THE ACADEMY OF MANAGEMENT AND ADMINISTRATION IN OPOLE

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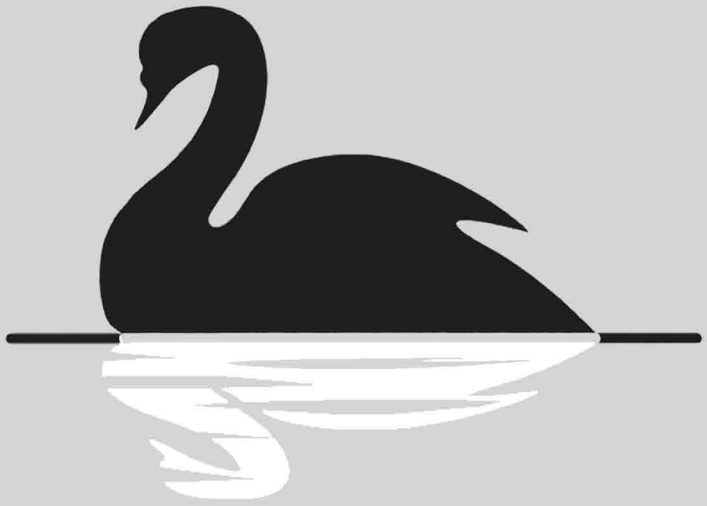

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CONTENT

PREFACE

The transition to a post-industrial society is marked by cardinalchanges that require the development of new methods and approaches in the functioning of society. Logistics as a field of human activity is also changing. Network, information, cognitive features of the new economic formation determine the approaches to flow management. New requirements appear, end-user inquiries become a priority, in connection with which the logistics of individual business processes is replaced by the concept of supply chain management.

In today's economy, one of the basic competitive advantages of any organization is the ability to quickly and efficiently meet consumer demands in accordance with their requirements. The most important tool in the process of achieving this goal is the direction of the organization as a whole, because it is the formation of an effective system of promotion of goods in supply chains, allows delivery of goods to the consumer in the right place, time, quantity, quality and cost.

However, a combination of adverse external factors, such as price fluctuations, arbitrary increases in supply lots, deviations from planned deadlines and production volumes, etc., can lead to disruptions or failures in the supply chain, and thus reduce supply reliability and increase costs. Therefore, the assessment of objects of different levels of government - from accounting for goods and materials to decision-making in transport logistics operations is extremely important.

Supply chain management is one of the effective strategies for creating competitive advantage, which attracts the attention of many researchers who are trying to explain the nature of this concept, identify the preconditions for the emergence and study areas for further development.

Given the new economic conditions, an efficient supply chain must meet all the requirements of the economy of post-industrial society, in particular, a rapid response to changes in demand, the execution of orders with high quality service. In this regard, during the construction of modern logistics systems, the policy of selling manufactured goods is replaced by the policy of production of goods sold or services; constant work is carried out to minimize the time of passage of products through the technological process, reducing the batch of resources and batch processing, reducing all types of downtime and irrational in-house transportation.

Modern economic organizations operate in a dynamic environment in which there are rapid and constant changes in demand, competition, technology and legislation. These changes directly affect the formation of characteristics that determine the competitiveness of production. It is safe to say that the key to the successful operation of the organization is not so much stability and stability, as the ability to respond effectively and dynamically to the uncertainties of the external environment.

Efficiency - one of the most important characteristics of the quality of the system, an indicator of human activity, which determines the ability to ensure the end result. If we consider economic efficiency, it is a relative indicator by which the obtained effect is compared with the costs or resources that were used to achieve it. The efficiency of the logistics system is associated with a certain level of stability of its operation at a given level of total logistics costs. From the point of view of the consumer, who is the final link in the supply chain, efficiency is determined by the level of service quality of his order.And it isefficiency of supply chains combines all these concepts and is characterized by both a high level of economic efficiency and the necessary levels of stability and quality of operation of all processes in it, including the efficiency of transportation.

In a market economy, transportation is seen as the most important opportunity to gain a competitive advantage. This explains the growing interest in the system of indicators for assessing transportation in supply chains. After all, with the help of a correctly constructed analytical system of indicators, you can calculate certain values, identify trends and, most importantly, plan the entire process of transportation in supply chains based on specific figures and results.

CHAPTER 1 SUPPLY CHAIN AS A NEW DIRECTION OF ORGANIZATION OF INTERFIRM INTERACTION

1.1 Methodological approaches to understanding the concept supply chain management

Search for new sources of sustainable development and ways to improve management efficiency, determined by the complexity of the external environment and business conditions, in particular, the rapid development of information and communication technologies, globalization, increased competition and transformation of consumer behavior.

Modern enterprises exist in a competitive environment for markets, resources, information, innovation and more. Accordingly, business practice often precedes the development of theory, and innovative management decisions and tools go beyond established paradigms, which leads to the emergence of new concepts of organization and management of the enterprise, which correspond to the level of market relations (Fig. 1.1).

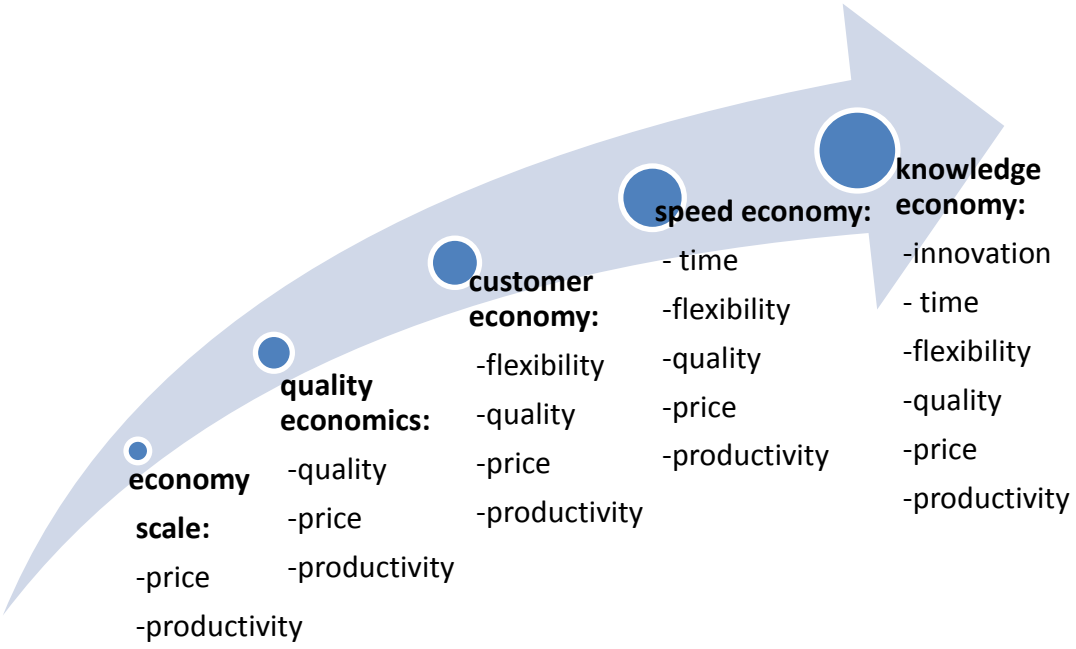


Fig. 1.1 Evolution of production and logistics concepts.

Source: Compiled by the authors

Today, economic development is associated with the intertwining of price and non-price methods of competition; the spread of oligopolistic structures; trends in mergers and acquisitions; globalization of competition; emphasis on new technologies, possession of information, knowledge, desire for innovation. And the development of information technology and the emergence of the global information network Internet have provided fundamentally new opportunities for business management.

In logistics, analytical, technological and marketing paradigms are being replaced by an integrated (logistics) paradigm. It goes beyond the problems of optimizing the business processes of an individual enterprise and involves the integration of individual enterprises into supply chains in order to thoroughly improve management processes and increase the overall efficiency of their business.

At the same time, it is well known that each new economic paradigm requires the improvement of existing management methods and the formation of new tools for regulating relations between economic agents. Accordingly, the implementation of marketing-oriented economic paradigm contributed to the emergence, formation and development of logistics as a scientific and practical direction of the concept of strategic partnership.

Its further development and improvement are reflected in the formation of a new view of business, namely the concept of supply chain management (PSM), which provides for effective internal organizational links of all participants in the chain through which the product moves, and building inter-organizational relationships and management them.

The latest stage of economic development, which experts call the "economy of interactions" or "economics of competencies", is directly associated with the proliferation of network structures and organizations, whose effective activities require a new quality of interactions and management (Table 1.1).

Table 1.1

Business paradigm changes with the introduction of the supply chain management concept

The paradigm of business to SLP	The paradigm of business for SLM
Focus on suppliers and own production	Customer focus
Production in a warehouse	Production according to actual demand
Insurance reserves	Coordination and information exchange
Local optimization of transportation, production, stocks	Optimization of the entire supply chain
Functional thinking	Process thinking
Cost savings, penalties for non-compliance with supply obligations	100% compliance with delivery times
Capacity load optimization	Flexibility and customer satisfaction
Operational planning based on medium-term plans	Operational planning for actual consumption
Constant lack of necessary materials	Control of availability and stocks of materials
Direct cost optimization	Optimization of total costs
Optimization of container use	Formation of supply parties based on JIT / JIS strategies
Volume maximization	Optimization of the order execution cycle
Individual companies compete	Supply chains compete

Source: compiled by the authors on the basis of literary sources

The practice (followed by theory) of SLM emerged in response to the new economic challenges of the late 1970s and early 1980s, when the macroeconomic indicators of stagnation in the world economy required considerable effort to develop new management decisions and concepts. At that time, one of the conditions for the survival of companies was to reduce logistics costs.

At the same time, it quickly became clear that the reason for significantly increased logistics costs is not so much the transport component, which has increased significantly, but the high cost of creating and maintaining insurance

stocks, writing off obsolete stocks or, conversely, lost profits due to lack of necessary stocks to meet growing consumer demand.

Further complication of market relations from the standpoint of taking into account the time factor and customer-oriented business, led to the transformation of supply chains into network economic structures, to the formation of economic relations in a special business environment - network economy.

Typically, networks use a combination of formal and informal procedures to coordinate and coordinate the activities of their members, helping to access partners' resources in order to maximize the synergies between their use.

Characteristic features of networks are:

- the presence of a common governing body;
- sustainability of information and financial relations;
- coordination of actions of network participants [59].

In this sense, coordination between partners in supply chains replaces traditional types of cooperation and is perceived more as a desire to jointly create value and reach the maximum possible market share, which becomes real only as a result of increasing the competitiveness of the final product.

Cooperation in the supply chain involves fair distribution of risks and rewards, joint planning, product development, exchange of critical information, implementation of integrated information systems, inter-functional coordination within each link in the supply chain, and focus on long-term partnerships.

Mai Kao and Kingyu Zan define it as "a long-term partnership process, where supply chain contractors work to achieve a common goal and benefits, for which they exchange information, cooperate in the context of implementing best practices" [67]. Accordingly, the supply chain according to J. Haulichen should be considered as "a single process and responsibility for the various elements of the supply chain and should not be divided by functional areas into production, purchase, distribution or sales" [90].

Therefore, in the case of merging into a single supply chain of companies with equal power in the market, to address the most important issues of their operation usually create organizational units, coordination boards or hire a network broker that:

- carry out general coordination of their activities;

- develop and implement common standards (rules, norms) of behavior related to management decisions, implementation of innovations, customer service, information processing, staff motivation, etc.;

- increase the level of trust between participants, promote the development of network corporate culture, which often becomes a key factor in achieving success.

In addition, according to D. Dusters and K. Haymerix the presence of a special organizational unit for alliance management helps to identify the necessary resources and distribute existing ones [80].

In this regard, the task of the special unit is also to find potential partners, because firms often have access to resources obtained with them from selected sources.

Thus, the presence of coordination in the supply chain allows to achieve cost-effectiveness for each counterparty, minimize operations that do not add value to the end user, adapt the intra-level processes of each link to the overall goals of the supply chain and guarantee the level of service.

It should be noted that "supply chain management" is a relatively new economic concept of management that has been widely recognized in the scientific and business environment. Many researchers [16, 72, 77] believe that it has not only become a catalyst for radical change in a number of industries, but has significantly affected the very idea of the nature of competition, replacing competition between enterprises with the competition of goods passing through their supply chains.

Today, supply chain management is one of the most dynamically evolving

scientific concepts and a practical direction of consumer-oriented business organization. Supply chain management is the organization, planning, control and execution of the flow of goods, from design and procurement through production and distribution to the final consumer in accordance with market requirements for cost efficiency [108]. As a scientific concept, it has a pronounced interdisciplinary orientation and combines not only different areas of economics (logistics, management, marketing), but also individual sciences (economics, sociology, psychology, etc.). And as a practical direction focuses on the end customer and requires the application of modern information technology management practices, integration of business processes and close relationships between all participants in the supply chain. The emergence of the concept of supply chain management is usually associated with four scientific theories:

Theory of transaction costs. The emergence of this theory is associated with the classic work of R. Coase "Firm, Market and Law" [23] and the question in 1937 about the nature of the firm. It examines the costs of transferring property rights from one economic agent to another and protecting those rights. O. Williamson's ideas about the boundaries of firms, as well as the explanation of these boundaries, had the greatest influence on the concept of SLM. In Markets and Hierarchies [113], he raises the question of the circumstances under which economic functions are realized within hierarchically constructed firms without falling under the influence of market processes.

Game theory. It was developed by von Neumann and Morgenstern [33] in 1944. Its main issue is to study and explain the optimization of economic solutions involving more than one participant (for example, a customer and a supplier, or several suppliers). Game theory has become a theoretical tool for analyzing decisions on inventory management, warehouse selection, production, the creation of strategic alliances and partnerships. For the development of SLM, game theory can be useful as a tool for analyzing strategic decisions in a dynamically changing environment and a large number of stakeholders in the

efficiency of the supply chain.

Systems theory. Appearing in physics and biology in 1950 in the first place thanks to the work Ludwig von Bertalanffand [63], in subsequent years was very quickly adapted by researchers in the field of management, in order to explain the processes, behavior of economic agents, firms and the economy as a whole. Systems theory considers the world through the prism of a set of resources and processes that exist to obtain certain "super profits". The system may consist of material, people, information and financial resources combined in an organizational or technical process to create and distribute goods and services and thereby achieve acceptable results.

Theory of inter-organizational relations. The study of inter-organizational relations became one of the dominant areas of the economy in the 90's and early XXI century. (W. Baker, R. Faulkner, D. Fischer [3]; M. Castells [20]; K. Perez [37]), which contributed to the development of relationship marketing and network approach to marketing. Under this approach, the object of management is not the result (overall decision) to promote the product, but the process of relations (communications) with the end user of the product and other sellers and buyers in the network. The progressiveness of this approach is confirmed by the fact that products are becoming more standardized and services unified, which contributes to optimization and repetitive marketing decisions.

The application of methodological approaches to the above theories and the relevant relationship between the factors and conditions of the modern economy have determined the evolution of the concept of supply chain management.

The concept of "supply chain management" appeared in the late XX century. In the information age or the era of post-industrial development. This period was characterized by saturation of demand and social orientation of production. Saturation of demand, transformation and distribution of the world

market, computerization of market relations, which provides instant access and comprehensive information about any product, have made firms think about what can be used for their survival. And the solution was found in the processes of integration of activities into efficient supply chains of goods and services.

The system-forming reason for this tendency was the realization by enterprises of the benefits of taking control of the chain reactions of fast-acting self-organization of the consistent establishment of economic relations under the influence of market demand or production orders. The objective preconditions for this step were created by the following three factors.

Firstly, free formation of a system of successive economic relations is usually accompanied by a negative vertical effect, which manifests itself in the form of the problem of "double marginalization and excessive reduction of demand" [47]. This problem has two aspects. One of them is the uncontrolled setting of the price of the product by each subsequent participant in the supply chain, which leads to its repeated distortion and reduced competitiveness of the product as it moves on the market.

Another aspect is characterized by the fact that the speed of material flow in this chain decreases due to the decision of each participant to maximize their own profits, which do not take into account the additional profit of its supplier and lead to weak production consumption of its goods or small resale.

Second, this is an intensification of the trend of segmentation of markets for goods and services, which forces companies to pay special attention to ensuring the necessary speed of response to personalized consumer requests by carefully managing their business relationships, which in turn necessitates purposeful organization of supply chains.

Thirdly, this is the desire of enterprises themselves to avoid uncertainty in demand and, accordingly, reduce risk through the cooperative separation of production processes and responsibility for their results and the use in supply chains of models of multilevel inventory management.

The term "supply chain management" (SCM) appeared in the early 1980s in the United States. It is first used in research by I2 Technologies and Arthur Andersen. In the vocabulary of the world scientific community, this term appears and became widespread in the mid-1990s. His appearance is associated with the article by K. Oliver and M. Weber "Supply chain management: Logistics Catches up with Strategy", published in 1982.

In it, the authors defined supply chain management as a material flow that flows through distribution channels from supplier to end customer, highlighting the main idea that the supply chain should be indivisible, and its optimization should take into account the requirements of all its participants [100].

In practice, supply chain management is widely developed in the mid-90s of the twentieth century. in Europe, the USA and Japan in the industrial and trade enterprises focused on the individual consumer. The practical idea of supply chain management was born from the attempt to expand the logistics horizon to the strategic level in terms of its competence and as a result of its activities beyond one enterprise.

Its implementation has facilitated the coordination of information, material and financial flows not only in a single enterprise, but also in a number of enterprises that are interconnected by technological and logistics chain. And at the initial stage of its formation, supply chain management was interpreted as a supplement to logistics in a coordination or integrated plan, carried out outside a particular firm, including its customers, suppliers and other contractors.

Considering the evolution of the concept of supply chain management, we can identify five main stages of its development (Table 1.2).

Table 1.2

Evolution of the concept of supply chain management

Stage	Period	Characteristic
I. stage Preparatory	To 1980	There is a gradual weakening of the influence of vertically integrated corporations and the strengthening of companies specializing in certain technological processes. Problems of cooperation of companies are revealed and researched and logistic decisions on the basis of the principle of the general expenses are developed. Management decisions and methods developed at this stage became the basis for the creation of modern tools for procurement management and gave impetus to the coordination of procurement not only the company but also its suppliers.
II. The origin of the theory of SLM	1980s	There is a need for a new concept of business management as the idea of coordinating the flow of materials and finished products not only within one firm, but also in a number of firms that are interacting. The practice of some leading companies in the field of supply chain management is consolidated. The first scientific and practical articles appear, a new term "supply chain management" is introduced. The dominant management approach is to harmonize the flow of materials and finished products through simple coordination of logistics processes with suppliers.

Continuation of table 1.2

III. Separation of SLM theory from logistics	The first half of the 1990s.	There is a separation of the theory of SLM from logistics, attempts are made to differentiate the conceptual apparatus. The coordination inherent in the previous stage is extended to the integration of the basic business processes of companies in the chain. Management approaches are logistics and procurement approaches. The main task of each of the approaches is to minimize the total costs in the chain while maintaining a given level of service.
IV. Formation classical concept of SLP	The second half of the 1990s - early 2000s.	The classical idea of supply chain management is formed. There is a shift in the focus of the concept from cost savings to customer focus and the transition to total supply chain management. The main areas of research focus on the processes of integration and the creation of strategic partnerships. The dominant management approach at this stage is to build cost-effective supply chains by integrating key business processes of companies.
B. The current stage of development of the concept of SLP	The second half of the 2000s and beyond	There is an even more in-depth study of the theory and practice of supply chain management and their adaptation to different markets. It is determined by many areas of development of the concept of supply chain management. The focus is on in-house planning and resource optimization in building the relationship

		between the focus company and the rest of the supply chain participants. The marketing approach based on integration into the process of joint production of consumers and suppliers becomes dominant

Source: Krotov K.V. Directions of development of the concept of supply chain management. Scientific report № 14 (R)/K.B. Krotov. 2010. SPb.: VShM SPbGU. http://gsom.spbu.ru/files/upload/niim/publishing/2010/wp_krotov.pdf;_Smirnova EA Supply Chain Management: A Tutorial. E.A. Smirnova. SPb.: Izd-vo SPbGUEF, 2009. 120 p.

Today, supply chain management is being transformed into a new concept of efficient business conduct and is an independent scientific discipline that includes logistics as a key component. This fact was finally confirmed in 2005, when the Logistics Management Board (USA) changed its name to the "First Professional Association of Supply Chain Management", and later to the Board of Chain Management Specialists. supplies "(from English - Council of Supply Chain Management Professionals (CSCMP).

A comparative analysis of the terms "logistics" and "supply chain management" (Table 1.3) shows that there are some differences in all criteria, i.e. these concepts are not identical.

Table 1.3

Comparative analysis of the terms "logistics" and "supply chain management"

Comparability criteria	Logistics	Supply chain management
Organization	Functional structure, intra-organizational relations	Integrated supply chain, inter-organizational relations
Vision range	Suppliers and consumers 1st level	Through system
The purpose of management	Logistic optimization internally-organizational processes	Advanced corporate optimization

Choice of partners	Pricing and competition	Proposal and negotiations
Interaction partners	Short-term contracts	Long-term contracts and strategic alliances
Relation to supplier	Source	Resource
Risk	Low	High

Source: compiled by the authors on the basis of literary sources

The main difference between these concepts is that logistics is an integrated function of material flow management, which includes supply, production support and distribution, while supply chain management combines all business processes in the supply chain to coordinate between suppliers, the company and consumers.

Common in these concepts are the systematic consideration of the supply process and the process approach to its management. Logistics is a micro-level, i.e. the integration of activities within the organization, and supply chain management is a macro-level, i.e. the integration, the interaction of individual independent organizations.

Thus, we can conclude that the terms "logistics" and "supply chain management" are interrelated, but not identical; the concept of "supply chain management" is a replacement for the concept of "logistics"; supply chain management in terms of its functionality and composition of business processes is much broader than logistics. The main feature supply chain management is not the management of participating organizations, which are links in the supply chain, and channels of interaction (information, innovation, finance, resources, etc.).

The concept of SLM provides an opportunity to combine the efforts of the focus company and its counterparties for end-to-end management of information, product and financial flows in an integrated chain "design - procurement - production - distribution - sales - service". The use of an

integrated paradigm in SLM is aimed at optimizing management decisions related to minimizing costs in the supply chain.

Such integration allows improving inter-functional and inter-organizational coordination, which, in turn, contributes to the implementation of multiplicative and synergistic effects from the combination and accumulation of resources. As is known in the law of synergy is based on the principle of emergence, according to which joint efforts with a combination of resources always give a greater result than the sum of separate efforts. The peculiarity of the competitive advantages of supply chains in creating synergetic and emergent effects is that they usually cannot be used by a single enterprise, but have positive externalities to strengthen the competitive position of all its participants. A larger share of the synergistic economic effect in the composition of the created value leads to greater production efficiency.

However, the modern supply chain differs from the vertically integrated corporation, which was the most developed form of wholesale production in the early XX century. Consisting of separate, formally independent (in fact interdependent), focused on their key competencies of enterprises that cooperate and integrate in order to minimize overall costs and maximize the value of their own products for the end customer.

In their activities, they are not isolated from each other, but act as a customer buying raw materials or components, from their suppliers and as a supplier, supplying products to their customers or end users. Almost all goods (services) in the process of their creation pass through a number of enterprises, gradually moving from primary suppliers to end consumers, while forming certain flows of goods and chains of enterprises that to some extent interact with each other.

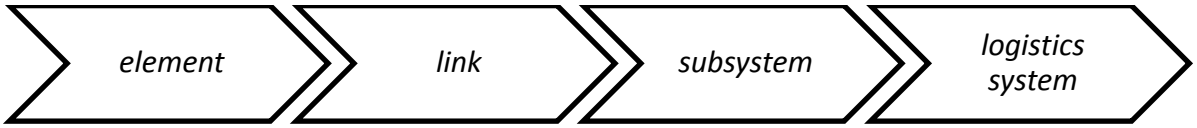
Different names are used for all these chains. If in the process of research attention is focused on operations, they say "process" (process); if the emphasis is on marketing - "logistic channel" (logistic SCHANNEL); if value added is

analyzed, the term "value chain" is used, but if preference is given to meeting consumer demand, it is called a "demand chain". When studying the discipline "Supply Chain Management" the primary interest is to move through the channels of materials and information, so first of all we will use the most general and used in scientific and practical activities - "supply chain".

Analysis of theoretical and practical aspects of understanding the concept of "supply chain", as well as its economic and organizational features, allows us to identify four main approaches on which scientists and practitioners focus. Each of which has its advantages and limitations in the practice of supply chain management.

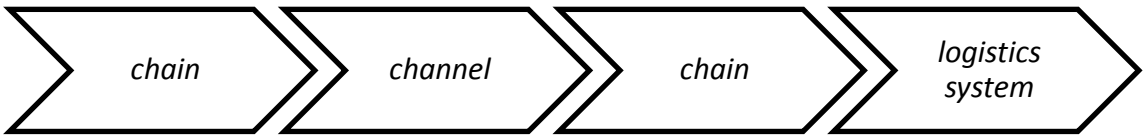
1. Object-spatial approach. According to him, the supply chain is primarily a set of certain individual economic entities (enterprises), interconnected by various economic and legal relations and ordered by flows and processes. The objects of management according to this approach are both the enterprises-participants of the supply chain, and the relations between them. This approach involves determining the composition of the chain and the possibility of its optimization, coordination of actions of participants, management of integration processes based on the conclusion of various agreements between participants. The links that make up the supply chain are organized by commodity, financial and information flows.

In practice, the object-spatial approach can be represented in two ways. In the first - the supply chain is formed from the following components:



Which are related by the principle of attachment: each previous element is part of the next element.

In the second embodiment, the supply chain is formed from the following components:



This option is a reflection of the implementation of supply chain management functions in which the supply chain appears as a set of interdependent enterprises, interconnected by joint management and control of flows flowing from the primary supplier through the focus company to the final consumer. It focuses on the main problem of the supply chain, namely the complexity of coordinating the efforts of legally independent enterprises interconnected by economic relations. In this case, it is necessary to consider such system-forming elements of the supply chain as unity of purpose, mutually beneficial cooperation of chain participants, the priority of system optimization over the optimization of individual elements.

It should be noted that the object-spatial representation of the supply chain has certain advantages, as it allows to define its physical and market boundaries as a meta-logistics system, but at the same time it does not pay enough attention to the processes occurring in the supply chain, and the relationship between the participating companies, through which the function of its management.

2. Process approach. Is to consider the supply chain as a consistently built business processes carried out by enterprises participating in the value chain of the product (service) to meet the requirements of their customers. Depending on the principles of management, it considers the functions or processes occurring in the supply chain as an object of management. Today, the process approach to management, which to a greater extent meets the requirements of continuity of management through internal system integration, is gaining great popularity in business practice.

Process approach as well as object-spatial, can be formed in two ways. In the first - the supply chain is divided into the following components:

Here, a logistics operation is understood as any elementary action or process aimed at transforming the material, information or financial flow within the real supply chain.

Logistic function - a group of homogeneous logistics operations aimed at achieving the goals of the logistics system. Logistics functions are divided into those related to operational activities and those related to the coordination and integration of processes and flows in supply chains.

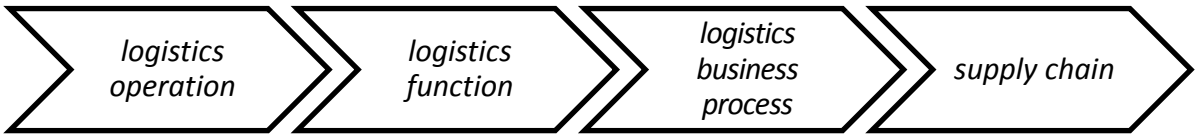
The first include management of supply of spare parts and materials, transportation, warehousing and cargo processing, packaging, management of return and utilization (processing) of waste, customs clearance of goods, information and computer support.

The second functions include order fulfillment cycle management, integrated planning and forecasting, inventory management, inter-functional and inter-organizational coordination, risk management, support of after-sales service quality standards, product life cycle management, etc.

Functional plane of logistics - is the field of application of logistics actions for integrated management of logistics functions and operations to promote products from manufacturers to end users. It includes: supply logistics; production logistics; distribution logistics; logistics of reverse material flows.

Logistics system - is a complex organizationally structured economic feedback system that performs certain logistics functions.

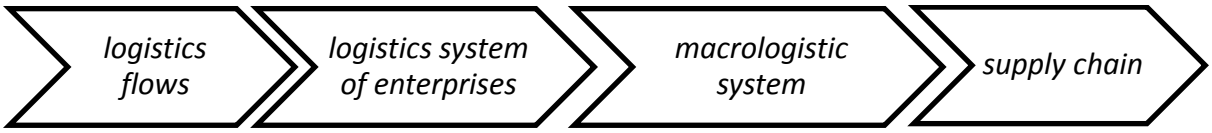
In the second variant, the supply chain is divided into the following components:



Here, the logistics business process is an interconnected set of operations and functions, which as a result of the current activities of the enterprise turn its resources into a result set by the logistics strategy of the enterprise.

