ABC-analysis

This figure shows, that group A is formed by 10% of the first positions of assortment by value (Σ_N), determining 50% of summed value (Σ_C); group C – appropriately 55% of the smallest by value positions of assortment, determining only 8% of summed value. Group B consists of 35% of positions by quantity, and 42% by value.

Naturally that such order of division into groups is slightly subjective, and, as result, there are different ratings of distribution. For example, different authors suggest forming the group A by the ratings:

– 8% of assortment is 70% of value;

– 20% of assortment is 70% of value;

– 10% of assortment is 50% of value, etc.

That's why the modified approach to the group forming is suggested. It is based on the integration of ABC- and XYZ-analysis methods.

Besides the analysis of materials, parts, and nodes stock, their consumption (ABC-analysis), ratings of permanence of consumption are also important for the processes of stocking, supply and transport. Consumption of one kind of material, parts and nodes positions is predictable, and has the deterministic nature, consumption of the others is unpredictable, random, and has the stochastic nature. Such a meaning makes possible to represent consumption structure by the factor of stability of consumption, forming the base of XYZ-analysis, the next block of presented block-scheme.

The special literature gives the following advices:

– group X – almost stable (deterministic) consumption, instability is random and is less than 20% a month, weekly predictability of consumption of materials, parts and nodes is more than 95%;

– group Y – the consumption of parts and nodes is characterized by strong instabilities, and is between 20% and 50% a month. Weekly predictability of parts consumption is more than 70%;

– group Z – stochastic consumption, instability of consumption is more than 50% a month, weekly predictability of the parts consumption is less than 70%.

While using the XYZ-analysis in the explained meaning the problem of quantity rating of instability appears, in other words, this is the problem of the scale of ratings. Using of the next ratings is recommended:

– group X – stable consumption, rating is 9-10 points;

– group Y – instable consumption, rating is 4-8 points;

– group Z – stochastic consumption, rating is 1-3 points.

The next step of the illustrated block-scheme is in the combined using of ABC- and XYZ-analysis. Let's consider the simple example for the assortment of 10 parts. The entries are listed in the table.

Table 4.1.

Parts	Monthly amount of parts, UAH	Percent (by value) of the total amount (C_i)	Percent of the total amount(N_i),	Rating of the consumption stability
1	**2**	**3**	**4**	**5**
P1	630	6,3	15,7	2
P2	910	9,1	7,5	6
P3	1090	10,9	5,4	6
P4	690	6,9	10,8	10
P5	500	5,0	18,0	1
P6	400	4,0	10,5	5
P7	2050	20,5	6,2	8
P8	2710	27,1	7,0	10
P9	320	3,2	6,6	6
P10	700	7,0	12,3	7
Σ	10000	100,0	100,0	x

Considering the illustrated meaning of analysis methods, we get the next table (see Table 4.2).

The columns 9 and 10 of the table 4.2. are the results of the classification of the each part to some group by ABC- or XYZ-analysis, but the column 9 does not include the recommended groups because of the loss of quantity ratings. That's why we use the next recommendation: classification to the groups A, B, C.

Table 4.2.

№	Parts	Monthly amount of parts, UAH	Percent of the parts (by value)		Percent of the total amount		Consumption stability, points	Recommended groups	
			C_i	ΣC_i	N_i	ΣN_i		j(A,B,C)	k(X,Y,Z)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	T8	2710	27.1	27.1	7.0	7.0	10		X
2	T7	2050	20.5	47.6	6.2	13.2	8		Y
3	T3	1090	10.9	58.5	5.4	18.6	6		Y
4	T2	910	9.1	67.6	7.5	26.1	6		Y
5	T10	700	7.0	74.6	12.3	38.4	7		Y
6	T4	690	6.9	81.5	10.8	49.2	10		X
7	T1	630	6.3	87.8	15.7	64.9	2		Z
8	T5	500	5.0	92.8	18.0	82.0	1		Z
9	T6	400	4.0	96.8	10.5	93.4	5		Y
10	T9	320	3.2	100	6.6	100	6		Y
Σ	x	10000	100	x	100	x	x	x	x

Classification is made by calculation indicator:

$$V = \frac{\Sigma C_U - \Sigma C_L}{\Sigma N_U - \Sigma N_L},$$

where the indexes "U" and "L" mean appropriately upper and lower values of these ratings (columns 5 and 7 of the table 4.2).

The intervals of this rating are:

– group A : $V > 3{,}0$;

– group B : $0{,}7 \le V \le 3{,}0$;

– group C : $V < 0{,}7$.

In our example, group A includes only three first positions of the parts (parts 8, 7, 3), because:

$$V_A = \frac{58{,}5 - 0}{18{,}5 - 0} = 3{,}145 > 3{,}0$$

Appropriately the group B includes only three next positions (parts 2, 10, 4), because:

$$V_B = \frac{81{,}5 - 58{,}5}{49{,}2 - 18{,}6} = 0{,}752 > 0{,}7$$

Appropriately the group B includes four next positions (parts 1, 5, 6, and 9), because:

$$V_C = \frac{100 - 81{,}5}{100 - 49{,}2} = 0{,}364 < 0{,}7$$

The results of the distribution of parts between the groups are represented in the next table.

Table 4.3

№	Parts	Monthly amount of parts, UAH	Percent of the parts (by value)		Percent of the total amount		Consumption stability, points	Recommended groups	
			C_i	ΣC_i	N_i	ΣN_i		j(A,B,C)	k(X,Y,Z)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	P8	2710	27,1	27,1	7,0	7,0	10	A	X
2	P7	2050	20,5	47,6	6,2	13,2	8	A	Y
3	P3	1090	10,9	58,5	5,4	18,6	6	A	Y
4	P2	910	9,1	67,6	7,5	26,1	6	B	Y
5	P10	700	7,0	74,6	12,3	38,4	7	B	Y
6	P4	690	6,9	81,5	10,8	49,2	10	B	X
7	P1	630	6,3	87,8	15,7	64,9	2	C	Z
8	P5	500	5,0	92,8	18,0	82,0	1	C	Z
9	P6	400	4,0	96,8	10,5	93,4	5	C	Y
10	P9	320	3,2	100	6,6	100	6	C	Y
Σ	x	10000	100	x	100	x	x	x	x

Received results of integrated using of ABC and XYZ-analysis allow making the following conclusions:

– the parts with stable and close to stable using can be produced “by side”, because supplier can produce them with less cost than the final producer (parts of groups X and Y);

– because of comparatively high cost, parts of groups A and B are suitable for JIT-supply, they act for reducing the size of advanced capital in supply, transport, stocking.

Considering the explained conclusions and with the objective to form the logistics decisions we will use the methods of matrix representation of integrated XYZ- ABC-analysis. On the next figure the area of JIT-supply includes the next fields with the parameters AX, AY, AZ, BX, BY.

	X	Y	Z
A	part 8	part 3 part 7	
B	part 4	part 2 part 10	
C		part 6 part 9	part 1 part 5

Figure 4.3 Matrix representation of ABC-XYZ-analysis with the optimal distribution of the parts.

Should note, that AZ field is JIT supply because of high cost, but also characterizes stochastic supply. Fields beyond the JIT-supply area form the category of the own production because of comparatively low costs of the parts or stochastic nature of their consumption.

Such variants of logistics decisions must be supported by availability and level of using the producing power. This calculation can base on larger comparison of current time fund with the necessary needs of technological time. That's why is appropriate to provide larger analysis of using the production power, including one in the sphere of structural branches. Applying of this larger analysis, comparing with ABC-XYZ analysis allows the detection of deficit in power, or its overflow concerning the separate departments, and this can be the base for the order placement from third-party producer-supplier. But such a decision accepts not because of optimal functioning of logistics system (the enterprise in this case), because the influence on stocking economy, transport, etc is not considered.

The other way of larger analysis of power using, after realization of ABC-XYZ-analysis leads to economically justified decisions about the order placement, appropriate investing politics concerning the separate producing departments or functional spheres, management development in the changing conditions of division of labor, optimal using of inner-production reserves, etc. In these conditions the adequacy of western-European representation of using the power and efficiency of enterprise makes sense.

So, the larger analysis of power using in the first variant allows the enterprise orientation to the third-party orders placement in case of deficit of power, and accept the order in case of production power overflow. But when compliance of logistics goals takes place, this larger power analysis can be recommended after realization of ABC-XYZ analysis.

Control questions

1. Describe the methodic bases of solving the “MOB” problem.

2. Describe the block-scheme of choose optimization of materials, parts and nodes concerning the own or third-party production and supply “at the right place, at the right time”.

3. Describe the graphical interpretation Of ABC-analysis.

4. What is the essence of XYZ-analysis?

5. What is acquiring by combining ABC and XYZ analysis in the optimization calculation?

6. Interpret the connection of optimization by ABC-XYZ-analysis with the power using level.

Chapter 5

Choosing of suppliers

Choosing of perspective supplier considering the market dynamics is the essential task, thus we must lead by the requirements of the changes in supply strategy, in the direction of "Single Sourcing", "Global Sourcing". This means that suitability of supplier is defined by not only the cost factors, but long-term of supply, availability of the guarantee of qualitative and quantitative parts and nodes development, their utilization. Such requirements exist also for the raw suppliers, e.g. sheet steel, pipes, casting billets, etc.

In this conditions for the rating of suppliers and their next choose only the multi-criteria approach can be suitable. Its using demands the realization of the following algorithm:

- forming the system of possible important criteria (stage 1);
- forming the non-conflicting system of criteria (stage 2);
- estimation of the importance (weight) of each criterion (stage 3);
- estimation of each supplier considering chosen criteria (stage 4);
- calculation of the integral criterion and supplier choose (stage 5).

Let's review the making of logistics decision basing on the example, following the listed algorithm:

1. We need to choose 1 of 4 possible suppliers A, B, C, D of concrete node or part. To do that, we form the system of possible criteria of each supplier rating, basing on the quantitative analysis.

C1 - the price of product;

C2 - distance to the final producer;

C3 - transport flexibility of supply;

C4 - product quality;

C5 -possibility of "Just in Time" supply;

C6 - flexibility concerning the requirements dynamics to the supplier; C7 - availability of further development of product;

C8 - availability of further recycling (utilization);

C9 - availability of connecting to the inner-production TUL-system of final producer. TUL is the system of transport, packaging, and storage;

C10- availability of the information system association;

C11 - intermediate storage of products by supplier;

C12 - common production planning and management.

2. For the further using of those criteria for the forming of non-conflicting system of independent criteria we should test them for of logistics freedom from contradictions and relative independence. Pairwise comparison of every criterion with others allows determining as dependent (one of the criteria includes the other by meaning), as the conflicting criteria. For example, criterion C11 contradicts with C6, because it denies the supplier flexibility to the changes in requirements to it, that's why criterion C11 is excluding from the estimation. The similar way we can approach to excluding the criterion C12. To simplify the calculation we may believe that remaining 10 criteria form non-conflict system.

3. Estimation of importance of each criterion can be realized by forming the half-matrix; in the cells of it are the numbers of those criteria, which are more important in pairwise comparison. Received advantages number for the each criterion normalizes, what defines "weight" of each one. Note, that pairwise comparison is quite subjective rating, but further process restores the lost objectivity. The calculation of expected ratings of importance can assist too. (See table 5.1)

Table 5.1

C_i / C_i	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	Number of advantages	Importance	Sequence
C_1		C_1	C_1	C_4	C_5	C_6	C_1	C_1	C_9	C_1	5	11.1	4
C_2			C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	0	0.0	8
C_3				C_4	C_5	C_6	C_7	C_3	C_9	C_{10}	2	4.4	7
C_4					C_4	C_4	C_4	C_4	C_4	C_4	9	20.0	1
C_5						C_6	C_7	C_5	C_9	C_{10}	4	8.9	5
C_6							C_6	C_6	C_6	C_6	8	17.8	2
C_7								C_7	C_9	C_7	5	11.1	4
C_8									C_9	C_8	2	4.4	7
C_9										C_9	7	15.6	3
C_{10}											3	6.7	6
$\sum$											45	100	X

The last column of the table forms the sequence of criteria, concerning their importance for the supplier suitability. Thus, the first place is the product quality (C4), and price (C1) is only the fourth.

