MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL AVIATION UNIVERSITY

Air Transportation Management Department

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Head of the Department
_____D. O. Shevchuk
“_____”_____2020

MASTER THESIS

(EXPLANATORY NOTES)

Theme: « Organization of technological equipment supply chain »

Done by: Mudryk Viktoriia

Supervisor: Yuliia V. Sevchenko, PhD in Economic, Associate professor

Standards Inspector: Yuliia V. Sevchenko, PhD in Economic, Associate professor

Kyiv 2020

МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ

НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ

Кафедра організації авіаційних перевезень

ДОПУСТИТИ ДО ЗАХИСТУ
Завідувач кафедри
_____Шевчук Д.О.
«_____»_____2020 р.

ДИПЛОМНА РОБОТА
(ПОЯСНЮВАЛЬНА ЗАПИСКА)

ВИПУСКНИКА ОСВІТНЬОГО СТУПЕНЯ «МАГІСТР»

Тема: «Організація ланцюга поставок технологічного обладнання»

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Київ 2020

NATIONALAVIATIONUNIVERSITY

Faculty of Management, Transport and Logistics

Air Transportation Management Department

Major (specialty): 275 “Air Transportation Technology”

APPROVED BY
Head of the Department
_____D. O. Shevchuk
“_____”_____2020

TASK
of completion the master thesis
MUDRYK Viktoriia

1. Theme of the master thesis entitled «Organization of technological equipment supply chain» was approved by a decree of the Rector order № 2026/ст. from 16.10.2020.
2. Term performance of thesis: from 05.10.2020 to 31.12.2020.
3. Initial data required for writing the master thesis: theoretical provisions of organizing business processes in supply chains; strategic elements of supply chains; analysis of production and financial activities of " Kuehne + Nagel"; analysis of the logistics system of the enterprise; development of proposals for improving the supply chain of technological equipment; calculation of the intensity of delivery, freight of containers and total costs in the supply chain of technological equipment.
4. Content of the explanatory notes: conceptual bases of the organization of the international delivery; ways of development of the supply chains e; assessment of supply chains of technological equipment.
5. List of mandatory graphic matters: tables, diagrams, graphs, diagrams illustrating the current state of the problem and methods of solving them.

6. PLANNING CALENDAR

№	Assignment	Deadline for completion	Mark on completion
1.	Collection and processing of statistical data	05.10.2020	done
2.	Writing of the theoretical part	16.10.2020	done
3.	Writing of the analytical part	26.10.2020	done
4.	Writing of the design part	16.11.2020	done
5.	Writing of the introduction and summary	26.11.2020	done
.	Execution of the explanatory note, graphic matters and the presentation	02.12.2020	done

7. Given date of the task: October 05, 2020.

Supervisor of the master thesis: Julia V. Shevchenko

Task was accepted for completion: Viktoriia V. Mudryk

EXPLANATORY NOTE

Explanatory note to the master thesis «Organization of technological equipment supply chain»: 122 pages, 43 figures, 32 tables, 77 references.

KEYWORDS: BUSINESS PROCESSES, CONTAINER TRANSPORTATION, SUPPLY CHAIN, LOGISTICS OPERATOR, TECHNOLOGICAL EQUIPMENT

The object of study is the process of supply chain management of technological equipment..

The objective of the diploma project is a set of theoretical, methodological and practical aspects of increasing the efficiency of product delivery to an enterprise..

Research methods: The methodological basis for carrying out research was advocated the methods based on the use of economic theory and system approach.

The relevance of the thesis and the growing interest in its study are due to the potential for improving the efficiency of supply chain management of technological equipment by Mitsubishi Heavy Industries with the involvement of the logistics operator Kuehne + Nagel. In the thesis, the main approaches to the design of a supply chain of technological equipment for a logistics operator are considered. The theoretical part highlights the theoretical provisions of the organization of business processes in supply chains. The analytical part is devoted to the analysis of the activities of the Kuehne+Nagel logistics operator. The main indicators of the company's activity are investigated; the analysis of information support for the activity of a logistics operator is carried out. In the project part of the thesis, proposals were developed to improve the supply chain of technological equipment at the enterprise. It is recommended to use materials of graduation work for scientific investigations, in an education process and in expert’s practical activity of logistics department.

ABREVIATIONS

BSC – Balanced Ssedre Card

DRP – Distribution requirements planning

EDI – Electronic data interchange

ERP – enterprise resource planning

ISO – International Organization for Standardization

KN – Kuehne + Nagel

KS – Key Solutions

MRP – material requirements planning

OE – Operating Expenses

SCM – Supply Chain Management

SCOR – Supply Chain Operation Reference

SSM – Supply Store Management

TSL – theory of systems limitation

CONTENTS

.

INTRODUCTION

Air Transportation Management Department				*NAU.20.07.42 001EN*			
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Standards Inspector	*Yuliia V. Shevchenko*						
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For modern companies, the issues of effective supply management are becoming more and more relevant. This process can be improved only under conditions of strengthening logistic integration and coordinated interaction both with external partners and between various departments within the enterprise.

Supply chain management (SCM - Supply Chain Management) is the process of organizing the planning, execution and control of the flows of raw materials, materials, work in progress, finished products, as well as providing efficient and fast service by obtaining operational information about the movement of goods. With the help of SCM, the tasks of coordination, planning and management of the processes of supply, production, storage and delivery of goods and services are solved. Supply Chain Management is the integration of key business processes, starting from the end user and covering all suppliers of goods, services and information, adding value to consumers and other stakeholders.

Successful supply chain management requires a number of key requirements: leadership support, leadership, willingness to make changes, and empowering employees.

Thus, Supply Chain Management is a highly interactive, comprehensive and systematic approach that requires simultaneous consideration and accounting of many exchange processes. The supply chain overlaps the boundaries of the organization, as it includes exchanges that take place both inside and outside the system. In each case, the composition of these exchanges depends on where stocks should be stored and perform certain activities [14].

The flow of products follows the flow of information. Although information is not a process, it greatly facilitates the coordination of all chains. It should be remembered that product flows occur only after the flow of information began to circulate.

Due to the dynamic nature of the external environment in which the business operates, managers must regularly, with the necessary frequency to monitor and evaluate the performance of supply chains. When the targets of its operation are not

provided, it is necessary to assess possible options for the use of other circuits and make the necessary adjustments.

Supply chain management is a difficult task, although even logistics management in the version "from the place of manufacture of the product to the place of its consumption" is much easier to say than to implement in practice. Thus, the scale of the difficulties is presented, if you really start to manage the activities of all suppliers from the place of manufacture of their original components and all goods and services to their places of consumption.

Supply chain management is a complex of approaches that helps the effective integration of suppliers, manufacturers, distributors and sellers. SCM, taking into account the service requirements of customers, allows you to ensure the availability of the right product at the right time in the right place with minimal costs.

The supply chain (supply chain) is a set of links interconnected by information, money and commodity flows. The supply chain starts with the purchase of raw materials from suppliers and ends with the sale of finished goods and services to the customer. Some links may belong entirely to one organization, others - to counterparty companies (customers, suppliers and distributors). Thus, a supply chain usually includes several organizations.

The rapid development of the market, increased competition, the requirement to improve the quality of customer service, pose new challenges to companies. In order to remain competitive and strengthen its advantages, a modern enterprise needs to optimize all value creation processes - from the supply of raw materials to the service of the end user. To solve these problems, the management of companies turns to SCM solutions.

In a competitive market environment, enterprises face new challenges - accurate and timely execution of orders, management of production costs, cost reduction, and the like. Therefore, there should be answers to important questions: what opportunities are provided by modern logistics concepts for planning the supply of material resources, how it is expedient to use production capacities, and what difficulties enterprises face when introducing logistics.