Note that the process approach is more progressive than object-spatial, because it combines the concepts of "supply chain" and "supply chain management". In it, by designing effective business processes, implementing them in business practice and further control of the basic parameters, the company can more accurately respond to changes in consumer preferences or market conditions. At the same time, in the process approach, not enough attention is paid to the system of relations between the participants of the supply chain. In addition, it requires coordination of the process approach with the subject of the study of logistics - flows, in particular, in order to model both logistics systems and supply chains.

3. Streaming approach. This approach involves considering the chain as a material flow and the corresponding financial and information flows. This interpretation of the supply chain corresponds to the methodology of logistics, which allows us to represent the logistics chain as a sequence of logistics systems of individual enterprises or a macro-logistics system.



Within this approach, the use of logistics tools and methods is possible to manage the supply chain. The advantage of the approach is that it provides continuity of flows, and, consequently, their management throughout the chain from the primary supplier to the final consumer.

However, despite the fact that the flow model of the supply chain provides for continuity of management along its entire length, in practice to achieve such continuity is limited to the presence in the chain of many individual enterprises characterized by varying degrees of maturity of their logistics systems.

This restriction is especially relevant in the case when the supply chain in some of its areas is insufficiently integrated. In this case, each participating company considers and manages flows only within its logistics system, which limits the ability to optimize the entire supply chain, replacing it with suboptimization of flow in individual sections of the chain.

4. Behavioral approach. This approach is the least represented in scientific sources. According to him, the activity of the enterprise depends not only on the structure of the distribution channel, but also on the behavior of its participants. It determines the purposeful nature of the relationship, which leads to cooperation, integration and coordination of actions of supply chain participants in the space-time coordinates and corresponds to the latest integration paradigm of logistics and the current stage of economic system development. The introduction of a behavioral approach to the consideration of supply chains opens up opportunities for obtaining a synergetic effect, which is the result of integration and cooperation of logistics systems.

The variety of approaches in defining the concept of "supply chain" does not allow to form a single interpretation of this category. The most common is the representation of the supply chain as "systematic, strategic coordination of traditional business functions within one company, as well as between all participants in the supply chain, in order to improve long-term performance of each participant and the chain as a whole" [76, p. 13]. Therefore, the supply chain is primarily identified with a group of companies that cooperate with each other and carry out joint activities necessary to meet the demand for products that move in this chain from the source of raw materials to the final consumer, while creating additional product value. At the same time, enterprises are interconnected by information, material and financial flows.

And since there are many definitions of the concept of "supply chain", there is no unity in the allocation of its basic properties. The analysis of scientific sources makes it possible to identify and characterize the main ones,

namely: adaptability, reliability, flexibility, efficiency, reliability, efficiency and stability.

Adaptability- the property of the chain to change its behavior in order to maintain, improve or acquire new characteristics to achieve goals in a changing environment over time, a priori information about which is always incomplete [18, p. 425-427].

Failure - property that characterizes the ability of the supply chain to function without failure for a certain period of time in accordance with the terms of contracts between the participants in the chain [73].

Flexibility - the property of the chain to respond quickly to changes in demand, and both quantitative and qualitative parameters [73].

Efficiency - a property that determines the ability to reduce costs due to the efficient operation of the supply chain, which leads to a reduction in the cost of goods, and, as a result, the price of goods for the final consumer [103].

Reliability - the ability of the supply chain to maintain within the established values of all its characteristics and elements (reliability, durability, recovery, storage), which indicates the ability of the supply chain to reliably provide all its functions in accordance with the terms of contracts between its participants [31].

Efficiency - the property of the supply chain to perform its functions in accordance with the agreements between the participants in the chain [31].

Stability - the property of the supply chain to be in the planned mode of operation is stable, if for a fixed set of allowable control effects, limited and relatively small effects lead to limited and relatively small changes in the original variables [18].

Given the defined properties and views of scientists, we propose the following definition of the supply chain - a complex logistics system formed by an orderly set of business partners who carry out technological and logistical operations to bring material flows to the final consumer with optimal resource

costs; thereby increasing the value of the product to the consumer.

The transformation of value creation resources for the final consumer is associated with the management of material flows (including raw materials, semi-finished products, work in progress and finished products), information flows, finance and innovation.

For supply chains of a particular product (service), these flows are divided into input (upstream), i.e. all related to the supply of raw materials for the production of product (service), and output (downstream), ie all related to the sale of products to the final consumer.

The supply chain has a number of characteristics:

- great number of different technical and logistics operations;
- number participants;
- complex nature interaction participants;
- the presence of each of participants of its unique purpose.

Given these characteristics, the urgent decision to form a supply chain requires coordination of the purpose of the participating companies.

Thus, the purpose of creating a supply chain can be:

- improvement of supplied products (services), production, distribution and provision of after-sales services;
- delivery to the consumer of a full line of products and services, a specific batch of products;
- creation of cost of a product both for the client, and for the enterprises of participants of a supply chain;
- satisfaction of ascending demand for products (services) and / or their service;
- cooperation, integration and coordination of activities of all links of the supply chain in the coordinates "space - time".

Features of the supply chain are primarily:

- legal independence of chain participants and their competition both with each other and with other supply chains;

- the presence of a focus company, i.e. the manufacturer of the final product or service (enterprise that assembles the final product in production, trade network in trade or logistics provider);

- cooperation and coordination relations with suppliers and customers.

These features give supply chain participants a number of benefits in terms of cost reduction, increased supply flexibility, market demands and ultimately customer satisfaction. However, if you look more closely at certain benefits, you can see that they are quite contradictory. According to M. Fischer's study [83], the most fundamental contradiction in the supply chain is between productivity and flexibility. In a high-performance supply chain, all available capacity is used to the maximum, and the amount of stocks is minimized at all stages of chain construction. However, it is known that the flexibility of the chain, and accordingly the maximum customer satisfaction is achieved by a sufficient number of free reserves, including stocks, to respond quickly to unforeseen fluctuations in demand.

Thus, overcoming a certain contradiction is possible provided that the speed of material, financial and information flows passing through the supply chain. Speed depends on the concept of inventory planning and management adopted in the organization and on the reliability of suppliers.

1.2 Causes and consequences of uncertainty in supply chains

As noted in previous sections, the supply chain is a complex system that operates in a dynamic and changing environment associated with uncertainty due to various factors (fluctuations in demand for products, late and inaccurate transfer of information, changes in political, economic or natural conditions etc.).

Thus, according to the American Economist F. Knight, "we live in a world

prone to change, in the realm of uncertainty.… We are not in complete ignorance, but we do not have complete and perfect information, and we have only partial knowledge" [32, p. 195]. F. Knight considered uncertainty as the probability of occurrence of an event and proposed to use the term "risk" to distinguish between measurable and immeasurable uncertainty. Risk refers to those cases when the distribution of results in the group is known through the study of statistics of previous experience or calculations.

The concept of "uncertainty" characterizes a situation where such a possibility is absent. In addition, he understood the situation of uncertainty as a lack of awareness and the need to act on the basis of opinion rather than knowledge. And as experts say [18; 85; 86], the very emergence and development of the concept of supply chain management is associated with the desire to reduce uncertainty based on methods and models of cooperation and inventory management in several organizations simultaneously (at the inter-organizational level).

Thus, uncertainty is a situation in which the probability of obtaining the results of the decision is unknown, and in some cases the full range of consequences of such a decision is unknown. Common sources of uncertainty in economic systems are environmental factors, market conditions and limited resources. They are caused by the variability of the external environment and are due to the unpredictability and instability of global and local markets, especially the markets of countries with economies in transition.

The competitiveness of economic entities of these countries is determined not only by objective production factors (natural, material, financial, human, information resources and quality of management of organizational structures), but also by subjective factors (institutional environment, level of development of scientific and technical progress, the presence of barriers to "entry" and "exit", the level of competition, the availability of infrastructure, the peculiarities of pricing, management system and the level of state influence, the socio-economic

condition of the territories).

The degree of uncertainty of the business environment depends on its complexity and dynamism. Different combinations of factors complexity - dynamism (variability) form four levels of uncertainty: low, moderate, moderately high and high. The highest level of uncertainty is characteristic of a complex (the number of factors affecting the enterprise exceeds 4) and dynamic environment.

Uncertainty is divided into: ignorance - if there is no information to predict the behavior of the system; uncertainty - if it is possible to assume what events may occur, but it is impossible to determine the probability of their occurrence.

In supply chain management, uncertainty is primarily due to the inaccuracy of the forecast of demand for the company's products in the chain, the lack of sufficient information about the volume, timing of supply and the availability of stocks in each link. The level of uncertainty affects the accuracy of supply planning and the risks associated with product sales.

Different contradictions may arise between contractors in the supply chain. The main cause of the problems is the mismatch between the type of supply chain and the type of product being promoted. M. Fisher proposes to classify products into mainly functional and innovative [83].

Functional goods are characterized by a long life cycle, mostly stable and well-predicted demand, because consumer needs for such products for a long time do not change significantly. Demand for innovative products is less predictable, the life cycle is much shorter and sometimes several months. The short life cycle and great variety inherent in innovative products increase the unpredictability of demand for them.

In general, uncertainty is insurmountable, it can be reduced, but it is impossible to avoid it completely, because the world around us and the relative knowledge about it are infinitely diverse. Consider the uncertainty of the

environment in more detail.

Incomplete and unreliable information about the economic environment is an objectively determined category, because it is impossible to collect all the information we need, which would also be reliable. Therefore, the first step in combating uncertainty is to gather more complete and reliable information about the desired activity and the business that surrounds this activity.

From the point of view of the reliability of the incoming information, it should be understood that the information field formed as a result of the search can be divided into three parts.

The first component is official information, which, despite its official status, is often distorted in such a way as to be the most attractive to a potential investor. This information needs serious verification.

The second is insider information that reflects the various corporate interests of stakeholders and groups and, regardless of its inconsistencies, may contain very valuable "signals" about the state of affairs in the enterprise.

And the third part - information in the interpretation of the media. The information presented here is the most valuable for the manager, because, collected from different sources, it shows different views, which as a result of comparison can give the most important result.

The manager's ability to perceive and process incoming information is limited. The next step in the fight against uncertainty is the processing and interpretation of the information obtained. Here the actions of the enterprise are limited by its internal resources, namely the experience and qualification and methodological capabilities of management, its ability to adequately operate and interpret as accurately as possible the information obtained from various sources. Overcoming this factor requires constant training and improving the skills of enterprise management.

For this purpose, it is very useful to use the method of scenario modeling of the company's development in constantly changing circumstances. Along

with the improvement of management skills and the growth of his professional skills, it is also necessary to use the capabilities of specialists (experts) and specialized firms (agencies) to process and interpret the information obtained.

Accidental occurrence of some adverse events in the process of activity. It is difficult or impossible to predict the possibility of some adverse events. This is due to the fact that the manager is not dealing with single random events, but with a whole set of positions, which are random chains of "elementary" events (malfunctions, fires, thefts, etc.). Estimating the probability of such events is quite complex and time consuming. But in any case, you should follow the rule: everything that can happen, sooner or later happens.

If a fire can happen, it will happen; if theft can happen, it will happen. It's only a matter of time. Therefore, the company should compile a catalog or list of possible adverse events, which should develop specific measures to neutralize them or reduce the degree of damage caused by them.

Opposition of market participants due to the actions of competitors, labor disputes, breaches of contractual obligations. A serious risk factor is the opposition of market participants, which should primarily include direct competitors of the company.

Combating competitors is mostly passive in the form of overestimation of their products, although there is also active action in the form of price dumping or dissemination of false information about the competitor, such as the low quality of its products. Economic intelligence, which has become popular with many of the world's leading companies, is very useful for studying competitors and their possible actions.

Also, risk factors lie in the limited material, financial, labor and time resources of the enterprise. First of all, it concerns the ability of the manager to develop measures to prevent or limit the likely adverse effects of a risky event. In conditions of sufficient provision of resources, the capabilities of the manager are one, in case of insufficient provision - others.

Supply chains are also characterized by other factors of uncertainty, namely: behavioral uncertainty and uncertainty of goals.

Behavioral uncertainty due to the managerial activity of the participants in the supply chain and the diversity of their interests. Game theory and fuzzy logic are used as models for estimating behavioral uncertainty. They implement the principles of conflict management, as well as taking into account informal factors such as trust and reputation.

Reputation as a sociocultural phenomenon is close in nature to a myth, existing to regulate people's behavior in the absence of objective information about possible benefits and losses, or in conditions where they do not feel competent enough to assess the information available to them [29].

A positive reputation makes it possible to convert intangible assets into tangible ones (into excess profits), and a negative reputation brings losses. It should be noted that reputation can bring excessive profits, but does not guarantee it. This may be due, for example, to economic conditions, crises and other external factors. In addition, as noted by J.-P. Baudouin, reputation is characterized by the effect of "memory": any discrepancy between the obligations and behavior of the company, between its communication and actual actions will be included in the "memory notebook" and absorb the reputational value produced by the company [62, p. 57].

In modern conditions of the Internet, this statement becomes even more relevant, because almost any information, once on the Internet, remains there forever, accumulated and analyzed. The total amount of negative information on the Internet over time can gain "critical mass" and become an additional risk factor - the risk of loss of reputation, or reputational risk.

Uncertainty of goals associated with the limited importance of unambiguous formulation of the purpose and conditions of the relevant tasks of supply chain management. Neural networks, genetic algorithms, ASO-

algorithms, multiagent systems are used to solve multicriteria problems of large dimension with the required calculation speed.

Thus, one of the most important practical problems of supply chain management is the reduction of demand uncertainty. In tasks of this type it is necessary to find a rational amount of stock, given that losses arise both in the presence of unmet demand and from the fact that the goods are in stock. It is often believed that demand is a random variable with a given distribution. Then the model of the stock storage system will be formulated as a model with a random factor, and uncertainty in supply chains can be reduced by:

- introduction of a certain redundancy of supply chain structures (for example, temporary buffers, insurance stocks, additional warehouses, capacity stocks, etc.);

- improving coordination and information exchange to improve the quality, timeliness and accessibility of all participants in the supply chain to demand forecasts;

- introduction of a monitoring system and means for possible regulation of the supply chain in case of violations and deviations from the plan.

However, it should be understood that it is impossible to completely get rid of uncertainty. It affects SLM at both strategic, tactical and operational levels:

- at the strategic level there is uncertainty of goals. To overcome it, planning and balancing of goals is introduced (multicriteria);

- at the tactical and operational levels there is uncertainty of demand (quantity and range of products), technological failures (equipment, transport, information systems), uncertainty related to the human factor (errors, incorrect transmission and interpretation of information, opportunism). To overcome them, redundancy is introduced (insurance stocks, purchase of materials "with stock", production and distribution insurance buffers), structural and functional

reserves (the possibility of redistribution of functions and the formation of new structures).

1.3 Significance of introducing the concept of supply chain management in business practice

Globalization processes inherent in the modern economy are associated with the emergence of positive externalities from the removal of geographical, sectorial and intra-corporate barriers - through the systematic cooperation of companies from different countries and their further integration.

In the new economic system it is necessary not only to produce (provide) goods (services), but also to sell them efficiently. It is desirable that these processes occur with minimal resource costs in supply chains. Therefore, on the one hand there is a need to optimize production and logistics processes, and on the other - maintaining a balance between resource needs and their supply, which is implemented through optimization of local processes and integration of inter-organizational links along the value chain.

As practice shows, this second aspect of the integration of production and logistics processes is the most critical in terms of business optimization opportunities. It is the main subject of supply chain management technology.

At the same time, the growth of the level of partnership of previously competing corporations and companies is primarily due to the desire of the latter to avoid uncertainty and risk in the promotion of goods in supply chains (Table 1.4).

Table 1.4

Reasons for the spread of supply chains

Reason	Explanation
Customer market dominance	Caused the need to meet a large number of customer requirements for ease of purchase (anytime, anywhere), product availability (which requires the maintenance of appropriate stocks), low price, individual adaptation to customer preferences.
Increasing competition	It led to the need to differentiate goods by the level of their quality, the quality of materials used in them and production technology, quality of service.
Reduce customer service time and orders	Caused the need for careful analysis and forecasting of customer needs, timely stockpiling, data exchange with suppliers and customers.
Globalization of supply and distribution	It has led companies to buy raw materials or sell their products almost all over the world; companies are constantly looking for new suppliers and customers due to the level of costs for supply and distribution.
Reduction of product life cycle	Encouraged a higher intensity of all measures to achieve the planned sales in a shorter period of time.
Trends in trade concentration	Encouraged the coordination of supply and focus on shopping centers with numerous retailers.
Development of information systems, technologies, methods of communication and automatic identification	Contributed to increasing the requirements of companies and customers in terms of data access, traceable and high-speed processing for mass flows of goods, automatic and error-free use and reading of product data in the supply chain.

Source: compiled by the authors on the basis of literary sources

Wal-Mart and Procter & Gamble in the field of trade and Cisco, Toyota, National Semiconductor in the field of production were among the first companies to introduce supply chain management technologies. Their supply chain management projects have shown the ability to both reduce overall supply costs and improve customer service. Thus, according to the well-known

consulting company "Accenture", which specializes in SCM-solutions, the implementation of the concept of SLM on average contributes to:

- improving customer service by 5-25%;
- reduction of forecasting errors by 50-60%;
- reduction of stocks by 10-50%;
- reducing the cycle time of the customer's order by 30-70%.

The key to the success of supply chains is the goals of the focus company. They become strategic measures that the focus company uses in its activities. When choosing such measures, the company should focus on the main principle in the supply chain, as well as on the choice of the most successful way to implement practical goals to support the competitive strategy. The working goals are divided into three groups:

1. Relationships with customers: delivery on time, excellent quality of orders, etc. This applies to those companies that operate in sectors with high gross margins and short product life cycles. For example: production of fashionable clothes, pharmaceutical products, cosmetics, toys, computers.

2. Efficiency: the key to minimizing prices and increasing productivity. This group includes companies operating in low-profit sectors. For example: food and beverage industry, consumer electronics, retail of consumer goods or industrial supplies.

3. Use of company assets: the main thing here is the maximum efficiency of use of funds (assets) of the company, equipment or inventories. For example: business sectors characterized by large capital flows, automotive, petrochemical and semi-finished products.

The strategic orientation of supply chains is particularly clear in those areas of economic activity where there is a high share of products with the so-called trust attributes (CA - meanness attributes) [78]. Trust attributes are characteristics of a good or service that cannot normally be recognized by a buyer before or after a purchase. This implies that consumers are aware of such

attributes, but cannot determine their presence in purchased products. Nevertheless, there are product requirements for such attributes. Governmental and / or non-governmental organizations guarantee compliance. An example of products with attributes of trust are foods produced organically. In this case, the consumer cannot identify whether the product was actually made without the addition of chemicals, but trusts the seller.

Focusing on "best practices" allows you to implement the principles of sustainable development in supply chains, increase market share, build trust in the focus company of the supply chain with customers and suppliers, promote a positive brand from the general mass, improve employee morale and increase efficiency and productivity companies. Of particular note is the fact that such an orientation reduces risks, avoids the manifestations of negative public opinion, creates a favorable social business environment.

As a result of the analysis of the best practices of application of the concept supply chain management on the basis of the research project of the company "Prologis", conducted by the University of Denver, the so-called "Ten Commandments" were developed, which could be interesting for further study of the phenomenon of SLP [110; 111].

1. The ideology of SLM has taken a central place in the competitive strategy of most companies.

2. The heads of the LP divisions have constantly emphasized that the greatest difficulty in their activities is created by constant changes in supply chains, which affect both their network structure and business processes.

3. There are many supply chain strategies to smooth out the negative effects of outsourcing (from offshore areas) to reduce production cycles and improve customer service.

4. Constantly growing customer service requirements lead to the need for dynamic restructuring of supply chains.

5. Many HR managers use the logistics cycle as the main criterion for

planning and managing the company's supply chains.

6. The unifying strategy was created to facilitate the operation of supply chains in joint activities, has become a leading element of mergers and acquisitions (M&A agreements).

7. The use of software for identification and complete diagnostics of network structure and processes (system landscape) of supply chains has significantly increased.

8. Many companies integrate production and distribution resources in order to reduce the gap between the size of inventories in the supply chain and the requirements of service (availability of stocks) by consumers.

9. The technological equipment of the network infrastructure of supply chains, upgraded in accordance with the latest innovations in the field of warehousing, distribution and warehouse and transport management systems (WMS / TMS), no longer requires the provision of expensive related materials.

10. Due to the growing number of mergers and acquisitions and the growth of cooperation, supply chains are becoming more global.

World leaders are successfully applying ideology supply chain managementin his business. According to the ranking of "Top 25 in supply networks", the company "Gartner Research" in 2019 (Table 1.5), in the top five took the place of corporations such as Colgate-Palmolive, Inditex, Nestlé, PepsiCo, Cisco Systems.

Table 1.5

25 best companies implementing the ideology of SLM in 2019

Rank	Company	Peer score (25%)	Gartner score (25%)	Weighted ROA assessment (20%)	Inventory turnover (10%)	Estimation of change in income (10%)	Evaluation of CSR components (10%)	Comprehensive assessment
1	Colgate-Palmolive	961	347	19.9%	5.0	-0.2%	10.00	4.88
2	Inditex	1,091 the most common	341	16.2%	3.8	6.5%	10.00	4.80
3	Nestlé	1,262 the most common	374	6.9%	4.8	1.2%	10.00	4.27
4	PepsiCo	997	368	11.7%	9.0	1.2%	8.00	4.22
5	Cisco Systems	699	518	4.0%	10.2	0.7%	10.00	4.13
6	Intel	576	454	12.4%	3.7	9.6%	6.00	4.12
7	HP Inc.	293	353	11.7%	8.2	7.3%	10.00	3.81
8	Johnson & Johnson	737	348	7.6%	3.1	5.8%	10.00	3.80
9	Starbucks	900	167	19.3%	12.7	9.0%	4.00	3.74
10	Nike	1,194 the most common	186	13.3%	3.9	6.0%	4.00	3.73
11	Schneider Electric	677	256	5.4%	4.9	0.7%	10.00	3.71
12	Diageo	625	404	9.8%	0.9	4.3%	10.00	3.44
13	Alibaba	1,095 the most common	72	10.6%	23.4	52.6%	0.00	3.43
14	Walmart	1,415 the most common	268	4.6%	8.6	2.5%	5.00	3.40
15	L'Oréal	858	229	9.9%	2.7	3.6%	8.00	3.38
16	H&M	582	155	13.7%	2.7	5.1%	10.00	3.35
17	3M	597	192	14.3%	3.8	3.2%	8.00	3.34
18	Novo Nordisk	86	54	36.4%	1.1	0.8%	10.00	3.31
19	Home Depot	402	124	22.2%	5.0	7.0%	5.00	3.29

Continuation of table 1.5

20	Coca Cola Company	1,329 the most common	196	5.8%	4.2	-10.7%	6.00	3.13
21	Samsung Electronics	748	83	13.2%	9.8	8.7%	7.00	3.05
22	BASF.	597	252	6.4%	3.9	-0.6%	8.00	2.89
23	Adidas	714	172	9.2%	3.2	7.9%	5.00	2.75
24	Akzo Nobel	137	0	20.9%	4.6	-8.6%	8.00	2.61
25	BMW	733	131	3.8%	3.8	1.3%	10.00	2.57

Source: Gartner Announces Rankingsofthe 2019 Supply Chain Top 25 https://www.gartner.com/en/newsroom/press-releases/2019-05-16-gartner-announces-rankings-of-the-2019-supply-chain-t

Today, companies seeking to strengthen their competitive position in the markets must use modern drivers such as trust and effective communications, have perfect information and are responsible for the activities of all their suppliers. The key issue of their activity is to build a relationship between the focus company and the supply chain counterparties at the network level.

The development of long-term, strategic relationships between contractors in the supply chain opens up new opportunities for creating significant competitive advantages. It should be remembered that the development of the concept of supply chain management has internal limitations due to the task of constantly reducing costs in the chain.

Thus, the main trend of modern enterprises is the desire to be flexible to rapid changes in market conditions, especially demand, over which they have no influence. The era of business predictability and linear solutions is over. The reality is unpredictable demand, rapid change in consumer preferences, mass and continuous data flow over the Internet, global video and telecommunications systems.

CHAPTER 2. SUPPLY CHAIN MANAGEMENT ORGANIZATION

2.1 Content, stages and structure of supply chain management

In scientific circles, as there is no single definition of the term supply chain, so there is no single view on the definition of the category of supply chain management. Thus, A.D. Bauersocks, D. Kloss and T. Stank consider supply chain management as "a strategy of cooperation that involves a combination of inter-organizational business activities in order to realize opportunities to gain a certain market share" [64, p. 61-86].

T. A. Vorkut, O.E. Bilonog, A. M. Dmytrychenko and Yu. Tretynychenko management concept supply chain is understood as a "systemic strategic approach to ensure based on the development of functional and process integration of the effective movement of material and related information flows in supply chains" [50, p. 42].

A. Harrison and R. Van interpret this term as "equalization of ascending and descending processes in the chain partners who supply materials and distribute products, to provide the highest quality services to the end user while minimizing unnecessary costs" [6].

In M. Christopher, supply chain management is defined as "management of a network of organizations that are involved through descending and ascending links in various processes and activities that create value in the form of products and services in the hands of the end user" [73, p. 18].

M. Cooper, D. Lambert and J. Page consider supply chain management as "an integrated philosophy of total flow management in the distribution channel from supplier to end user" [77].

J. Mentzer believes that "supply chain management is the management of a group of three or more organizations directly interconnected by one or more

incoming and outgoing flows of goods, services, finance and information from source to consumer" [99].

IN K. Oliver and M. Weber insupply chain management is a process that “covers the flow of products from the supplier, through the manufacturer and distribution channels to the final buyer "[100].

And, V.I. Sergeyev believes that supply chain management is "a holistic concept of doing business that combines advanced organizational principles and capabilities of modern information technology."[41].

Thus, different authors give this definition at their discretion, depending on the approach they take or the direction in which they work. Some consider supply chain management in terms of material flows. The second is the coordination of interdependencies, partnership and cooperation. Others believe that supply chain management is a logistical concept of production organization. Fourth believe that supply chain management is part of the concept of corporate (or strategic) management in the enterprise.

According to today, there is no single approach to supply chain management - an approach that would combine the principles of coordination (coordination of actions) with the peculiarities of partnerships (coordination of interests). For this reason, it may not be possible to identify the sources of problems that arise with supply chain management. However, regarding the definition of stages or stages insupply chain management most authors have a similar view. These include (Fig. 2.1):

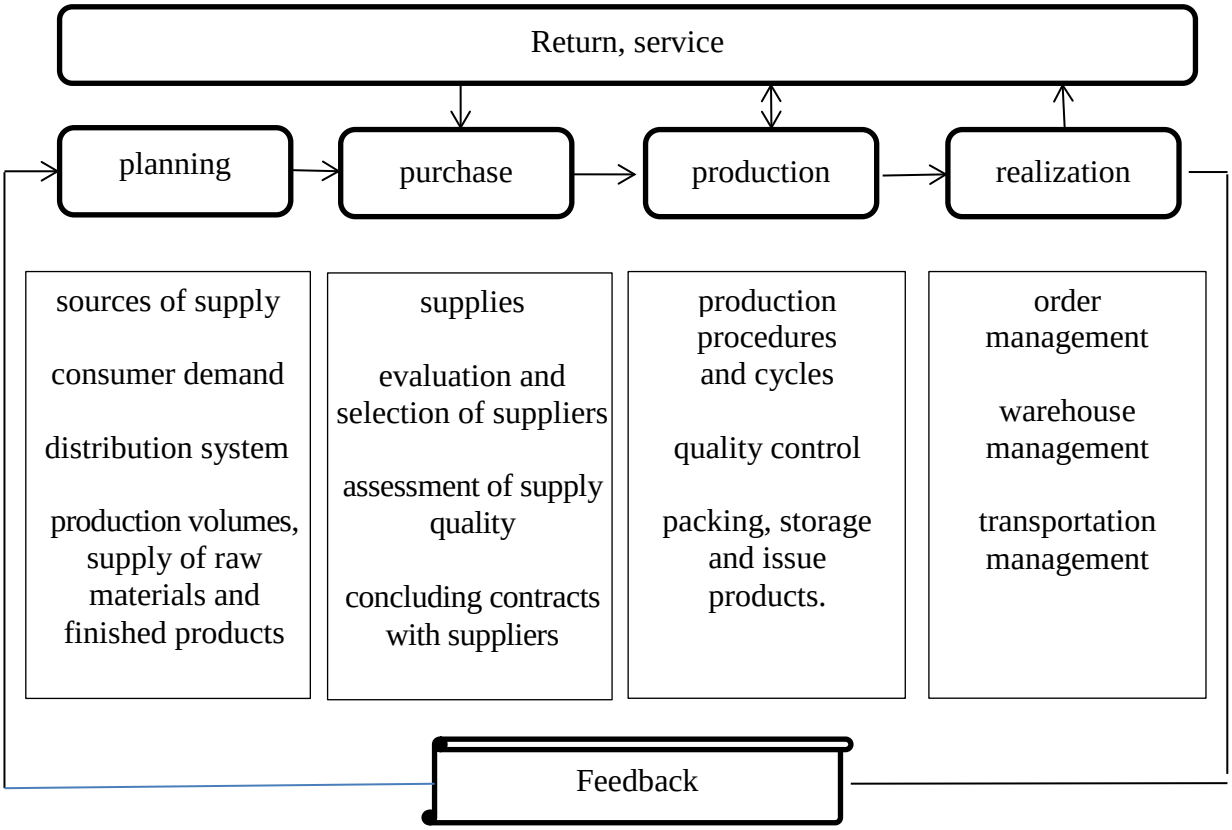


Fig. 2.1. The structure and content of the supply chain management process.