4. Rating each supplier by chosen criteria is realized using the experimental method. Expert ratings are given by the 10 point scale, for example, low price is rated by higher point, and the big distance to supplier is rated by lower points. Experts can rate by three variants:

– clear (expected) rating;

– maximum (optimistic) C_{max} and minimum (pessimistic) C_{min} ratings and its expected value C_{ex}, calculated by the formula:

$$C_{ex} = \frac{3C_{\min} + 2C_{\max}}{5}$$

– maximum C_{max}, the most likely C_{nb} and minimum $C_m i_n$ ratings and its expected value, calculated by formula:

$$C_{ex} = \frac{C_{\min} + 4C_{nb} + C_{\max}}{6}$$

As for the considered example, expected ratings for 4 suppliers are submitted in the next table.

5. In the same table by "weight" of each criterion we calculate the integral criterion.

Table 5.2.

Rating matrix for the supplier choose

Criterion	Importance (normalization)	Rating of criteria for suppliers							
		A		B		C		D	
		expert	weighted	expert	weighted	expert	weighted	expert	weighted
C_4	20.0	8	1.6	10	2.0	7	1.4	6	1.2
C_6	17.8	5	0.89	8	1.42	10	1.78	6	1.068
C_9	15.6	4	0.624	7	1.092	6	0.936	6	0.93
C_1	11.1	10	1.11	3	0.33	5	0.555	10	1.11
C_7	11.1	6	0.666	8	0.888	4	0.444	4	0.444
C_5	8.9	8	0.712	8	0.712	6	0.534	3	0.267
C_{10}	6.7	3	0.201	7	0.469	2	0.134	1	0.06
C_3	4.4	1	0.044	8	0.352	9	0.396	2	0.088
C_8	4.4	5	0.22	3	0.132	7	0.308	0	0.0
C_2	0.0	10	0.0	5	0.0	1	0.0	10	0.0
$\sum$	100.0	60	6.067	67	7.402	57	6.487	48	5.18

Results show that by the generalizing criterion ($K_R = \sum_{i=1}^{10} K_i \alpha_i$) the row of suitability of suppliers is:

supplier B (K_R=7.402, $\sum_p$=67);

supplier C (K_R=6.487, $\sum_p$ =57);

supplier A (K_R=6.067, $\sum_p$ =60);

supplier D (K_R=5.180, $\sum_p$ =48).

It is slightly different from previous row of suitability, built not considering criteria importance (sequence B, A, C, D).

Control questions

1. Describe the procedure of choosing the optimal structure of suppliers.
2. Name the possible important criteria of supplier rating.
3. Characterize the using of expert ratings method for calculating of integral criterion.

Chapter 6.

Choosing the strategy of transportation and stocking in supply.

Ability to react on the changes in customer's wishes mostly forms in preparation sphere is determined by the chosen strategy of transportation and stocking on the enterprise. Depending of the assortment of materials, parts and nodes is necessary to make such decisions:

– available path of products and the stocking strategy;

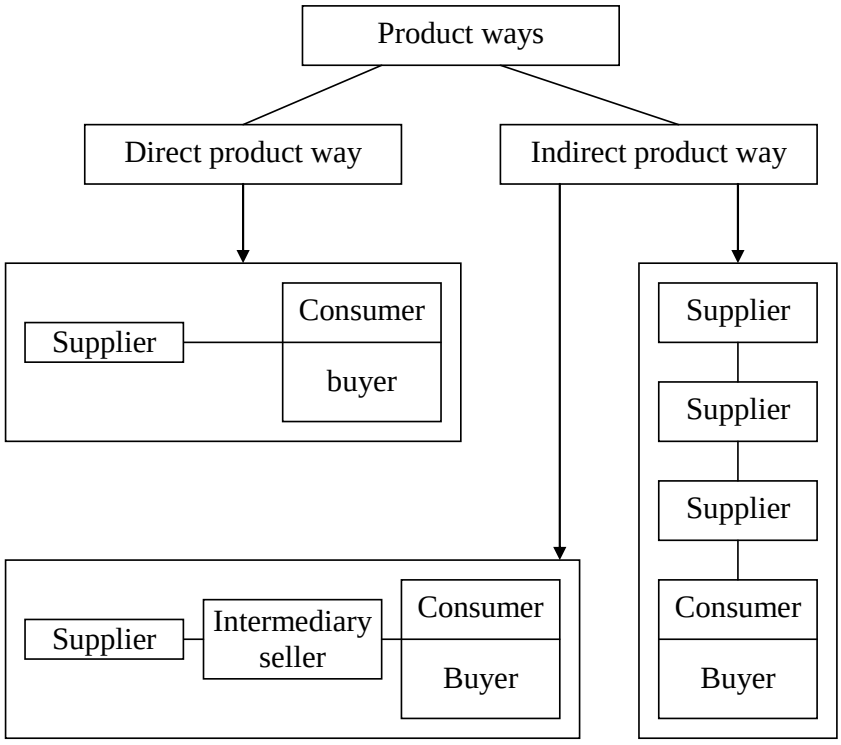
– types of transport, which will be used, and the meaning of transport technology;

– economically expedient stocking strategies;

– what service producers and services themselves can be integrated in the supply system.

Certain criterion of optimal technology should be considered as possible minimum supply terms, and possible low general transportation, placement and stocking costs.

Before keep going to consideration of methodical instruments of choosing the optimal technology of transportation and stocking in supply, lets give the theoretical basics of products flow and types of market operations in supply. In the next scheme we represent options of the products movement, also known as product ways. Figure 6.1.



For the direct product way, in general 3 types of market operations are used.

1. Direct operation. Between the supplier and customer (consumer) -buyer is making the agreement about the product supply using different types of transport. Payment is providing directly to the supplier. Schematically it is represented as:

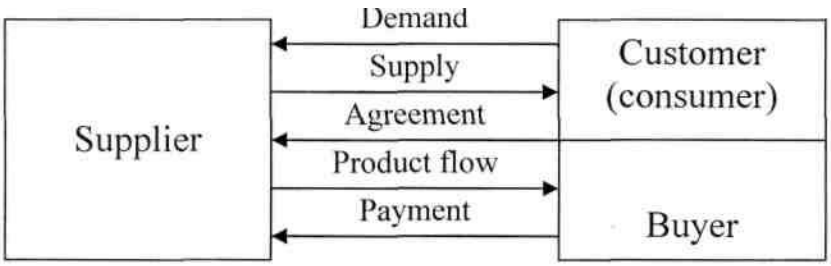


Figure 6.2. Principle scheme of the direct trade operation.

2. Intermediary trade operation. The intermediate chain between the supplier and customer is added - the intermediary (wholesale organization, centre of product distribution, cargos, etc.), which take the functions of agreement making and providing the calculations, but the product flow stays straight from the supplier to the customer, and implements by the customer's direction. Schematically it is represented as:

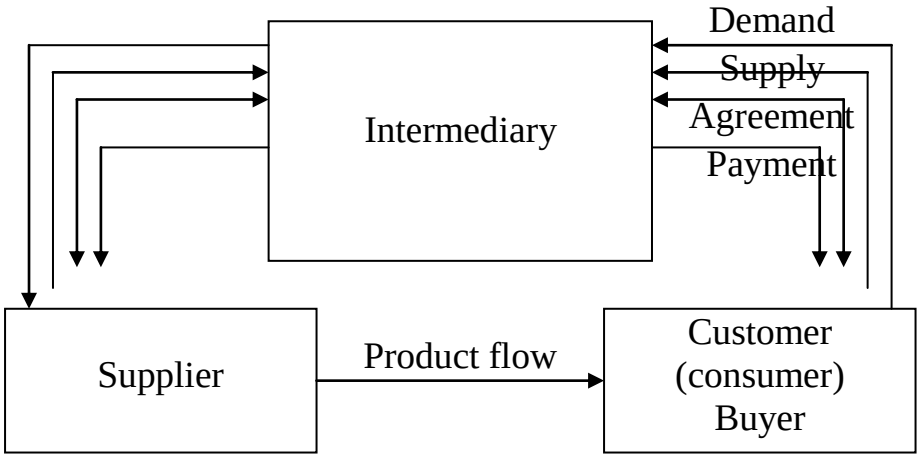


Figure 6.3. Principle scheme of the intermediary trade operation.

Notice that according to this trade operation, customer's wishes, demand changes, recalling bad supplies are executing by intermediate.

3. Trade operation with partial involvement of intermediary. Between the supplier and consumer is also added the intermediate chain, which can only adjust business contacts, having the special information for it. Making an agreement, product flow and payment is providing the straight way from supplier to customer.

Notice, that this type of trade operation is used mostly while applying big investing projects, in the tools export, etc.
Schematically it looks like:

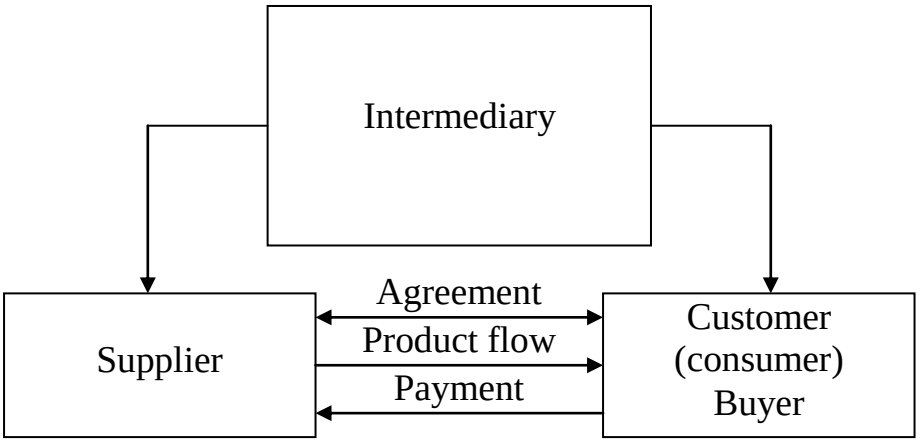


Figure 6.4. Principle scheme of the trade operation
with the partial involvement of intermediate.

On the indirect way as material, as informational flows go through the intermediate. The intermediate here should be considered as "service provider", because with classic (standard) functions they provide such services as:

– receiving and purchasing product from producers;
– intermediate stocking of the products assortment concerning the quantity and time demands compliance;
– commission profitable for customer;
– organization and performing the supply transportation;
– realization of the calculation-based information connection between supplier and customer.

With the appearance of these organizations, so-called centers of logistics or logistics service centers, the new radical abilities in industrial production organization appear (in cooperation, combining, specialization, concentration, etc.). Concentration of wide products assortment, servicing the big number of customers, organization of intermediary stocking, packing, transportation, etc will be provided much more effective in such logistics centers, comparing with immediate producer or customer. Such approach makes possible the investing concentration for the TUL-techniques - techniques, automation or partial automation, minimization of capital and functional costs, optimization of producing and supply terms.