Urgency of the research is due to the potential for improving the efficiency of supply chain management of technological equipment by Mitsubishi Heavy Industries with the involvement of the logistics operator Kuehne + Nagel. In the thesis, the main approaches to the design of a supply chain of technological equipment for a logistics operator are considered.

So, **the goal** of the work is to substantiate the theoretical and methodological foundations and develop practical directions for improving the supply chain management of technological equipment.

The theoretical and methodological basis of the study is the fundamental provisions of modern economic science, the main provisions of the theory of logistics, legislative and regulatory acts of Ukraine.

The information base of the thesis was made up of statistical materials of the State Statistics Committee of Ukraine, monographs and other scientific publications of domestic and other foreign scientists on the problems of supply chain management, as well as data from the system of statistical, operational and managerial accounting of a number of manufacturing equipment manufacturing plants, the results of a survey of economic entities " objects, electronic databases and knowledge.

The main tasks, the solution of which is necessary to achieve the goal of the study are:

- to reveal the concept of supply chain management;
- to define targets for the performance of the supply chain;
- describe modern integration chains in international business;
- research the logistics market of Ukraine and analyze the production and financial performance of the company "Kuehne + Nagel";
- calculate the optimal size of the supply of products to consumer countries;
- select and substantiate the optimal supply chain of technological equipment for effective supply chain management.

The object of study is the process of supply chain management of technological equipment.

The objective of the diploma project is a set of theoretical, methodological and practical aspects of increasing the efficiency of product delivery to an enterprise.

Methodology and methodological foundations of the study based on the basis of a comprehensive and systematic approach, using general scientific and economic research methods, in particular: methods of scientific logic, grouping, comparison and generalization, methods of tabular and graphical analysis, methods of structural-factor and economic-mathematical analysis, project forecasting method.

1. THEORETICAL PART

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1.1. The essence of supply chain management

Supply Chain Management (SCM) is the integration of key business processes, starting from the end user and covering all suppliers of goods, services and information, adding value to consumers and other stakeholders [47].

Supply China Management is the management of eight key business processes, shown schematically in fig. 1.1.

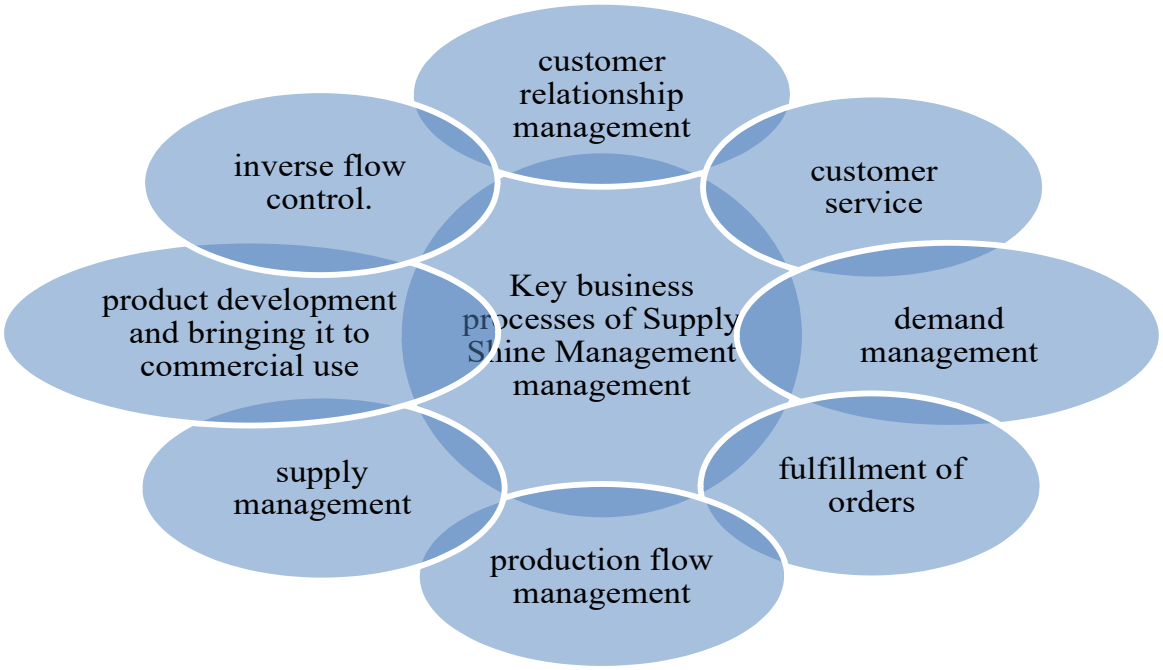

Fig. 1.1. Key business processes of Supply Chain management

Successful supply chain management requires a number of key requirements: leadership support, leadership, willingness to make changes, and empowering employees.

Thus, Supply Chain Management is a highly interactive, comprehensive and systematic approach that requires simultaneous consideration and accounting of many exchange processes. The supply chain overlaps the boundaries of the organization, as it includes exchanges that take place both inside and outside the system. In each case,

the composition of these exchanges depends on where stocks should be stored and perform certain activities [14].

The flow of products follows the flow of information. Although information is not a process, it greatly facilitates the coordination of all chains. It should be remembered that product flows occur only after the flow of information began to circulate.

Due to the dynamic nature of the external environment in which the business operates, managers must regularly, with the necessary frequency to monitor and evaluate the performance of supply chains. When the targets of its operation are not provided, it is necessary to assess possible options for the use of other circuits and make the necessary adjustments [4].

Supply chain management is a difficult task, although even logistics management in the version "from the place of manufacture of the product to the place of its consumption" is much easier to say than to implement in practice. Thus, the scale of the difficulties is presented, if you really start to manage the activities of all suppliers from the place of manufacture of their original components and all goods and services to their places of consumption.

Therefore, leaders want to manage their supply chains in the first place only to the places of consumption of products, just because the one who is related to the end user has great authority in the supply chains.

Depending on which company is the central company - that is, the company whose leadership determines the structure of the supply chain, this will be the network structure. First-tier suppliers are those organizations from which the central company purchases goods and services directly. Second-tier suppliers are suppliers of first-tier suppliers, etc.

The Supply Chain Management block diagram is a network of members of supply chains and connections between them.

Business processes are activities that give consumers concrete value.

Management components are management variables that enable business processes to be integrated and managed across all supply chains.

In fig. 1.2. the Supply Chain Management model is presented.

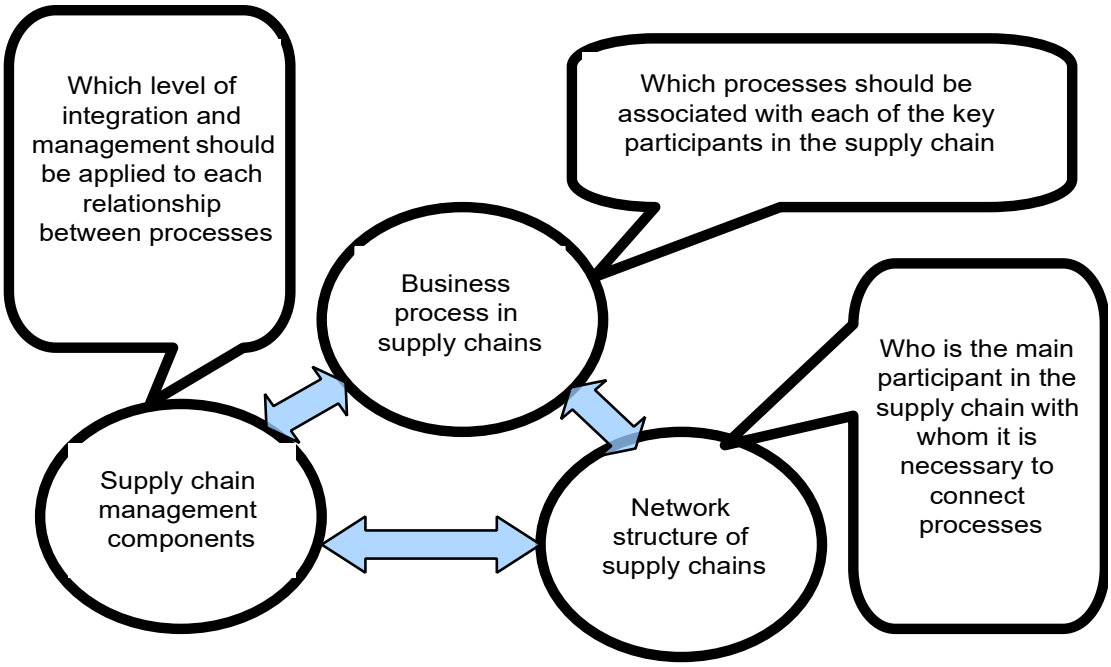

Fig. 1.2. Supply China Management Flowchart: Elements and Key Solutions

Supply chain implementation involves identifying the supply chain participants with whom it is important to establish links, the processes to be associated with each of the key actors, and the types or levels of integration for each process.