Source: compiled by the authors on the basis of literary sources

Planning. The planning process identifies sources of supply, prioritizes consumer demand, makes decisions on product lifecycle management, production of necessary materials, or their purchase, analyzes and plans stocks, determines the main criteria of the distribution system, sets the volume of finished products and supplies of raw materials and components. The processes that take place at the planning stage allow you to find a balance for the effective construction of the end-to-end process "purchase - production - delivery».

Purchase. At this stage, the main elements of the supply management process are formed: there is an analysis and selection of suppliers, conclusion of supply contracts, direct purchase and transportation of materials, quality control

of supplies, storage of materials. All actions that take place at the procurement stage must meet the planned and/or current demand.

Production. The main process of the supply chain, which includes direct production, implementation of technical and technological innovations, control over technical and technological changes, capacity management and schedule of production changes. At the stage of production there are both production procedures and cycles related to the production of finished products and quality control, and internal logistics cycles (packaging, storage and production). It is important to note that and how at the stage of "purchase" all components of the process of processing the input product into finished products must meet the planned and / or current demand.

Realization. This stage consists of three main processes: order management (creation and registration of orders, choice of product form, formation of its value, organization and maintenance of a database of customers, goods and prices, as well as management of receivables and payables); warehouse management (selection, assembly, packaging and shipment of goods) and transportation management (due to the rules of management of delivery channels and orders, regulation of goods flows for delivery and quality of delivery). All of the above processes must also be aligned with planned and / or current demand.

Return. At this stage, the elements of return of the goods are determined, for example, defects that require replacement or repair that occurred at any stage (from purchase to delivery), the condition of the product is assessed (defect of production or packaging), return schedules and referrals for destruction and / or recycling. The return phase also includes after-sales service.

Among the patterns of organization of supply chains can be identified conflict of interest of chain participants, dynamism, complexity and uncertainty and stochasticity of its parameters (Fig. 2.2).

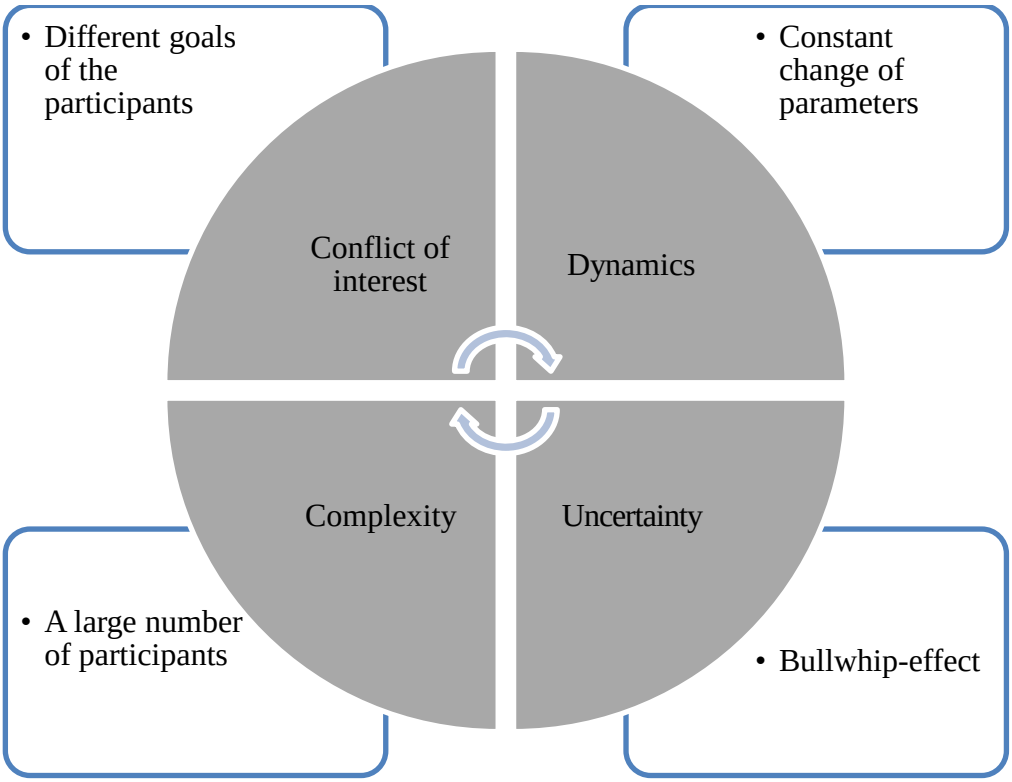


Fig. 2.2 Regularities of the organization of supply chains

Source: compiled by the authors

Accordingly, the complexity of any supply chain is primarily due to its structure, which can often be considered as a network with multiple nodes, where different participants can interact with one or more other nodes. The purpose of supply chain management is primarily to coordinate and integrate all activities related to the supply of goods into a single process, with an emphasis on managing the relationship between the various links in the supply chain.

Thus, nFor the purpose of supply chain management understand the combination of the following processes [4]:

1. Adaptation to the needs of production. Analysis of information on product needs using Data Mining methods.

2. Identification of needs to increase production: analysis of production capacity and planning of production activities.

3. Solving the routing problem. To solve this goal requires a large amount of information, because it is necessary to take into account several factors, namely, distance and time, as well as to have a cartographic idea. All space-time information should be contained in the data warehouse for the analysis of previous routes, on the basis of which it is possible to build new ones, because minimizing the route only by the parameter distance does not lead to the optimal transportation option.

4. Warehousing with minimal costs. It is necessary to analyze the information in order to draw up a production plan and supply immediately to the supplier to reduce warehousing costs and minimize warehouse space.

5. Improving logistics service. This parameter also requires data mining to identify problem areas, as well as the necessary implementation of information models that take into account dynamic information.

All these goals lead to the main goal of supply chain management - to increase the total cost of the final product, i.e. the difference between the price the consumer is willing to pay and the costs incurred in creating the product to provide it to the customer.

Achieving these goals shows how effective supply chain management is. Therefore, scientists identify the main areas of improving the efficiency of supply chain management [72]:

- increase in orders and increase demand;

- reduction of the level of insurance reserves to the exact value;

- reducing the level of risk and increasing the degree of reliability of supplies and plans;

- reduction of costs for concluding contracts and direct production costs.

The solution to the problem of improving efficiency is:

1) creation of single information data warehouses for all participants in the supply chain;

2) availability of compatible information systems;

3) introduction of information models that work with dynamic and fuzzy information in the information systems of supply chain participants;

4) introduction of OLAP-analysis (operational data analysis);

5) introduction of information models using previous experience.

Accordingly, the task of supply chain management is the simultaneous coordination of interests and actions through cooperation and coordination of efforts of participants at three levels: network, level of bilateral relations and the level of the firm. Its implementation allows you to optimize all value creation processes (from raw material supply to end-user service).

Cooperation and coordination are the foundation of effective supply chain management. However, this may lead to the idea that in the process of supply chain management there is one organization (instance) that directly manages the entire chain.

In practice, however, there is no supply chain that implements such a principle. The essence of supply chain management is to establish equal relations of interaction between enterprises participating in the supply chain using modern information technology. But these interactions are formed decentrally in each part of the supply chain.

Each company in accordance with the defined goals and its own vision for the practice of doing business manages interactions with its counterparties. There is no single governing body for the entire supply chain. Therefore, we can talk about supply chain management only in relation to a specific part of it. And integrated management is achieved through integration coordination and balancing of interests in specific parts of the supply chain.

2.2 Strategic design and supply chain planning

The supply chain design methodology is based on the alignment of business objectives, is a strategic advantage and provides a flexible approach. Given that supply chains differ significantly from each other depending on the

specifics of the business activity, the supply chain must be designed taking into account the optimal ratio between the level of logistics service and the costs associated with its formation.

At first glance, this may seem like a simple task. However, designing supply chains is a daunting task, as it is based on various variables (the balance of which must take into account future needs and alternatives), and the delivery of goods to the end customer is the result of a network of organizations (many of which may be part of other chains), supplies).

Supply chain design requires a large number of operations, grouped into certain functions that need to be assigned to specific performers. This leads to the use of a functional approach. In addition, the design of supply chains can be considered by enterprises as a project of organizational innovation, which leads to the use of an innovative approach.

Of particular importance in the design of supply chains is the integration approach, the use of which provides opportunities for synergies in supply chains through integration, cooperation and partnership of all parts of regional logistics systems - production and infrastructure enterprises and organizations and public authorities.

However, today supply chains are mostly formed spontaneously. Given this, one of the current problems at the present stage of development of logistics and supply chain management is the preventive design of logistics processes in supply chains (Fig. 2.3).

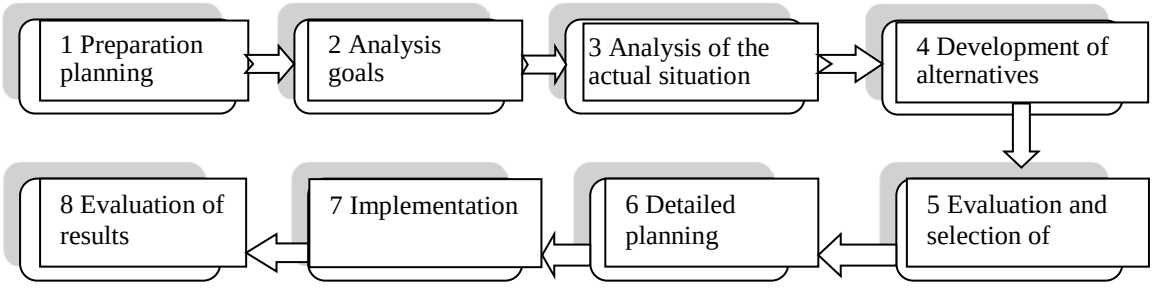


Fig. 2.3 Design phases logistics processes in supply chains.

Source: compiled by the authors

The need to use a structural approach to the design of supply chains stems from their classical definition as a related structure of business units, united by the relationship "suppliers - focus (main) company - consumers" in the process of creating and selling goods that have value for the final consumer, in accordance with market requirements [18].

The marketing approach to supply chain design aims to enable the companies in the chain to work with the end user under the new scheme and to transform traditional supply and distribution channels into vertical marketing systems.

The optimization approach to the design of supply chains is fully consistent with the concept of integrated logistics and has a thorough analytical and optimization organization of all flows, based on the end results: improving the quality of customer service (users) and reducing total logistics costs.

The application of a behavioral approach to the design of supply chains is facilitated by the need to optimize the relationships of all its participants. That is, the behavior of participants in the supply process must be taken into account when solving problems of supply chain design.

Thus, in the design of supply chains it is important to use modern methodological and methodological approaches, which are interconnected and together form a theoretical basis for design that meets the requirements of a competitive market.

A typical supply chain design model covers all stages of the movement of material and associated flows and consists of six successive stages (Fig. 2.4):

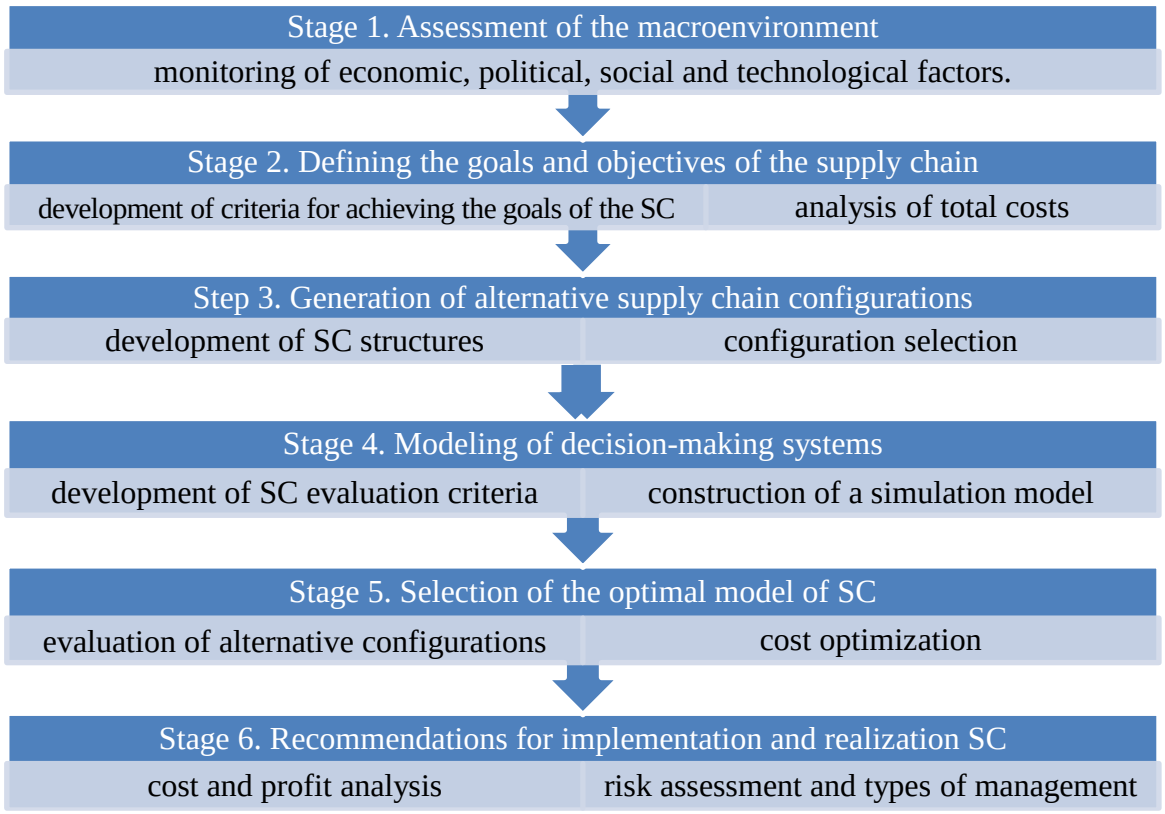


Fig. 2.4 Stages of planning and design of supply chains.

Source: compiled by the authors

At the first stage the macro-environment is assessed to identify potential opportunities and threats. Before forming a supply chain, it is necessary to define and comprehensively assess the environment in which it will operate. The analysis of the external environment is an assessment of the state and prospects of development of the most important, in terms of supply chains, actors and environmental factors. To accomplish this task, it is necessary to: comprehensively monitor economic, political, social and technological factors that may affect the functioning of the supply chain.

In the second stage the main and related goals and objectives of supply chains are defined, and criteria for achieving certain goals are developed. Achieving the main goal of supply chains is an optimization task with limitations on quantity, quality, location, and delivery time of the product. The criterion for the effectiveness of this task is the total costs that need to be

optimized (namely to optimize, not minimize, because the successful operation of the supply chain requires constant coordination of price, quality and level of service).

In the third stage alternative supply chain configurations are generated. The formation of supply chains is a strategic decision that primarily concerns the structure of the chains: the definition of participating organizations (number and location of suppliers, production facilities, distribution centers, warehouses and customers) and distribution channels. The choice of the best configuration is determined by a compromise solution. Different configurations affect costs in supply chains in different ways. First of all it is transport costs, costs of maintenance of stocks, costs of acquisition / rent of objects.

In the fourth stage decision-making systems are modeled. This stage is to develop criteria for evaluating supply chains and build a simulation model. Alternative supply chain configurations are evaluated using a decision modeling system that emulates the implications of making a specific chain configuration and the basic principles of managing them.

The simulation model is developed using a universal modeling approach, which is particularly well suited for modeling different circuit configurations. The obtained results are stored in the supply chain modeling database.

In the fifth stage the most responsible design processes take place, namely: evaluation of alternative configurations and selection of the optimal supply chain model. When choosing a configuration, you should determine the optimal cost-benefit ratio.

At the final sixth stage, recommendations for the implementation of supply chains are being developed. Here attention is paid to cost-benefit analysis, risk assessment, and management.

Strategic planning as a process includes seven main stages:

1. Formation of preconditions for changes in the state of the supply chain by reviewing its mission and goals and setting the problem as a result of clarifying the goals, their significance and timing.

2. Comprehensive analysis of supply chain resources, in order to identify its uniqueness, as well as analysis of the situation in the industry and related industries.

3. Clarification of strategic goals taking into account potential threats and supply chain opportunities.

4. Development of the actual strategy, ie a set of projects, programs, activities, the implementation of which with a high degree of probability will ensure the achievement of strategic goals in a timely manner.

5. Coordination of the strategy developed at the previous stage with the strategies of enterprises in the supply chain.

6. Development of industrial policy of supply chain enterprises.

7. Monitoring and evaluation of the main results of the supply chain, adjustment of the chosen strategy and methods of its implementation.

Due to the fact that the supply chain is a set of organizations that differ in the criteria of optimization of operation, there is a need for strategic compliance, i.e. strategies at all levels must be consistent with each other.

Coherence in this sense is important because resources and main activities at the functional level must constantly support the solution of problems at the highest level. For example, if the overall supply chain strategy leads to the sale of goods at low prices, then all functional activities must correspond to the ability to bring products to market at the lowest possible prices.

The final task of design is to implement it in such a way that it pays off all the costs, including the strategic planning. This procedure consists of four main stages:

1. Development of an implementation plan.

2. Scheduling the project.

3. Definition of criteria of acceptability of results.

4. Implementation.

The initiator of the design of supply chains can be a manufacturer, wholesaler or retailer; primarily it depends on its relative market position, financial capacity and ability to get the "right" participants for the supply chain.

2.3 Strategies for integrated supply chain management and coordination

To avoid many inefficient decisions, increasing overall costs and deteriorating service levels, all actors in the supply chain need to act as one and develop a strategy that aims to achieve the overall goals of the supply chain and meet the aspirations of all actors in the supply chain.

The very concept of "strategy" is today one of the most popular economic categories. At the same time, the literature contains so many different definitions of competitive strategies that the average reader is easy to get confused. Among foreign authors [71; 73; 77] has long been convinced that the term strategy is not a rigid determinant, and does not describe an objectively existing phenomenon, but rather is an operational concept, which in each case indicates a separate aspect of long-term, planned and purposeful management.

The strategy is based on the following elements of strategic management of the firm:

1. The company's mission is to determine the highest value of the company, its "purpose" in the market. The chosen mission corresponds to certain ideals. Ideals are values that point in a certain direction. The ideal can be considered absolute perfection, which is unattainable in the real world, has a theoretical nature and is a constant reference point. If a certain experience is considered as an ideal, the result will be the success of a particular organization. You can try to emulate specific examples, but do not use them as guidelines.

They are suitable for analysis, study of methods and actions. However, we should not forget that this success took place in a certain place and at a certain time, thanks to the talents of the people who implemented this strategy, in special environmental conditions and under certain market conditions.

2. Strategic intention of the firm. Strategic intentions are usually also called "strategic vision". It meets the goal for a certain time. For example, the goal of making a profit from an online store must be achieved by a certain time.

3. The content of the goal and the logic of the strategy, i.e. certain causal chains. Goals are a measurable indicator that can be used to determine the degree of project implementation. The goal more accurately reflects the desired results than the strategic vision. The goal is what the firm wants to achieve in the future. The strategy is part of an action plan on how to achieve the goal.

The strategy is developed for specific goals, if the goals change, the current strategy becomes useless. For example, market share may be an end in itself, or it may be a strategy to oust competitors. The essence of the strategy in the company is that in senior management it is a tool, and at the lower level it becomes a goal.

4. Tasks. Strategic tasks put the strategy into action and ensure its implementation. They form a "portfolio" of strategic projects of the company, coordinated with each other and provided with resources.

5. Indicators that measure and demonstrate the degree of achievement of the goal. For example, profit or market share, expressed in turnover.

6. Implementation of specific measures and projects to achieve the goals. To successfully implement the strategy, it should be borne in mind that there are two types of strategic decisions: the first sets the conditions, rules and objectives to be met, and the second shows how to achieve these rules in practice. For example, a company's strategic decision to expand sales is the rule, and the introduction of an additional sales channel through the Internet is a specific means of enforcing the rule.

Targets for supply chain performance should be formulated in the planned operational terms: market coverage, sales and service support, sales volume, profitability, inventory turnover, time between cash receipts and return on investment.

The supply chain strategy includes solutions related to the intensity of distribution, the use of direct and indirect distribution channels, servicing intermediaries in each geographical area and product sales plans.

In the most general form, all strategies in supply chain management can be divided into two alternative strategies: "economical" and "dynamic" (Table 2.1).

Table 2.1

Characteristics of "thrifty" and dynamic strategy

Factors influencing the choice of strategy	Supply chain strategy	
	"Thrifty"	"Dynamic"
Basic orientation	Productivity	Efficiency
Product characteristics	Standard	Wide variety
Product life cycle	Long	Short
What is the emphasis	Economies of scale	Speed, flexibility and quality
Capacity utilization	The level is set by the graph production	The level is set by demand
Supplier selection criteria	Price and quality	Availability of reserve power. Speed, flexibility and quality

Source: compiled by the authors on the basis of literary sources

Analysis of the factors influencing the overall choice of supply chain strategy shows that the "economical" option is quite justified in conditions when demand is predictable, the requirements for diversity are limited, and production is high.

Lean supply chains are formed in markets that focus on standard products. The most important processes for this category of supply chain are the management of production flows and logistics processes and the management of the relationship with the supplier and the procurement process. These supply chains exist in companies such as VW, Renault and Hyundai.

A dynamic option, on the other hand, is needed in a less predictable environment, when demand changes dramatically and product diversity requirements are high. Dynamic (customer-oriented) supply chains are formed in new markets and focused on relatively innovative products. The most important processes for this category of supply chains are customer service, relationship management and product development. These supply chains exist in companies such as BMW and Audi.

The concepts of "thrifty" and "dynamic" strategy are not mutually exclusive. Ideally, organizations should strive to create hybrid supply chain strategies that combine both of these philosophies, and thus - to obtain the most cost-effective solutions [49, p. 362]. The choice of one or another variant of the hybrid strategy is based on: the application of the Paretto rule (80:20) to divide products into slow and fast sales, the value of decoupling points or order penetration points and the distribution of demand on the base and wave components.

Push (pushing) and pull (pulling) strategies are also important in supply chain management.

The first is based on the demand forecast, the second on the basis of customer orders. According to the Push principle, production and trade "push"

their goods to the point of sale according to the delivery schedule and do not depend on the needs of the buyer (Fig. 2.5).

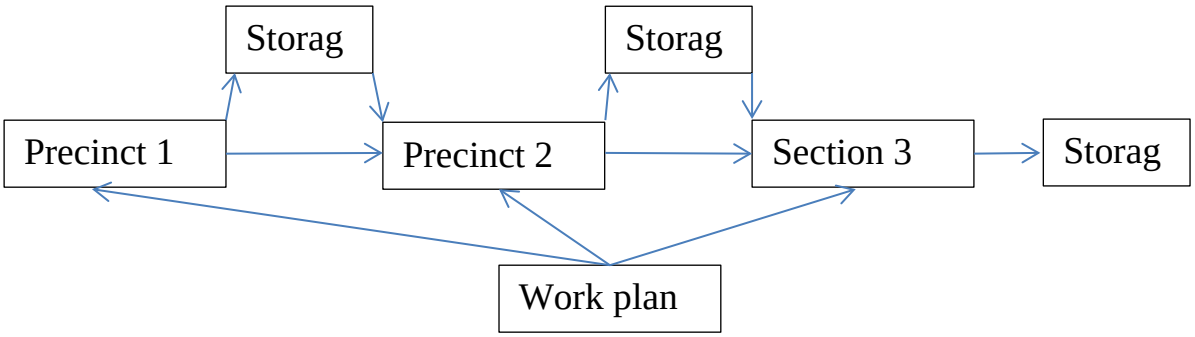


Fig. 2.5

Source: compiled by the authors

Pull-principle, on the contrary, is that the buyer is "attracted" to the point of sale and the signal to start the production process is also given by the consumer. If there is no signal, the production process is temporarily stopped (Fig. 2.6).

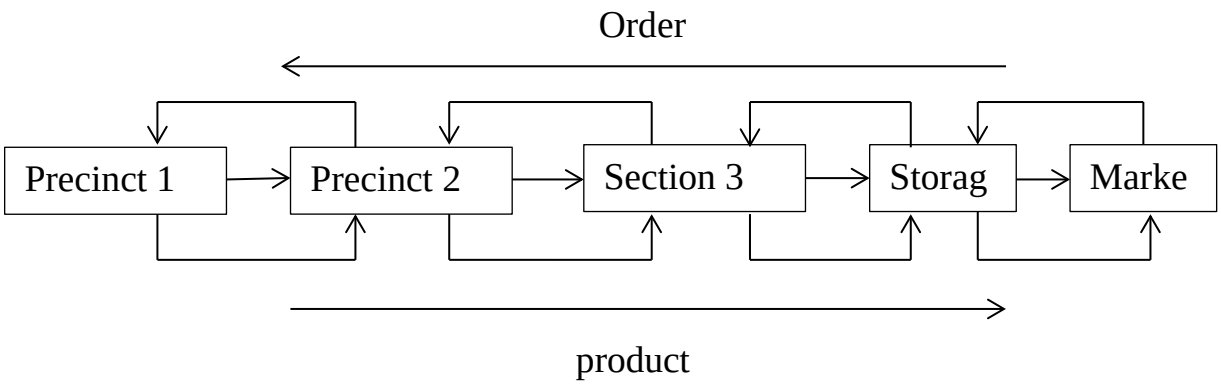


Fig. 2.6 Scheme of Rull-strategy.

Source: compiled by the authors

If we conditionally divide the supply chain at the stage: procurement, production, installation and marketing, we can distinguish five main combinations of Push and Pull strategies: work in a warehouse, distribution to order, assembly to order, work to order and design to order (Fig. 2.7).

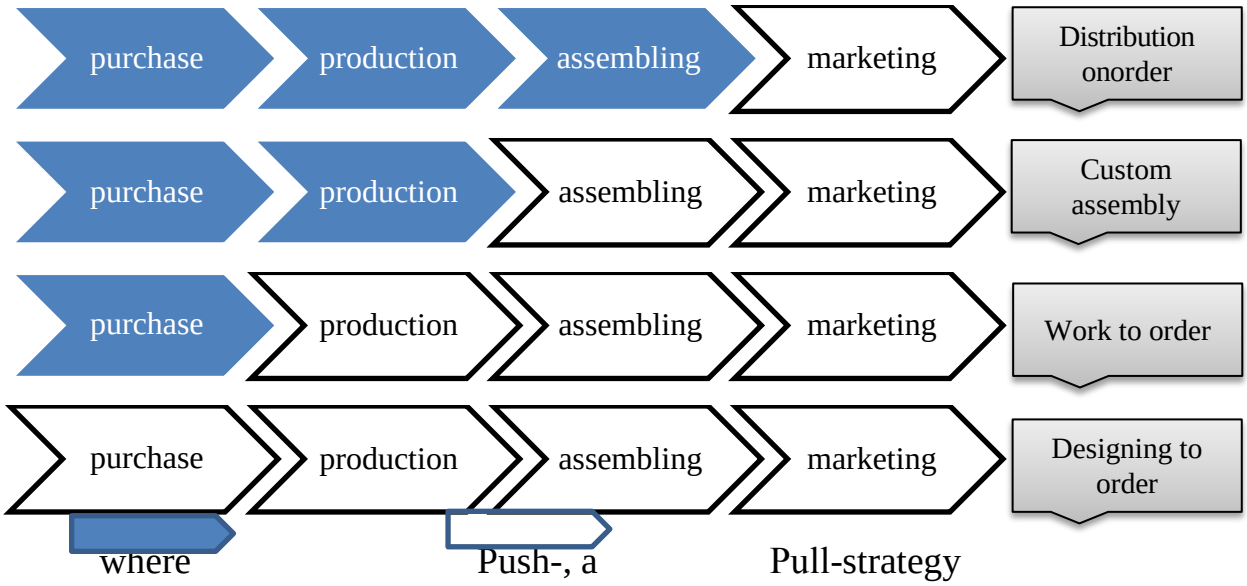


Fig. 2.7 Basic combinations of Push and Rull strategies.

Source: compiled by the authors

The principles of the Rull strategy and "constraint theory" [43] are taken as the basis of another strategy - logistics controlling supply chains. Its main idea is that no production system can run faster than its slowest link. This means that a certain link that works at a minimum speed sets the pace of the whole process in the supply chain, being for him a "limitation" or in other terminology - "insufficient resource". The downtime of the least productive link determines the downtime of the whole process.