Considering represented, lets imagine the indirect way of products as:

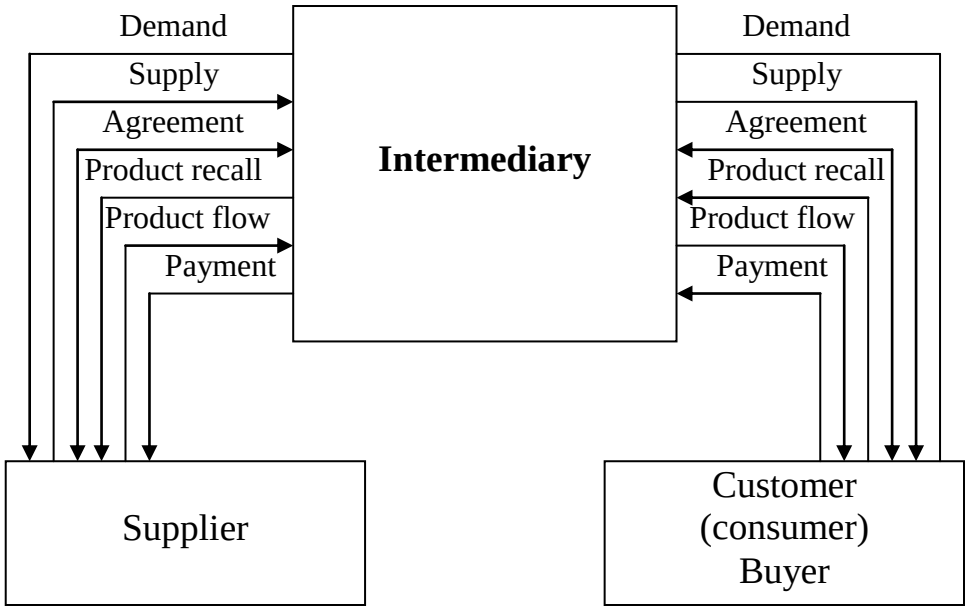


Figure 6.5. Principle scheme of indirect product flow

Theoretical representation of the classification of product ways and trade operations allows realizing the methodic of choosing the conception of transportation and stocking in supply. Algorithm of calculation is in following:

- classification of materials, parts, and nodes according to ABC-XYZ analysis (stage 1);
- forming the distributive matrix combining the classification by ABC-XYZ analysis with the product ways types and types pf trade operations (stage 2);
- forming the basic decision about necessity of stocking depending of parts classification (stage 3);
- forming the coordinated decision about necessity of stocking depending of parts classification and characteristics of their using (stage 4);
- transport type choosing (stage 5);

In the previous chapters the meaning of combined ABC-XYZ analysis is represented, according to that any position in supply can be attributed the concrete group of classificatory (AX, AY, AZ, BX, BY, BZ, CX, CY, CZ).

This classification assists forming the answer of question:

- direct or indirect way should the products be transported;
- what trade operations can be used during it.

Answers to those questions are given by realization of stage 2 in form of distributive matrix, represented in table 6.1.

Table 6.1.

Distributive matrix of ABC-XYZ groups concerning the product ways and operations

ABC-XYZ groups of materials, parts, nodes	Direct product way			Indirect product way
	Direct trade operation	Intermediate trade operation	Trade operation with partial involvement of	Product-distributive (logistics)
AX	++	++		
AY	++	++		++
AZ	+		++	+
BX	++	++	+	
BY			+	++
BZ			++	++
CX		++		++
CY				++
CZ				++

In the listed distributive matrix recommendations about choosing the product way and trade operations are given. Two "+" means that that way and operation are goodly suitable for the concrete group of parts (nodes, materials), one "+" - accordingly suitable, empty cell - unsuitable. These recommendations allow proceeding to forming the stocking conception, i.e. defining parts which should not stock, and should be in small quantity, and those which should be in large one. Executing the stage 3 of algorithm is assisted by such characteristic of requirements to stocking.

In table 6.7. "+" "++" "+++" - relatively mean slightly important, important, and quite important sizes of necessary stock power.

Table 6.2.

Requirements of the stock size according to parts classification.

	X	Y	Z
A	+	+	++
B	+	++	+++
C	++	++	+++

In the table 6.2. "+" "++" "+++" - respectively mean lightly important, important, and quite important sizes of necessary stock power according to appropriate group classification.

Stage 4 of represented algorithm provides correcting the previous project decision taking into account the character of material, parts or nodes application, which can differentiated by following features:

– characteristic of using is defined only by demands of supply;

– characteristic of using depends of customers (buyers) concerning the final production;

– characteristic of using does not depend of customers (buyers) concerning the final production;

– characteristic of using in form of spare parts supply (customer service);

The result of considering of noticed characteristics is the new distributing matrix (table 6.3).

The final stage concerns the choosing of transport type. For this we are to follow such criteria:

– speed of transportation;

– requirements to transportation concerning package, weight, possible overloads;

– price of transportation;

– product specifics (possibility of crashing, physical condition, etc);

– transport quantity;

Choosing the suitable type of transport does not provide using of universal recommendation, but is quite dependent of subjective characteristics of the enterprise's position in market, such as:

- reached and planned part in market;
- the level of production cost;
- ecological requirements;
- the speed of reaction on customer's wishes;
- the level of transport services cost.

Table 6.3

Distributing matrix concerning the stock size depending of classification and using of the parts

		Characteristic of using is defined by:		
Classification part	Way of product	Needs of supply	Final produce, independent of customer	Final produce, dependent of customer
AX	direct	X	X	X
	indirect	X	X	X
AY	direct	X	X	X
	indirect	X	X	X
AZ	direct	XX	XX	XX
	indirect	X	XXX	X
BX	direct	XX	X	X
	indirect	X	X	X
BY	direct	XX	XX	X
	indirect	XX	X	X
BZ	direct	XX	XX	XX
	indirect	XX	X	X
CX	direct	XXX	XX	X
	indirect	XX	X	X
CY	direct	XXX	XX	XX
	indirect	XXX	XX	XX
CZ	direct	XXX	XXX	XX
	indirect	XXX	XX	XX

Coordination of counteracting goals in supply

Realization of project logistics decisions in functional spheres will have economical benefits in case of removal of the inner contradictions within these general-entrepreneurial spheres. This requires development of appropriate methodical mechanism of their coordination. So, lets review the typical examples of detected contradictions.

Object analysis of functional sphere of supply logistics caused such a representation of counteracting economics goals in this sphere, (figure 6.6)

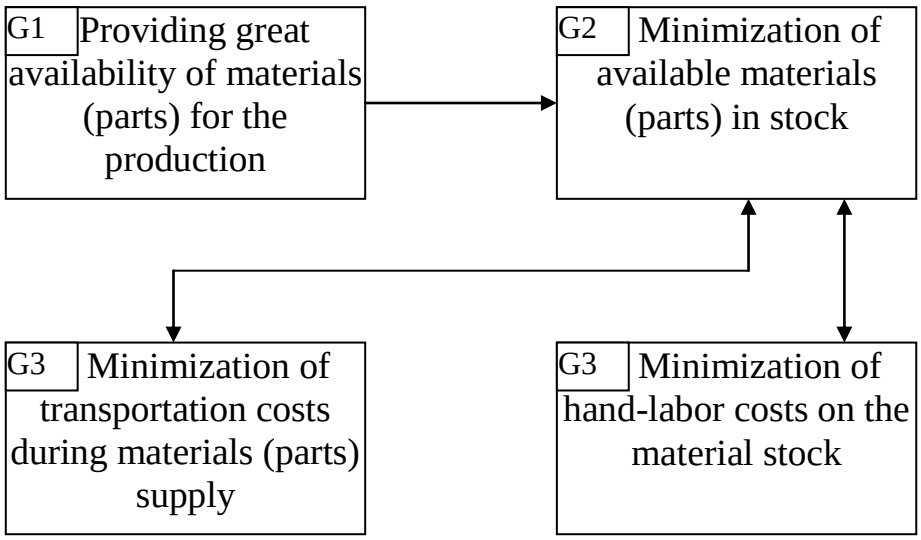


Figure 6.6. The structure of counteracting goals in supply logistics

Graphical interpretation of the contradiction between two goals Gl and G2 looks like described in figure 6.7.

Forming of guarantees of production process is provided by creating of necessary stocks of materials (parts), and it meets the goal Gl. But, goal G2 requires minimization of the stock size, which creates the danger of production process failure and can cause significant loss. The same character have the counter tendencies between the goals G2 and G3, or G2 and G4.

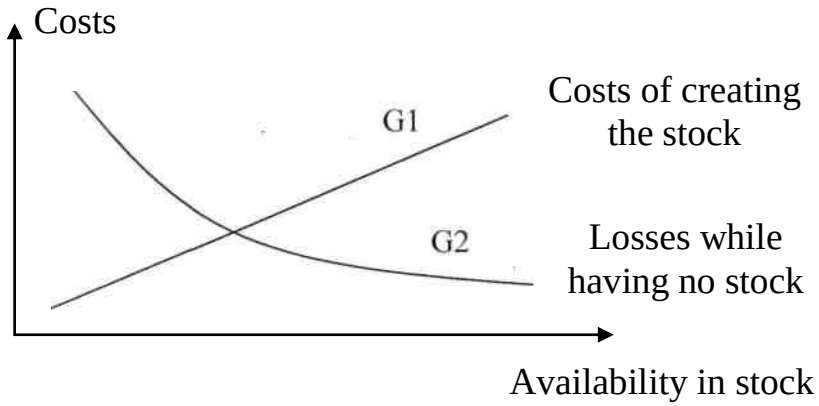


Figure 6.7. Graphics of the counter tendencies G1 and G2 depending of stock size

Thus, minimization of transport costs or hand labor can be reached in case of large supply, and this leads to stacking in some periods the large stocks of materials (parts) in the warehouses, what, of course, contradicts with the goal G2 "minimization of materials (parts) stock".

Control questions

1. What is the economics meaning of choosing the strategy of transportation and stocking in supply?

2. Characterize the meaning of the product ways and the types of trade operations.

3. Give the algorithm of choosing the strategy of transportation and stocking in supply.

4. How the potential of ABC-XYZ analysis is realizing in the algorithm of choosing the strategy of transportation and stocking in supply?

5. Characterize the spheres of using of the different types of transport.

6. Argue the appearance of goal conflicts in logistics of supply and give its graphic interpretation.

Chapter 7

Stocks logistics.

In the logistics system during the products purchasing, appears the problem of the minimization of combination of different spending elements, connected with moving and storing of the product stocks. That's why purposes and types of stocks, systems of stocks management, question of choosing the size of bought or produced consignment, providing the spending minimization as for product purchasing are considered.

1. Stocks management and goods politics in the commercial logistics.

While developing the strategy of stocks management the goods politics of the enterprise is considered. What are goods? Good - are the physical object or service, and also symbolic obligations, which can satisfy needs and demands, bring profit to the customer. According to this definition good is considered from the customer's point of view. The customer buys the good not only as the physical object, but also services, which are related to selling. In other words, customer buys the satisfaction of on or another need or demand of himself. That's why it can be said, that goods are material, and services are abstract, but both are to satisfy the customer's demands and are the object of research in commercial logistics.

In logistics the meaning of good includes the actual good (in material form), and service is the techniques of promoting the goods, stimulation of sale, production processes, related to products quality improvement, etc.

The good can be express in commodity unit, i.e. concrete specific kind of a product. There is a concept of goods assortment and goods nomenclature. The first concept is the group of goods, closely related between each other by one or more characteristics: common consuming group, common distribution channel, similar

prize range, etc. Goods nomenclature is characterized by three indexes: width, depth, and sequence (harmony). Width of goods nomenclature is the general quantity of different assortment groups, depth - is number of types (variants) of each separate good in each assortment group. Sequence of goods nomenclature means the degree of proximity between the goods f different assortment groups from the point of view of final using, channels of distribution and other indexes.

Decisions, made within goods politics, have to determine the number of following positions: goods nomenclature, range of each good size, quality of product, modification of good, the new goods production, goods standardization, quantity of each type of good, produced by some period of time, etc. Goods politics forms the product stocks on the enterprises. That's why in commercial logistics is appropriate to consider the firm politics in the sphere of stocks management.

2. Purpose and types of stocks.

Stocks serve to weaken the direct dependence between supplier, producer, and customer. Availability of stocks allows to supply the production with raw, which is supplied by batches optimal by size. The raw stocks weaken the dependence of the raw supplier from the goods producer; stocks of the ready products weaken the dependence of these goods producer from its customer, and the stock of half-stuff being in the stage of production weakens the dependence of different departments one from another. On the enterprises, where goods production is built in the way that materials are processed by separate batches, the existence of between-department buffer stock of semis.

The stocks are divided into following types:

1. Buffer stockjs organized between the supplier and the customer. It is used for the compensation of delays, related to the goods flow; for weakening the dependence of the customer from suppliers; for providing the availability of production purchasing, and also its production by optimal size batches.

2. Complete production stocks serve the next goals: providing the production of goods by the optimal size batches; satisfying of predicted demand; compensation of the actual demand deviation from predicted one (guaranteed stock).

Stocks for the delay compensation related with material recourses movement. Of course, calculation of the size of such stocks does not cause complications, when the delay time is known.