The purpose of Supply Store Management is to achieve maximum competitiveness and profitability of the company, as well as the entire network structure of supply chains, including the end user. In this regard, the integration and reengineering of supply chain processes should be aimed at improving the overall efficiency and productivity of supply chain participants [41].

Some components of supply chain management are common to all business processes and participants in the logistics process. It is these common components that are critical to the success of supply chain implementation, as they are the main ones that determine how each process link is integrated and managed. The level of integration of business process connections and their management depends on the number of components added to each connection and the degree of their activation.

The degree of integration of the communication process of the business process can be increased by adding management components or increasing the level of activity of each component.

The main components in relationship management in Supply Manage Management are:

- methods of planning and control;
- infrastructure of flows and activities related to work;
- organizational structure;
- communication and information flow infrastructure;
- product flow infrastructure;
- management methods;
- the structure of the division of powers and leadership;
- distribution of risks and rewards;
- culture and relations.

Some researchers [20] introduce a synonym for the supply chain - the supply chain. The process of moving to integrated supply chains is represented by four successive phases of integration (fig. 1.3).

Applying the definition of the logistics supply chain (by analogy with the definition of logistics) a threefold understanding that it is, firstly, the philosophy of integrated flow management in the channel of transformation of materials from source to end customer, and secondly, the strategic concept of value added maximization) for the end customer, thirdly, integrated activities to effectively serve the end customer.

We can following to the next strategic changes [31]:

- shifting the plane of competition from individual firms to entire supply chains;
- supply chain management, as a whole, radically affects the reactivity and lead time of the order, accelerating the processes of design, production and distribution of goods;

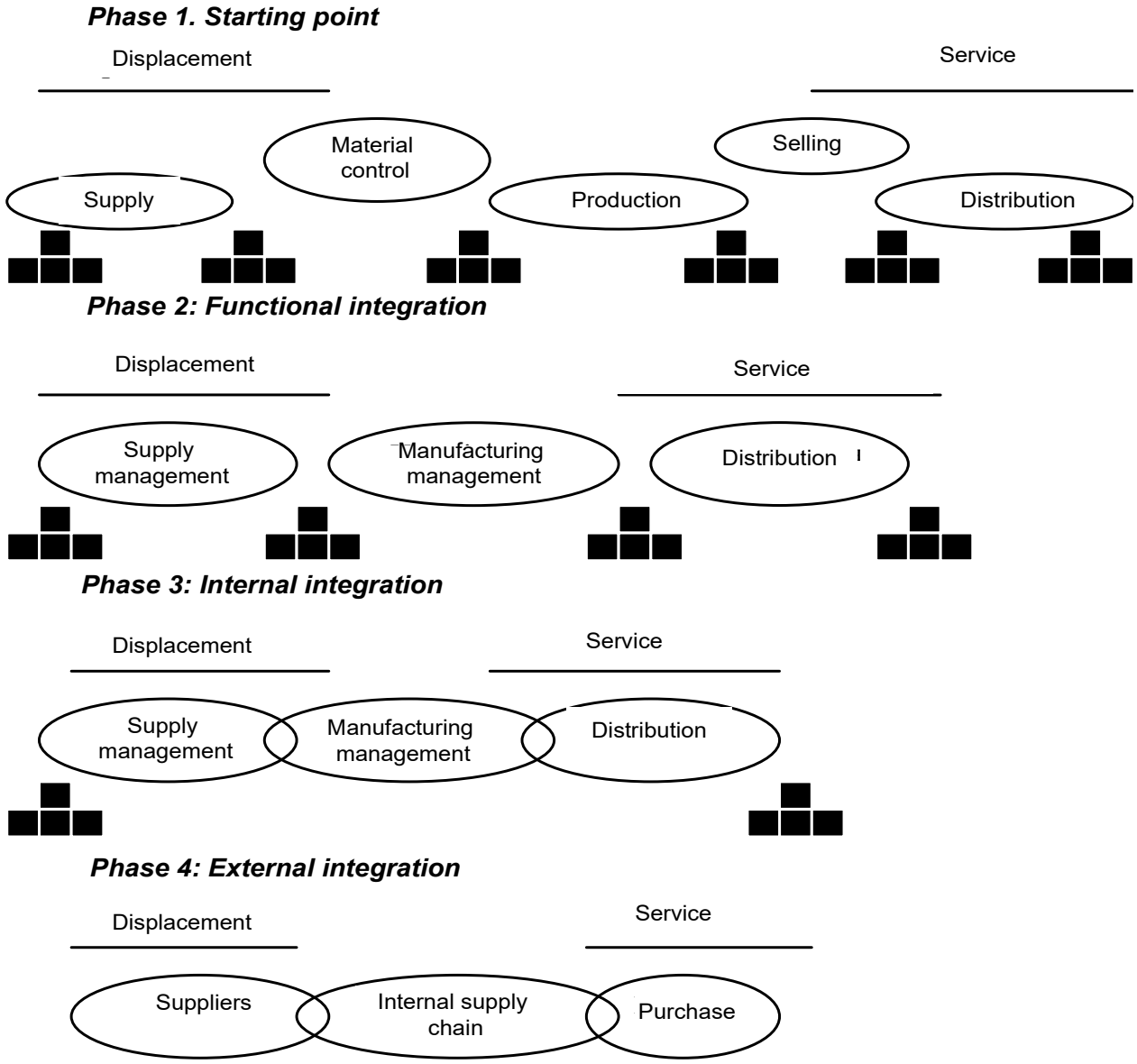

Fig. 1.3. Phases of supply chain integration

- supply chain management modifies the quality management strategy, expanding its scope beyond the requirements of the end customer to the level of service;

- in the logistics supply chain it is possible to significantly reduce the level of stocks both due to their holistic optimization and due to the full-fledged replacement of parts of these stocks with timely information, which will increase the return on capital;

- supply chain management changes the system approach to optimizing the organization in the direction of deepening specialization through logistics outsourcing, limiting the number of carriers, consolidation of suppliers and more.

1.2. Strategic elements of Supply Chain Management

Under the supply chain we will understand the sequence of economic entities from suppliers of raw materials, parts, components and components to consumers of the final product (service), which, carrying out production, trade, logistics and other processes, are those that are directly related to movement of material and corresponding information flows in the established stages [46].

The term SCM (Supply Chain Management) has been widely used in countries for more than 20 years, but to date there is no consensus among logistics and general management professionals on the definition of this concept. Many people view Supply Chain Management from an operational perspective, understanding Supply Chain Management as material flows. Others consider Supply Chain Management to be a management concept, and finally others understand Supply Management to implement the concept for the enterprise. The following are the most popular definitions of Supply Chain Management:

Supply Manage Management is a set of approaches that helps to effectively integrate suppliers, manufacturers, distributors and vendors. SCM, taking into account customer service requirements, allows you to establish an uninterrupted supply of the right product at the right time in the right place with minimal costs.