Accordingly, the focus should be on increasing the capacity of such a link, i.e. easing the constraint by reserving work in progress in front of this link, which will ensure full load of the supply chain and, accordingly, reduce its downtime to zero.

In practice, there are five variants of such systems of production logistics (Pull Scheduling), which underlie modern production management: drum-buffer-rope; limited queues; limit of work in progress; filling the "supermarket"; method of calculated priorities.

The ideology of the theory of constraints is embodied in a specific algorithm for planning reserve stocks, known as "drum-buffer-rope" - Drum Buffer Rope. Its basic principle is to determine the production rhythm by assigning the status of "drum" to a limited resource and giving signals that are used to adjust the rhythm of the entire production and logistics system and subordinate the work at other work centers to the drum. The production time at the work centers in the process of production in front of the drum is called "buffer" or "shock absorber".

Work in the buffers must begin in advance, at the specified time before the scheduled start time of the drum. The duration of the buffer should be chosen in such a way that the work in it must be performed before the time of operation of the drum. In this way, the buffer protects the drum from downtime. This approach prevents the creation of excess inventories of work in progress, with which insufficient resources may not cope. The connection by which signals are transmitted to other elements of the production system, which is a signal "rope", is shown in Figure 2.8.

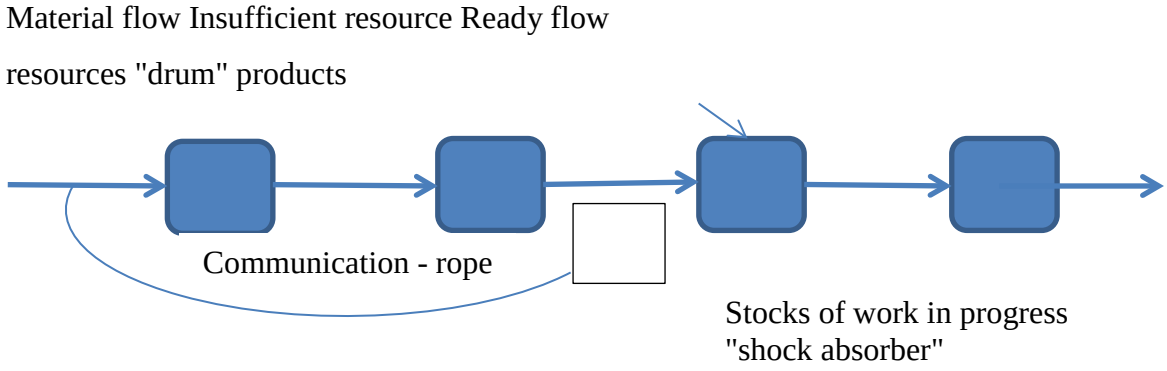


Fig. 2.8 The scheme implements the principle of "drum-buffer-rope", if the "drum" is an insufficient resource.

Source: compiled by the authors

The "drum" can be taken not as an insufficient resource, but also a resource of limited capacity - which is operated with insufficient load, but on average has the necessary production capacity. In this case, you can create two reserve stocks: one stock of work in progress before this resource, and the other at the end of the production process - a stock of finished products (stock) (Fig.2.9).

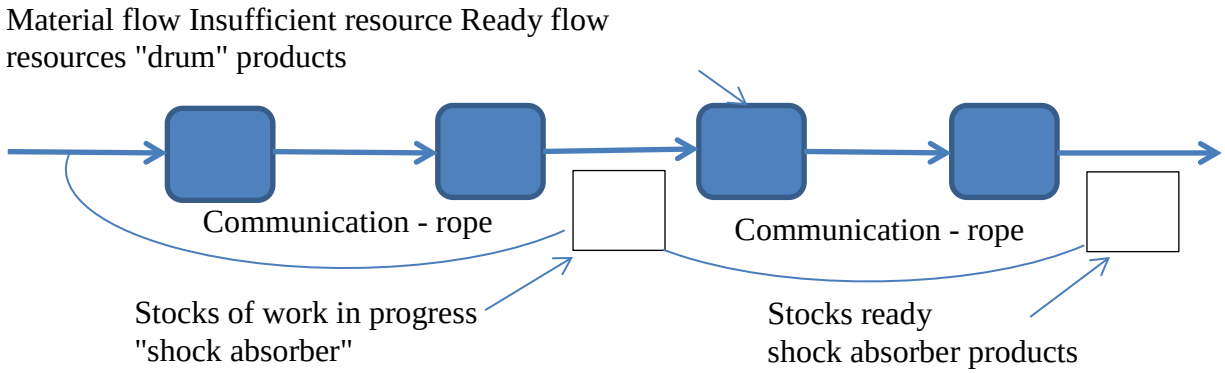


Fig. 2.9 Scheme implementation of the principle of "drum-buffer-rope", if the "drum" is a resource of limited power.

Source: compiled by the authors

It is necessary to note the temporary, not the material nature of the buffer, because the loss of time on the link of the resource that limits productivity is equal to the loss of time of the entire logistics system. Therefore, a buffer is created, a time reserve that protects the most valuable resource from downtime.

The use of this type of traction logistics systems is limited to serial and large-scale production, because it requires the existence of a resource that limits productivity in the area of planning the schedule of work performed.

Limited FIFO queues (from the English. "First-In-First-Out" - "first come, first come out" - the order of receipt. Scope - serial and multi-series production. process for the entire product line produced by the enterprise (Fig. 2.10).

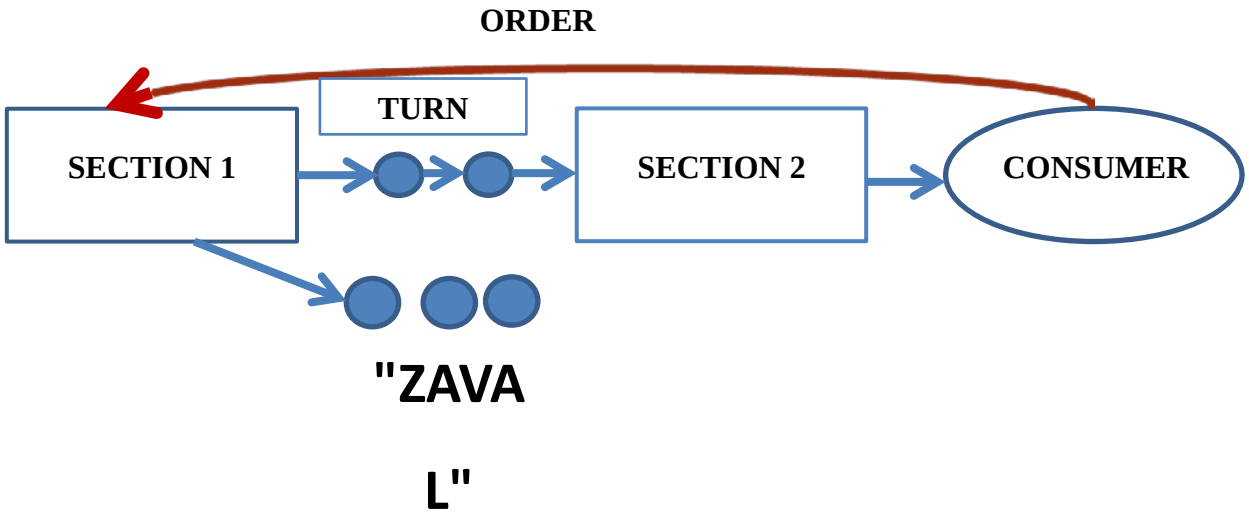


Fig. 2.10 Scheme of implementation of the principle of "limited queues"

Source: compiled by the authors

The mechanism of this type of strategy is the sequence of receipt of raw materials, components from the previous to the next link of the logistics chain. The point of extraction in this case is the end consumer, who transfers the order to the beginning of the supply chain. The order of passage of the resource throughout the chain is strictly defined, so section 2 does not require a plan, it is automatically formed by measuring the needs of section 1. If section 2 completes product production, and tasks from section 1 do not come, it ends. For the 2nd process, this is a signal that it is running faster than the entire logistics system. Thus the whole process of production of goods (services) is synchronized.

However, it should be noted that with such an organization of material flow, there will always be a link that works at a lower speed than others. It forms the largest volume of work in progress, which is called the resource that limits the productivity of the entire system. In order to smooth the flow for the links of the chain, which are not a resource that limits the performance, a certain buffer

is formed from additional tasks (blockage), which can be performed by free resources.

However, this approach mostly leads to an increase in the actual volume of unfinished production. Therefore, such a system is often called "blockage management".

Incomplete production limit (WIP Cap). The difference between this type of extraction logistics system from the method of "drum-buffer-rope" is a buffer that is material, not temporary, and distributes its action to all system processes, rather than ending with a resource that limits productivity (Fig. 2.11).

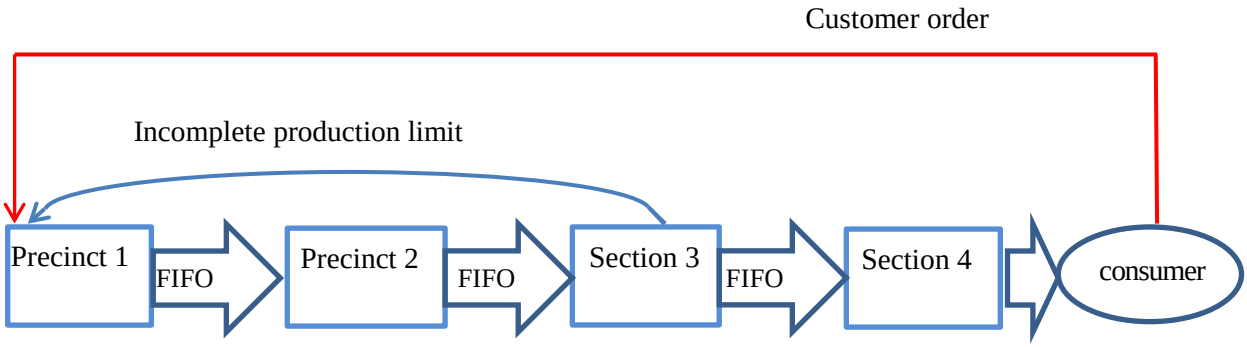


Fig. 2.11 Scheme implementation of the principle of "limit of work in progress".

Source: compiled by the authors

In this scheme, the work in progress limit is a fixed amount of inventory that applies to the entire process. The implementation of the extraction system built on the principle of "limit of work in progress" is much easier than the implementation of the above systems. For the work in progress limit, the extraction point will be section 1.

If we compare this system with the systems "drum-buffer-rope" and "limited queues FIFO", we can identify the following advantages: no impact on the overall bandwidth of the system; only one process is subject to a rigid

schedule; no fixed resource requirement that limits performance; the ability to easily identify and localize the current resource, which limits performance.

The use of this type of extraction system is appropriate for mass and serial production of goods and services, because it better meets the requirements of the logistics system with a stable range, rhythmic production process and constant technological processes. Instead, a work in progress logistics system loses its effectiveness if only the FIFO rule is used in the process of transferring materials / resources from one site to another.

Supermarket Replenishment. The principle of this type of extractive logistics system is to fill the stock when reaching the limit (threshold) level (Fig. 2.12).

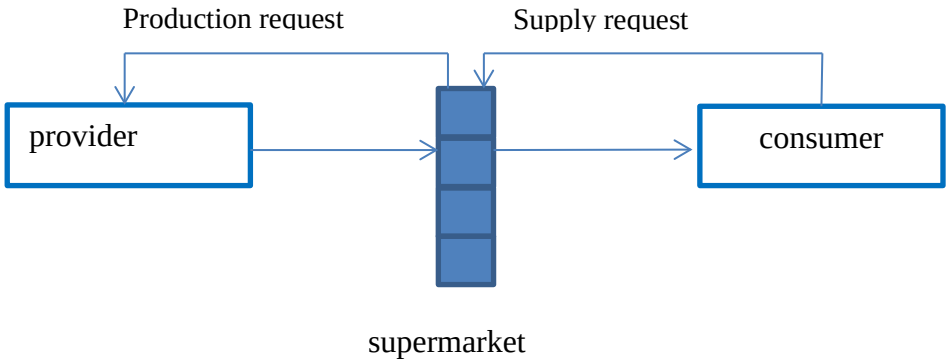


Fig. 2.12 Scheme of implementation of the principle of "filling the supermarket"

Source: compiled by the authors

The consumer, supplier and "supermarket" take part in the presented scheme. The consumer is the next link in the logistics chain, it can be both the end consumer and the shop, production site or department of the company. The supplier is the previous link of the logistics chain, it can act as an external structure and internal, for example, the supplier or warehouse. "Supermarket" is a kind of stock that is freely available to both suppliers and consumers.

The mechanism of this type of "traction" system is a scheme in which the consumer takes from the cells of the "supermarket" the required amount of resources. As soon as their total stock in the "supermarket" and executed orders reaches the "order point", the supplier sends a request for the supply of these resources.

It is important to note that for each resource / material, the optimal order size is calculated, which is then fixed for all new resource / material orders. The point of extraction in this system is the consumer, and the plan may be the demand or need of the next link in the supply chain. The traction logistics system automatically generates a work plan for the supplier.

If it is necessary to connect several production sites of the traction system, several "supermarkets" are used. Construction of a logistics system of this type is possible both in the field of production and services. It should be noted that the limitation of the use of this type of extraction system is the choice of many options of materials / resources located in the cells of the "supermarket".

Priority Sequenced Lanes (RSL) method is a compilation of the "supermarket" replenishment system and the system with limited queues FIFO. A distinctive feature of this type of system is the variability of the methods used to replenish the cells of the "supermarket".

Abandonment of a strict FIFO sequence is replaced by priorities calculated by a number of parameters. Priority calculation criteria are created for a single extraction point. In the fig. 2.13 a similar section is section 2.

The tasks of each section of the system are:

- ensuring timely processing of orders based on their priority;
- optimization of internal material flow;
- timely identification of problems related to ensuring the movement of material flow.

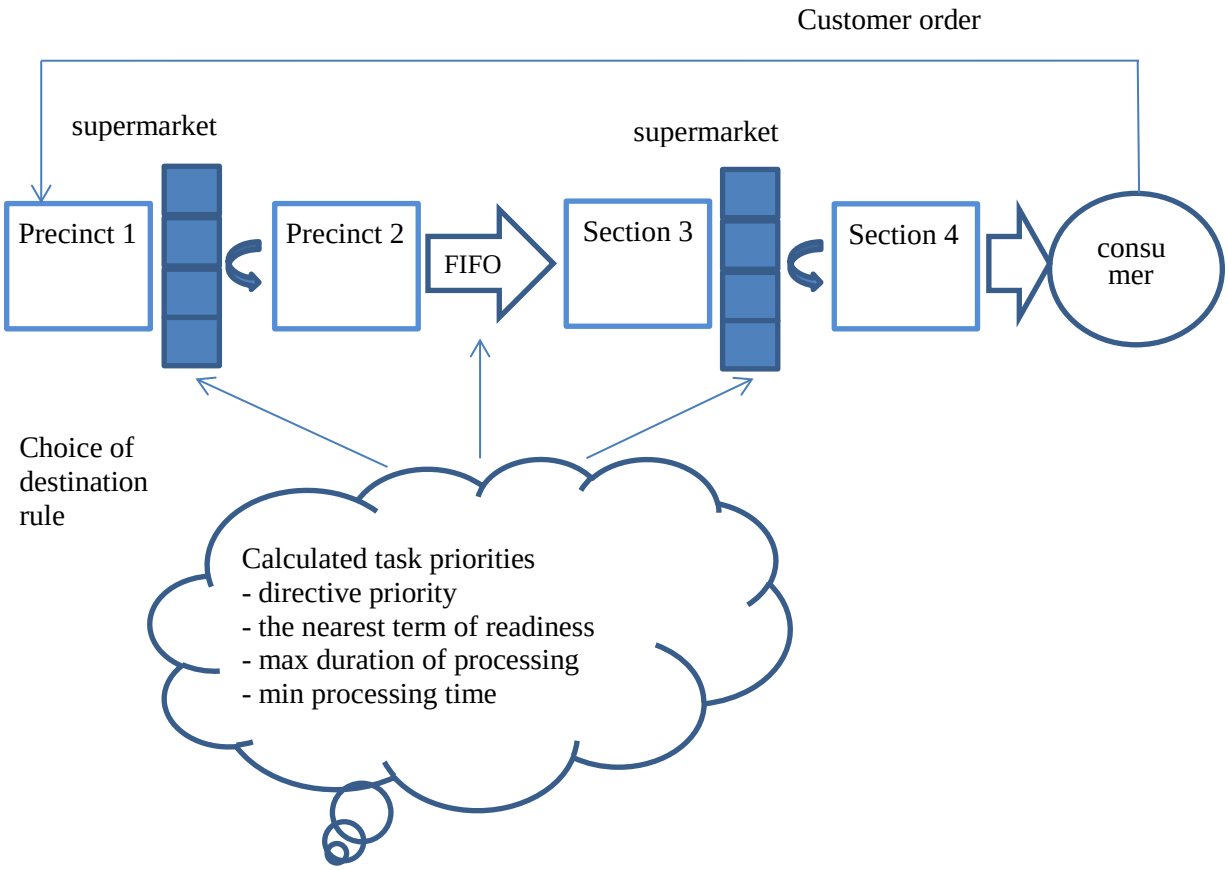


Fig. 2.13 Scheme of implementation of the principle of "calculated priorities"

Source: compiled by the authors

The mechanism of the system of calculated priorities is that each subsequent link in the logistics chain begins with the tasks that have the highest priority; thus, in the "supermarket" not all free cells are filled, but only those that meet the priority tasks. It should be noted that section 2, which is the point of extraction, in turn should perform only the highest priority tasks. Numerical values of priorities are calculated by determining the value of the criterion common to all sections at each site. The type of this criterion is set by the main extracting link - section 2, then each link in the chain independently calculates its value for its tasks.

The condition of limitation (limit) of the queue of production tasks transferred from section 2 to section 3 does not contradict the change in the sequence of their receipt, which occurs depending on their current (calculated) priority. Thus, the precinct does not choose from which task to start work, but performs the task with the highest priority. In the event of a sudden change in the priority of tasks, the site transfers the current task to work in progress and switches to the highest priority.

It is important to note that the rules for calculating the priorities of the tasks are assigned "from the outside" for each production site of the process and the criteria for loading the site equipment determine the nature of the passage of internal material flows.

Toyota was the first to use this method of replenishing the cells of a "supermarket", where it was called the "Production Leveling Procedure", or "Heizunka" [30].

The advantages of the method of calculating priorities are that:

- the bandwidth of the system is increased by calculating the priorities of tasks that deviate from the specified rhythm;

- there is no need to fix the position of the resource, which limits the productivity and limitation of work in progress;

- the mechanism of control of failures on each site by giving the chance to change sequence of processing of a resource is created;

- the presence of local production plans at certain sites makes it possible to conduct operational functional and cost analysis of production.

However, supply chain management is generally not limited to one or more strategies. It uses a certain "strategic set" in the form of a system of strategies of various types, which reflect the specifics of the functioning and development of the supply chain, as well as the level of its encroachment on a particular place and role in the external environment. That is, with regard to

supply chains, we need to talk about the use of integrated management strategies.

The market structure and resources of the company directly affect the company's development strategy. In addition, the formation of supply chain management strategies is influenced by modern megatrends, namely:

- globalization, which determines the mass nature of production, product standardization, globalization of marketing and the formation of global supply chains, which are focused on the global system and allow to get the effect of open space;

- individualization, which focuses on the single nature of production, the full range of products, individualization of orders, differentiated marketing and determines the focus of the strategy on the consumer and logistics service;

- greening, which necessitates the development of environmentally friendly production of environmentally friendly products;

- socialization, which requires the development of socio-ethical marketing and determines the orientation of logistics strategies in the interests of society and social impact;

- informatization, which determines the development of flexible production of a wide range of goods, interactive marketing and aims at a logistics strategy to optimize individual interests and obtain an individual effect.

Taking into account the identified megatrends for the strategic development of enterprises is possible provided they are used and presented as a universal concept of 4 D:

- for the product - the creation of the product, its structure (first D);

- regarding the manufacturing process - creation of a production system, technology, etc. (second D);

- for the customer - the creation of a supply chain, starting from raw materials and ending with the final product (third D);

- in relation to the environment and society - the creation of a reverse chain (chain of utilization of waste products) (fourth D) [25].

In the practice of building supply chain strategies, there are three main stages of development.

Stage 1. Compilation of the supply chain uncertainty spectrum. Uncertainty in the supply chain depends on both the objectively present uncertainty of demand in product markets and the subjective uncertainty in the interaction between partners and the variability of the structure of the supply chain itself.

Therefore, in determining the supply chain development strategy, it is first necessary to assess the uncertainties that need to be avoided or at least reduced.

Accordingly, companies operating in market segments, which are characterized by high uncertainty in demand and in which the costs caused by this uncertainty are also high, when building a supply chain should focus on one of the following types of strategies: "flexible" or strategy built on the client.

These types of supply chains are characterized by the presence of excess capacity in response to high variability in demand. As for the uncertainty of interaction, it can be reduced by applying during the design of the most optimal for a particular supply chain interaction strategy: team, competitive or cooperative.

Stage 2. Understanding supply chain capabilities. At this stage, you need to solve the problem of how to meet consumer demand for products, taking into account the available resources of the supply chain.

The main characteristics of the supply chain are considered in terms of finding a compromise between the total cost of the chain and the degree of customer satisfaction with price, product quality and level of service.

This trade-off in supply chain management theory has been called the reactivity/efficiency trade-off.

Supply Chain Responsiveness (SCR) is the ability to respond quickly to changes in the environment, namely:

- response to the breadth of the range of products required by the market;
- readiness to reduce the order execution time;
- maintaining the depth of the range (a wide variety of desired characteristics);
- creation of highly innovative products;
- support for a high level of service;
- supply uncertainty management.

"Supply Chain Efficiency" (SCE) is determined by the total costs in the supply chain from product development to delivery to the end user and after-sales service.

In the general case, these two approaches are mutually exclusive, because the increase in reactivity (quality of service) leads to increased costs, and reduced costs - to a decrease in service quality. Thus, the company seeks to either reduce costs or increase service.

However, in practice, the level of service should suit the customer, and the cost should guarantee the planned profitability of the supply chain. Therefore, when formulating a strategy, the emphasis is on one of the approaches, and the second approach acts as a constraint. Further configuration and supply chain building is based on a key strategic choice towards efficiency or reactivity.

Stage 3. Compilation of a matrix of strategies. At this stage, the results obtained in the previous stages are entered into the matrix. The relationship between the parameters "Supply Chain Efficiency - SCE / Supply Chain Reactivity - SCR" and the degree of certainty of demand and interaction of participants opens the choice of different supply chain strategies (Fig. 2.14).

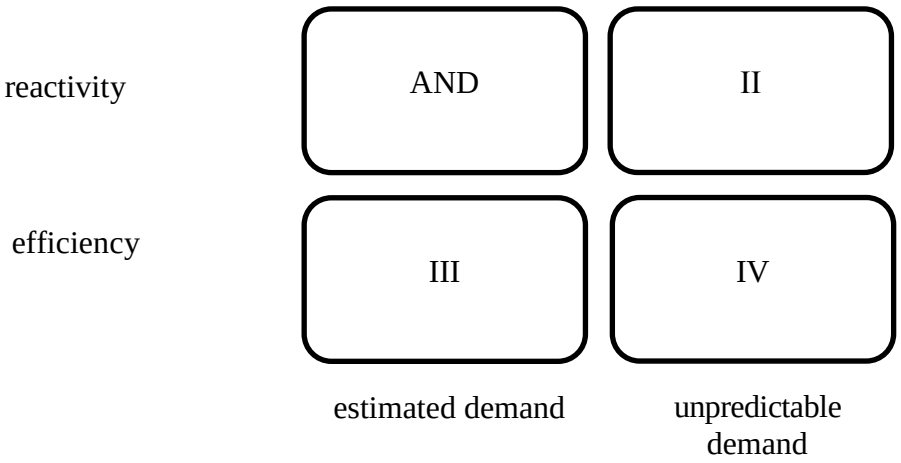


Fig. 2.14 Supply chain strategy development model

Source: compiled by the authors

The main strategies of integrated management and coordination of supply chains at the level of the company's relations with suppliers and customers are:

1. JIT (Jist In Time) - just in time.

2. JIS (Just In Sequence) - exactly in the specified sequence.

3. VMI (Vendor Managed Inventory) - transfer of inventory management to sellers (customers) of products.

4. ECR (Efficient Consumer Response) - effective customer-centric response.

5. QR (Quick Response) - quick response.

6. CPFR (Collaborative Planning, Forecasting and Replenishment) - joint planning, forecasting and replenishment.

2.4 Decision-making on supply chain management in conditions of uncertainty

Decision-making in conditions of uncertainty in the event of deviations in the implementation of works in the supply chain is one of the most important stages of operational management. To provide an opportunity to adequately assess the situation and make the most favorable decision, special concepts and

information systems have been developed and implemented in the practice of supply chain management.

The main one is the concept of Supply Chain Event Management (SCEM). Its idea is to build an information system for continuous updating of data on the course of processes in the supply chain in order to:

- detection of violations and deviations in the performance of works (for example, delay or malfunction of the vehicle, exceeding the level of insurance stock, deviations in production processes, etc.);

- decision-making to eliminate the negative consequences of the identified deviations.

Functional processes of SCEM-systems are to monitor events related to risk (recognition and visualization of violations and obstacles), alert management (alert management) and simulation of alternative options for further implementation of processes.

For the effective functioning of SCEM-systems it is necessary to create a single information space from the information systems of all participants in the supply chain, which will ensure the required degree of relevance and accuracy of data.

SCEM is based on three main provisions.

Firstly, these are information systems for reading and transfer of the actual information on a course of processes in a supply chain.

Second, it is a management method used to compare actual and planned performance indicators in the supply chain.

Third, is an event simulation method used for acceptance decisions to restore the efficiency of work in the supply chain.

Figure 2.15 presents the main idea of event analysis in the SCEM concept.

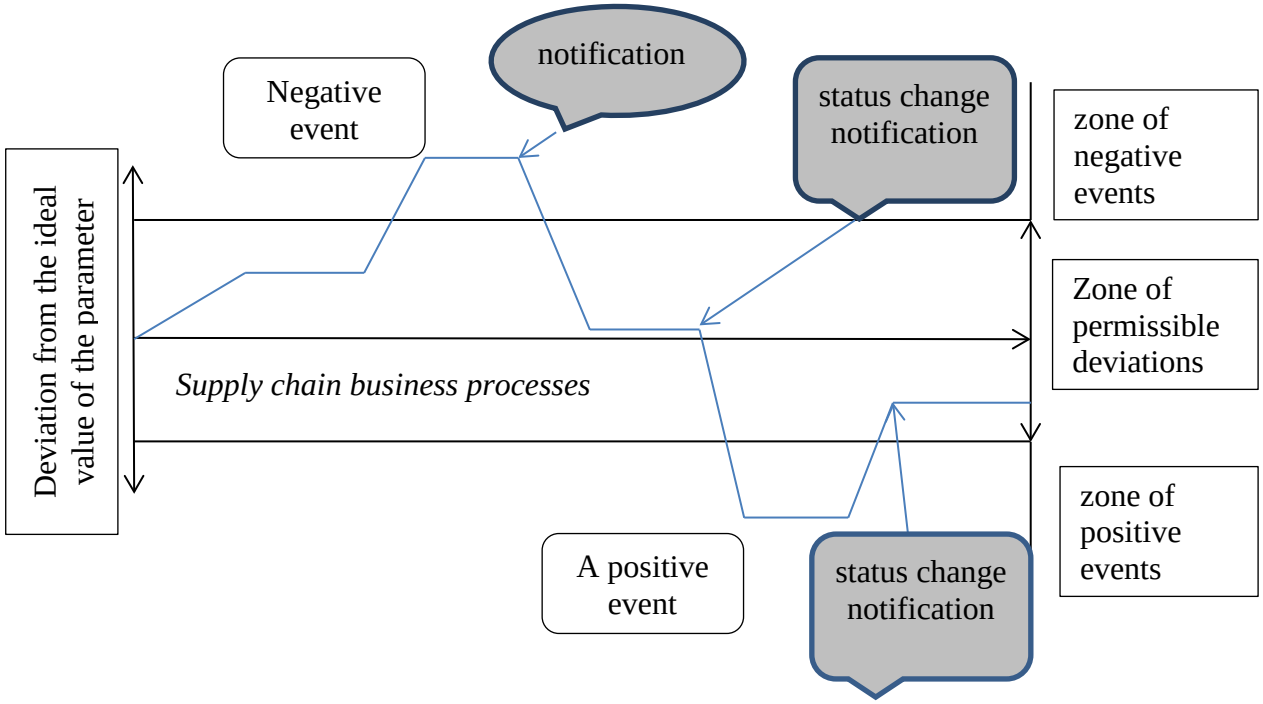


Fig. 2.15 Scheme of event analysis in the concept of SCEM

Source: compiled by the authors

Each event in the SCEM concept is characterized by three statuses:

1) documentation (describes the processes and places of transfer of responsibility for the process), for example, the transfer of goods to the customer;

2) observation (captures the current values of process parameters);

3) expectations (characterizes the completeness and availability of the necessary information at this checkpoint), for example, the driver can deliver the goods and enter data about it into the system using his mobile phone, but for technical reasons this information was not delivered to the supply chain monitor.