Stocks, necessary to satisfy the existed demand, are to cover the predicted demand. Since the size and time of demand are determined, the. calculation of such goods does not cause any special complications.

5. Guaranteed stock serves for satisfying of unexpected demand increasing. Availability of such stocks compensates the deviation of actual demand from predicted one.

Practical realization of logistics conception is connected with optimization of current stocks on the firms and enterprises. Criterion of stock optimization is spending: purchase, stock keeping, and as a result of production absence etc.

The purchase spending is: order registration spending; an order registration spending about supply and communication with suppliers; transport spending if the transport cost is not included in the cost of received product; stocking and product receiving spending.

Some of them are fixed in order and are not depended of its size, the others, for example transport and stocking spending are directly dependent of the order size.

Spending of the stock storage is determined by costs of the warehouse storage of production during determined time and is directly dependent of the amount of production in stock. In this group there is also a warehouse spending. and rent payment, if the room is for rent, or the current spending of keeping the warehouses. Capital spending is also included in this group of spending.

Insurance and taxes are also in this group of spending. Insurance reserves are formed as a defense from fires or thefts. The reserves are taxed concerning the status at the day of rating. This level does not always show the actual content of stocks.

The same group of spending also includes loss from destruction or spoilage of stocks. In case of absence of production, the producer is responsible if he can not satisfy the random demand caused by absence of production is stock. This spending divide into two types:

– Value of the lost sales, when the customer transfers its order to other producer. In this case spending is determined as expected profit minus expected spending.

– When the customer expects the order performance. Sales are not lost, but delayed. Waiting can cause additional spending for the order figuration, transport and stocking spending, when the order cannot be performed.

Chapter 8.

Stocks management systems

We can determine the next stock management systems: with fixed stock size; with the time interval between supplies. The other systems are the combinations of two listed above.

Let's consider the first system closer: it is simple and is kind of classic. In this system the order size is constant, and the next repeating order is giving if the available stocks are reduced to some critical level – the order point.

This system is based on the batch size choosing, which minimizes the general spending of stocks management. Last one includes the order execution spending and the stocks storage spending.

The order execution spending is the current spending, connected to the order realization; it depends of the order size. In industry this spending are considered as preparing-fmal operations.

If C_0 – order execution spending, and q - the batch size, then the cost of order execution per the product unit will be C_0/q.

To determine annual costs of order execution the cost of order execution per the product unit should be multiplied on the quantity of product S, realized during the year, i.e.

$$C_0S/q \quad (1)$$

Annual costs of order execution are reduces while the batch size grows, also the costs of order execution per product unit changes.

Costs of stocks storage include costs, connected to the physical content of the stocks in warehouses, and possible percents of capital, invested in these stocks. These costs are expressed in percents of purchase prize per some period of time (e.g. 20% a year). If C_U – purchase prize of the product unit, i – storage spending, expressed as the part of this prize, then C_U*i*q – annual costs of products storage.

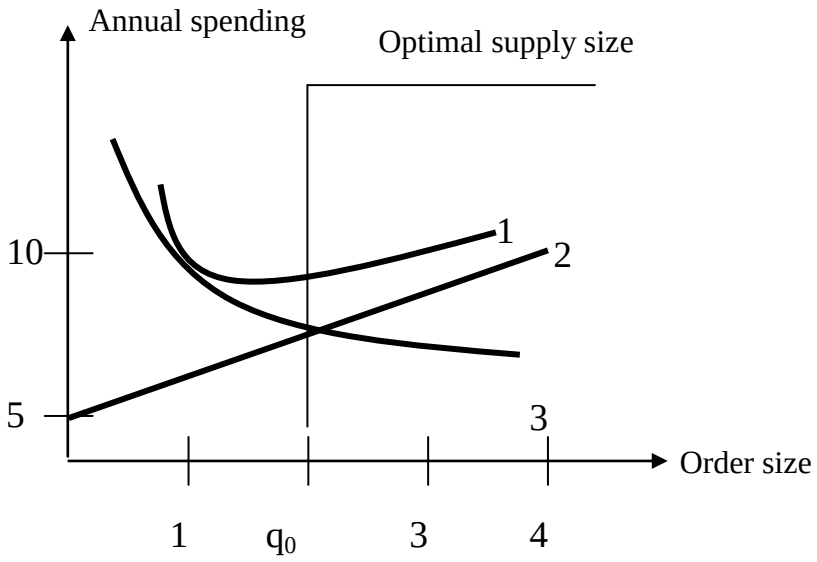


Figure 8.1. Dependence of the annual spending from the order size.

On the figure 8.1 the line 1 - is the stock management spending, 2 -stock storage spending, 3 - order execution spending.

The stock storage spending is determined by the average level of stocks. In case of constant intensity of sale the annual stock storage spending is:

$$C = C_U*i*q/2 \qquad (2)$$

This spending rises linearly. Common annual management spending is the sum of annual spending of order execution (formula 1) and annual spending of stock storage, i.e.

$$C_0*S/q + C_U*i*q \qquad (3)$$

Also another formula of annual costs calculation is used:

$$C = C_0*S/q + S*C_1*i*q_0/2 \ (4),$$

where C_1 is the prize of one unit of product.

Dependence of annual costs is quite sloping near the minimum point. This shows that near the minimum point the stock can vary within some range without notable change of general costs.

The value of batch size q, minimizing the annual costs of stocks management, is called the most economy size of order and is marked Q_{OPT} – Optimal batch size Q_{OPT} can be calculated based on general annual spending using the Wilson formula:

$$q_{OPT} = \sqrt{\frac{2C_0S}{C_Ui}}$$

or

$$q_{OPT} = \sqrt{\frac{2C_0S}{i}} \quad (5)$$

and in case of deficit:

$$q_S = q_0\sqrt{\frac{i+h}{h}},$$

h – spending of deficit

$S_{\max} = q_0\sqrt{\frac{h}{h+i}}$ – maximum stock in case of deficit

$T_y = \frac{q_S}{S}$ – general cycle time

On practice more complicated model should be used. To calculate the order points we should know temporary delay between the moment of order sending and the moment of its receiving, and the expected average sale Sd per delivery time L. But it is not enough, because in fact the sale and delivery time can be higher than average value and the temporary lack of product (deficit) may occur. That's why while calculating the order point P_K to the expected sale and delivery time is also added reserve (or insurance) stock B.

The order point in this case can be calculated as:

$$P_K = B+S_dL \quad (6)$$

Where Sd - average daily sale.

Formulas (3) and (4) describe the work of model with fixed order size. The average stock level for this model will be:

$$J = B+Q/2 \quad (7)$$

There are other systems of stocks management, e.g. the system with constant stock level. In this system the stock management spending is not considered in visible way, and the constant order size is absent. In some permanent intervals of time the inspection of the stock condition is taking place, and if some number of goods has being sold since last inspection, the order is send. The size of order is equal to difference between maximum stock level, and factual level at the moment of inspection.

There is one more stock management system - the, two-level system, or Ss-system. Actually it is the system with constant stock level, with the lower limit of order size set. In such system the maximum stock level M is considered, and it is

calculated by formula (7), and, besides that, the point of order is used; it is calculated by following formula:

$$P=B+S_d(L+R/2)$$

The order of work can be formulated the next way: if at the moment of periodic inspection $J+q_0 < P$, then the order $q = M-J-q_0$ is sent, if $J+q_0 > P$, the order is not sent. (q_0 is ordered quantity of product).

Summary

Considered systems depend of the following conditions:

1. If the stock management spending is significant and can be calculated, then we should use the system with constant order size.

2. If the stock management costs are not important, then the most viable system is the one with constant stocks level.

3. If ordering some goods the supplier imposes restrictions on the minimum batch size. In this case it is preferable to use the system with constant order size, because it is easier to correct the fixed batch size once, than to regulate its movement permanently.

4. If the restrictions are imposed connected to the load of vehicles, than the system with constant order level is preferable.

5. The system with constant stock level is preferable also if the supply is executed within determined time period.

6. System with the constant level and two-level system are often chosen if it is necessary to react the sale changes.

7. The systems of stock regulation have such adjustable parameters:

– *System with constant order size* : The order point, order size;

– *System with constant periodicity:* maximum stock level, the repeating period time;

– *System with two constant levels without constant periodicity, or S_s-system:* maximum stock, the stock point, order periodicity

Chapter 9.

Optimization of marketing concentration and localization

The important task of the distributive logistics is the definition of the trade centers influence, which has the significant role on forming the system of stocks in consumer goods retail. To solve this problem is appropriate to use some-called Raily's Gravitation rule of retail: "The city centers attract client's purchases in relation, directly proportional to cities population and inversely proportional to square distance between clients and cities".

Basing this rule we can determine the purchase proportion, which are done in cities A and B by residents of city C. Lets consider the next example: how do the residents of Haysin town make purchase (P_v) in Vinnitsya (94 km far, population of 387 thousand people) comparing to closer town Uman (64 km far, population of 94 tohosand people) - Py. We make the ratio: (9.1)

$$k_1 = \frac{P_V}{P_U} \cdot \frac{L_U}{L_V} = \frac{387}{94} \cdot \left(\frac{64}{94}\right)^2 = 1.91 \qquad (9.1)$$

Obtained ratio shows that despite the bigger distance, inhabitants of Haysin make their purchases in Vinnitsya more often than in Uman: 100 purchases in Uman are compared to 191 in Vinnitsya.

To adapt the Gravitation rule for the material market instead of population (as the "gravitation power") we should use the production volume (350 million UAH for Vinnitsya and 95 million for Uman)

$$k_1 = \frac{350 \cdot 10^6}{95 \cdot 10^6} \cdot \left(\frac{64}{94}\right)^2 = 1.71$$

That shows, that purchases in Vinnitsya are 71% higher than in Uman.

Using Raily's rule we can also determine borders of "indifference" sphere between two centers, within which inhabitants (or enterprises) will make purchases equally in both centers. Determined borders of "indifference" sphere will characterize territorial diapason of market influence. Obviously, that determined this way spheres of influence of Vinnitsya, for example, on highways Vinnitsya-Uman, Vinnitsya-Khmelnitskiy, Vinnitsya-Berdichiv, will be located in different distances dependent of separate cities values. For represented example diapason of influence of Vinnitsya market in direction of Uman will be:

$$D_{VU} = \frac{L_{VU}}{1+\sqrt{\frac{\phi_U}{\phi_V}}} = \frac{158}{1+\sqrt{\frac{94}{387}}} = 106\,km \qquad (9.2)$$

Where L_{VU}=158 km – distance between Vinnitsya and Uman, φ_V, φ_U are populations of cities.

So, the "indifference" sphere between Vinnitsya and Uman will locate in 106 km from Vinnitsya. Approximately the same diapason of influence we will get, taking as the "gravity power" the production size:

$$D_{VU} = \frac{158}{1+\sqrt{\frac{95}{350}}} = 104\ km$$

One of the objects of logistics decisions in distributive logistics, which concerns the definition of rational logistics channels, is necessary to consider as the localization of trade network (retails, wholesales, warehouses). Such a problem is a key for the production of meat, milk, beer and beverages, vegetables, production of sewing enterprises, etc.

Aiming the optimization of the wholesale base location on this territory, considering existing location of suppliers and receivers (retail objects) on this territory, we will use the coordinate system, determining the coordinates of suppliers Xj and Yj and retails Xj and Yj The final equations of determination of the wholesale warehouse optimal location are:

$$\left.\begin{aligned} X &= \frac{\sum_i p_i \cdot x_i + \sum_j q_j x_j}{\sum_i p_i + \sum_j q_j}; \\ Y &= \frac{\sum_i p_i \cdot x_i + \sum_j q_j x_j}{\sum_i p_i + \sum_j q_j}; \end{aligned}\right\}, \qquad (9.3)$$

where p_i; is the product supply of i-supplier;
q_j is the demand on the products of j-store.