SCM is the process of organizing the planning, execution and control of flows of raw materials, work in progress, finished products, as well as providing efficient and fast service by obtaining operational information about the movement of goods. With the help of SCM the tasks of coordination, planning and management of processes of supply, production, warehousing and delivery of goods and services are solved [15].

The supply chain is a set of links interconnected by information, cash and commodity flows. The supply chain begins with the purchase of raw materials from suppliers and ends with the sale of finished goods and services to the customer. Some links may be wholly owned by one organization, others by contracting companies (customers, suppliers and distributors). Thus, the supply chain usually includes several organizations.

Supply Chain Management systems are designed to automate and manage all stages of supply to the city and to control the entire movement of goods for the company. The SCM system allows to meet the demand for the company's products much better and significantly reduce logistics and procurement costs. SCM covers the entire cycle of raw material procurement, production and distribution. Researchers typically identify six main areas in which supply chain management is concentrated:

- production - the company decides what and how to produce;

- supplies - after making a fundamental decision on the construction or entry into the supply chain, the company must determine what it produces independently, and what components (components, goods or services) - to buy from third parties;

- location - decision on the location of production facilities, warehousing centers and the choice of sources of supply;

- inventories - the main purpose of inventory management - contingency insurance, such as demand surges or supply delays;

- transportation - solutions related to transportation. They depend on the location of the supply chain participants, the inventory policy and the required level of customer service. It is important to determine the right means and effective methods to quickly manage transportation, because these operations account for about thirty% of total delivery costs, and delays in delivery are associated with an average of more than 70% of errors in the distribution of goods;

- information - efficient functioning of the supply chain requires prompt exchange of data between all its participants.

The supply chain performs two main functions:

1) The physical function of the supply chain is visible to everyone: materials are transformed into parts, others - into finished products, and everything in one way or another moves in space.

2) The intermediary function of the supply chain is less obvious, but less important - the market should decline what consumers need.

Both functions, of course, are performed at some cost. As a result of the physical function there are costs of production, transportation and storage. The intermediary function involves the costs of another. When supply exceeds demand, it is necessary to lower prices and sell at a loss, and when demand exceeds supply, lost incomes and dissatisfied customers appear.

Tasks of SCM:

- increasing the level of service;
- optimization of the production cycle;
- reduction of warehouse stocks;
- increase the productivity of the enterprise;
- increase profitability;
- control of the production process.

Supply chain management includes the following steps:

PLAN (Planning). As part of this process, the sources of supply are clarified, there is a generalization and prioritization of consumer demand, stocks are planned, requirements for the distribution system are determined, as well as production volumes, supplies of raw materials and finished products.

SOURCE (Purchase). This category identifies the key elements of supply management, evaluation and selection of suppliers, quality control of supplies, contracting with suppliers. Also included are processes related to the receipt of materials, such as: acquisition, receipt, transportation, similar control, holding (storage before posting) and arrival. It is important to note that actions to manage the supply of goods and services must meet planned or current demand.

MAKE (Production). This process includes the production, implementation and management of structural elements make, provide control over technological

changes, management of production facilities (equipment, buildings, etc.), production cycles, production quality, schedule of production changes, etc. Specific production procedures are also defined: actual production procedures and cycles, quality control, packaging, storage and production. All components of the process of processing the input product into finished products must meet the planned or current demand.

DELIVER (Delivery). This process consists of order management, warehousing and transportation. Order management includes the creation and registration of orders, the formation of value, the choice of product configuration, as well as the creation and maintenance of a customer base, along with maintaining a database of goods and prices. Warehouse management involves a set of actions for the selection and assembly, packaging, creating a special packaging / label for the customer and shipment of goods. The infrastructure of transportation and delivery management is determined by the rules of management of channels and orders, regulation of goods flows for delivery and quality management of delivery.

RETURN. In the context of this process, the structural elements of product returns (defective, redundant, requiring repair) are determined both from make to source and from delivery: determining the status of the product, its placement, request for return authorization, return schedule, destruction and recycling . These processes also include certain elements of after-sales service [23].

Supply chain management optimization is designed to solve the following tasks:

1) Reducing the planning cycle and increasing the planning horizon by obtaining reliable and timely information;

2) Cost optimization through the ability to identify strategic contractors, the optimal choice of purchased products and their suppliers, support interaction with them in real time;

3) Reduction of production costs through the optimization of product flows and the operational organization of information exchange between contractors;

4) Reduction of warehousing costs by bringing production volumes in line with demand. This task corresponds to the concept of Just-In-Time supply management ("just in time");

5) Improving the quality of customer service is achieved through efficiency and flexibility of the supply process.

Thus, SCM is a process of planning, execution and control of flows of raw materials, work in progress, finished products, as well as providing efficient and fast service by obtaining operational information about the movement of goods. With the help of SCM the tasks of coordination, planning and management of processes of supply, production, warehousing and delivery of goods and services are solved.

1.3. The main aspects of product supply chain quality

In a competitive environment, the processes of sale or exchange of goods become particularly important, and therefore they are primarily the need to transport products, goods from place of production to place of consumption. Prerequisites for exchange appear when there are differences between the available products of the manufacturer and the actual need for it by the consumer. When the waiting time for buyers is less than the delivery time, we deal with distribution. This means that the manufacturer must manufacture and send the product to the network before there is an actual demand for it. As a result, there are intermediate organizations that ensure the delivery of goods and services to the final consumer. The combination (interaction) of these organizations is generally called supply chains.

Analysis of literature sources [4, 15, 23, 41, 46] shows that the level of "tolerance" of consumers in the supply chain to inconsistencies is reduced. If 10 years ago the buyer could allow 1% of discrepancies in the received order, 5 years ago this figure was already 0.5%, and today we can say only about 0.1% of discrepancies. In the delivery system "just in time" (Just-in-Time) the level of "tolerance" to inconsistencies, errors or defects in general is unacceptable [11, 23]. In this regard, the issue of supply chain quality management is relevant, the solution of which allows you to build an efficient chain with minimal losses, which in turn allows you

to say about the high efficiency of the logistics system. The problem of the quality of the supply chain is still insufficiently considered in the modern scientific literature on logistics and quality management.

Logistics systems, including the process of moving (transporting) products from the manufacturer to the trading company, from the trading company to the dealers or branches, from the dealers or branches to the final consumer, and are a supply chain. The quality of supply of products from manufacturers to trading companies, and from trading companies through dealers and branches to the final consumer is especially important to maintain the image of the trading company and meet the requirements and needs of consumers.

The concept of "quality" is defined by the International Organization for Standardization (ISO) as a set of characteristics of an object that relate to its ability to meet specified or anticipated needs and requirements. The organization's need to build an efficient supply chain is due to the need to deliver goods to the end consumer better, faster and cheaper than competitors. The ultimate goal of any activity in the field of logistics is the "six rules of logistics" [23]:

1. Cargo (required goods).
2. Quality (required quality).
3. Quantity (in the required amount).
4. Time (must be delivered at the right time).
5. Place (in the right place).
6. Costs (with minimal costs).

The purpose of logistics activities is considered to be achieved if these six conditions are met. Based on their presented provisions, it is possible to define the concept of supply chain quality. Supply chain quality is a set of supply chain characteristics that relate to its ability to meet the needs of end users better, faster and cheaper than competitors.

The goals in creating a supply chain in an organization are usually quite contradictory. As Marshall Fischer explained in his classic review of the Harvard

Business Review, most of the fundamental contradictions in the supply chain are contradictions between productivity and flexibility (fig. 1.4).

Indeed, in a high-performance supply chain, all available capacity must be used to the maximum; Inventory management operations are simplified to achieve economies of scale, and the company seeks to reduce inventory to a minimum at all nodes in the chain.