However, events can be both negative ("truck delay of 5 hours") and positive ("delivery is possible today").

One of the important aspects in SCEM is the detection of deviations. For their analysis a certain zone of permissible deviations from ideal values of parameters is established. If the deviations are within the given zone, they do

not cause violations that can lead to non-fulfillment of supply chain objectives, or to reduction of efficiency of works in the chain (for example, excess of costs, non-fulfillment of obligations on delivery terms). This zone of permissible deviations is the basis for notification and launch of calculations for the decision to eliminate violations.

In recent years, a number of large focus companies have been effectively implementing Supply Chain Monitoring (SCMo) systems.

Unlike the SCEM systems described above, SCMo systems lack complex optimization algorithms, and are designed solely to visualize the real course of processes in the supply chain, mainly in the field of inventory control and capacity utilization. Within the SCMo system, a so-called control panel is designed and installed in a focus company. Thanks to which the supply chain manager gets the opportunity to have a comprehensive view of the current situation in the supply chain and has complete information for the preparation of various analytical reports on the behavior of individual participants in the supply chain. Participants in all other parts of the supply chain receive similar information within their areas of responsibility (suppliers). Moreover, the information for the system is provided by the suppliers themselves via the Internet.

Therefore, it should be noted that although SCMo-systems do not contribute to the optimization of basic business processes, but they are quite effective when used in practice. And first of all, this is due to the psychological aspect of the transparency of the system, which leads to an increase in the responsibility of suppliers and their trust in each other.

At the same time, the complexity of the system is determined by the level of uncertainty in it. In this regard, there is a need to move from linear models to nonlinear polymodel complexes that provide a dynamic synthesis of adequate market structures of business structures. Accordingly, effective supply chain

monitoring should be based on a non-hierarchical approach consistent with decentralized management principles.

One such approach is an integrated approach. The basic factors that characterize an integrated approach to risk management in the supply chain include:

- basic structure of the management system;
- viability;
- stability;
- adaptation based on multilevel (multilayer risk).

The identified factors have a decisive influence on maintaining the working condition of the supply chain and the possibility of its recovery after a violation of the regime of sustainable operation. Taking into account these factors, including the hierarchy of the supply chain as a complex object of management, the methodology of a comprehensive security system of supply chains is built.

The purpose of the security management system is to develop requirements for the management system and support decision-making based on a risk-oriented quality platform and some other management models. Risk identification and management is carried out at different stages of management, life cycle processes and hierarchical levels of the supply chain management system. The elements of the requirements for the basic structure of the supply chain management system are the following:

a) policy;
b) planning;
c) implementation and operation;
d) performance assessment (performance);
e) improvement;
f) analysis by management.

The above six elements of a management system are part of any of the risk-oriented systems. In which special emphasis is placed on taking into account decision-making factors by people rather than automatic systems (for example, as in ACS), which does not allow to use for supply chain management methods for assessing reliability as a key element of decision-making and requires the development of new management mechanisms .

An integrated approach is reflected in the integrated supply chain management concept, which is based on the following five levels of supply chain security management:

- level of regulations (standards);
- level of risk management methods;
- level of event and process management;
- level of information technologies;
- the level of physical security of goods.

Levels of regulations and risk management methods belong to the stage of supply chain planning. At these levels, general safety management rules in the supply chain are prescribed, uncertainty is analyzed and risks in different parts of the supply chain are identified.

These risks are then correlated with supply chain processes, the probability of their impact on the chain (for example, in the form of EPI event probability index) at the level of event and process management, as well as scenarios of managers in case of dangerous situations (for example, based on the method of OMR event management plan - event management plan [91]). The level of event and process management is key, it is divided into stages of planning and implementation of works in supply chains.

At the planning stage, certain reserves are created to ensure the security of supply chains. Many alternative plans are formed with different indicators of economic efficiency and safety. This stage ends with the reproduction of possible scenarios for the operation of supply chains in the conditions of various

incitement and management influences and the final drawing up of a plan corresponding to the submission of the manager who decides on the level of risk in his business.

Then begins the stage of implementation of the work performed in the supply schemes. At the level of physical security of goods, primary information about the movement and storage of supplies is collected on the basis of various sensors (for example, RFID or bar codes). These relevant data are transmitted to the level of information systems, where the initial processing of information, its analysis of compliance with the plans and notification of participants about possible deviations based on the monitoring of supply systems. These data are transmitted to the process level, where based on the method of event management, management actions are developed to compensate and eliminate the deviations.

Among a number of important characteristics influencing the formation of the supply chain management mechanism in conditions of uncertainty, there are viability, resilience, adaptation and reliability.

Viability is determined by the ability of the supply chain as an organizational structure to withstand threats and recover quickly from process failures. In combination with the adaptation characteristic, this category belongs to the most important criteria of self-renewal of the supply chain.

Sustainability management is the process of developing and implementing impact measures that can return the supply chain to a working (efficient) position and minimize losses caused by failure. Such management can be carried out at different levels of the supply chain, depending on the nature of the threats. In today's environment of instability, it is the main link in security management.

External and internal threats are taken into account in the process of viability analysis. External threats are divided into general economic and natural (man-made). These include: the growing level of competition and its changing

nature; instability of demand and its low predictability; failures (technological gaps) in the supply chain; terrorism, the shadow economy and corruption. Internal threats include: inflexibility of contracts with suppliers, lack of common standards and technologies; surplus or shortage of stocks; low level of customer service; lack of risk-oriented process management throughout the life cycle of the system.

Supply chain stability is understood as its state when it is in the planned mode of operation under the condition of a fixed set of permissible inciting and controlling influences, limitations and insignificant influences that lead to limited and relatively small changes in the initial data of the supply chain.

The peculiarity of the stability of the supply chain is that the control action in it is formed by man, not machine. This is exacerbated by a combination of centralized and decentralized management, i.e. the need to combine the management influences of enterprises participating in supply chains, whose interests may be different. Accordingly, in the event of the supply chain coming out of equilibrium, the search for a new equilibrium is carried out taking into account the decentralized balancing of interests of all participants within the general global criteria of efficiency of the supply chain.

Stability has a pronounced dynamic nature and is directly related to the factors of uncertainty of the external and internal environment. It characterizes the ability of the system to return to its original state and remain within acceptable limits of operation under the influence of factors that incite it in a certain period of time.

If the system does not return to acceptable operating limits within a given time interval, the system is said to have lost stability. It is important to emphasize that the stability of the system is always determined in relation to certain classes of disturbances. Analysis of supply chains showed that the main causes of loss of stability include:

- narrowly specialized orientation;

- lack of choice of new suppliers;
- the presence of high credit debt;
- development strategy focused only on continuous profit growth;
- accumulation of most of the basic capacity of the supply chain in one place;
- inconsistency of planning with demand and supply;
- lack of insurance reserves;
- malfunctions of equipment and technologies;
- human factor [60; 97].

The reasons that led to the loss of stability of the supply chain arise in the case of poor organization of information processes and technologies. Therefore, the effective management of supply chains requires the introduction of information technology that meets the necessary requirements and minimizes the impact of the human factor.

Stability analysis is especially necessary in cases where it is impossible to build stochastic models of risk factors. Sustainability analysis allows you to select a plan with the necessary performance assurance, identify bottlenecks in the plan and measures to strengthen them, as well as develop scenarios to support operational decisions to reconfigure supply chains based on analysis of key performance indicators and tolerances of plan parameters.

Adaptation means adaptation to constantly changing operating conditions. With regard to supply chain management, adaptation can be defined as the process of adjusting supply chains and supply chain management models to changing operating conditions. Adaptation depends on the level of system management. The first, operational level of management, designed for parametric adaptation of the supply chain in the event that the elimination of abnormalities in the functioning of the supply chain is possible by adjusting some parameters of the chain (e.g. delivery times, inventory levels, etc.).

If it is impossible to adjust the supply chain through parametric changes, it is necessary to carry out appropriate structural transformations (level 2 - structural adaptation of the supply chain). This stage places higher demands on decision support information systems and requires a comprehensive analysis of the problem in close cooperation of the disrupted participants in the supply chain. If structural-functional and process adaptation do not bring the desired effect, adjustment is necessary by adjusting the target parameters (for example, project completion dates, cost levels, etc.). Targeted adaptation is management level - 3 and emphasizes the need to harmonize supply chain planning and monitoring models (the monitoring model should meet the objectives of risk-based supply chain management).

A special place for the adaptation of the whole system are management levels 4 and 5, designed not only to adapt to the new environment, but also to develop mechanisms for self-renewal of the supply chain, as well as strategic objectives of supply chain management, including regulatory changes. Level 4 is a model that provides an integrated approach to the security management system based on risk identification and assessment. Level 5 is the highest level of adaptation of the supply chain, when the violations in the chain are so serious that the achievement of the initial goals of top management is no longer possible.

Under the reliability of the supply chain is understood a set of criteria such as: the effectiveness of the execution of orders in terms of compliance with delivery deadlines; quality of services provided, product range and total costs. Obstacles in the supply system are understood as accidental deviations from normal behavior. These deviations correspond to changes in process parameters and / or results of interaction of elements of the supply chain. Violations, as a result of the influence of dangerous factors, can be mutually compensated. Thus, the impact of barriers to interaction in the supply chain is always manifested through the reliability of suppliers.

Today, the emphasis in the design of supply chains should be on improving the reliability of the whole chain. There are three main ways to achieve a reliable supply chain, which can be divided into: quantitative, qualitative and combined approaches.

Quantitative approach - introduction of spare elements of the supply chain. For example, inviting additional carriers to carry out uninterrupted carriage of goods when the main carrier is unable to fulfill its contractual obligations for one reason or another.

Qualitative approach - increase the reliability of all elements of the supply chain (or the most unreliable of them), such as reducing the delivery time of goods and, as a result, increase the accuracy of its delivery or the organization of special methods of transportation to improve the safety of goods.

Combined approach - application of the first two approaches together.

The attractiveness of the supply chain for the customer is due to a certain level of reliability, which must have a competitive advantage over the reliability of similar supply chains of other firms present in the market of goods (services). Qualitative functioning of the supply chain according to a given criterion of reliability depends on the following condition:

$$Pc \geq P0, \quad (2.1)$$

where Pc is the level of reliability of the entire supply chain;

P0 - the required level of reliability.

Reliability in this case means the probability of performing the required functions in a certain time interval.

Product supply management, taking into account the reliability and risk assessment of the supplier, should be carried out within an integrated approach. The state of the process is characterized by the values of two parameters:

- profitability (degree of costs) (Di);

- the probability of income from the use of an efficient process structure (Pj).

To determine the risk of distribution (supply) of material resources through different suppliers, it is advisable to determine the standard deviation, which can serve as an indicator of how much each option differs from the average value. This indicator can characterize the absolute risk by the structure of resources and the estimated income from their use:

$$R_i = \sqrt{\frac{\sum (Dn_i + Dc_i)}{n}}^2, \quad (2.2)$$

where Ri is the total standard deviation of all elements of profitability, taking into account the probability;

Dpi - optimized profitability of the i-th element of resources;

Dci - average yield for the i-th element;

n - the number of elements.

The risk factor K will be determined by the ratio root mean square (standard) deviation Ri to the average profitability of all elements Dsi of total income throughout the supply chain

$$K = \frac{R_i}{Dc_i}, \quad (2.3)$$

The security of supply chains is affected by the following groups of risk factors:

- physical: theft of property (loss); low quality of input raw materials and materials; vehicle accidents; main equipment accidents, etc.;

- economic: inaccuracy and unreliability of forecasting the demand for products; disruption of supply of materials; supply of low-quality resources; lack of funds for the purchase of resources; rising prices for resources, etc.;

- technological: reduction of capacity (capacity) of the logistics system or supply chain counterparty; technical impossibility of production; equipment failure; violation of production, storage and transportation technology; physical

wear of production equipment, vehicles, warehouse lifting and transport equipment; non-compliance with the technology of production, storage, transportation, etc.;

- organizational: inefficiency of sales activities; lack of quality control and supply chain monitoring system; mistakes in choosing intermediaries; inefficient inventory management, etc.

Supply chain reliability management is associated with the choice of a tool (method of improving its reliability), which allows in specific conditions or for a specific business process to achieve the goal. For example, if the goal is to increase supply chain failure, the most effective tool to increase reliability will be to back up business processes in supply chains (virtual, physical, and over time).

Therefore, to reduce production and logistics costs it is necessary to use quite complex planning methods based on operations research (linear, nonlinear or target programming, simulation, etc.), and to increase security - risk management methods (distribution of risk between supply chain participants, diversification, insurance and other).

CHAPTER 3. ECONOMIC EFFICIENCY OF SUPPLY CHAIN MANAGEMENT SYSTEM

3.1 Economic efficiency of the supply chain

Efficiency is one of the most important characteristics of the quality of the system, an indicator of human activity that determines the ability to ensure the end result. The concept of economic efficiency reflects the effectiveness of the economic system, which is expressed in the degree of conformity of resources expended and the results obtained.

In scientific circles, the authors dealing with the evaluation of the efficiency of economic processes, offered many of its definitions. Efficiency is defined as achieving certain results with the minimum possible costs or obtaining the maximum possible volume of products from a given number of resources. That is, it is a relative indicator by which the obtained effect is compared with the costs or resources used to achieve it.

The efficiency of the logistics system determines the level of stability of its operation at a given level of total logistics costs of the system. For the end consumer, efficiency is determined by the level of service quality of his order. And the efficiency of the supply chain combines all these concepts and is characterized by both a high level of economic efficiency and the necessary levels of stability and quality of operation of all processes in it.

Therefore, the economic efficiency of supply chains means an increase in the effectiveness of joint activities of its participants in the production process, transport and warehousing services, development of innovation capacity and increase the level of production and logistics cooperation.

The economic efficiency of the supply chain is multilevel. During its evaluation it is necessary to take into account how the formation of optimized production and logistics relationships will affect not only the activities of each

individual participant in subcontracting relations, but also the effectiveness of the project throughout the supply chain. Optimization for subcontracting determines the growth of profitability of each participant in the supply chain (contractor and subcontractors) and the growth of the number of qualified personnel in enterprises.

Supply chain optimization determines the growth of its overall efficiency, reducing inventories, increasing sales and increasing market coverage. Accordingly, the effect of optimizing the logistics processes of subcontracting relations can be divided into individual and synergistic. The individual socio-economic effect determines the benefits of the interaction of enterprises in the supply chain for each participant in subcontracting. The synergetic effect determines the cumulative benefits of the association of enterprises - participants in the supply chain, which exceed the sum of the effects of the activities of each enterprise separately.

The concept of "efficiency" is extremely complex, because its assessment must take into account many criteria that characterize the enterprise, production and management. On the one hand, it is necessary to strive to simultaneously take into account the whole set of changes in the supply chain, using a single integrated summary indicator, on the other - "the efficiency of the enterprise should be assessed in multi-criteria and multilevel project, which for a long time combines production, market and innovation-reproduction processes "[21].

The main features of the system of indicators of the functioning of the supply chain should be:

- simplicity and ease of use;
- clear definition and purpose of application;
- reachability (limits of admissible value should be not less than 70-80%);
- measurability;
- compliance with both long-term and short-term goals of the organization;

- balance and interconnectedness;
- compliance with customer requests;
- the ability to detect and eliminate losses.

In addition, there must be a clear isolation of the mutual influences of these factors on each other, which is an extremely difficult task, as they reflect multidimensional socio-economic phenomena.

NO. Chukhrai and IB Mlinko [56, p. 29], in the hierarchy of factors for assessing the functioning of supply chains are structured by the most traditional factors that allow you to build a rational system that covers both general and partial indicators (Fig. 3.1).

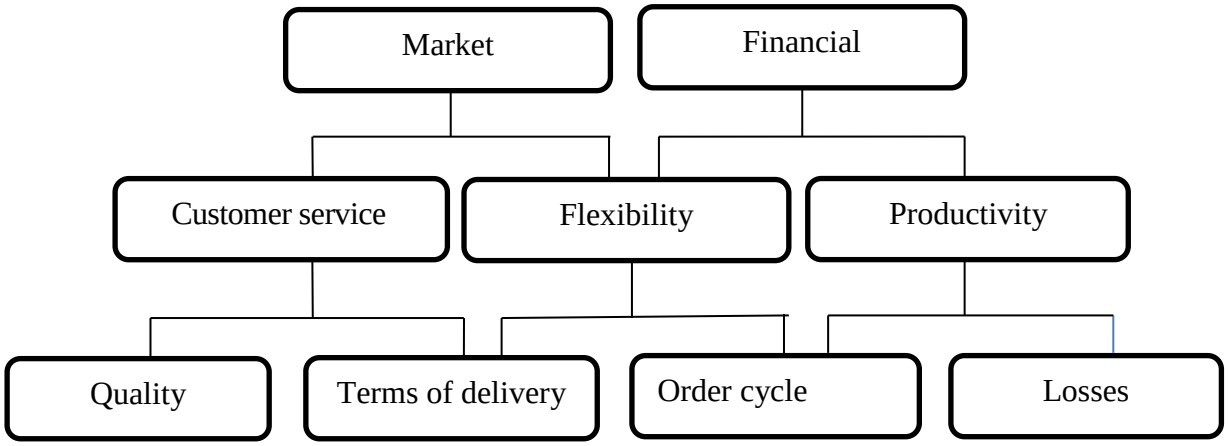


Fig. 3.1 System of indicators for evaluating the functioning of supply chains.

Source: compiled by the authors

A rationally constructed system for evaluating the efficiency of the supply chain allows to identify the optimal ways to increase it and strengthen the company's competitive advantage in the market. However, the most difficult problem faced by the company during the modernization of its system is the choice of flow management, which is determined based on the company's goals, market situation, the peculiarities of enterprise processes and other factors. Thus, the company's management faces a multi-criteria task to solve which may

use different methods. Among them, the following methods have been most widely used in the scientific literature and business practice:

- method of utility theory - construction of utility function or value;
- method of theory of importance of criteria;
- weighted amount method.

To build a utility function, information on the quantitative relationship between results and probable alternatives is needed, as well as expert assessment of the possibility of occurrence of certain events. However, it is not always possible to fulfill such conditions, “which imposes restrictions on the application of the method of utility theory. In addition, it should be remembered that the procedure for constructing the utility function is time consuming and poorly formalized "[40].

Theory of the importance of criteria based on precise definitions of the concepts of equality and advantage in the importance of some criteria along with others. It develops decisive rules for a number of combinations of different types of information about the importance of criteria on a predetermined scale that define the corresponding binary relations of preferences.

Weighted amount method based on the merging of all criteria into a single generalized (global, integrated, aggregated, complex, synthetic, compromise, etc.) criterion, which is the sum of criteria weighted by coefficients of their relative importance or weight [38, p. 41].

Today, the economic literature highlights and analyzes a sufficient number of indicators to analyze the effectiveness of the company, but a study of scientific sources to assess the effectiveness of supply chains showed that most of the proposed systems are not consistent with the overall financial performance of the company.

Thus, A. Gunasekaran, S. Patel, R. McGuffy, offer a system of performance indicators, classified by types of processes in supply chains, as well as the division into strategic, tactical and operational levels within each process: planning, procurement, production, supply [7, p. 336-339].

B. Beamon divides performance indicators by: resources, results and flexibility. The category of resources covers the assessment of inventories, costs and return on investment. The result reflects the assessment of the level of consumer satisfaction and the volume of shipped products. Flexibility testifies to the company's ability to respond to changes in the volume and schedule of deliveries, it is measured in monetary units or units of delivery time [61, p. 277-285].

J. Cyberl, K. Manodt, D. Durtsche and D. Lediard distinguish three criteria for evaluating the efficiency of the supply chain: time, quality, cost [96, p. 225-230].

Given the fact that within the supply chain there is a movement of three interconnected flows (material, information, financial), W. Hauzman proposes a distribution of indicators by type of flow. For material flow - is the grouping of indicators by: customer satisfaction, stocks, speed of turnover of resources; for information - the number of sources of information, speed and availability of information; for financial - this is the period of turnover of working capital, inventories, receivables and payables [87, p. 9-10].

Chan and Ki divide the performance evaluation criteria into two groups:

1) quantitative (costs, time of execution of orders, use of production capacities and resources);

2) quality (level of consumer satisfaction, the degree of flexibility of the supply chain, the level of flow integration, the effectiveness of risk management and the work of suppliers) [69, p. 209-213].

H. Bullinger and M. Kuchner use the Balanced Scorecard model to assess the efficiency of the supply chain. In this model, the indicators are grouped by four projections:

1) financial aspect (level of costs and stocks, return on investment, financial cycle);

2) customer aspect (level of customer satisfaction, timely delivery, order fulfillment time, level of service);

3) internal economic aspect (accuracy of order fulfillment);

4) the aspect of innovation (the share of sales of a new product) [66, p. 3535-3540].

Existing systems for measuring the effectiveness of the supply chain involve the use of many qualitative and quantitative indicators that require the analysis of a large array of information with a rather dubious probability, which in most cases distorts the results of the overall efficiency analysis. Therefore, the essence of performance evaluation should first of all be to compare the results obtained and the resources spent on their achievement. The indicators used should be determined by the nature and objectives of the supply chain operation process, the quality of its processes, as well as external influences. According to the theory of dynamic efficiency [51], it is necessary to take into account three groups of process efficiency indicators that characterize: the degree of goal achievement (target effects); resource costs (resource intensity of the process); time costs (efficiency of the process). According to these criteria, the economic efficiency of the supply chain is considered, because it is essentially fully consistent with the concept of system. In the process of activity in the supply chain, a value chain of participating companies is formed, each of which adds its value to the created product (service) and in turn incurs certain costs. Thus, on the one hand, a value chain is formed, on the other - a cost chain, the ratio between which determines the level of profitability of the product at a particular stage of its manufacture and the level of cost efficiency throughout the chain.

Value chain in its simplest form, it is a sequence of productive actions that contribute to the creation and provision of products that have value for the consumer. It shows what the organization does and in what sequence. From the standpoint of the process approach, the value chain is a set of interconnected and

organized in a certain way business processes of the organization that create value for consumers. To build a value chain model you need:

- identify target groups of consumers;

- to form a list of goods (services) of the organization, provided to target groups of consumers, taking into account their requirements and needs;

- to form the current flow of value creation of goods (services) used by target groups of consumers;

- design the future flow of value creation of the product used by target groups of consumers;

- develop and implement an action plan to improve current and future flows.

It should be noted that the value chain is the foundation on which the process approach is implemented in the practice of organizations: process management subsystems and activities to improve them are formed, organizational design is redesigned, standardization and regulation of activities, development of a system of indicators. When building a chain of values, you can approach the selection and classification of productive actions of the organization in different ways. An example of one of the approaches is a typical value chain of an industrial company, built on the basis of the proposed company "McKinsey" (McKinsey) concept of "business system" (Fig. 3.2).

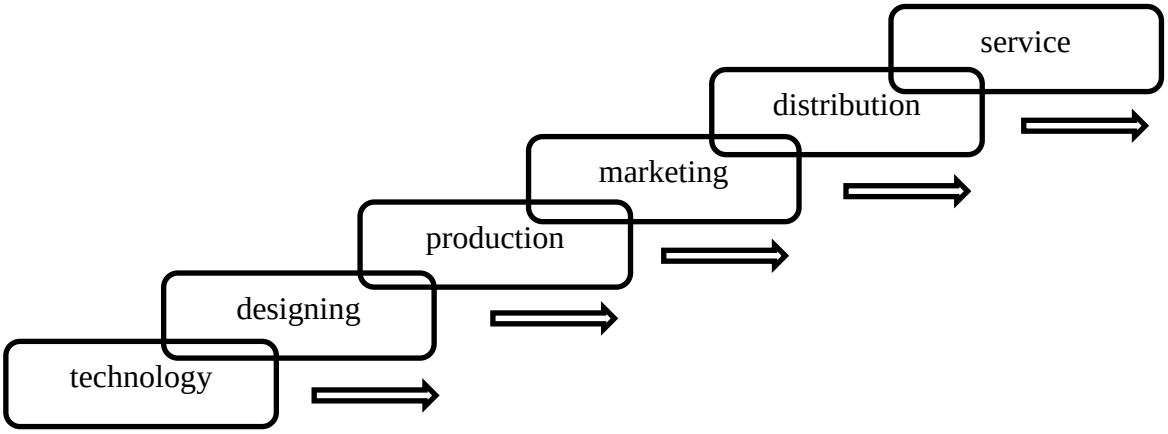


Fig. 3.2 A simple McKinsey value chain.

Source: compiled by the authors

It creates value gradually as the product is developed, produced and promoted to the consumer.

A significant contribution to the development of the value approach was made by M. Porter, who not only defined the essence of the category "consumer value", but also developed the concept of the value chain. He presented the organization as a set of different activities aimed at development, production, marketing (external and internal), delivery and service [39].

The value chain creates an idea of strategically related activities of the organization and allows you to track the entire process of value creation. Sometimes a cursory analysis of the value chain allows you to understand the strengths and weaknesses of the organization. Moreover, a creative approach to reconstructing the value chain can lead to the discovery of new ways of grouping resources and, consequently, to the creation of new types of organizational skills.

From a strategic point of view, the concept of the value chain, contrary to the concept of value added, provides for at least four areas of profit growth, namely: communication with suppliers; communication with consumers; technological connections within the value chain of a separate division of the company; the relationship between the value chains of units within the company.

Further scientific approaches to value creation are based on the following principles [102]:

1) ensuring economic benefits (conducting marketing campaigns that provide remuneration to consumers who often make purchases and / or purchase large volumes of goods);

2) optimization of the process of creating value through the development of social ties (the relationship of employees of the organization with consumers), providing individualization and personalization of relations;

3) expansion of structural ties (conclusion of long-term contracts, optimization of payment systems, transformation of the product into a long-term service);

4) creation of "value innovation" with the help of innovations that anticipate new consumer needs (development of new proposals, technologies, development of innovation infrastructure);

5) development of infocommunication integrated systems based on IT-technologies that provide reengineering of value chains and formation of network structures.

Accordingly, the organization must, on the one hand, ensure the availability of the expected product by optimizing routine processes, and on the other - to guarantee the uniqueness of the offer through innovations in product, infrastructure, related services, which must be individualized, personalized and non-reproducible competitors. To do this, in the opinion of scientists it is necessary:

- constantly improve their own value chain and explore consumer value chains to help consumers attract the necessary resources, make improvements in the process of production and delivery of goods (services) to their consumers (P. Doyle [11]);

- with the help of systematic surveys to identify consumer perceptions of product values (P. Drucker [12]), by: using special methods of psychology, marketing research, statistics with qualified staff and infocommunication technologies to obtain and process data (R. Kaplan, D. Norton [19]); analysis of the impact on consumer satisfaction of any changes in product quality, delivery time, order volumes, number of product returns (NG Olve, J. Roy, M. Wetter [36]);

- control the existing relationships not only within the value chain, but also between the value chains of the organization and other external entities (e.g., business partners or suppliers), which leads to a network structure of their interaction with the formation of a common value chain covering the value chains of suppliers, marketing channels, buyers, partners and other external stakeholders (J. Lamben) [28].

Supply chain costs (logistics costs) is a set of labor, natural, material, financial. intellectual and information resources, which are due to the performance

of the organization of its functions to meet the needs of consumers. A special role among the costs of the supply chain is occupied by logistics costs, which are very diverse and are divided by cost elements, functional areas and centers of responsibility.

In contrast to the traditional approach to cost accounting, logistics involves the introduction of post-operational cost accounting along the entire path of material flow. In logistics, the key event, the object of analysis is the consumer's order and actions to fulfill this order. Accounting for process costs gives a clear picture of how the costs associated with customer service are formed, what is the share of each of them. Summarizing all the costs horizontally, you can determine the costs associated with a particular process, order, service, product, and so on.

A striking example of supply chain costs is the 2008 video iPod value chain analysis conducted by Jason Dedrick. The well-known phrase on Apple products "Designed in California, assembled in China - developed in California, assembled in China", and it seems that its meaning is clear, but if you break down the value chain by supply chain, we will see a very interesting picture. The most expensive components, such as hard drive, memory, battery, processor, display are made in the US, Japan and South Korea, their total cost is about 140 dollars, while the rate of return of each part for the manufacturer is on average from 20 to 40 %.

All components are shipped for general assembly to China for production run by a Vietnamese company. The cost of assembling and testing products is less than $ 4, which is less than 2% of the final selling price of the iPod. The total cost of production is approximately $ 145, of which the increase in value is about $ 38, and the selling price in US stores for the iPod is $ 299. in the end, about $ 144, about half goes to distribution and retail, the other half is the margin of Apple, which created the idea of the iPod, introduced innovations into the project and developed the design [79, p. 30].