Lets review the next example: trading firm has 5 retail shops, the main suppliers are 3 producers. For minimization of the general transport costs we consider the expediency of creation of the central warehouse with functions of the only supplier of shops. Placing the coordinate starting point in the place of the farest in

south-west direction shop, we graphically interpret coordinates of suppliers and shops, (see figure 9.1)

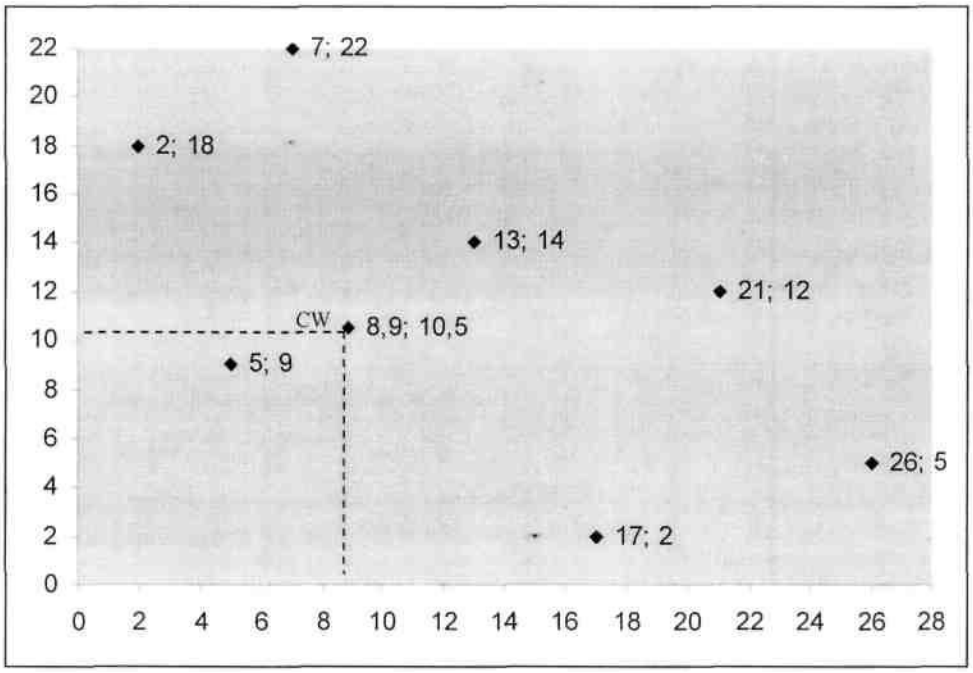


Figure 9.1 Shops and suppliers position

By the formulas listed above we calculate the coordinates of optimal central warehouse:

$$X = \frac{(200 \cdot 13 + 150 \cdot 17 + 450 \cdot 2) + (100 \cdot 5 + 300 \cdot 0 + 100 \cdot 7 + 150 \cdot 21 + 150 \cdot 26)}{(200 + 15 + 450) + (100 + 300 + 100 + 150 + 150)} = 8,9$$

$$Y = \frac{(200 \cdot 14 + 150 \cdot 2 + 450 \cdot 18) + (100 \cdot 9 + 300 \cdot 0 + 100 \cdot 22 + 150 \cdot 12 + 150 \cdot 5)}{(200 + 15 + 450) + (100 + 300 + 100 + 150 + 150)} = 10.5$$

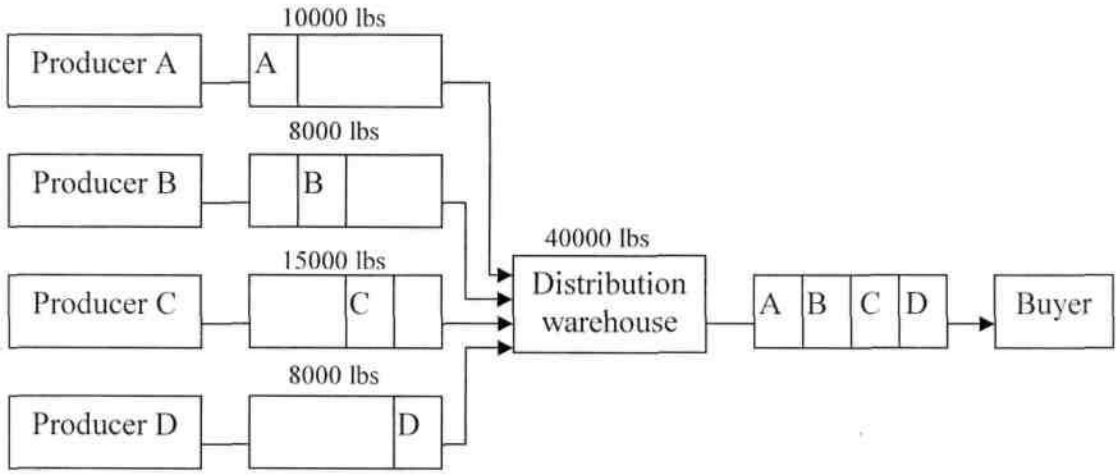
So, optimal location of the central warehouse (CW) has the coordinates X=8,9, Y=10,5. Basing the proportion of the distance to transport costs, we can calculate the minimum value of goal function for this variant, but such calculation requires correction by comparison with the existed transport network, which will influent the rating of distances between suppliers, shops and the central warehouse

Chapter 10.

Warehouse storage

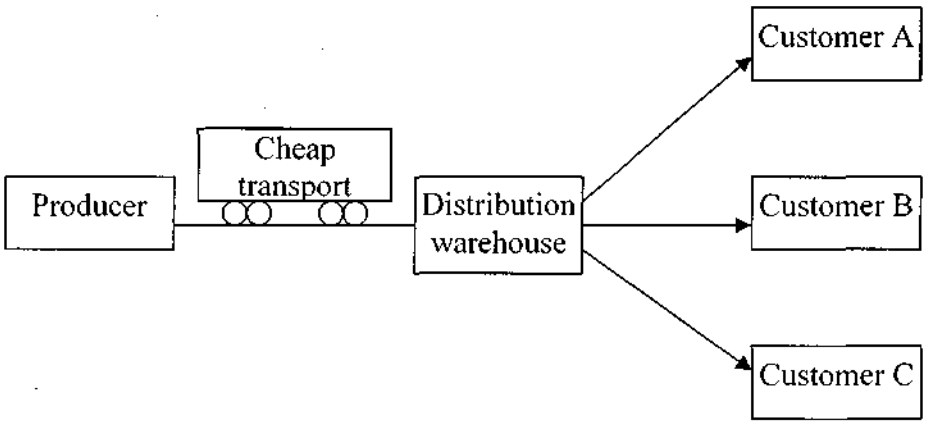
Functions of warehouse system

- Storage functions
  - material stocks storage;
  - consolidation;
  - unloading;
  - moving.
- Functions of transport processing of materials
  - loading and unloading;
  - transporting in/out the warehouse;
  - orders execution.

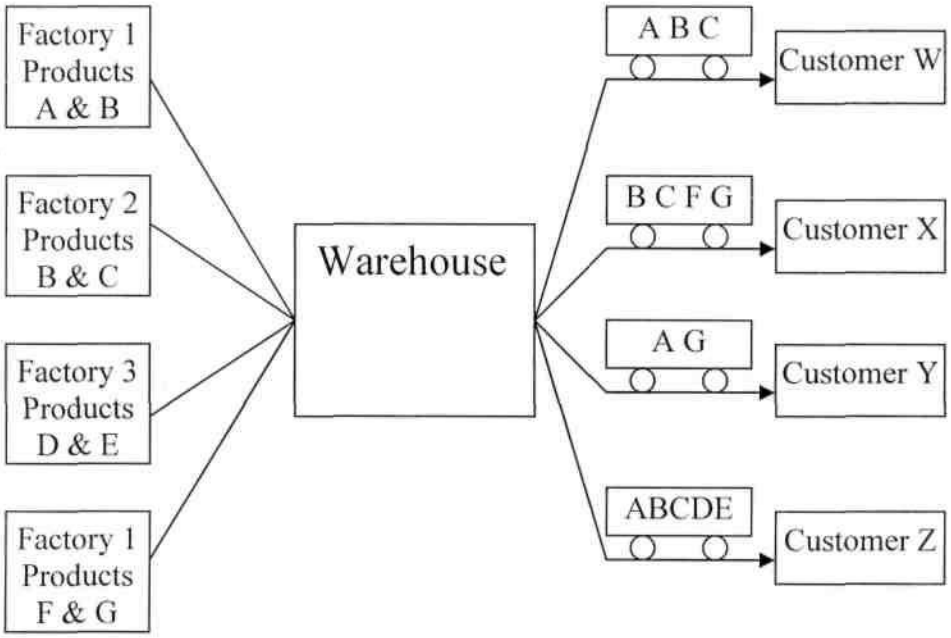


Distribution warehouse, which is used to unite small input batches into large product batches on the exit

Distribution warehouse, used for unloading



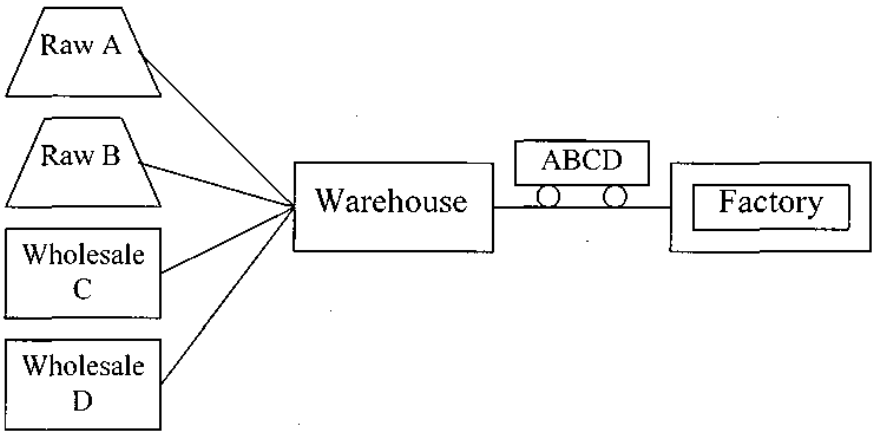
Product mixing



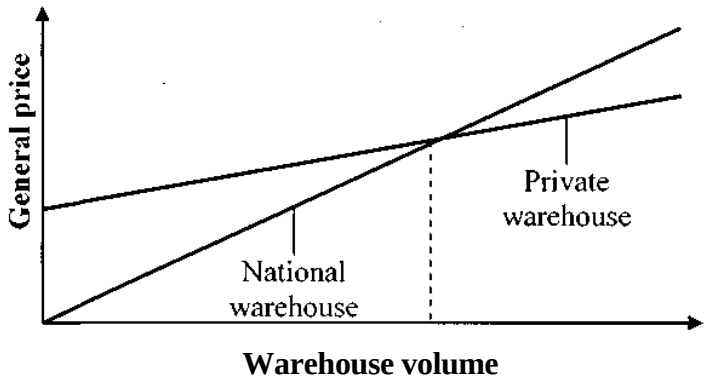
General decisions concerning the warehouse

- Choice between the own warehouse and the common warehouse;
- choice between centralized and decentralized warehouse;
- size and location of warehouse;
- location plan;
- stored products;
- employee safety.

Supply mixing



Comparison between prices of storing in the own warehouse and the common warehouse



Constant characteristics, which make influence on the warehouse type choosing

Constant characteristics	OWN	COMMON
Traffic capacity	High	Low
Demand variability	Stable	Variable
Market concentration	High	Low
Special physical control	Yes	No
Requirements of customer service	High	Low
Safety requirements	High	Low
Recycling requirement	Yes	No

Advantages of storing in own warehouse

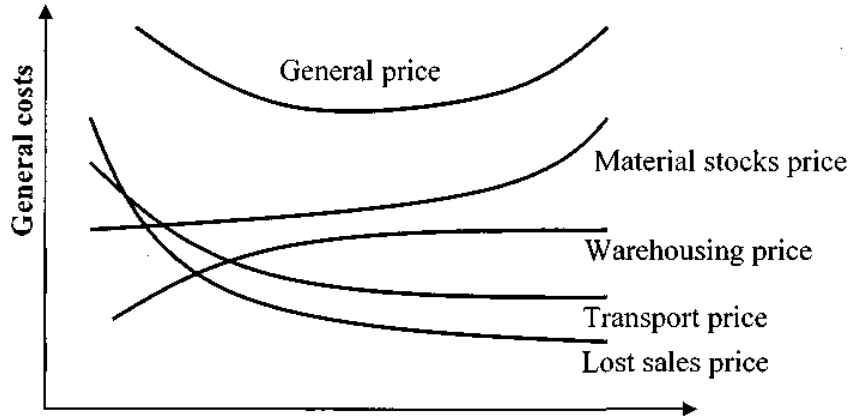
• Cheaper storage if to compare with rented warehouse, especially when tools are maximum used most of the time;

• Higher control rate of storage activity, which helps to provide effective storage and high level of service;
• If products require special tools and human resources, such as pharmaceutical or chemical goods, then the only suitable alternative is the own warehouse;
• Advantages, caused by ownership;
• Warehouse area can change its purpose with time, i.e. can be used for production;
• Area can be used as the distribution department base, private trucks park, transport department, or purchase department.