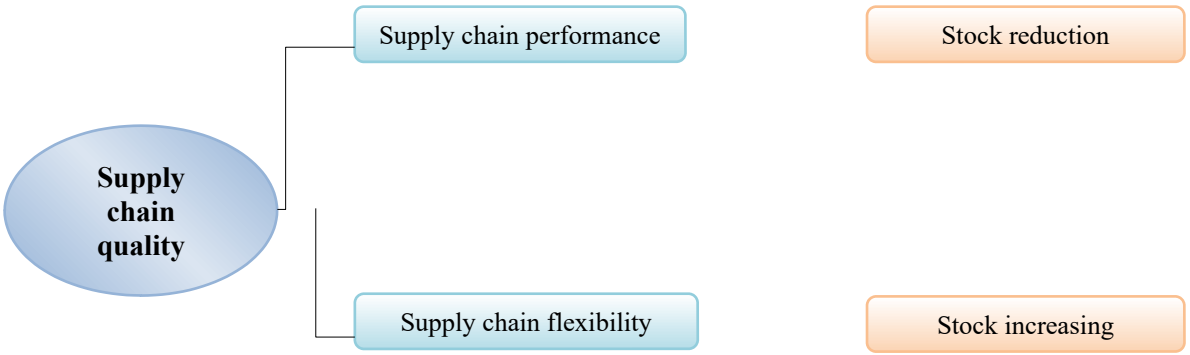

Fig. 1.4. The main contradictions in the supply chain

On the other hand, the most flexible supply chain should provide enough free reserves, including stocks, to respond quickly to unforeseen fluctuations in demand. It must provide "processing" of various volumes of goods in a very short time. To solve these problems, additional insurance stocks are created, the company inevitably increases the amount of funds invested in stocks of its kind. The main contradiction of supply chains is the opposition of strategies to increase and decrease stocks.

Conflict resolution is to determine the initial premise that is incorrect. In this case, it is a statement that increasing stocks allows for supply chain flexibility.

Supply chain flexibility should be determined by the speed of material 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. Larger stocks in this case are only a consequence of shortcomings in the activities of the organization to manage the supply chain [12]:

- low quality of products (services);

- inability to make purchases in small batches;
- inability to plan properly;
- inability to properly buy the right product;
- failures in production;
- supply disruptions.

Therefore, the trade-off between a productive and flexible supply chain is to improve the quality of the supply chain. Supply chain quality means a productive, efficient supply chain characterized by flexibility based on a strategy to reduce inventory levels and capable of continuous improvement.

Assessing the quality of the supply chain is to identify and evaluate the characteristics that determine the ability of the chain to better, faster and cheaper than competitors to meet the needs of consumers. The system of indicators of supply chain management efficiency at the enterprise consists of two main groups of indicators.

The first group is supply chain efficiency targets. The indicators of this group characterize the purpose of the chain. The proposed efficiency targets are based on the indicators given in the theory of systems limitation (TSL) by E. Goldratt. Targets and methods of their calculations are given in table. 1.1.

Revenue generated is defined as the rate at which an organization generates money (usually by selling goods or services). This indicator is the amount of new money coming into the supply chain (and remaining in it) - the value added generated by the functioning of the supply chain.

Investments are defined as the money an organization spends on what it intends to sell later. These tools are linked within the system - they cannot be easily converted into cash, and they are used to generate income. This indicator should be divided into two groups:

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

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

Operating costs (Operating Expenses, OE) are all costs that are not included in the revenue generated, ie are not really variable (disproportionate number of units

sold). Very often OE is described as a means of leaving the system. These include most of the overhead (fixed) costs [12, 18].

Table 1.1

Supply chain efficiency targets

№	Characteristic	Method of calculation
1	2	3
1	Income generated in the supply chain, UAH	T = Sales profit - Variable costs
2	Costs required for the operation of the supply chain, UAH	I = Fixed assets + Revolving funds
3	Operating costs, including procurement costs for maintenance of stocks, UAH	OE = Inventory maintenance costs + Procurement costs
4	Stock turnover period in the supply chain, days	$D^s_{turn} = \frac{T_{cond}}{R^{inv}_{turn}}$, D^s_{turn} - number of days for which stocks in the chain are completely renewed, days; T_{cond} – conditional (financial) year, which consists of 360 days; R^{inv}_{turn} – inventory turnover ratio

The period of inventory turnover in the supply chain characterizes the speed of the supply chain and affects efficiency, ie increases turnover. Temporary measurement is extremely important for business. It can take various forms, but in the general case the tendency is to constantly, and sometimes significantly, reduce it.

The four indicators are comprehensive to assess the effectiveness of the supply chain, as they are a means of linking local operational decisions to the financial well-being of the company, and reflect the functioning of the supply chain at certain times better, faster and cheaper.

The second group - key operational indicators (table 1.2) of the supply chain - a group of indicators that characterize the qualitative and non-quantitative achievement of goals at the operational level. Each key operational indicator has a criterion of lower level functioning. These criteria are indicators of the performance of individual employees.

The main criteria for functioning in the supply chain [25]:

1. The total number of days the stock is in the chain, days.

2. The level of defects in the supplied materials,%.

3. Order cycle time, days.

4. Turnover of stocks of the participant of the supply chain.

5. Capacity utilization (loading),%.

6. Percentage of orders executed "exactly on time",%.

7. The share of transport costs in the selling price,%.

8. Percentage of damage and damage to cargo,%.

9. Supply chain income, UAH

10. Profit of the supply chain, UAH

11. The cost of production at the end of the supply chain, UAH / unit.

Table 1.2

Key operational indicators of the supply chain

№ п/п	Characteristic	Method of calculation
1	2	3
1	Level of supply demand,%.	$L_{demand} = \frac{K_{sold}}{K_{sold} + K_{unsatis}}$, K_{sold} – number of sold stocks for the period, pcs $K_{unsatis}$ – number of unsatisfied requests for the period, pcs
2	Supply chain capacity, units	The maximum amount of goods that can be delivered to end consumers at a given time
3	Accuracy of order execution	S = C Q N, C – number of deliveries in time / total number of deliveries, Q – quantity of materials of appropriate quality / total quantity of materials supplied N – number of deliveries corresponding to quantity / total quantity of deliveries
4	Sales volume, UAH	The total amount of materials sold during the period, UAH
5	Volume of stocks, UAH	The total amount of residual materials in the chain for the period, UAH

The proposed system of evaluation indicators is used in accordance with Figs. 1.5.