However, from the standpoint of a customer-oriented approach, the concept of consumer value should be considered. When buying a product or service, a

person makes an "assessment" of consumer values, examines their quality, compares the objective and subjective aspects of the consumer value of various goods and services. Consumer values are both the products of labor and the many things given by nature (fish in the pond, the fruits of wild plants, etc.).

However, in terms of commodity production, the product of labor acquires new specific properties that make it a commodity. A consumer can have a consumer value only if it satisfies to a greater extent the needs not of the producer but of other market participants, ie such goods must have a public consumer value. Since the business processes of the organization and, consequently, the process of creating consumer value are significantly influenced by suppliers, public institutions and other entities, according to TQM principles, special attention is paid to building interaction with all stakeholders, where the best results are achieved parties. The ISO 9000 standard identifies five groups of stakeholders: consumers, shareholders (owners), staff, suppliers and society.

The assessment of the consumer value of the organization's supply is carried out for the purpose of pricing, building a balanced system of indicators or to assess the competitiveness of supply and other purposes. Thus, pricing based on consumer value assessment involves the calculation of a competitive market supply price depending on the value of supply, which is carried out according to the formula:

$$Pn < Pa + (Vp - Va), \quad (3.1)$$

where: Pn - the price of the market offer of the organization;

Pa - the price of the best alternative offer on the market;

Vp - the value of the market supply of the organization;

Va - the value of the best alternative offer of competitors.

However, for supply chains, the customer value delivery system is a system consisting of the logistics chains of the focus company, its suppliers, distributors, who work together to create consumer value. Assessing the value chain allows top management to determine how activities increase the value of the product for consumers, identify points of possible growth, study the

interaction of individual activities, identify the relationship between activities and key competencies, assess resource efficiency, identify blockages (barriers to interaction) that reduce the competitive advantage of the organization.

3.2 Analysis of methods for economic evaluation of supply chain efficiency

In various industries, profits are concentrated in some parts of the value chain and completely absent in others. Thus, in the production of personal computers, profits are concentrated in microprocessors and software. In the chemical industry - in production, and in consumer goods, on the contrary - in distribution. In the automotive industry, profitability is higher in financial and service maintenance than in assembly or distribution.

Any company seeks to take a place in those parts of the value chain where profitability is higher or to find options to compensate for the loss of profits in value chains by acquiring additional key competencies. To do this, companies need to identify the key success factors that influence this industry or market.

Analysis of the company's resources and competencies allows us to determine the composition of the company's key competencies, ie what it does best and more successfully than its competitors. The coincidence of the key success factors of the chosen industry and the key competencies of the company leads to a competitive advantage. In this case, the role and place of the company in the value chain becomes key. If the company does not have the necessary competencies that are critical for the selected industry or market (or these competencies are underdeveloped), it is necessary to create missing or develop imperfect competencies.

Therefore, today the issue of forming an analytical base for assessing the economic efficiency of supply chains is acute for specialists. This is primarily due to the fact that in a dynamic market environment it is necessary to make management decisions based not on empirical data, but on quantitative

calculations, which allow at the stage of supply chain planning to assess all indicators of interest to its developers.

When solving the issue of measuring the value of individual segments of the company, managers often turn to the concept of value management, and the system of indicators by which the effectiveness of the company within this concept is constantly adjusted.

A promising direction in assessing the effectiveness of supply chains in terms of development of scientific and methodological base are the models of measuring the value of the company, which allow, among other things, to track the impact of transport operations on the financial activities of the company. The most popular of them are:

1. Total logistics costs (TLC - total logistics costs).
2. Profitability.
3. Strategic profit model (DuPont model).
4. Indicators of company value management (EVA, MVA, SVA).
5. Cash Value Added CVA (Cash Value Added).
6. RAVE.TM concept

Consider some of them in more detail.

In terms of ease of use and the ability to unambiguously trace causation, the most successful is the DuPont model (Du Pont model), which is a system of financial analysis that allows you to explore the company's ability to generate profits, reinvest it and increase turnover. This method is used to analyze the profitability of the company, using traditional tools to determine the effectiveness of management.

So in din the factor model of Dupont tocoefficients own profitability capital (ROE - Return on Equity) and total capital (ROA - Return on Assets) using certain methods of deterministic modeling can be related to each other using the coefficient of financial dependence (*Kzal*) [27, p. 216].

$$(\text{ROE}) = \frac{\text{net profit}(\Delta P)}{\text{equity}(E)} = \frac{\text{net profit}(\Delta P)}{\text{equity}(E)} \times \frac{\text{assets}(A)}{\text{assets}(A)} =$$

$$= \frac{\text{net profit}(\Delta P)}{\text{assets}\,(A)} \times \frac{\text{assets}\,(A)}{\text{equity}\,(\text{E})} = R_K \times K_{rat}, \quad (3.2)$$

where R_K - (ROA) return on assets (or return on assets);

Krat - financial dependency ratio (or financial leverage).

DuPont's model allows you to decompose indicators into factors (components) and give a comparative description of the main reasons that influenced the dynamics of economic growth of the company, integrating the components of the statement of financial performance and balance sheet. It shows the return on assets of ROA, a key component broken down into its constituent elements: asset transformation ratio (asset turnover) Kt and return on sales (gross profit) RQ, which in turn are broken down into other financial indicators, namely:

$$ROE = K_{dr} \times ROA\left(\frac{R_Q\left(\frac{NOPAT(EBIT - Interests - Taxes)}{V}\right)}{K_T\left(\frac{V}{A(NA + OA)}\right)}\right), \quad (3.3)$$

where NOPAT - net profit;

EBIT-operating profit (profit before taxes and loans);

Interests - interest on borrowed funds;

Taxes- tax liabilities;

V - net revenue from sales;

NA - non-current assets of the enterprise;

OA - current assets of the enterprise.

ROA shows how effectively assets are used to achieve a certain level of sales. Thus, ROA links profitability and asset value, thus providing the best consolidated performance of the company. Accordingly, the shareholder value

of the supply chain can be defined as the set of values of legal entities that are part of it.

As other systems that form the indicators of company value management, today science and practice recommend systems that are based on indicators:

EVA - added economic value;

MVA - added market value;

SVA - shareholder value added.

The most popular value management system of the company is a system based on the indicator of economic value added (EVA - Economic Value Added). It was proposed by T. Copeland, T. Koller and J. Murrin [24] and developed by the consulting firm Stern & Stewar.

The essence of EVA's value-added management concept is that the main focus of management should be on ensuring the growth of the market value of the company and its shares. That is, all the aspirations of management should be aimed at maximizing the value of the company. According to the EVA concept, a company's value is its book value increased by the current value of future EVAs.

The main idea that justifies the use of economic value added is that the company's investors should receive a rate of return for the risk they take. A positive value of EVA characterizes the efficient use of capital, a negative value of EVA characterizes the inefficient use of capital.

There are two main options for calculating the EVA:

$$1)\ EVA = NOPAT - WACC \times Capital\ \ employed, \tag{3.4}$$

where WACC - weighted average cost of capital;

Capital employed – investment capital.

or:

$$2)\ EVA = (ROI - WACC) \times Capital\ \ employed, \tag{3.5}$$

where ROI is the rate of return on invested capital.

The weighted average cost of invested capital (WACC) in the most general form is calculated as follows:

$$WACC = \Sigma ki * wi = ke * we + kd * wd + kps * wps, \quad (3.6)$$

where w - the share of each source in the invested capital;

ke - cost of equity;

kd - cost of borrowed capital;

kps - the value of retained earnings or capital raised through the issuance of preferred shares.

If the equity consists only of ordinary shares:

$$WACC = ke * we + kd * wd (1 - T), \quad (3.7)$$

where T is the income tax rate.

The advantages of applying this concept in the management of company value are due to the fact that with this indicator it is possible to easily and adequately determine the degree of achievement of a unit, company or individual project to increase its market value.

An alternative indicator of the company's value is the Market Value Added (MVA) indicator. It is calculated as the difference between the market value of the company and the total capital invested in it:

$$MVA = MV - IC, \quad (3.8)$$

where MV (Market value) - market value;

IC (Invested capital) - invested capital (the sum of equity and debt capital).

The sum of the market values of debt and equity is actually the market value of the company. Thus, the value of MVA shows how much a company is worth more than its total capital. The high MVA indicates that the company has created significant value for shareholders. A negative MVA indicator means that the value of management actions and investment decisions is lower than the value of capital invested in the company by capital markets.

Indicator of added money SVA (Cash Value Added) shows how real cash flows generated by strategic investments are more or less cash flows that meet investors' requirements for the return on these investments. In the most general form, it is calculated by the following formula:

$$SVA = SCSC - BCSC, \quad (3.9)$$

where SCSC (Settlement cost of the share capital) - the estimated cost of share capital;

BCSC (Balance cost of the share capital) - the book value of share capital.

Growth rate SVA indicates an increase in the value of shareholder ownership, a decrease, on the contrary, a decrease and the probable loss of owners of the company

However, the CVA value added indicator also shows the residual cash flows generated by the investment in the organization. Hence, this indicator is often defined as Residual Cash Flow (RCF). Therefore, the concept of residual income is the basis for the exact calculation of this indicator. The formula for its calculation is as follows:

$$RCF = AOCF - WACC * TA, \quad (3.10)$$

where AOCF (Adjusted Operating Cash Flows) - adjusted operating cash flow;

WACC (Weighted Average Cost of Capital) - weighted average cost of capital;

TA - total adjusted assets.

According to this approach, the positive value of CVA indicates the presence of economic profit, and hence the increase in the value of the company. A negative CVA, on the other hand, suggests that the cash flow created or planned is not sufficient to cover the amount of cash flow required to recoup strategic investments.

The most modern of the available models of valuation of the company is the concept of RAVETM (literally: amplifier of the value of tangible assets)

proposed by the consultants of Boston Consulting Group - R. Strack and W. Willis [109].

The concept of RAVETM is based mainly on the premise that in modern companies is no longer financial or material capital, but intellectual, including knowledge that is owned and used by the company in the field of marketing, supply and human resources development. The concept of RAVETM, based on the principles of a balanced scorecard, provides a quantitative assessment that simplifies the analysis, and also allows you to determine which factor contributes more to the value of the company. This approach can be applied to the company as a whole and to any of its divisions.

In the concept of RAVETM, the authors identified 4 key areas: human capital, investment capital, suppliers and customers (CustomicsTM approach), each of which brings some value to the company. In addition to influencing the cost structure, the importance of staff, suppliers and consumers is determined by their contribution to the company's success. Therefore, the quality of these factors of each company seriously affects its value and is taken into account in the concept of RAVETM together with the costs in the following approaches: WorkonomicsTM - human capital; SupplynomicsTM - suppliers; CustomicsTM - customers. Consider each of these pain approaches in detail.

Workonomics. Similar to how the EVA value-added management approach allows you to measure the effectiveness of invested financial capital, Workonomics provides an opportunity to assess the effectiveness of a company's human capital using a system of quantitative indicators that are staff-oriented and similar to financial.

Similar to the calculation of EVA or CVA, we obtain:

$$EVAW = (VAP - ACP) * P, \tag{3.10}$$

where VAP (value added per person) - the ratio of total value added of employees to the number of employees. In essence, this indicator can be interpreted as employee productivity;

ACP (average costs) - the cost of staff development and wages per person;

P (number of employees) - the total number of employees in the enterprise.

Supplynomics. In this approach, efficiency will be measured by value added per supplier, which is compared to the average cost to contractors.

Thus, the added value of the company within the concept of Supplynomics is estimated as follows:

$$EVAS = (VAS - ACS) * S, \quad (3.12)$$

where VAS - value added to the supplier;

ACC - average costs for suppliers;

S - the number of suppliers.

In this concept, suppliers can also be replaced by products or product groups (materials).

Value in this case can be created by increase in added value on the consumer or the delivered material; by reducing the average cost per supplier or product group, such as logistics costs or warehousing costs, as well as purchase prices directly or by increasing the number of suppliers (given that VAS> ACS).

Custonomics. In this approach, the capital provided by consumers comes to the fore, and EVA is expressed only in terms of characteristics related to customers, and does not use the data of financial capital or human resources of the company:

$$EVAC = (VAC - ACC) * C, \quad (3.13)$$

where VAC - value added to the buyer;

ACC - trade and marketing costs per buyer;

C - the number of buyers.

The value of the company in this case can be created by increasing the added value per buyer, reducing sales and marketing costs, or increasing the number of customers through the introduction of special programs to attract and retain consumers.

Thus, the overall value of the RAVETM concept goes beyond the control of the company's activities, because it covers the solution of a number of strategic tasks.

It should be noted that today the limitations for its application are unresolved issues regarding:

- calculation of economic value added on the basis of all its components (workonomics, custonomics, supplynomics);

- methods of estimating all components of the average return on the use of components of intangible assets: human resources, customers and suppliers.

3.3 Methods of reducing uncertainty in supply chains

Among the methods of reducing the uncertainty of the most common in practice were the following three methods:

1. Reduction of the Bullwhir effect.

2. Introduction of postponement of product differentiation (postponement) and optimal determination of order penetration point.

3. Evaluation of the quality of logistics service based on the indicator of "perfect order" (Perfect Order Fulfillment - POF).

Vullwhir effect (effect spur, or whip effect) characterizes a situation in which minor changes in the demand of the final consumer (or the last link in the supply chain, ie the enterprise producing the final product) lead to significant deviations in the plans of other participants in the supply chain (subcontractors, suppliers).

The full-effect effect causes an increase in the amplitude of fluctuations in demand as information progresses along the supply chain, thereby disrupting the

smooth flow of material and information flows in the supply chain, thereby causing the risk of non-fulfillment of the customer's order (Fig. 3.3).

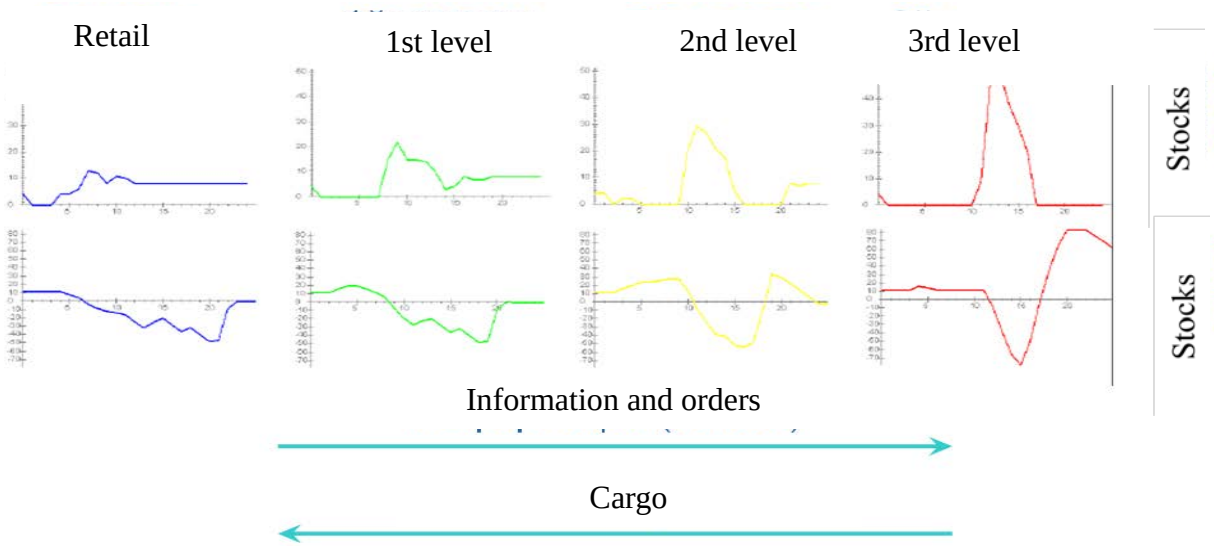


Fig. 3.3 Graphic representation of the Bullwhir effect.

Source: compiled by the authors

How it happens? Let's take the simplest example in which the balanced plan will look as follows (fig. 3.4):

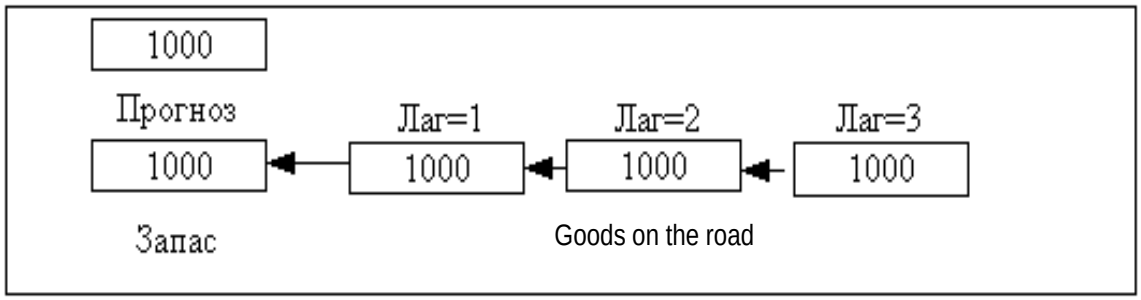


Fig. 3.4 Supply chain diagram.

- 1 store, current stock 1000 units. Sales forecast 1000 units for the period.
- 1 supplier, current stock 1000 units.
- the total response time of the supplier - 3 periods.

Suppose that at this point for some reason the demand changes and becomes 500 units. Then the store will not order goods at all for 4 periods. Let's compare the orders that come to these two levels:

Even such a completely simplified example shows that the magnitude of fluctuations in demand is increasing. And even the reason becomes clear - the presence of non-zero reaction time to changes, and the longer this time, the greater the effect. Thus, the Bullwhir effect is proportional to the magnitude of the change in the forecast accumulated during the reaction of the system (Fig. 3.5).

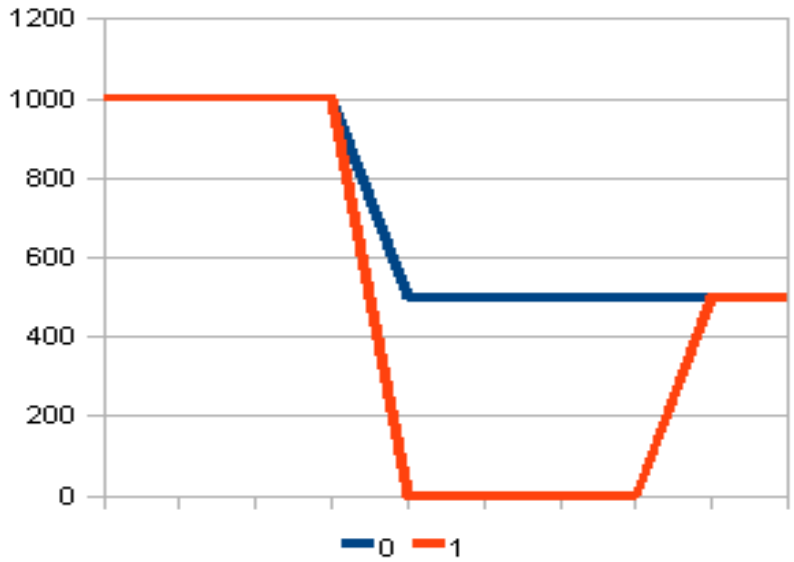


Fig. 3.5 Graph of fluctuations in demand.

Source: compiled by the authors

The main causes of the Bullwhir effect are:

- inaccuracies in demand forecasting;
- additional insurance reserves;
- arbitrary increase in the size of supply lots;
- price fluctuations and delays in obtaining the necessary information about new prices and new consumer needs;

- deviations from the planned terms and volumes of production and deliveries;

- lack of transparency of the whole chain, a situation in which any of the participants focuses only on current orders and can not assess the reality of other levels and choose the optimal course of action:

- Insufficient level of information exchange between participants in the supply chain.

Regarding the stage of operational management, the Vullwhir effect characterizes the delay in informing the participants of the supply chain about changes in its previous sections due to information asymmetry. Special attention should be paid to the human factor of the Bullwhir effect, associated with errors in the transmission and interpretation of information. Many modern studies consider the human factor as the main cause of the Bullwhir effect.

Reduction of the Bullwhir effect is possible by:

- joint forecasting and process-oriented planning;

- coordination and synchronization of business processes;

- reducing the size of purchased and manufactured batches;

- increasing the frequency and regularity of procurement;

- improvement of information communication between enterprises-participants of the supply chain;

- increasing the transparency and accessibility of demand forecasts (including operational ones) for all participants in the supply chain;

- building a new inventory management policy based on a strategic partnership.

Deferred product differentiation (postponement) and order penetration point (ORP).

The main problem that occurs in most supply chains is the limited vision of actual demand. Because supply chains are often long and have many levels of

inventory between the place of production and the final market, most of their work is based on forecasts rather than actual demand.

The point at which actual demand appears at the top of the supply chain is called the decoupling point or the order penetration point.

Order penetration point determines the point at which processes in the supply chain are built on the basis of efficiency and production in the warehouse (Rush principle), and from which processes in the supply chain are lined up on the basis of flexibility and customer satisfaction - (Pull principle). The location of the order penetration point is associated with finding a compromise in the level of service and costs (Fig. 3.6).

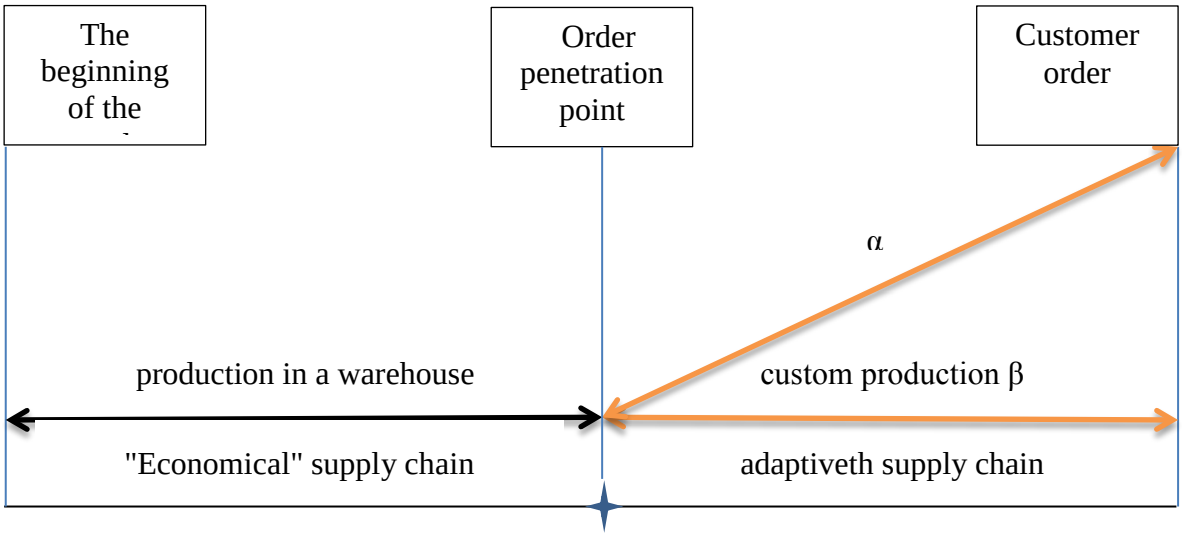


Fig. 3.6 Order penetration point.

Source: compiled by the authors

Ideally, it is necessary to strive for the closest possible location of the penetration point of the order to the customer with the required level of service. The larger the area of the "lean" supply chain, the lower the cost and level of service. Increasing the area of the adaptive supply chain leads to an increase in the level of service, but also the level of costs.

Analysis of the factors influencing the choice of supply chain strategy shows that the "lean" option is quite justified in some conditions, in particular, when demand is expected, diversity requirements are limited, production is high. Instead, a dynamic option is needed in a less predictable environment, when demand changes dramatically and product diversity requirements are high. Dynamics means a rapid response on a global scale to the demands of ever-changing markets.

Dynamics is inherent in any business. It includes organizational structures, information systems, logistics processes and the level of professional competencies of staff. The key characteristic of a dynamic organization is flexibility.

The third common approach is to assess the quality of logistics service based on the indicator of "perfect order" (Perfect Order Fulfillment - POF). POF in the general sense means the error-free execution of all operations of the full order cycle in strict accordance with the terms of the contract.

The number of transactions is related to the characteristics of the orders and can vary from 3 to 11 transactions (or factors) that are taken into account when determining the level of POF. In practice, the three-component POF model is most often used, which is determined by such factors as timeliness of delivery, completeness of the order and the accuracy of its execution [26].

Timeliness means delivery on time, within the exact time agreed with the customer (delivery on time). Completeness means delivery of a fully completed order in full (delivery in full). Error-free means the delivery of the ordered goods without damage (correct condition and correct place) in compliance with the conditions of transportation and the absence of errors in the documents.

However, the most effective factor in overcoming uncertainty and the simplest, at first glance, but the most difficult in practice is trust - personalized trust between producer and consumer, seller and buyer, trust in abstract systems: institutions of quality and stability of socio-economic conditions in the country. .

It is an important norm of informal relations, on which all economic relations are based. In societies where it is absent, everything is much more expensive.

The process of building trust is long and due to the historical experience of many previous generations. It depends on the establishment and effective functioning of such formal institutions in society as the state, property, democracy, the realization of human rights, the rule of law and the actions of the informal (culture, religion, respect, traditions, customs, morals, etc.).

Pokaznik trust ratio by nroeyктive kategopher it is proposed to consider from two points of view. On the one hand, it allows us to assess the extent to which the partnership really exists. On the other hand, there is a potential risk for each partner in the supply chain. The numerator of the indicator determines the percentage of sales of the seller for a particular product category, which he sells to a particular customer or consumer and which, respectively, the customer or consumer buys from this seller, and the denominator - the percentage of purchases of this product category to the extent that he (customer or consumer) needs in general.

From a supply chain partnership perspective, the value of the indicator at the unit level indicates an ideal balance of power and trust between supply chain partners. In terms of risk, if the ratio is close to its critical limit - 100 (100/1) or 0.01 (1/100), the imbalance of power and the level of risk increases significantly.

The confidence factor determines the possibility of "shifting the demand curve either right up or left down, depending on whether confidence increases or decreases". [46, p. 6]. When trust grows, the economy forms the basis for the formation and development of social capital, the formation of national ideology aimed at cultivating in the individual the desire to perform their duties in good faith and professional growth.

Consumer confidence is formed by setting a fair price for the product, compliance with quality standards of the product and providing truthful information about it. Therefore, there is an urgent need to encourage manufacturers to provide the most complete information about the product through the labeling system. After all, without complete and truthful information about the quality of products, it is impossible to activate technical, organizational, technological, economic and other levers aimed at improving product quality.

An indicator of the ratio of the number of open databases to the total number of databases can be used to assess the desire of supply chain partners to create a common strategy for managementdifferent processes.

Openness in the exchange of information is an important prerequisite for the success of partners in supply chains, because without it it is difficult to avoid duplication, reduce costs or improve flexibility. Information blocks on forecasting demand, sales data, production schedules, target consumers, etc. should be disseminated, supporting inter-organizational integration and teamwork [50, p. 33].

3.4 Indicators for assessing the effectiveness of the supply chain

Evaluating the effectiveness of the supply chain is to identify and analyze the factors that determine the ability of the chain to better, faster and cheaper than its competitors to meet customer requirements. All indicators of supply chain management efficiency can be divided into four main groups.

The first group is supply chain efficiency targets. According to the indicators of this group, the efficiency of the target functions of the supply chain is analyzed in terms of obtaining the result of activities and resources spent to achieve them (Table 3.1).

Income, generated in the process of moving goods along the supply chain is defined as the speed at which an organization generates money (mostly by

selling goods or services). This indicator shows the amount of new money that enters the supply chain (and remains in it) and accordingly characterizes the value added generated by the functioning of the supply chain.

Table 3.1

Supply chain performance targets

Characteristic	Method of calculation
Income generated in the chain deliveries, UAH	T = Sales profit - Variable costs
Resources required for the functioning of the supply chain, UAH	A = Fixed assets + Revolving funds
Operating costs, including procurement costs for maintenance of stocks, UAH	OE = Inventory maintenance costs + Procurement costs
Supply chain efficiency, UAH	$E_{SC} = \frac{\Delta V}{\Delta C},$ where ELP - supply chain efficiency; ΔV - value added in the process for the final consumer (selling price); ΔC - value added by the process for the final consumer (cost of resources expended).
The period of turnover of stocks in the chain supplies, days	$Д_{tr}^{T} = \frac{T_{cond}}{K_{tr}^{t}},$ where $Д_{tr}^{t}$ - number of days for which stocks in the chain are completely renewed, days; Tcond - conditional (financial) year, consisting of 360 days; $K_{tr}^{З}$ - inventory turnover ratio

Source: compiled by the authors

Resources required for the functioning of the supply chain include all material, financial and information resources necessary for the functioning of the chain. This indicator shows the quantity and quality of resources in the supply chain.

Costs are defined as financial investments made by the organization to maintain the supply chain. These funds are linked in the middle of the system, are used to generate income and cannot be easily converted into cash. This indicator should be divided into two groups:

Group 1: investment in stocks of materials, components and finished products in the supply chain.