Advantages of common warehouses

- No capital investments;
- Lower spending;
- Location flexibility.

Price of material-technical supply relative to the quantity of warehouses



Warehouses classification

1. By the activity type.
2. By type of materials stored (versatile, special).
3. By the construction type (closed, semi-closed, special).
4. By location (central, departmental).
5. By the degree of fire resistant.

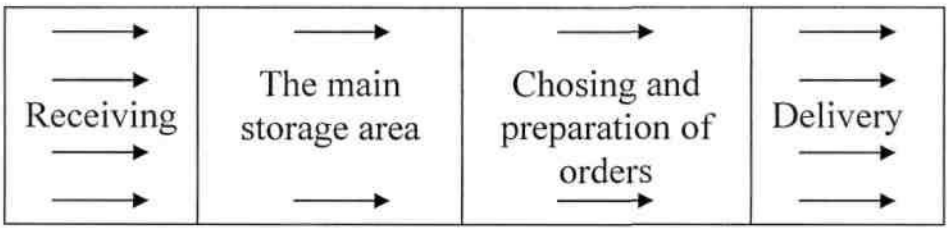
$$\text{General } S_{\text{warehouse}} = S_{\text{effective}} + S_{\text{accept-emission}} + S_{\text{staff buildings}} + S_{\text{additional}}$$

Principles of planning and designing of warehouse

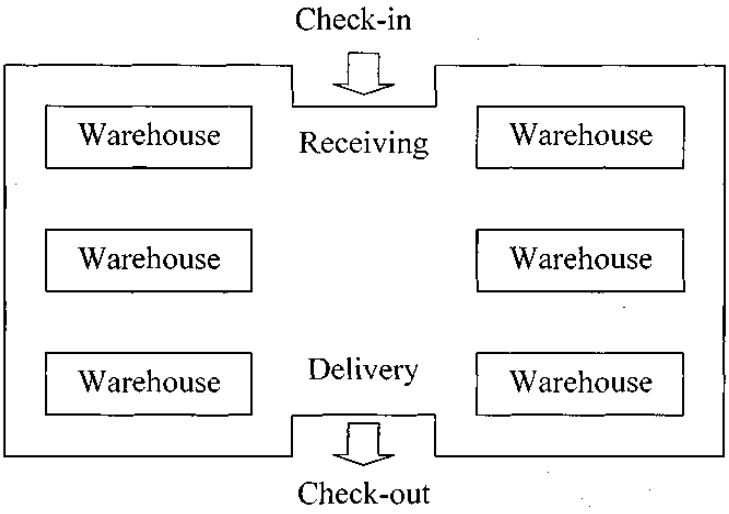
- Use one-stored buildings;

- place goods in lines;
- use effective tools to move the cargo;
- plan the effective using of warehouse;
- minimize the space for passages;
- use the maximum height of building.

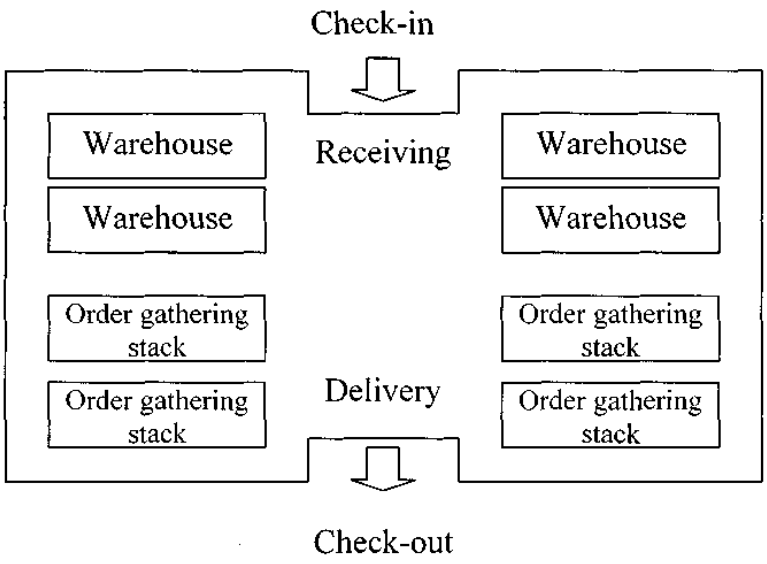
General structure of warehouse



Scheme of general zone of order receiving



Scheme of modified zone



Chapter 11.

Transport logistics

Cost of automobile transport is the important rate of transport work. It shows money representation of all spending, related to production-economic activity of auto-transport enterprise. There are such types of cost:

– full cost;

– cost per unit of transport work (1 or 10 tons kilometers).

Full cost of transporting S S_{full} consists of variable S_{var}, constant, loading-unloading $S_{l\text{-}u}$ and road S_r costs.

$$\Sigma S_{full} = S_{var} + S_{con} + S_{l\text{-}u} + S_r$$

Variable are costs, which depend of car mileage. They include spending on fuel, oil materials, technical support, repair of vehicles, repair and restore of tires, amortization. These costs are calculated per 1 km of run.

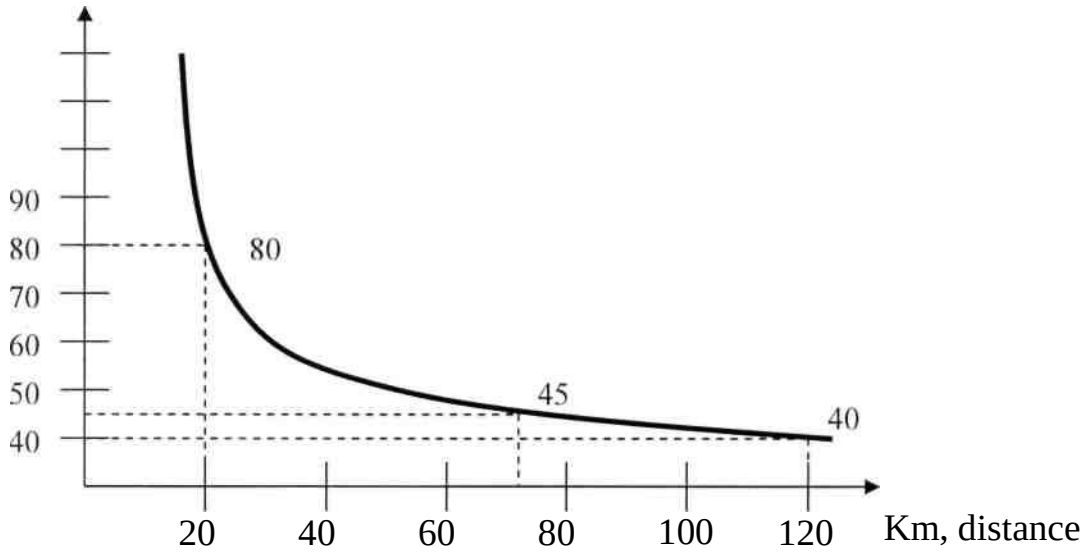
Constant costs include overhead costs, driver's salary, and amortization deductions. These costs usually are calculated per one hour of the vehicles presence on the enterprise (not considering where they placed - on the line, repairing, idling, etc.

With increasing of technical speed and reducing of idling time during loading and unloading vehicles run and efficiency are improving while sum of constant costs does not change. It allows reducing the transportation cost per 1 tons km. Especially hard the cost reduces with improving the using coefficient, load, and run of vehicles, because it reduces sum of variable and constant costs per 1 tons km. As the cost of transport depends of volume of provided works and the funds spent, the main requisition of its reducing is rise of labor efficiency of drivers and other workers of auto-transport enterprise, saving of the material resources (reducing the fuel, material, spare parts and other sending), and also reducing of administrative-management costs by management rationalization.

Important role in reducing of transport cost is played by the effective organization of transportation and complex mechanization of loading-unloading works. Rational decision of these questions allows maximum using of using of vehicles load and provides minimum idle while loading and unloading. Loading-unloading costs include all costs, necessary for prosecution of suck works (movers and loaders attendants' salary, electricity, materials cost, etc). They are calculated per

1 ton of transported cargo, or 1 hour of loading-unloading works. Road costs are loses, related to production, repairing and keeping of roads. These costs are calculated by tons-kilometer, or by kilometer of run. In practice with determined cost of transportation, constant and variable costs are considered. $S_{fu}n = S_{var}$ + Scon-

In transport process the investigation has been provided, which showed changing of transport way length gives slight influence on the cost at the long-distance transportation, and conversely, very high influence at short-distance transportation.



Significant reducing of cost can be achieved using trailers, which significantly improve vehicle efficiency.

While choosing the type of moving composition, detailed analysis of character and conditions of production moving has to be performed. This task should be performed in order to provide full and high-quality satisfaction of the enterprise demands.

While choosing the type of moving composition for delivery to customers, there is logical solution. For example, to transport lumber we use special timber-hauling vessel, for the lengthy materials - trailer, for milk or bread - special vehicles.

Qualitative analysis of transport agency

Geographical territory:

- served area;
- quantity of terminals;
- closeness to the factory. Marketing:
- distribution calls;

- understanding of demands;
- providing information;
- providing current financial reports, insurance, patent, etc. Transport performance:
- competitive service standards;
- emergency service;
- constant in-time supply;
- transporting without damage;

gathers and supplies on order.

Tools:

- available on demand;
- good condition and appearance;
- tools meet requirements.

Customer service:

- computer interface;
- questions and answers;
- direct information about condition of the products sent;
- customer-oriented employees.

Price-making:

- simplified rates;
- structure of prices and discounts;
- competitive prices;
- readiness to conversation;
- readiness to resist competition.

Transport waybill making:

- central or local waybill;
- data accuracy;
- in-time waybill making.

Losses and damage:

- number of claims last year;
- claims in monetary representation;
- fair and fast claims solving;
- providing the proofs of delivery.

Financial stability:

- operation coefficient;
- tendency of operation profits;
- current coefficient;

- amortization as a part of income;
- coefficient of the debt ratio to the own capital;
- market part (tonnage)

Classification of decisive factors of the transport agency choosing

Factor	Place
Reliability and stability of the transportation time	**1**
"gate-to-gate" transporting price	**2**
General time of "gate-to-gate" transportation	**3**
Agency readiness to discuss rates	**4**
Financial stability of agency	**5**
Tools availability	**6**
Service frequency	**7**
Gathering and delivering services	**8**
Losses and damages during transportation	**9**
Fast transportation service	**10**
Customer service quality	**11**
Transportation tracking	**12**
Agency readiness to discuss service changes	**13**
Schedule flexibility	**14**
Direct trip serving	**15**
Claims procession	**16**
Market abilities quantity of agency	**17**
Special equipment	**18**

Transport departments responsibility

- determining the transportation cost;
- audit and management of orders;
- scheduling of equipment using;
- prosecution of conversations about rates;
- investigations;
- route designing and operating.

Chapter 12.

Program-mathematics and information supply of the logistics systems functioning.

Becoming and functioning of logistics systems in its historical development allows determining sequential stages, for which one or another meaning of program-mathematics and information supply is distinctive. Initial (first) stage concerns introduction of logistics concepts into separate activity spheres of enterprise (supply, production, sale), that cover homogenous by meaning parts of material flow, do not cover integrated material flow within instituted borders of the enterprise - logistics system. This stage is characterized by primitive (from the point of view of automation) software and separated functional-information supply.