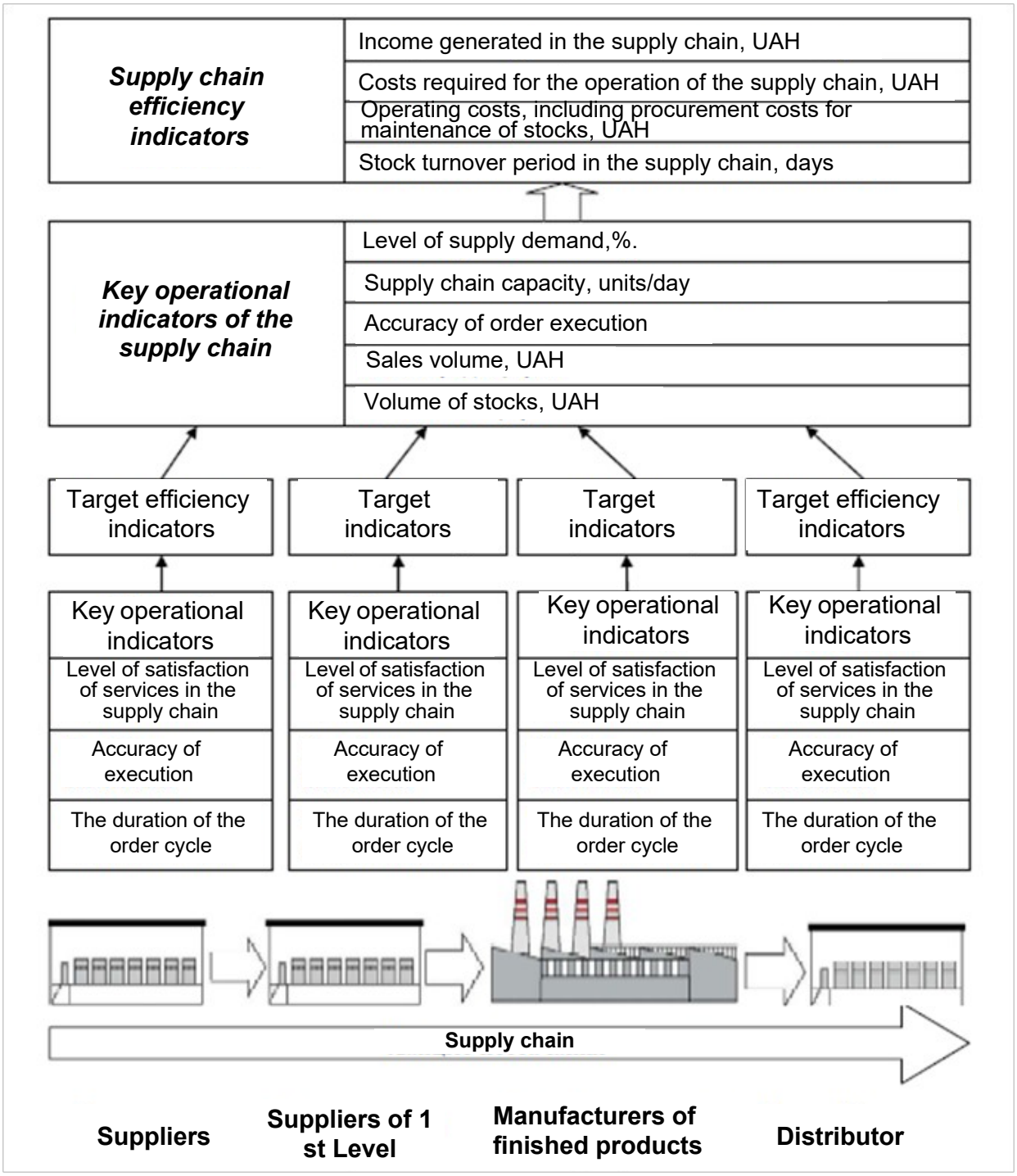

Fig. 1.5. Application of the system of evaluation indicators in supply chains

Thus, the assessment of the quality 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 key operational indicators and 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 we can influence, and which really characterize the efficiency of the supply chain.

For the whole chain, the target performance indicators of the chain and the key operational indicators of the chain are determined. These indicators are assigned and monitored by the "focus" company in the supply chain, in this example it is the organization - the manufacturer. Individual elements of the chain (organization) determine performance targets and key operational indicators within their own organization. Regular monitoring of supply chain quality indicators is the basis for effective supply chain management, which involves the integration of key business processes, from suppliers to the end user.

1.4. Information support of the supply chain modeling process

The widespread penetration of logistics into the economy has been made possible in large part by the computerization of material flow management. Continuous improvement of quantitative indicators of microprocessor technology (speed, memory, ease of communication with a computer, cost) provided a qualitative opportunity to integrate various participants in logistics processes into a single system, exceeding the traditional boundaries of enterprises and reaching national and international boundaries. However, in such integrated systems the requirements of operational management of material flows are actualized, which means the need to ensure parallelism in time of material and information flows, ie to ensure the collection, processing and transmission of information in real time. The creation of multi-level automated material flow management systems, although it requires significant costs for software development and database formation, on the one hand,

should ensure the versatility of the system, and on the other - a high level of integration of all supply chain participants [4].

The rapid development of information technology actively affects all aspects of business development, including logistics. The various information flows circulating inside and between the elements of the logistics system, between the logistics system and the external environment, form a logistics information system, which can be defined as an interactive structure containing personnel, equipment and technology combined with the information flow used by logistics. management for planning, regulation, control and analysis of the logistics system. Today, certain software packages have been developed to effectively solve some logistics problems [41].

Creating and managing a corporate database is possible using a well-known enterprise resource planning system (ERP). With this system perform [4, p.57]:

- collection, processing and transmission of unsystematized supply data;
- collection and dissemination of reports summarizing this data;
- transmission of information in the supply chain.

However, this system has some disadvantages:

- ERP system sets strict requirements for data and their processing, which is not always convenient for the user;
- ERP system is closed, ie it is impossible to integrate modules purchased from other manufacturers into the existing system;
- incompatibility of the ERP system with the supply system, ie it is impossible to integrate the database of the supply system with suppliers and consumers, especially with those who can not purchase ERP;
- the data needed for decision-making are redundant;
- it is difficult to choose the data that are needed for integration with other participants in the logistics chain.

These shortcomings do not allow the effective use of ERP systems for supply chain modeling. These shortcomings are reduced by the SAP R / 3 software, which handles very large databases using the four main modules "Financial Accounting", "Human Resources", "Production and Logistics", "Sales and Distribution".

The name MRP is used for material requirements planning (MRP I) and production resource planning (MRP II) systems.

MRP I aims to minimize inventories while maintaining a sufficient amount of materials needed to support the production process. This system allows [4, p. 275]:

- reduce stocks of raw materials and components;
- place orders, taking into account time intervals;
- get more accurate and reliable information about available and required stocks;
- promptly respond to market demands;
- reduce production costs.

However, this system has a number of disadvantages, namely:

- this system does not allow to optimize the cost of purchasing materials;
- increased risks of shortage of raw materials due to unforeseen restrictions on delivery;
- Standard computer software is not efficient enough, and custom development requires a lot of time and money.

The MRP I system is used by many enterprises and companies, but it is constantly improved, elements of financial, marketing and logistics subsystems are added to it. Thus arose MRP II.

This system has certain advantages over MRP I:

- reduction of stocks of raw materials and components;
- greater turnover of stocks;
- stability and timeliness of product delivery to consumers;
- reduction of costs for the purchase of materials.

These benefits make it possible to reduce the company's costs, but it should be borne in mind that the implementation and maintenance of this system during the first year may amount to more than 750 thousand dollars. [4, p. 277].

DRP (DRP I and DRP II) systems are widely used in distribution. DRP I is used for efficient distribution of finished products through the determination of demand, stocks in distribution centers and warehouses. is an extended version of DRP And thanks to the blocks of personnel, transport, finance.

In DRP II, logistics requirements determine the production schedule, which in turn is related to MRP and ERP systems.

The advantages of DRP II include [4, p. 282]:

- reduction of costs for delivery of products to distribution centers and end consumers;

- reduction of stocks of finished products;

- reduction of storage area;

- coordination of activities between producers and intermediaries.

However, the systems discussed above do not allow to obtain optimal solutions for the supply chain as a whole. For effective use of information support it is necessary to divide it into transactional and analytical information technologies (fig. 1.6).