Group 2: investment in fixed assets required for the functioning of the supply chain.

Operating costs - this is the cost associated with management activities and aimed at organizing the sale of products moving along the supply chain.

Supply chain efficiency characterizes the process of transforming the object of labor and adding value to it, and values from the standpoint of the consumer - both external and internal (the more the process adds value to products and less resources, the higher the efficiency of such a process).

The period of inventory turnover affects the speed of the supply chain and characterizes its overall efficiency.

These indicators are sufficient to assess the effectiveness of the supply chain, as they are a means to link local operational decisions with the overall financial condition of the company, and also show the level of functioning of the supply chain at certain points in time - better, faster and cheaper.

Another group - *supply chain functionality indicators,* characterizes the activities of the supply chain in view of the functional features of processes and flows. The aspect of functionality in this group of indicators is represented by marginal profit, supply chain flexibility indicator, order fulfillment cycle, financial cycle and supply chain cycle efficiency indicator (Table 3.2).

In a market economy, the main end result of the supply chain is usually the rate of return on sales.

Table 3.2

Indicators of supply chain functionality

Characteristic	Method of calculation
Marginal profit	$P_{м} = V - (Z_{v.c.} + Z_{f.c.})$, where V is the revenue; Zv.c. - variable costs; Zf.c. - fixed costs.
Supply chain flexibility	$G = \frac{n}{m}$, where: n is the number of changes made; m is the total number of required changes.
Order fulfillment cycle in the supply chain	$T_{fc} = T_{op} + T_{pm} + T_{pc} + T_{n}$, where: Top - order processing time; Tpm - time of purchase of materials; Tpc - duration of the production cycle; Tdt - delivery time.
Financial cycle of the supply chain	Фс = Period of stock storage + Period of turnover of receivables - Period of turnover of accounts payable.
Supply chain cycle efficiency indicator	$E_{cycle} = \frac{T_{e.v}}{T_{t.r.t.}}$, where: E_{cycle} - efficiency of the supply chain cycle; T.e.v. - the total time of adding value to the product; Tt.r.t. - the total residence time of the product in the supply chain.

Source: compiled by the authors

The mechanism of financial flows management is built taking into account the density of the relationship of this indicator with other key financial indicators (revenue and expenses). The system of this relationship, called the model of "costs-sales-profit", allows to highlight the role of individual factors in the formation of financial flows and ensure the effectiveness of management of the process of their formation in the supply chain.

Supply chain flexibility is determined by the ability of the system to maintain the stability of the initial parameters (material, information and financial flows) due to the objective function, despite the unpredictable destabilizing actions of the external environment. The concept of flexibility covers all components of the system.

Order fulfillment cycle determines the maximum period of time from the placement of the application for the manufacture of products to the fact of its receipt by the consumer. This indicator depends on whether the products were made to order or were supplied from pre-prepared stocks of finished products, ie the strategy by which the supply chain operates. The order fulfillment cycle proportionally affects the financial cycle and the level of consumer satisfaction with the products or services provided to them.

Financial cycle shows the period of time between investment in resources and financial income from the sale of products made from purchased resources. It is this measure of supply chain efficiency that affects all components of working capital. Reducing the cycle means increasing the efficiency of the supply chain.

Supply chain cycle efficiency indicator shows the efficiency of business processes in the supply chain in terms of value added growth. ANDthe actual value of the indicator is a unit, which indicates that there is no time in the supply chain for operations that do not add value, for example, the time to wait for loading (unloading).

The third group - operational indicators of supply chain efficiency - a group of indicators that characterize the qualitative and quantitative achievement of goals at the operational level.

Here the focus is on three groups of factors: the terms of delivery, which characterize the compliance of the results of supply actions with the expectations of buyers in terms of two main criteria: quantity and delivery time of the order (the result is a positive or negative assessment); accuracy of order execution - delivery time, calculated from the moment of acceptance of the order from the client to the moment when the cargo arrives at the place of acceptance determined by the client; and the volume of supplies that meet the requirements of chain participants (Table 3.3).

Table 3.3

Operational indicators of supply chain efficiency

Characteristic	Method of calculation
Level of demand supply,%	$R_{dem} = \frac{K_s}{K_{un.r}}$, where Ks - the number of sold stock positions for the period, pcs .; Kun.r. - the number of unsatisfied requests for stock positions for the period, pcs.
Supply chain capacity, units	The maximum amount of goods that can be delivered to end consumers at a given time
Order execution accuracy,%	$S = C \times Q \times N \times 100$, where C is the number of deliveries in time / total number of deliveries; Q - quantity of materials of appropriate quality / total quantity of supplied materials;

	N - the number of deliveries corresponding to the number / total number of deliveries.
Punctuality of execution of orders,%	$П = \frac{I_{c.o.}}{T}$, where Ic.o. - the number of completed orders; T - the planned time for their implementation.
Optimal order quantity	$Q = \frac{\sqrt{2 \times B_o \times P}}{B_g}$, where Bo - the cost of the i-th order; P - annual demand; Bg - the cost of storage units. goods.
Sales volume, UAH	The total amount of materials sold during the period, UAH
Volume of stocks, UAH	The total amount of residual materials in the chain for the period, UAH

Source: compiled by the authors

Each key operational indicator has a criterion of functioning of a lower level, which are indicators of the performance of individual employees.

The main criteria for functioning in the supply chain:

1. The total number of days of stock within the supply chain, days.
2. The level of defects in the supplied materials,%.
3. Order cycle time, days.
4. Turnover of stocks of members of the supply chain.
5. Capacity utilization (loading),%.
6. Percentage of orders executed "exactly on time",%.
7. The share of transport costs in the sale price of goods,%.
8. Percentage of damage and damage to cargo,%.
9. Supply chain income, UAH

10. The cost of production at the end of the supply chain, UAH / unit. [2]

The fourth group - innovative indicators of supply chain efficiency - a set of projections of the system of indicators of innovation in the supply chain, where for each purpose a certain set of indicators is proposed:

Projection of goal 1. "Improving the efficiency of innovation management" as a set of indicators: the number of patents and other intangible assets put on the balance sheet as a result of research and development (R & D), the number of new technologies implemented as a result of R & D, percentage from sales of new products in total sales, reduction of delivery time as a result of the introduction of innovations in the supply chain.

Projection of goal 2. "Improving the efficiency of innovation management" as a set of indicators: profitability of sales of goods produced or promoted in the supply chain using the results of R & D, return on capital invested in innovation, energy efficiency, productivity.

Projection of goal 3. "Improving the quality of innovation management" as a set of indicators: the number of innovative proposals and projects received from the company's employees and the expected payback potential; the number of projects that move from one stage of the process of development and marketing of innovative products and services to the next; the duration of the cycle of the innovation process or its individual stages.

Projection of goal 4. "Increasing technological leadership" as a set of indicators: the number of patents received, the number of patented products (services), the quality of the innovation portfolio (balance between breakthrough and improvement projects).

Projection of goal 5. "Ensuring the necessary rational financing of innovation" as a set of indicators: the amount of R&D funding with own funds, the weighted average cost of capital invested in innovation projects, net present value of innovation projects, payback period of investment in innovation projects.

Therefore, the evaluation of the effectiveness of the supply chain is carried out using a system of evaluation indicators, which is the deployment of indicators from the level of targets to operational indicators with criteria for the functioning of each employee. In addition, the presented system is not overloaded with a large number of parameters, which is achieved by highlighting only those indicators that can be influenced, and which really characterize the efficiency of the supply chain.

CHAPTER 4. ANALYSIS OF INDICATORS OF EFFICIENCY OF TRANSPORT PROCESSES OF SUPPLY CHAINS UNDER UNCERTAINTY

4.1 Balanced system of supply chain performance indicators

Traditional approaches to building a system of indicators for assessing business performance are usually based on financial and accounting principles. Of course, financial indicators make it possible to understand how certain changes in the operating activities of the enterprise affect its financial position. But financial indicators alone are not enough to assess the functioning of supply chains. For example, they cannot be used to measure customer service, customer loyalty, or product quality. In addition, financial indicators do not provide an opportunity to predict the situation in the future, as they are mostly focused on the past and contain little control information needed for decision-making. Therefore, successful supply chains must use integrated evaluation systems as a means to achieve their organizational goals. Accordingly, an economic assessment of the effectiveness of the supply chain requires an integrated method to determine how well the implementation of the chosen strategy is managed and how it can be improved.

Under such conditions, the assessment of the contribution of transportation indicators as the most capital-intensive process of the logistics system in the end result of business activity acquires a special role. Therefore, the company needs to have a clear idea of the system, number and composition of indicators for evaluating transport activities to highlight the relationship between them and the business strategy of the organization.

In work [49] emphasizes that performance indicators used in logistics systems, give the manager general guidance, help to communicate, influence the behavior of the organization's staff, promote improvement, help assess

positioning and operational capabilities. It is advantageous for enterprises to implement performance evaluation and measurement systems for the following reasons:

- providing a common management base;
- facilitation of communication on a company scale (including bottom-up communication);
- HR;
- implementation of improvements and implementation of innovations;
- assessment of their position in relation to competitors, statement of their own advantages or disadvantages.

A well-thought-out system for evaluating performance indicators becomes the foundation for making informed decisions. Properly designed performance indicators have a number of characteristics, namely: directly related to goals and strategies; understandable and attract due attention; reasonable; vary depending on the location of the enterprise or consumer segment, change over time, provide feedback.

One of the first ways to systematically evaluate the supply chain is a pyramid of performance indicators, which was first proposed by A. Judson (1991), then improved by K. Cross and R. Lynch (1995) [49].

In Figure 4.1, the top of the pyramid contains the most general concept - the company's vision, below are the operations of the transport system, grouped into three levels: the level of strategic planning, the level of business units and the operational level.

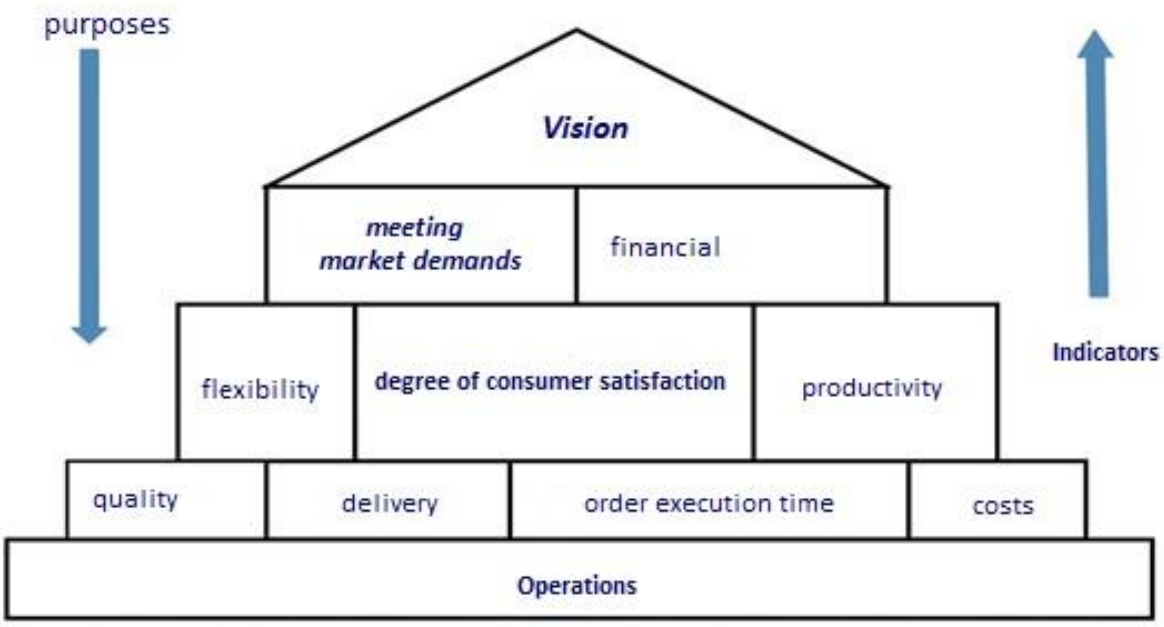


Fig. 4.1 Pyramid of performance indicators.

Source: compiled by the authors

This structure implies the transfer of goals from top to bottom, and indicators - from bottom to top.

However, the most popular and used method is the Balanced Scorecard (BSC), developed in 1996 by Robert S. Kaplan and David P. Norton [19]. The authors of the balanced scorecard used the principles of universal management principles of A. Fayol [82], but they went further, for the first time using the "translation" of organizational strategies into operational, current work, ie agreed strategic and operational levels of management, formulated principles of strategic management : strategic compliance of the organization with each operational level; strategy as a continuous process in the daily activities of each employee; strategic changes as a result of active leadership [94].

This technique is aimed at developing a set of key indicators on the basis of which the evaluation of companies, regardless of industry specifics. This system connects indicators in monetary terms and operational measures of various

aspects of the enterprise, such as customer satisfaction, internal processes, innovation, financial results.

Thus, the SSP provides answers to the most important questions about the organization of clients (client aspect); individual process support of the enterprise and development of innovations (aspect of internal processes); improvement of development and training (aspect of training and development); evaluation of the organization by shareholders (financial aspect) [54].

The key feature of the proposed methodology is the division of all economic activities of the company into 4 main perspectives, namely finance, customers, business processes, personnel (Fig. 4.2).

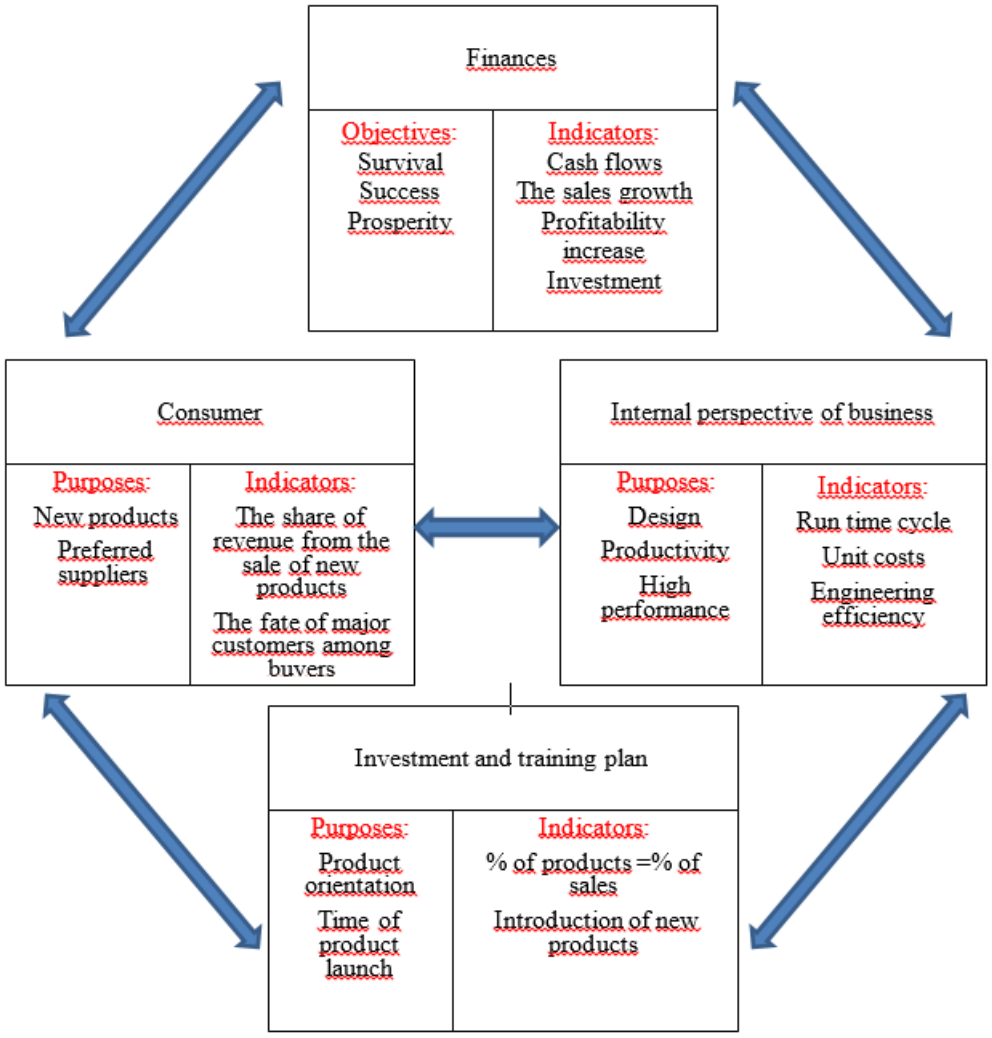


Fig. 4.2 Main prospects of SSP

Source: compiled by the authors

For each of these blocks, the organization formulates key objectives, identifies performance drivers and indicators that evaluate them.

However, given the significant impact of uncertainty in decision-making in changing market conditions, in our view, a fifth - the environment / society - needs to be added to the four identified perspectives. Then the balanced scorecard will look like this (Table 4.1).

Table 4.1

Components of a balanced scorecard

Perspectives	Key goals
Finances	• use of assets; • working capital optimization
Customers and marketing	• increase consumer satisfaction; the choice of customers who generate the main profit.
Business processes	• timely and full deliveries; • technology optimization; • effective relationships with key stakeholders.
Personnel	• transfer of authority to employees; improving their skills and ability to adapt, • recognition of personnel merits
Surrounding environment/society	• local business support; • establishing ties with the future employees; • community leadership.

Source: compiled by the authors

For each of these blocks, the organization formulates key objectives, identifies performance drivers and indicators that evaluate them. These areas are sub-goals of the goal tree, for which the main thing is "market efficiency". With the continuation of the construction of this tree, a branched scheme is obtained, the lower level of which contains indicators by which the implementation of each aspect is carried out [34].

The composition of the evaluation aspects is different in each organization. It is determined by the specifics of the organization, so when designing the SSP, pay attention to the choice of aspects that are most characteristic of it. Finances are assessed from the standpoint of satisfying the interests of shareholders. Within the financial perspective, the ultimate goal is usually to increase turnover, profitability, net profit, cash flow, and so on.

The framework of the marketing perspective determines the key market segments where the company intends to actively promote and sell its products. Efficiency drivers in this case are customer satisfaction, preservation and expansion of the customer base, profitability in each market segment. In the perspective of internal processes, innovative projects are considered first of all.

The reasonableness of managers' management of the system of internal processes at the enterprise, the optimality of the organization of these processes is determined. In the choice of key processes it is necessary to take into account not only the current efficiency of the enterprise, but also the possibility to improve it. Perspective staff implies the degree of concern of the enterprise for its own development with the help of such a valuable resource as staff. To ensure a long-term presence in the market, it is necessary to make a constant investment in training of employees, in the development of modern technologies [35].

The perspective of the environment / society is primarily related to the socially oriented component of the enterprise, its relations with society (local communities and public organizations) and the level of impact on the environment in which it operates.

The projections of the classical scheme are universal, ie they can be applied to most organizations. However, to take into account the specifics of an industry in which the company operates, we should not dwell on the proposed classic scheme of five perspectives, it is necessary to supplement its perspectives that are important for the company's management, such as environment or public relations.

In practice, there are four or eight projections, then the selection, formation and justification of the number of key performance indicators by areas of activity (prospects) and their correlation with the structure of strategic goals of the company.

Below are examples of building a strategic and computational map of the enterprise (Fig. 4.3 and 4.4).

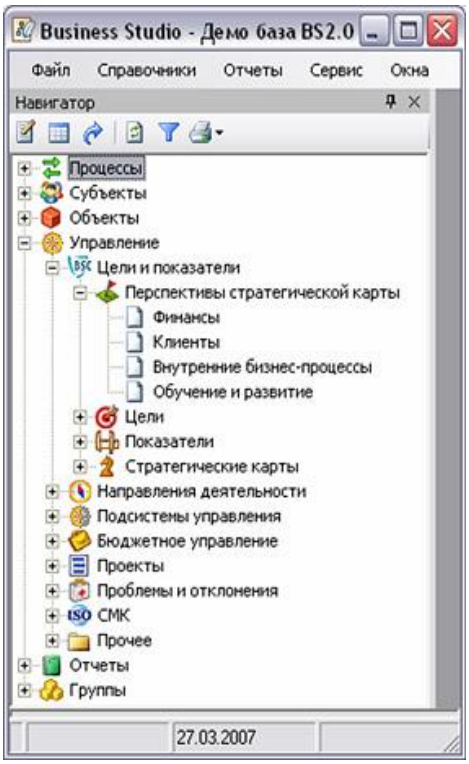


Fig. 4.3. An example of building a strategic map of the enterprise.

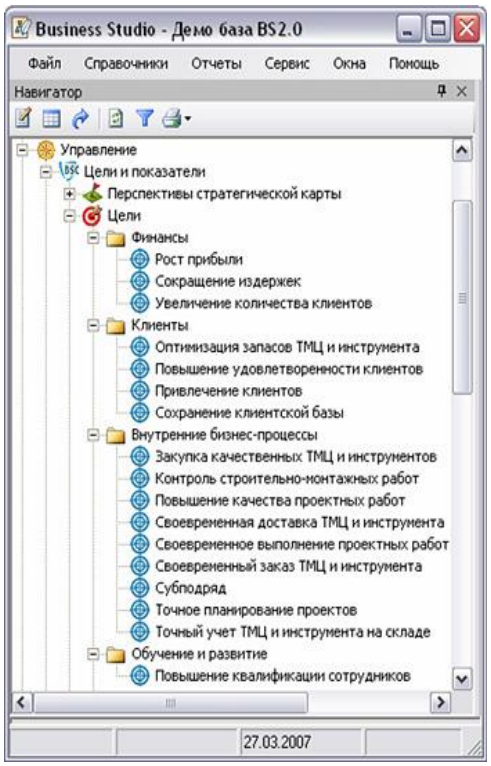


Fig. 4.4. An example of building a counting map of the enterprise.

Strategic maps, which are a description of strategy by establishing cause-and-effect relationships at each level of government, can link the vision, strategy, prospects, indicators and initiatives of each process into a single whole; allow to allocate in the course of the purpose of the financial prospect, a client component and the personnel.

For each goal aspect, you can develop key performance indicators that will measure its achievement, you can develop ways to calculate indicators, which will ultimately allow you to cascade SSP to lower levels of management, up to the personal plans of each employee. However, even at the stage of concept development it is necessary to limit the number of basic indicators of the management level map (for example, their number should correspond to 15-20 for one management level) in order to ensure balance and consistency of indicators (Fig. 4.5).

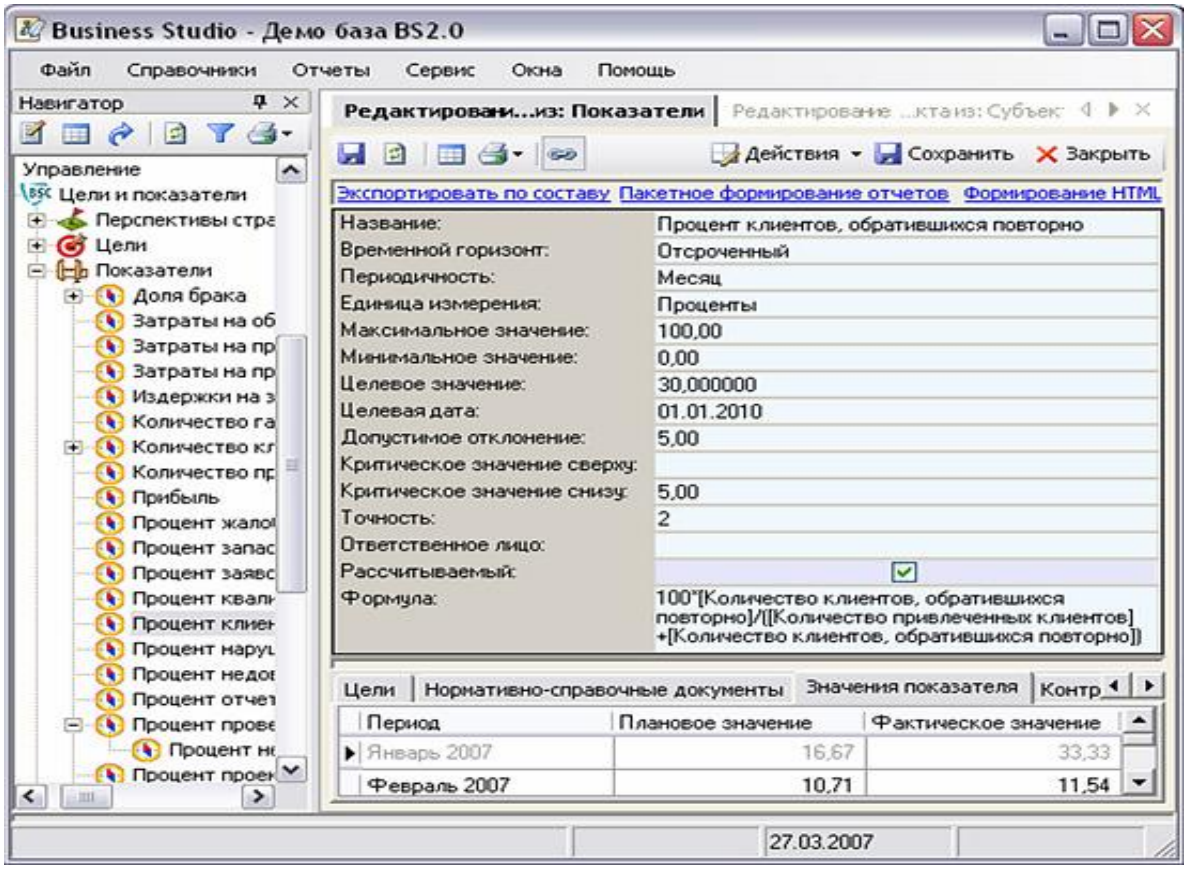


Fig. 4.5. *Indicators card* BSC.

Finally, the goals and indicators of all components are linked to each other and financial goals. Such a system is the meaning of the organization's strategy from the moment of defining long-term financial goals through a sequence of actions in the direction of each perspective (financial, client, processes, staff

training and development, interaction with the external environment) to obtain the expected economic result [95]. Thus, the BSC contains not autonomous, but interconnected, ordinary elements and indicators that are used for different management purposes depending on the management functionality.

4.2 Estimates of efficiency of transport processes in supply chains by the method of BSC

The concept of application of SSP was further developed in the work of D. Parmenter "Key performance indicators. Development, implementation and application of critical indicators", where Key Performance Indicators (CRIs) were included in the FTA.

CRI - quantitative or qualitative indicators that measure the degree of achievement of the goal facing the company, structural unit, group of positions or position. With the introduction of KRI there is an opportunity to create individual guidelines for employees. KRI includes - key performance indicators (KPI), production indicators (PV) and key performance indicators (KPI).

Key performance indicators (CRC) include:

- consumer satisfaction;
- net income before taxes;
- customer profitability;
- employee satisfaction;
- return on working capital.

A common feature of these parameters is that they reflect the results of many activities and give a clear vision of the correct direction of movement of companies in the supply chain. However, they say nothing about how to improve these results. Thus, this type of indicators is very convenient for board members (i.e. for people who do not participate in the day-to-day management of companies in the supply chain). Production indicators (PV) can usually be as follows:

• profitability of 10% of key customers;

• net profit of the main product lines;

• percentage increase in sales of 10% of key customers;

• number of employees involved in rationalization.

Key Performance Indicators (KPIs) are a set of indicators that reflect those aspects of organizational performance that are most important for today's and tomorrow's supply chain success. They are leading indicators that link the implementation of the plan with the main results of supply chain management and, as a result, identify the necessary corrective action.

KPIs should be measured once a week, daily, and in some cases every hour. Thus, they are current or future indicators (for example, the number of key customer meetings scheduled for the next month or the list of key customers with the date of the next meeting), which show what needs to be done today to improve the efficiency of the supply chain.