The next stage of introducing of logistics concepts into the management practice is characterized by overall system approach of making logistics decisions within instituted borders of the enterprise and becomes possible due to forming of appropriate information environment, which operates the information in scope of time, close to real. In such conditions only the program-mathematics supply of the processes of computerization in information forming, processing, transfer, and storage provided the work regime, close to real time parameters of material flow.

Third, modern stage of introducing of logistics concepts goes beyond instituted borders of enterprise due to forming of information networks in regional, national and international aspects.

Information flow as the element of logistics system functions as a form of some information system, which can be conditionally represented as the integration of two subsystems: function and supply. Traditionally, supply subsystem of information system includes the following elements:

- technical supply as the complex of technical method for the information flows processing;
- information supply as the complex of variable directories, classifiers, codifiers, catalogs, rules, data formalization tools, etc.;
- mathematics supply as the complex of methods of the logistics problems solving. Since modern logistics information systems function in automated mode, mathematics supply of such systems represents the program-mathematics complex that provides solving the problems of the material flow planning and management and is possible only upon condition of modern technical supply (microprocessor-based).

Functional subsystem is the complex of the problems solved, which can differ depending of the type of logistics information system. Three groups logistics information systems can be separated:

- planned, which are created on the administrative management level and serve to make the strategic decisions;
- dispositional, which are created on the level of department or warehouse management and serve to provide normal functioning of logistics systems;
- executive, which are crated on the administrative or operative management and serve for the real-time activity.

Due to the listed development and introduction stages the appropriate integration of information systems occurs. Horizontal integration in disposition and execution systems with horizontal information flows formed the basics of logistics functioning of separate spheres of enterprise's activity, and appropriate vertical integration as the unification of planned, disposition and execution information system with vertical information flows led to the forming of integrative information systems, able to systematically, transversely cover entire material flow "supply - production - sale" with necessary adaptation to the environment changes, and, if needed, to expand borders of integrated information systems beyond the enterprise borders.

So, logistics information system as the tool of logistics planning and management of material flow on the enterprise by meaning of its subsystems has to meet the main requirement - ability to function in real-time mode, because this exactly determines specific conditions of the logistics system efficiency forming. Based on the presented requirement, program-mathematic supply has to fully response to it. As for technical supply on the modern period (such as personal computers connected into networks, electronic devices, text-processing systems, copiers, input, search, and accounting automation systems, video systems, local area networks, integrated networks of the enterprise), we can definitely say about their significant advance above functional subsystems and program-mathematic supply.

Fundamental base of the solving of problems, provided by functional subsystem, and, respectively, methodical base of program-mathematic supply, is the method of operation research as the means for solving of practical economics problems. In base of the operation research method is the system analysis of directed actions (decisions, operations) with following comparative rating (quantitative, first of all) of possible results of these actions. For example, the diversification of production in order to increase realization volume, demands simultaneous and interdependent solving of the complex of partial problems:

– in supply - forming the appropriate system of material-technical supply of raw, materials, spare parts, transport and warehouse powers, etc.;

– in production - enterprise reconstruction, upgrading and new technologies introduction, new equipment purchase, operating-production planning and supervising systems changing, organization rebuilt, etc.;

– in sale - planning and organization of appropriate distributive systems, organization of the market research system, forming the logistics service model.

– in human resources sphere - training and completion of employees with qualification required, management structure reform;

– in financial sphere - financial resources mobilization and forming reasonable financial support;

– in the information sphere - forming the necessary information flow.

While solving these partial problems and their integration into final system decision about the task given, analysis of possible results of logistics decisions is followed by considering such specific factors as uncertainty, randomness, and risk.

Considering the possibility of multi-variant decisions in logistics systems, which is called strategy or alternative, we can state that the method of operations research prosecutes the search of the optimal available recourses using way to realize the objective, and it determines the most rational variant of forming the next economic potential of enterprise.

Quantitative methods of operation research are determined by achievements of economic-mathematic and statistics disciplines and include the next problem classes:

– stocks management problems;

– resources distribution problems;

– ordering and coordination problems;

– competition problems;

– searching problems, etc.

Creating the multi-level automated systems of material flow management demands significant spending on the developing of software, and, from the one hand, must provide multi-functioning of the system, and from the other hand -high integration level. That's why, in conditions of logistics systems functioning there is an attractive way of using rather cheap standard software with the following adaptation to local conditions. First of all, this will be contributed by classification one or another enterprise to the appropriate group according to the classification methodic represented above. Comparatively high level of standard software using can be achieved with solving problems using planned information systems, which is harder using disposition systems.

Creating logistics information systems, you must be led by the next principle scheme:

– principle of using of hardware and software modules;

– principle of possibility to step-by-step creation of the system;

– principle of strict determining of the mating places, in order to their usual overcoming;

– principle of the system flexibility from the point of view of specific demand and concrete using;

– principle of acceptance (availability) of the system for the using in conversational mode.

Wide incision of logistics into the economics sphere became possible because of computerization of material flows management. Constant improvement of quantitative values of microprocessor systems (speed, memory, conversation simplicity, cost) provided qualitative possibility of integration the different members of logistics processes into common system, passing the existed borders of enterprises and reaching national and integral borders. But in such integrated systems demands of operated material flows management are actualized, what means necessity of implementation of material and information flows parallelism in time, i.e. providing gathering, procession, and transmission of information realtime. As the world experience evidences, problem of functioning of information flow in temp of material flow decided with help of appropriate technology -automated identification of bar-codes. It is microprocessor-based, able to identify goods unit by scanning variable bar-codes. This equipment allows us to obtain information about logistics operation in the moment and place of its prosecution -in warehouses, distribution bases, transport, stores, etc, and that means possibility of its procession in real-time mode and appropriate influence on material flow within optimal terms.

Represented interpretation of logistics information systems in contest of management system on the enterprise made possible appearance of the meaning "information logistics". This appearance is logical from the point of view of economic production science with economic informatics. Together with the meaning "information logistics" functions of general management and coordinating the material flows on the enterprise and its environment, used for economic processes regulation goes on the front plan. Informational logistics in logistics of enterprise stands aside with logistics of supply, production, sale (known as real logistics) and is connected to information management. Information logistics, in contrast to the meaning "information management" is oriented on cross-cutting review in- and between-producing logistics chains. Along this, strategic directions are completely determined by created potential of world's information and telecommunication

infrastructure. Considering this, exactly between-production aspects of information logistics come on the front plan.

Represented material allows understanding the management complex of using the economic information in horizontal and vertical aspects, in inner and outer coordination as the information logistics. Simultaneously this means' necessity of forming appropriate information-logistics infrastructure as regular provider of information-logistics services. Information logistics by meaning looks like (see Figure 12.1)

Considering the enterprise in information-logistics plane, we can note three of the most important flows: real (material), nominal (financial), and information. This causes information logistics priority from the point of view of rising meaning of information flow for coordination of material and financial flows as inside the enterprise, as well as in environment. That's why logistics-oriented model of enterprise allows operative implementing of logistics planning, analysis, and management of enterprise.

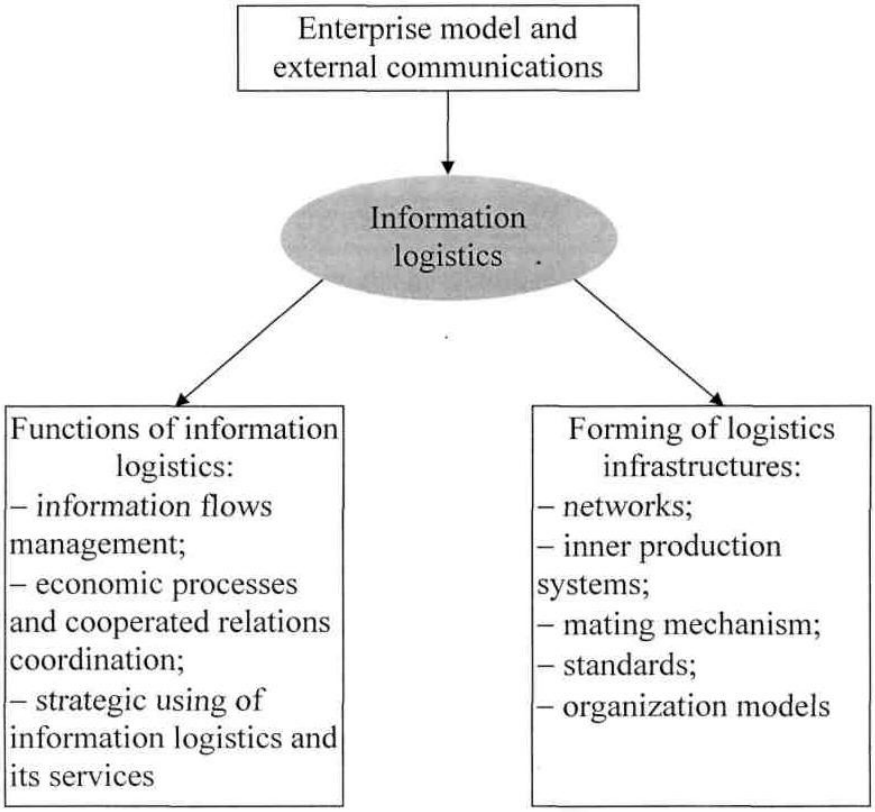


Figure 12.1 Meaning of information logistics

Chapter 13.

System "logistics-controlling" and the logistics systems economics.

Introduction of logistics concepts into practice activity of enterprises in strategic plan can provide sufficiently reliable optimality of strategic management. But in tactical plan, and, moreover, operative, functioning of logistics systems demands constant correction by influence of environment, which means partial change of information basis for logistics planning (stages 1,4).

Recent researches approve necessity of integration of logistics and controlling. Term "controlling" means the complex of analysis, forecasting, decision making methods, and their adjustment in process of realization of strategic goals of the enterprise. So, integration of logistics and controlling will contribute adjusting of logistics decisions in proves of strategic logistics goals realization. Graphically this interpretation can be illustrated as on the figure 13.1.

System logistics-controlling

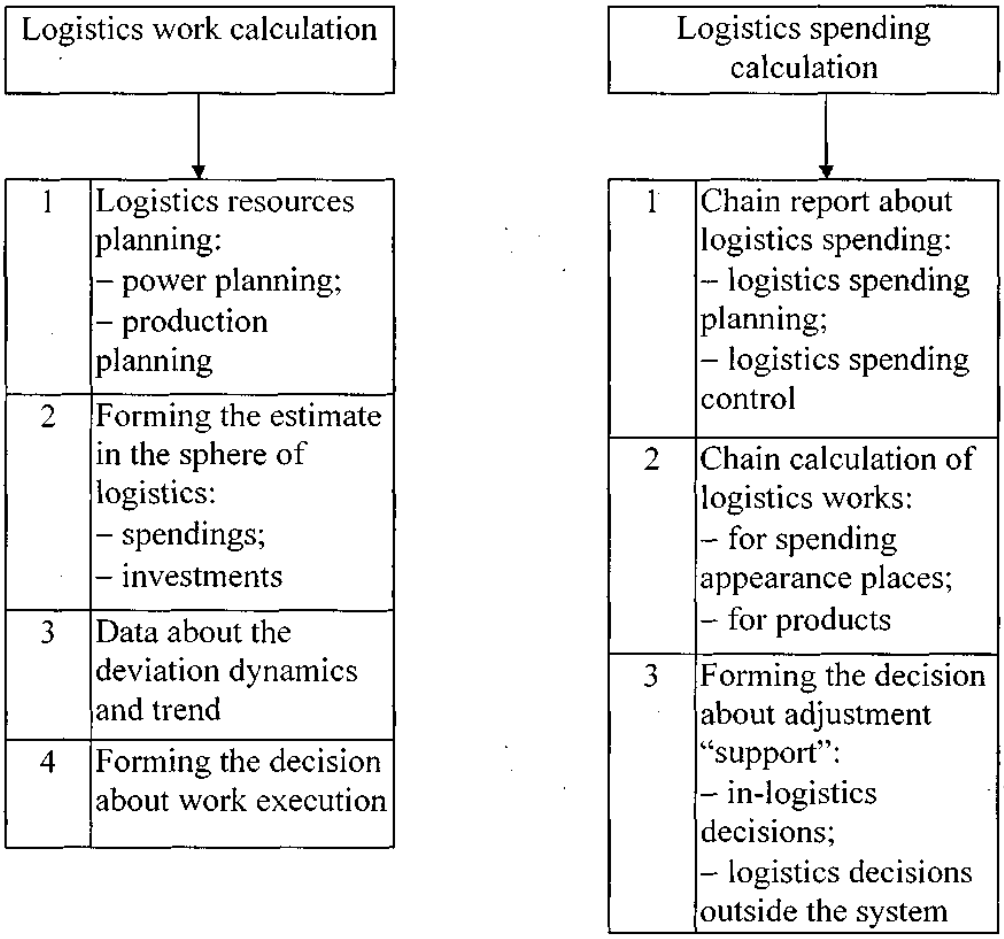


Figure 13.1 Controlling in the system of logistics

Figure above arguments incision of controlling into the logistics system. The left side of scheme "Logistics work calculation" shows the decision making process concerning performance of logistics services (stocking, transporting, packing, etc.), and their project adjustment considering deviations dynamic and expected tendencies. The right side "logistics spending calculation" provides operative factor analysis of logistics spending concerning the places of appearance and concrete products (complete products, semis, etc.), providing the logistics works and decision making concerning the logistics functions adjustment as inside logistics system, as in "logistics environment".