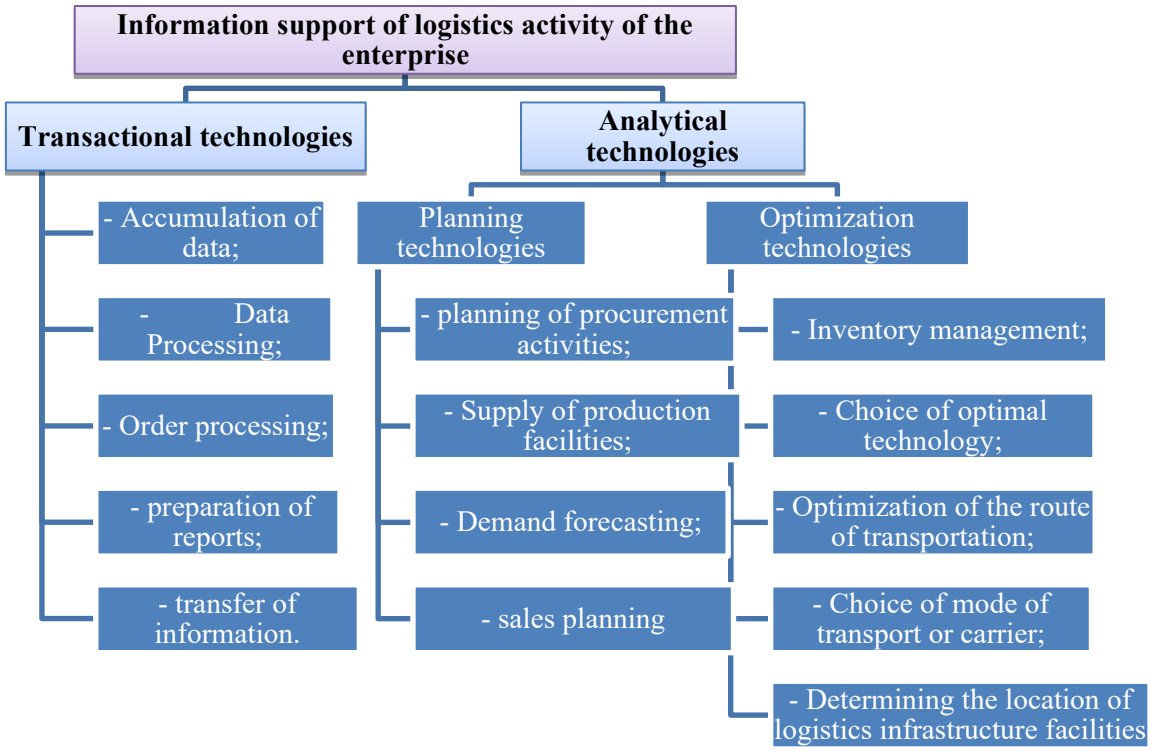

Fig. 1.6. Tasks of transactional and analytical technologies

Investigating the features of each component of information support of the logistics activities of the enterprise, we can identify their main differences, which are presented in table. 1.3.

Table 1.3

Differences between transactional and analytical information technology

№	Features	Transactional	Analytical
1	2	3	4
1	Action horizon	Current	Future
2	Goal	Accumulation, processing and transmission of data	Forecasting and decision making
3	Use of databases	Unsystematized and slightly changed data	Systematized, significantly changed and analyzed data
4	Query execution time	Upon admission in real time	If there is a problem with data processing in batch mode
5	The result for the system	Replacement or elimination of ineffective management decisions	Coordination of management decisions

The above main differences between transactional and analytical information technology allow us to conclude about a certain relationship between them. This is confirmed by the research of the American scientist J. Shapiro, who considers the hierarchy of supply chain management systems (fig. 1.7).

Each of the supply chain management systems performs certain functions (Appendix A).

All proposed systems should contain a set of specific optimization models that will constitute the overall supply chain model. However, the first step in using such a model is a detailed analysis of the data that will make up the supply chain database.

Each of the input files must correspond to a specific supply chain object. These files are divided into two types: structural and numeric data.

To create a supply chain requires structural data, which must contain [4, p. 191]:

- names and locations of existing and potential suppliers, logistics infrastructure facilities and consumers;

- names of products that pass through the supply chain, which can be raw materials, components or finished products;

- names of processes that take place at all objects;

- names of resources consumed by objects;

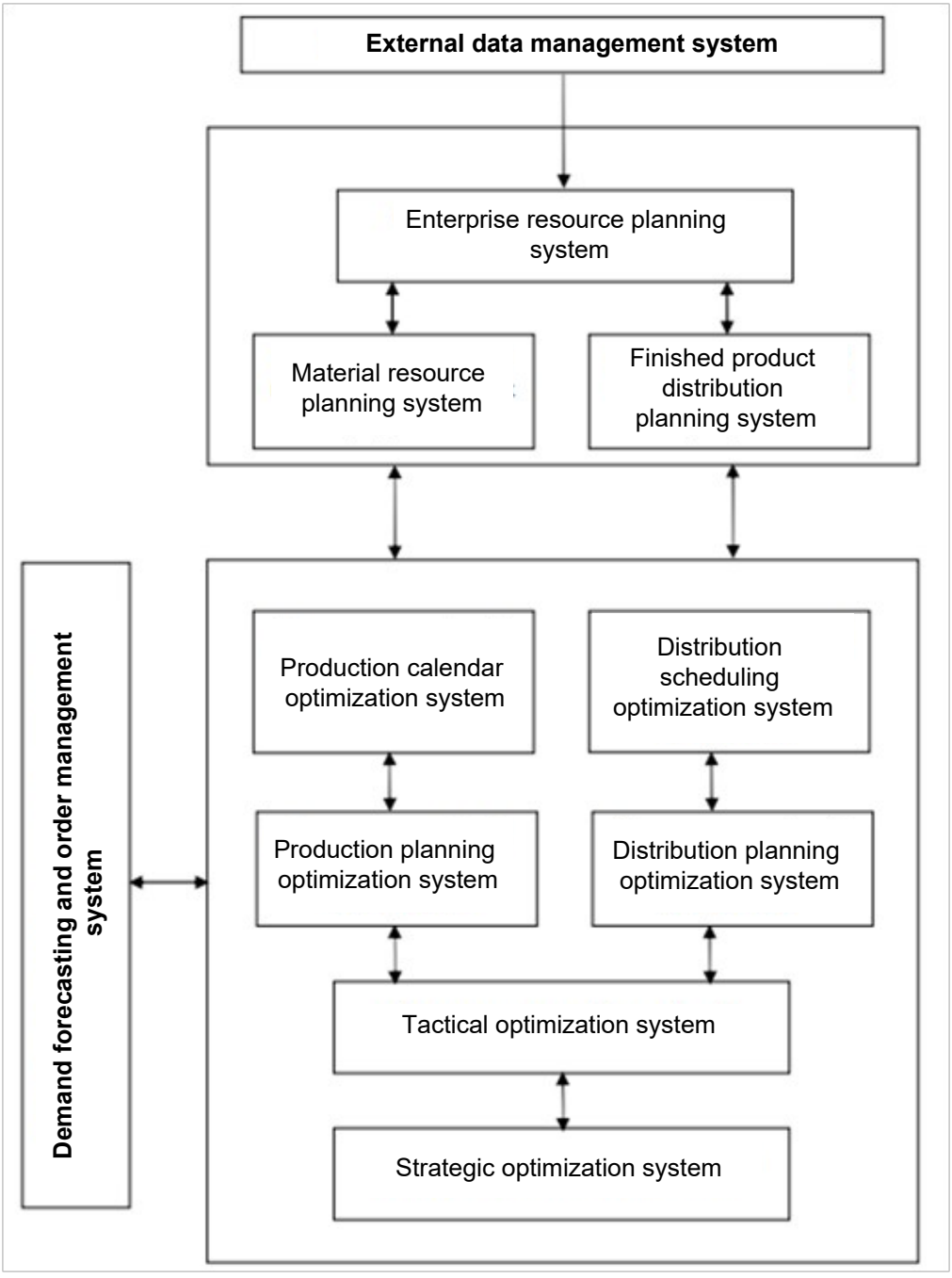

Fig. 1.7. Structuring supply chain management systems

- list of transport connections, which consist of points of departure and destinations.

Numerical data are related to structural data and must contain:

- the amount of raw materials that can be provided by the supplier and the cost of its purchase;
- direct and indirect costs for the purchase and operation of equipment;
- capacity of objects;
- the amount of input and output material flow at each object;
- costs and capacity associated with the processes and resources used by these processes;
- costs and capacity associated with inventory management;
- costs and capacity associated with transport links;
- the number of finished products needed on the market.