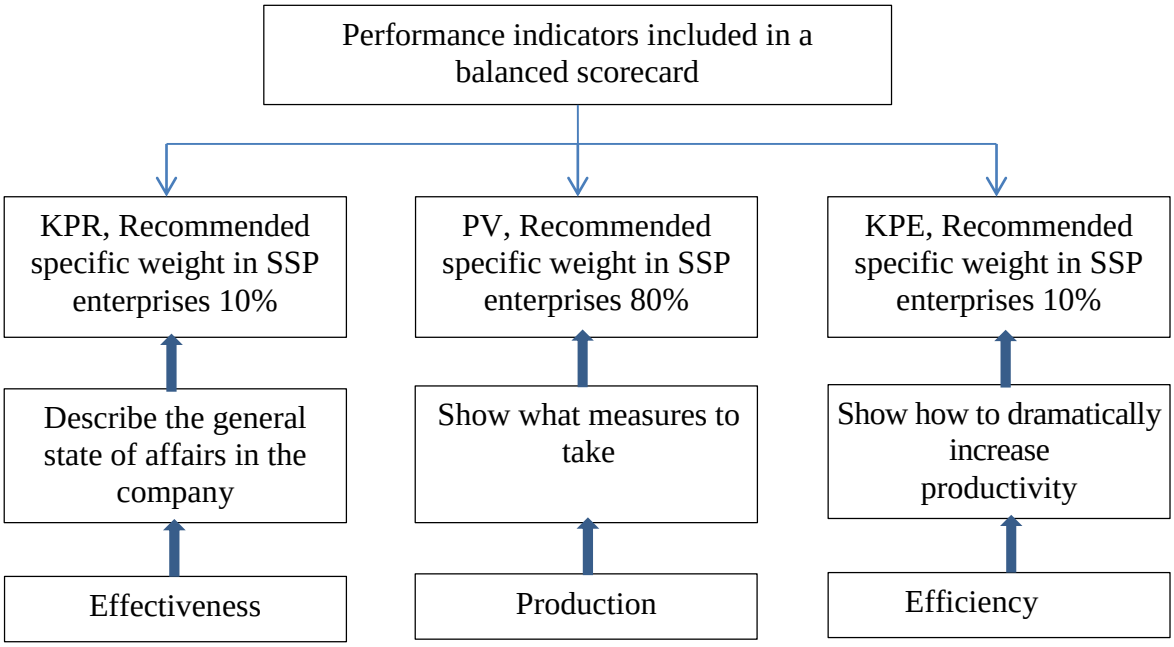


Fig. 4.6 Classification and ratio of key performance indicators

Source: compiled by the authors

The number of KRI and their ratio in the overall structure of the SSP is determined directly by the company's management. However, a good recommendation is the "10/80/10" rule, which means that the organization's performance evaluation should include about 10 key performance indicators, up to 80 production indicators and 10 key performance indicators. In very rare cases, a larger number of evaluated parameters is required - usually there are even fewer (Fig. 4.6).

Accordingly, a logical continuation is the widespread use of the concept of key performance indicators outside the FTA.

Within the KPI management it is proposed to abandon the use of only financial indicators to assess the effectiveness of the company and focus on non-financial indicators that assess customer satisfaction, efficiency of internal administrative and technological processes, the potential of service personnel - these indicators, in turn, provide financial success of the company. This takes into account those indicators, the relationship between which is difficult to describe by formalized methods.

Non-financial indicators are inherently advanced, as they allow timely decisions to prevent certain situations and adequately assess the processes taking place in the company, as well as provide long-term management influence.

However, financial performance is recognized as an effective measure of success. Financial efficiency is measured by short-term indicators, which, for the most part, leads to short-term managerial influences.

One of the variants of the system of indicators that allow to assess in general the efficiency and effectiveness of the supply chain are: general logistics costs (KPE-1); quality of logistics service (KPE-2); duration of logistics cycles (KPE-3); productivity (KPE-4); return on investment in logistics infrastructure (KPE-5) [22]. These indicators are key and comprehensive. In addition to the key, there are additional indicators: productivity (efficiency) and effectiveness, PIi and Pie,

respectively. The general classification of indicators can be presented in the form of the scheme (Fig. 4.7).

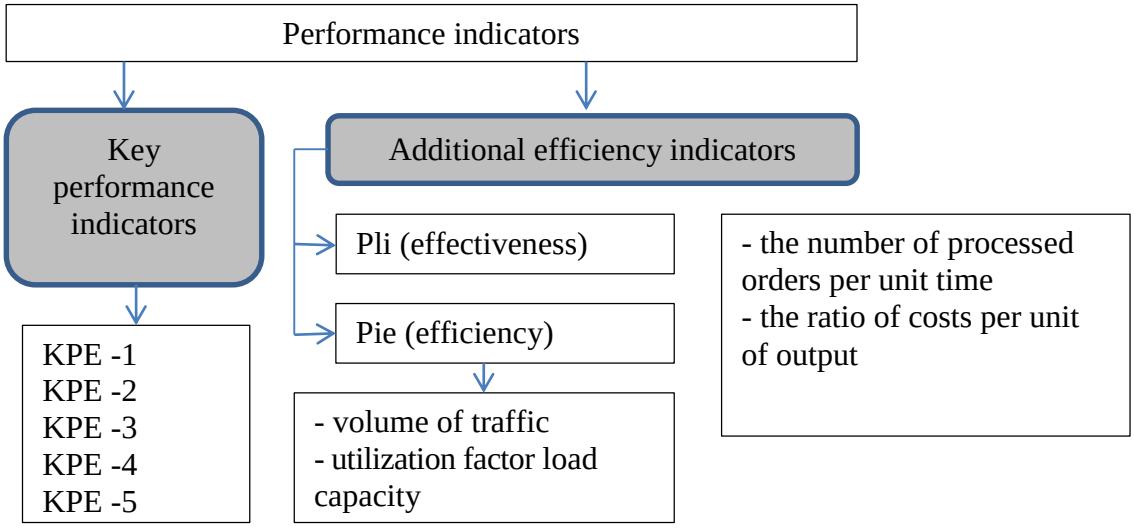


Fig. 4.7. Performance indicators in supply chains.

Source: compiled by the authors

In world practice, the key indicators of KPI efficiency are an integral element not only in the assessment of certain technological and business processes, but also the management system. However, with the current development of globalization of economic processes, special attention should be paid to the introduction of new indicators, involving professional experts in the analysis process. They can be managers, as well as the most trained specialists of financial and commercial structures of enterprises, analysts of specialized consulting companies and more.

A new direction in the development of methods for evaluating the effectiveness of supply chains is considered in the previous sections SCOR-model. Assessment of the functioning of supply chains in the SCOR-model is carried out in two stages (Table 4.2).

Table 4.2

The structure of indicators of efficiency of supply chains

	Group of parameters of chain functioning		The first level of metrics	
External	Indicator	Name	Indicator	Name
	RI	Reliability	RI 1.1	Perfect order
	RS	Response speed	RS 1.1	Order execution time
	AG	Maneuverability (dynamism)	AG 1.1	Supply chain flexibility level (up)
			AG 1.2	Level of adaptability (up) up the supply chain
			AG 1.3	Level of adaptability (down) down the supply chain
			AG 1.4	Total cost measure of risk
Internal	CO	Costs	CO 1.1	Supply management costs
			CO 1.2	The cost of goods sold
	AM	Assets (property)	AM 1.1	Asset turnover
			AM 1.2	Return on non-current assets
			AM 1.3	Return on current assets (working capital)

Source: compiled by the authors

The first stage includes generalized groups of indicators, such as reliability, response speed, maneuverability (dynamics), costs and asset management. The second stage of assessment involves the presence of a system of metrics of three levels (groups of measured indicators). The first level of metrics contains key KPIs that reflect the most general data for strategic planning. The second level of metrics details the metrics of the first level and helps to understand the reason for the deviation from the planned result. At the third level, the metrics are groups of specific indicators, such as "costs to authorize payment to the supplier", for the metric of the second level "delivery costs".

Regarding transportation processes in supply chains, the group of key performance indicators used in all modes of transport usually includes:

1. Time (for example, loading and unloading)

2. Productivity (in particular, transport work)

3. The cost of transportation

4. Quality of service

5. Profitability

The selected group of indicators has a number of features that allow us to talk about its importance:

- aggregated indicators, can be detailed and have an integrated nature;

- indicators are universal for all modes of transport, ie can be used to assess multimodal transport (in this study we will follow the definition adopted by UNCTAD rules, according to which multimodal transport is a method of transportation in which the carrier organizes the delivery process and takes responsibility for delivery with delivery necessary documents on multimodal transportation);

- indicators are promising in terms of the possibility of their further inclusion in the FTA and study in the context of strategic objectives of the enterprise.

However, despite significant efforts to assess the effectiveness of supply chains, this issue is being actively explored, and all new approaches are proposed, in particular, conducted by colleagues abroad. Thus, in [81] it is noted that at the present stage the assessment of logistics activities is carried out at two levels - macro-level (within the country, or association of countries, which implies a comparison of results between states or within one country, but in different time periods) and micro-levels (corporate level).

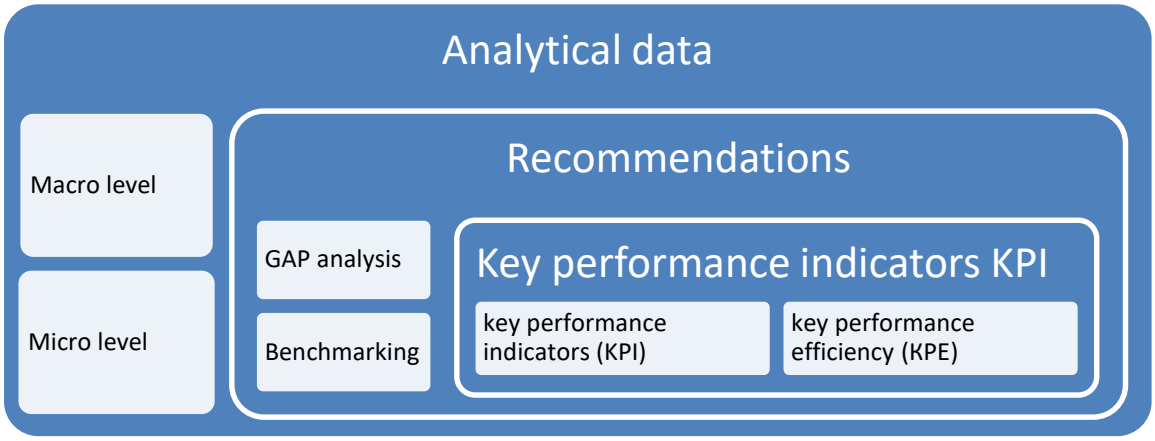


Fig. 4.8 Algorithm for assessing the efficiency of transport activities.

Source: compiled by the authors

Figure 4.8 shows the algorithm for assessing the effectiveness of transport activities, which includes the first stage of database formation, then the definition of aggregated indicators - key performance indicators KPI, then taking into account the level of analysis (micro or macro) formed a set of key performance indicators) and key performance indicators (KPIs). The assessment can also be carried out simply on the basis of comparison with the best practice of a similar enterprise. At the final stage, it is proposed to use the method of strategic analysis, which is used to find steps to achieve the goal - GAP analysis and development of recommendations.

4.3 Development of a mathematical model for assessing the impact of transport processes on the efficiency of the supply chain

Despite the variety of these factors, common to all models is the desire to reduce inventory and maintain the optimal economic size of the order. The EOQ model of the optimal economic size of the order, better known as the Wilson model (formula), provides a minimum amount of total costs and allows you to minimize the cost of stock storage and their order. The calculation mechanism of the EOQ model is based on minimizing the total operating and logistics costs for

the purchase and maintenance of inventories at the enterprise. These costs are predivided into two groups:

1) the amount of costs for placing orders: the amount of costs for the delivery of goods, the cost of transportation and acceptance of goods. The cost of placing orders for the supply of inventories is defined as the ratio of production of raw materials for the period to the average volume of one batch, multiplied by the average cost of placing one order;

2) the sum of the costs of keeping goods in the warehouse, which are defined as the product of half the average volume of one batch of raw materials and the average cost of storage of a unit of production stock.

The EOQ model allows you to optimize the proportions between these two groups of costs so that their total amount is minimal. To do this, use Wilson's formula, which has the form:

$$EOQ = \sqrt{\frac{2 \cdot D \cdot C}{Z_{XP}^{1}}}, \quad (4.1)$$

where: EOQ - the optimal average volume of the supply of raw materials, materials, etc.;

D - volume of production consumption of raw materials for the period;

C - the average cost of placing one order for the supply of raw materials;

Z_{XP}^{1} - the average cost of storage per unit of inventory for the period.

As the average size of one batch of goods increases, the operating costs of placing an order decrease and the operating costs of maintaining stocks in the company's warehouse increase (and vice versa).

Therefore, the main task is to match the cost of storing a large number of stocks with the cost of placing the same number of orders. Accordingly, the optimal size of the order is a certain amount of stock, at which the total cost of storage and ordering stock will be minimal. This level is determined by the so-called order point (Order Point), which determines the required number of ordered

goods and is equal to the expected demand for the period of execution of the order increased by the insurance stock [5].

$$Order\ point = Daily\ demand \times Order\ execution\ time + Insurance\ stock$$

The disadvantage of this model is a rather rigid system of input prerequisites, in particular, the following assumptions are made: demand for products is known, uniform and constant; shortage of products is not allowed; receipt of goods is instantaneous. These assumptions are not so critical for practice, and they can be bypassed if desired, without developing special modifications.

But in addition to them, the classical model has another significant drawback due to the fact that a number of variables that it takes into account is too small and does not meet modern business requirements. However, this shortcoming was offset by repeated modifications of the EOQ-model by various authors, in order to take into account many additional factors due to market development. And corporations with large supply chains and high variable costs use this algorithm in their computer software to determine the optimal economic size of the order.

Moreover, there are already some modifications of EOQ-models [8; 10], which allow to take into account the factors of carrying capacity / carrying capacity of vehicles and discounts on the organization of deliveries depending on the size of the container when calculating the parameters of the economic size of the order.

Therefore, in addition to the characteristics defined in the basic model of the optimal economic size of the order EOQ, a significant impact on the process of formation and delivery of the order have other indicators of transportation, namely: cost and productivity.

The cost is related to the route and the number of rides. It shows the effectiveness of using different models of rolling stock. Cost-effective and the best rolling stock, in which this value will be minimal. The full cost of road transport includes the costs of transportation St, which are taken into account by trucking companies, the implementation of forwarding services Se, loading and unloading operations Snp and road component Sa:

$$SP = St + Se + Snp + Sa. \quad (4.2)$$

The cost of transportation, which is taken into account in the ATP, consists of costs associated with the movement of the car and its downtime at the points of loading / unloading. You can write that:

$$St = \frac{\sum C_v}{P_r(W_r)}, \quad (4.3)$$

where $\sum C_v$ - the amount of travel expenses;

$P_r(W_r)$ - the volume of traffic or transport work performed per ride.

The amount of travel expenses consists of variable and fixed costs.

$$\sum C_v = \sum C_z + \sum C_p, \quad (4.4)$$

C_z and C_p depend on the load capacity of the car. These dependencies are linear and have the form:

$$C_z = a_z + b_z \cdot q \cdot \gamma_{st}, \quad (4.5)$$

$$C_p = a_p + b_p \cdot q \cdot \gamma_{st}, \quad (4.6)$$

where a_z and b_z are constant coefficients (parameters) of the dependence $C_z = f(q\gamma_{st})$;

a_p *and* b_p - constant coefficients (parameters) of dependence $C_p = f(q\gamma_{st})$;

q - load capacity of a motor vehicle, t;

γ_{st} - static capacity utilization factor of the car vehicle.

Productivity, on the other hand, includes the technical parameters of the route and is represented by such indicators as the average loading / unloading time, load capacity of vehicles, and so on. It is calculated by the formula:

$$p = \frac{q_a \times y_c \times \beta \times V_{TA}}{L_{CA} + \beta \times V_{TA} \times t_{н/р}} \quad (4.7)$$

where q_a - is the load capacity of the car, t;

y_c – coefficient of statistical load-carrying capacity;

β - mileage utilization factor (<= 1);

V_{TA} - technical speed of the car, km/h;

L_{CA}– planned transportation distance, km;

$t_{n/p}$ - time of loading / unloading of the car, h.

Accordingly, if you know the type of goods, its volume and load capacity of the vehicle, you can calculate the average speed - Vsp and loading / unloading time - tn/g. Based on these data, you can estimate the delivery time (T) of one order

$$T = L/V_{sp} + t_{n/p} \quad (4.8)$$

Based on the time of delivery, we obtain the size of the transport tariff in UAH. per hour. It should be noted that when transporting long distances, the transport component is particularly important, as it can significantly exceed other components of the total cost of the supply chain (in some cases up to 50% of the cost of the product). Therefore, if the average cost of placing one order C for the supply of raw materials can be represented as the sum of the average operating costs for placing order Co and the average logistics costs for transporting B, as a group of costs that are an integral part of any order, then the optimal size batch (model EOQ) can be found by the formula:

$$EOQ = \sqrt{\frac{2 \cdot D \cdot (C_0 + C_t)}{Z_{XP}^1}}, \quad (4.9)$$

The proposed approach allows to link the components of inventory management efficiency models, in supply chains in particular the EOQ model with the productivity of the transport process and as a consequence to include in them the parameters of technical transportation:

$$C_m = 2y \times (\frac{L}{V_{cp}} + t_{н/р}) \times g = \frac{kygL}{V_{cp}} + kygt_{н/р} \quad (4.10)$$

where y - the mileage utilization factor;

k - number of rides for one route;

g - tariff, UAH / year

The indicator Cm includes the product of transport work and transport tariff, which allows you to move to the economic and cost expression of the result. Transport work, in turn, is represented by such indicators as the average loading / unloading time and load capacity of vehicles. Thus, the formula for calculating transport costs (C_t) includes essential parameters of transportation of a technical nature, which must be taken into account when planning the supply chain and determining the optimal size of the order. Then when substituting formula 10 into formula 9 we obtain:

$$EOQ = \sqrt{\frac{2 \cdot D \cdot \left(C_0 + \frac{kygL}{V_{cp}} + kegt_{n/p}\right)}{Z_{XP}^1}}, \quad (4.11)$$

The resulting formula allows you to link transport costs with other types of costs, and in turn, the components of transport costs are reflected in the EOQ model.

At the same time, the modern market environment, along with the optimization of costs, puts before the participants of commodity-money relations more and more requirements related to the speed of customer service and increase the efficiency and productivity of transport activities.

One of the main characteristics of any logistics system is the timeliness of deliveries, ie the time parameter. The most common causes of delays in the practice of modern logistics companies include:

1) violation of the planned time for transportation - shifts work in other areas, which, in turn, may lead to arrival at the point of unloading (transshipment, customs control, port, etc.) during non-working hours;

2) intentional violation of delivery terms by the carrier (example for hourly payment);

3) lack of a mobile navigation system;

4) road accident, speeding violation, etc.

Each of the identified causes can be determined both objectively and subjectively, and depends on many factors. However, given that the modern market has higher requirements for compliance with all the terms of the contract, including the terms of delivery of goods, in the construction of supply chains, it is advisable to use the concept of accurate-in-time (JIT).

The ELA glossary defines the concept of JIT as "the delivery of goods (or consignments of goods) to the desired point in the supply chain at the exact time when they are needed" [1].

Thus, the concept of JIT is based on the synchronization of volumes and quality of supply in accordance with the operational needs of production. It is based on the decentralized principle of material flow management, when instructions to start production come directly from the warehouse or sales system of the enterprise, and the key elements are integrated information processing, segmentation of production and supply, synchronized with production. Accordingly, having an accurate calculation of the duration of traffic is one of the basic ideas of the JIT concept, especially when it comes to supply chains and related transportation.

According to this strategy, the calculation of time to find the total duration of the flight (taking into account the relevant operations: travel time, accumulation, loading and unloading, etc.), is carried out according to the formula:

$$T_0 = \sum_{r=1}^{N} \sum_{i=1}^{A} t_{r,i} + \sum_{r=1}^{N} \sum_{j=1}^{B} \tau_{r,j} + \sum_{r=1}^{N} \sum_{k=1}^{C} \theta_{r,k} + \sum_{r=1}^{N} \sum_{l=1}^{D} \varphi_{r,l} + \sum_{m=1}^{E} \psi_m + \sum_{n=1}^{F} \eta_n \quad (4.12)$$

where t, i + 1 - travel time between the i-th and (i + 1)-th points;

τ_j - time of registration of customs documents in the j-th point (inside the country and at border crossings);

θ_k - time of loading, unloading and warehousing in the k-th point;

A, B, C - the number of sections of the vehicle and loading / unloading points, respectively;

φ_l - random component that reflects the increase in flight time for maintenance work;

ψ_m - a random component that reflects the restrictions associated with the mode of operation and rest of the crew;

η_n - random component that reflects the prohibitions on the movement of vehicles along the route (weekends, accidents, malfunctions, etc.);

D, E, F - the number of cases of vehicle downtime, taking into account the above reasons, respectively;

r - an index that reflects a certain type of transport for multimodal transport (for example, when used on the route at the same time road, rail and sea transport N=3).

Given that in a particular model one of the components ψ_m associated with the peculiarities of the mode of work and rest of drivers (accumulation of driver's time during the ride, which is a limitation for each day of movement of the vehicle during the flight), in our opinion, it should be limited by inequality

$$\sum t_{i,i+1} \le T_{yn} \tag{4.13}$$

where T_{yn} - normalized duration of driving the vehicle per day (T_y = 9 hours).

In addition, we must introduce a restriction related to the duration of daily rest $T_в$

$$\sum t_{i,i+1} + \tau_i + \theta_к + \varphi_l + \eta_n \le 24 - T_{вi} \tag{4.14}$$

In which the statistical parameters of the cycle - time and standard deviation - are determined by the formulas:

$$\bar{T} = \sum_{i=1}^{N} \bar{T}_i , \tag{4.15}$$

$$\sigma_T = \sqrt{\sum_{i=1}^{N} \sigma_i^2 + 2\sum_{i \le j} r_{ij}\sigma_i\sigma_j} , \tag{4.16}$$

where $\bar{T}$ - the average value of the execution time of the operation of the i-th cycle; σ_T - the standard deviation of the execution time of the operation of the i-th cycle; r_{ij} - correlation coefficient between the i-th and j-th operations of the cycle.

Our refinements for the model of estimating the performance of transport operations according to the JIT allow to obtain more accurate data on the total total time of transportation; the probability of delivery or delivery time with a given probability. And the model constructed in this way allows to take into account all the variety of factors that affect the duration of transportation, which allows managers at the planning stage to assess all the threats and risks that could potentially face their designed supply chain.

The extended model of determining the time of transportation for several modes of transport allows for an analytical assessment of a key indicator of transportation, namely the duration of logistics cycles and to make a competent decision based on calculations. Which in turn will allow to obtain probabilistic estimates of transport operations in accordance with the concepts of JIT. This model differs from the existing empirical approach in that it allows the decomposition of the transportation process into individual components, and describe them as independent elements using statistical parameters.

Approbation of the model for a comprehensive assessment of the efficiency of transportation in supply chains requires a comprehensive information database. The result of calculations and convenience of their carrying out depends on how correct and complete the initial data will be. The issue of forming a reference and information base for a comprehensive assessment of target indicators can be divided into groups.

The first group of questions is related to the existing corporate reporting (management accounting, accounting, annual income statement) and the possibility of using this data for evaluation.

The second group is the report of the logistics service on the key functions of the enterprise: monthly / quarterly / annual reports on supply, production and sales.

The third group of questions relates to the collection and receipt of lower-level information on all transport functions and related operations: data from process maps, rolling stock operation diagrams, reports on the operation of forklifts at the terminal, and so on.

In addition to taking into account the technological map, we conducted daily monitoring of the warehouse area and on these data formed a daily work schedule, which is the source of data in the formation of information and reference database.

As we noted in previous sections in a market economy, transportation is seen as the most important opportunity to gain a competitive advantage. This explains the growing interest in the system of indicators for assessing transportation in supply chains. After all, with the help of a correctly constructed analytical system of indicators, you can calculate certain values, identify trends and, most importantly, plan the entire process of transportation in supply chains based on specific figures and results.

Analysis of the logistics services market has shown that in modern economic practice, companies seek to increase the efficiency of transportation, including at the stage of evaluating results and further planning. However, most literature sources propose an estimation technique based on comparison with some average values (for example, average speed on the route, average distance of transportation). Obviously, there is a fairly large scatter of data that does not allow for an accurate assessment for specific sections of the supply chain. Therefore, in our opinion in the conditions of the modern market it is expedient

to focus on formation of the individualized system of indicators of an estimation of transportation for each concrete enterprise. Then we can talk not just about modeling the expected performance indicators,

The system of equations can be easily expanded and supplemented taking into account the specifics of a particular enterprise, thus, the assessment is carried out without experiments, but on the basis of analytical models, which allows to reach a fundamentally new level of planning and evaluation of transportation in supply chains. The proposed algorithm includes a step-by-step solution of key tasks for assessing the efficiency of transportation.

Approbation of the developed methodological approach to assessing the efficiency of transportation in supply chains should answer whether the proposed economic and mathematical model will work in real economic processes for different types of supply chains. Which in turn will allow a comprehensive assessment of the efficiency of transport activities in the supply chain and analyze the impact of individual performance and performance indicators on the final indicators.

CONCLUSIONS

1. The era of business predictability and linear solutions is over. The reality is unpredictable demand, rapid change in consumer preferences, mass and continuous data flow over the Internet, global video and telecommunications systems. Today, companies seeking to strengthen their competitive position in the markets must use modern drivers such as trust and effective communications, have perfect information and are responsible for the activities of all their suppliers. The key issue of their activity is to build a relationship between the focus company and the supply chain contractors at the network level.

2. The main featuresupply chain management is not the management of participating organizations, which are links in the supply chain, and channels of interaction (information, innovation, finance, resources, etc.) and the most important practical problem of supply chain management is the reduction of demand uncertainty. In tasks of this type it is necessary to find a rational amount of stock and the best ways to supply them. Accordingly, uncertainty in supply chains can be reduced by:

- introduction of a certain redundancy of supply chain structures (for example, temporary buffers, insurance stocks, additional warehouses, capacity stocks, etc.);

- improving coordination and information exchange to improve the quality, timeliness and accessibility of all participants in the supply chain to demand forecasts;

- introduction of a monitoring system and means for possible regulation of the supply chain in case of violations and deviations from the plan.

3. Supply chain management is generally not limited to one or more strategies. It uses a certain "strategic set" in the form of a system of strategies of

various types, which reflect the specifics of the functioning and development of the supply chain, as well as the level of its encroachment on a particular place and role in the external environment. That is, with regard to supply chains, we need to talk about the use of integrated management strategies.

4. Evaluating the effectiveness of the supply chain is to identify and analyze the factors that determine the ability of the chain to better, faster and cheaper than its competitors to meet customer requirements. The authors propose to conditionally divide all indicators of supply chain management efficiency into four main groups:

- efficiency targets;
- indicators of functionality;
- operational efficiency indicators;
- innovative efficiency indicators

The presented system is not overloaded with a large number of parameters, which is achieved by highlighting only those indicators that can be influenced, and which really characterize the efficiency of the supply chain.

5. Analysis of the logistics services market has shown that in modern economic practice, companies seek to increase the efficiency of transportation, including at the stage of evaluating results and further planning. However, most literature sources propose an estimation technique based on comparison with some average values (for example, average speed on the route, average distance of transportation). Obviously, there is a fairly large scatter of data that does not allow for an accurate assessment for specific sections of the supply chain. Therefore, in today's market it is advisable to focus on the formation of an individualized system of indicators for assessing transportation for each enterprise. Then we can talk not just about modeling the expected performance indicators, but to have a substantive conversation about the results of a particular enterprise,

6. The paper proposes to use methods aimed at developing a set of key indicators of the SSP, on the basis of which the assessment of companies, regardless of industry specifics. This system links indicators in monetary terms and operational measures of various aspects of the supply chain, such as customer satisfaction, internal processes, innovation, financial results.

The key feature of the proposed method is the division of all economic activities of the company into 4 main perspectives, namely finance, customers, business processes, staff.

7. Developed on the basis of the runway algorithm for assessing the effectiveness of transport activities, includes a number of stages:

- formation of a database.

- definition of aggregated indicators - key indicators of KPI activity.

- taking into account the level of analysis (micro or macro) of the formation of a set of key performance indicators (KPI) and key performance indicators (KPI).

- conducting a strategic analysis, which is used to find steps to achieve the goal - GAP analysis and development of recommendations.

8. The clarifications proposed by the authors for the model of estimating the performance of transport operations according to JIT allow to obtain more accurate data on the total total time of transportation; the probability of delivery or delivery time with a given probability. And the built model allows to take into account all the variety of factors that affect the duration of transportation, which allows managers at the planning stage to assess all the threats and risks that could potentially face their designed supply chain.

The extended model of determining the time of transportation for several modes of transport allows for an analytical assessment of a key indicator of transportation, namely the duration of logistics cycles and to make a competent decision based on calculations. Which in turn will allow to obtain probabilistic estimates of transport operations in accordance with the concepts of JIT. This

model differs from the existing empirical approach in that it allows the decomposition of the transportation process into individual components, and describe them as independent elements using statistical parameters.

9. The implementation of a model for a comprehensive assessment of the efficiency of transportation in supply chains requires a comprehensive information database. The result of calculations and convenience of their carrying out depends on how correct and complete the initial data will be. The issue of forming a reference and information base for a comprehensive assessment of target indicators can be divided into groups. The first group of questions is related to the existing corporate reporting (management accounting, accounting, annual income statement) and the possibility of using this data for evaluation. The second group is the report of the logistics service on the key functions of the enterprise: monthly / quarterly / annual reports on supply, production and sales.

Approbation of the developed methodological approach to assessing the efficiency of transportation in supply chains should answer whether the proposed economic and mathematical model will work in real economic processes for different types of supply chains. Which in turn will allow a comprehensive assessment of the efficiency of transport activities in the supply chain and analyze the impact of individual performance and performance indicators on the final indicators.

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