Enterprise activity specifics in logistics services sphere in some extent are defined by character and meaning of logistics activity, which requires appropriate quantitative rating. Schematically it can be interpreted the next way.

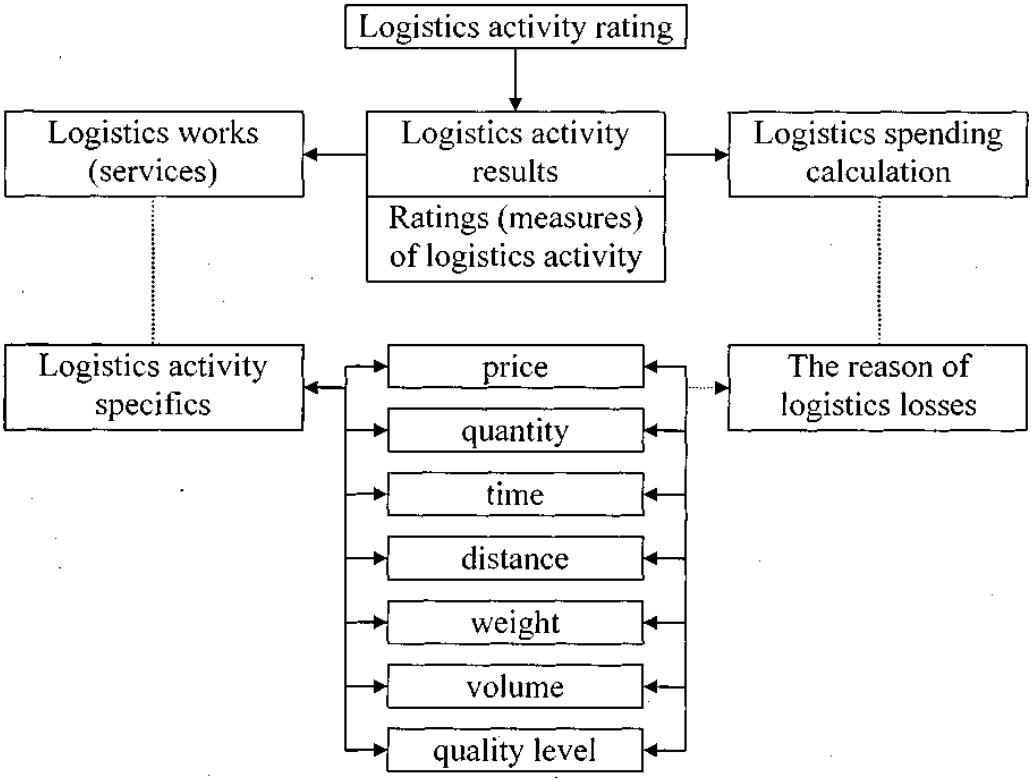


Figure 13.2 Logistics activity ratings

Illustrated scheme shows, that as the volume of logistics works, as the necessary logistics spending changes by the influence of a lot of factors. Transportation of one or another production requires considering not only quantity, but also weight, volume, time, distance, etc. The same rating will define size of logistics spending.

- Controlling as the integrated function of management more and more requires the logistics approach. Meaning of this is in many aspects. Thus, logistics activity can be considered in the following planes: influence plane;
- result plane;
- process plane;
- factors plane.

Schematically it can be represented as:

Plane	Rating	Using
Logistics work as the guarantee of resources using (influence plane)	Service level	Determining the level of supply readiness for certain quality level
Logistics work as the providing space-time movements (result plane)	Ton-kilometers, time of storage in the warehouse	Planning of product delivery considering the demand
Logistics work as the variable logistics process (process plane)	Distance traveled by auto-train on the highway	Planning of vehicles movement
Logistics work as the guarantee of readiness of performed logistics works (factors plane	Preparation of reserve stock powers of some size.	Periodic powers planning

Figure 13.3 Meaning of logistics in the controlling system

Forecasted calculation and accounting of logistics spending as the part of controlling will serve as basis for optimal decisions making, provided by their appropriate specification. Process of calculation of the logistics spending is represented in the next figure.

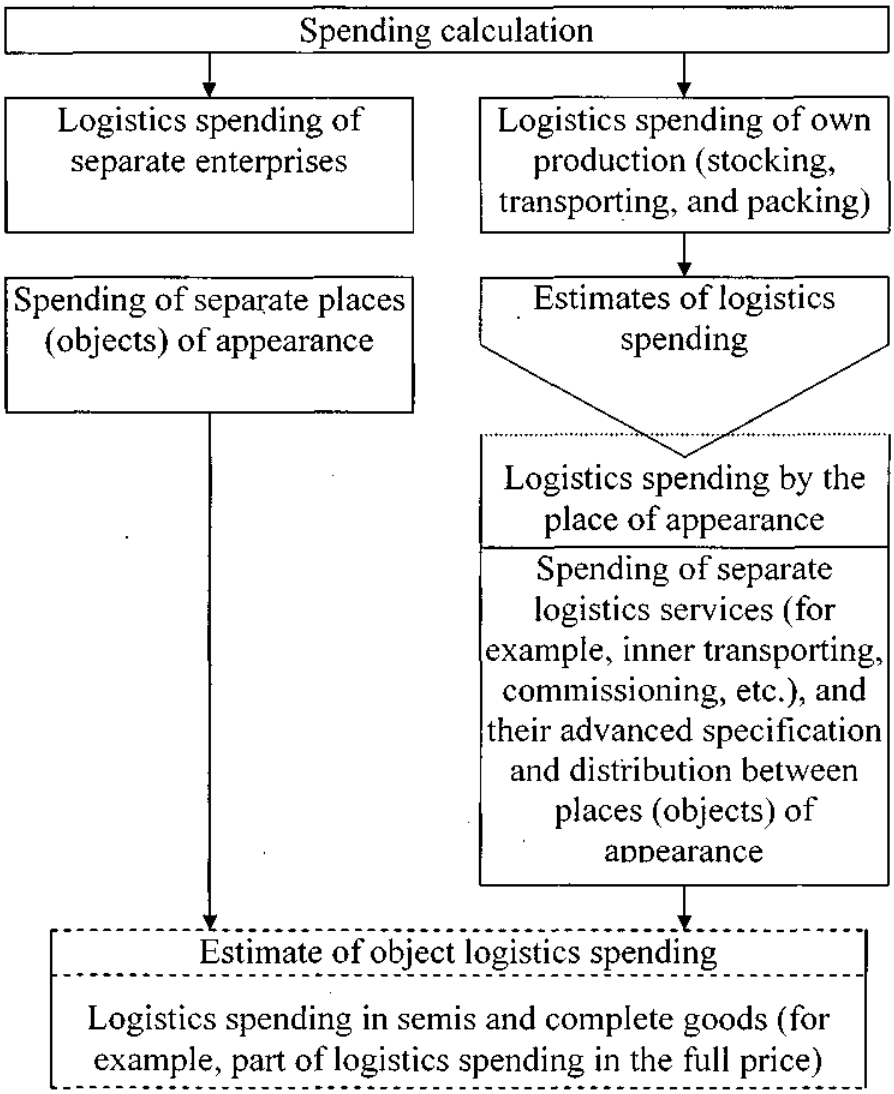


Figure 13.4 The order of calculation of logistics specific spending

Meaning of analysis and accounting of logistics spending can be presented this way:

Table 13.1. Analysis and accounting of logistics spending.

Spheres of investigation	Frequency of performance	
	Discrete	Continouous
Types of logistics spending	Specified (factor) analysis of important types of spending (for example, freight with structure and variations)	Basic calculation of spending by the place of appearance and the spending accounting; limitation in planning and control of important types of spending
Place of spending appearance (attachment)	Factor analysis of important places of spending considering parts of logistics spending. Improving the logistics spending accounting	Basic calculation for accounting of object spending (logistics calculations) and their accounting; limitation in planning and control of important spending places
Objects of logistics spending (semis, complete goods)	Factor analysis of important or whole objects of spending to determine the deviation from "standard". cost	Following stage specification of the logistics spending calculation

Structure of spending of the logistics functions executions by third-party organizations looks this way (see figure 13.4).

Represented fully objectively persuades in necessity of	
Spending on external transportation	Spending on external storage
1. Auto transport spending 2. Railroad transport spending 3. Marine transport spending 4. Other transport types spending: a) aircraft; b) postal; c) pipeline.	1. Trade outlays: - stocking outlays; - commission outlays; - between-warehouses outlays; - other outlays; 2. Products storage on warehouses outlays. 3. Other outlays.

Figure 13.5 Forming of spending on the external logistics services

Forming the ratings of logistics systems economics is carried out on the stage of project analysis, and further, these ratings are used as the constant element of comparison base. Lets consider detailed meaning of project analysis within borders of logistics system, and in aspect of logistics concept's involvement influences on the final results. For the logistics system enterprises of medium size, that works for stable inner market and is not monopolist, financial analysis is considered enough. But in case of large enterprises (corporations), that have global influences on the global market or are monopolists in some sphere, also for new firms of cooperated relations with international character (for example, integrated information connection) except of financial, economic analysis is necessary.

Since financial analysis is oriented on perspectives of private market, rating profits and spending we use prices of private market. Vice versa, in economic analysis we should use social ratings ("dark prices" or "dark valuables").

Executing the financial and economic analysis is characterized by couple of important differences in rating profits and spending, namely:

a) financial analysis:

- private market prices are used concerning profits and losses;
- capital outlays are divided on the all time of project service;
- groups taxes and other one-sided payments between groups are included;
- private rate of discount is used.

b) economic analysis:

- alternative social valuables are used (dark prices of unused labor, ecologic effects, unused production factors (powers), foreign currency).
- capital calculates once a year of using;
- inner taxes are not included in calculation;
- justice questions are solved by considering "weight" of group pure profits;
- considering the effect of secondary multiplicator.

Rating of project's usefulness (suitability) executes considering such factors as acceptable market perspective, existence of limitations of resources, fluctuations of pure financial flows. As the criteria, most often we can use one or a combination of listed below:

- pure given value (pure given price) as the difference between discounted value of project and discounted value of project cost (NPV);
- coefficient benefit-loss as the ratio between amount of discounted benefits and amount of discounted costs (B/C);
- time of economic return (used only in financial analysis);

- inner rate of income as the discount rate, which equalizes given value of benefits with the given costs value (IRR) (one of the most often used in financial analysis);

- Bruno criterion as the ratio between pure economies of foreign currency (by reducing of import or growing of export) and inner production spending (is used to rate projects about import substitution).

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