Input data are converted into output data using an optimization model (fig. 1.8).

Fig. 1.8. Scheme of optimal decision making

As for the source information, it should be in a user-friendly form and contain information about the optimal:

- the amount of raw materials that can be obtained from each of the suppliers;
- location and capacity of new facilities;
- the level of material flow from suppliers to facilities;
- the level of resources used at each facility;
- maintenance of semi-finished products in the supply chain;
- the level of material flow of finished products to end users;
- the level of logistics services to end users.

Therefore, application packages are widely used to solve logistics problems, which allow to obtain the optimal solution at a certain stage of activity. Systems such as ERP, MRP and DRP require that the various logistics and production activities of the enterprise work in coordination. In order to achieve such coordination, it is necessary to minimize conflicts between participants in the supply chain and introduce new information support for modeling the supply chain. This can be achieved through joint planning and decision making.

1.5. Ensuring integrated activities of enterprises participating in the supply chain

The current level of economic activity of global organizations is characterized by such characteristics as strategic cooperation, development of key competencies, use of innovative technologies, virtuality and interaction. It is also possible to observe the transfer of these trends to the micro level, to the level of enterprises within a particular region. These characteristics are reflected in the concept of supply chain, which provides a systematic approach to integrated planning and management of all flows from suppliers of raw materials to the final consumer [23].

The concept of the supply chain helps to increase the efficiency of enterprises in compliance with the following requirements:

- connection of logistics with corporate strategy;
- improving the organization of the movement of material flows;
- receipt of the necessary information and modern technology of its processing;
- accounting for profits from logistics in the system of financial indicators.

The supply chain strategy is a continuation and logical conclusion of the concept of vertical integration of enterprises, which, in addition to the benefits of cooperation, causes problems with the bureaucratization of management, as it focuses not only on goods but also information and cash flows.

The simplest form of integration, called "vertical integration", can be considered the full integration of organizations on a constitutional or contractual basis in such a chain, when one participant can be a member of only one chain. The integration process is much more complicated when one or more participants of a vertically integrated chain can be a participant not only of one such chain, but of several. The key problem in the implementation of the concept of supply chain in practice is to ensure the integrated activities of enterprises participating in the supply chain and its evaluation, which is why this article is devoted.

Before implementing the concept of supply chain in practice, it is necessary to conduct a quantitative and qualitative assessment of the level of integration of enterprises participating in the supply chain. At the present stage, there are several methods for assessing the effectiveness of supply chain management. The main ones are SCOR (Supply Chain Operation Reference - a benchmark model of logistics chains), BSC (Balanced Ssedre Card - a system of balanced scores) and logistics audit. It should be noted that the use of the BSC methodology requires consideration of the specifics of supply chains. First of all, indicators of supply chain efficiency should characterize the quality of interaction of enterprises in supply chains, the level of synchronization of business processes and integrated management.

The SCOR methodology describes supply chain management processes and compares them with benchmarking data and software functions. SCOR approach is presented in fig. 1.9.

This methodology should be used to create universal models for evaluating business processes within supply chains. SCOR is a descriptive model, has a three-tier structure and allows the company to:

1) make a structured entry into the project of functioning of the supply chain;

2) to model the current and future state of the supply chain at the level of business processes and compare each of their elements with benchmarking data;

3) prepare the basis for the implementation of business processes using information technology.

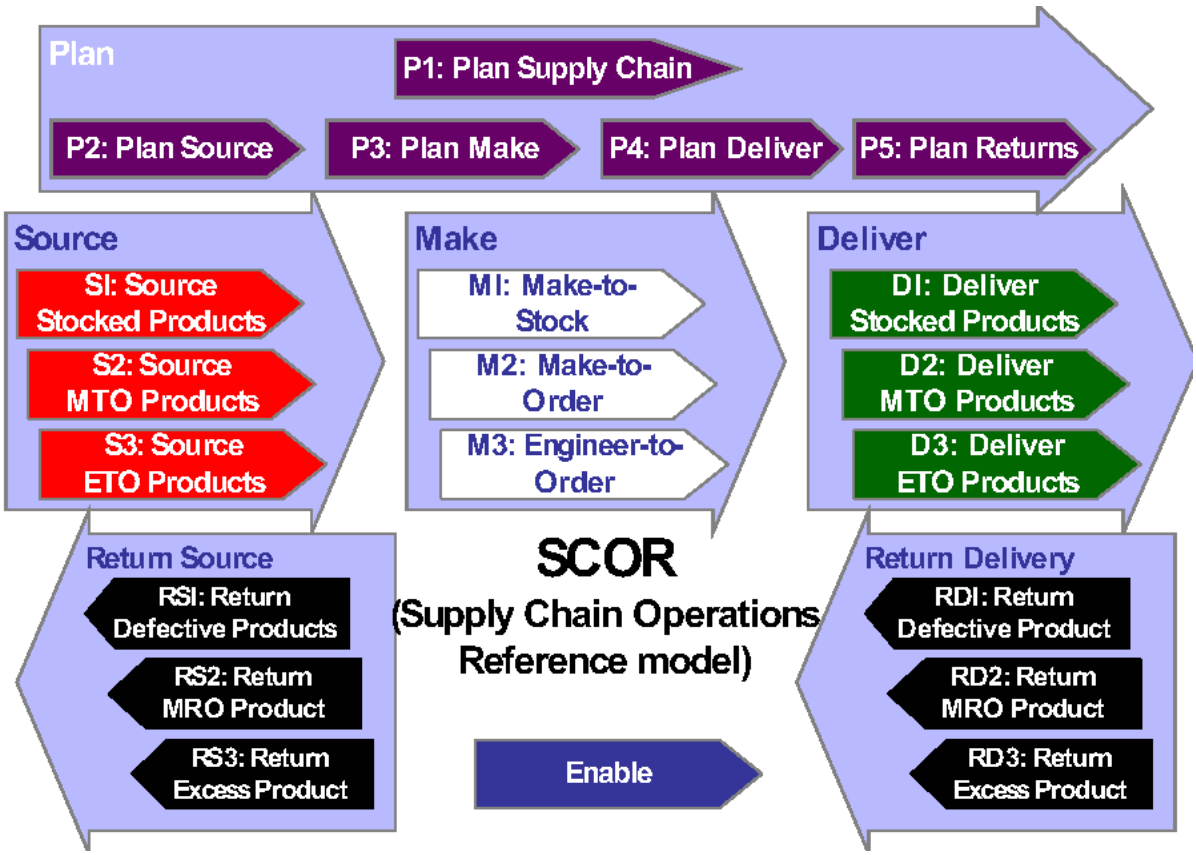

Fig. 1.9. SCOR approach

The disadvantages of SCOR mainly include: focus on a single enterprise rather than on the supply chain, limited modeling of planning and organization processes, lack of control and regulation phases.

Krykavsky Eu. describes the emergence of a specific criterion for assessing the readiness of an individual potential participant in the supply chain to operate in real life - the level of logistics excellence, first introduced into the terminology of logistics by the American Bureau of Logistics in research. A sufficient level of availability of elements of logistics excellence allows the integration of the enterprise with other participants in the logistics supply chain in order to integrate the functions of strategic and operational management of the entire supply chain. Their integrated implementation (planning, organizing, controlling, regulating, etc.) will generate a synergistic effect in the form of reducing total costs, increasing the level of end-user service, reducing overall inventories, accelerating the turnover of production resources, and ultimately creating additional reserves to increase the competitiveness of final products. : in the form of competitiveness of supply chains. On the other

hand, such integration of participants in the logistics supply chain in strategic terms is important for each of the participants, as it creates certain guarantees for demand for their products or services, in particular for some of them such participation may coincide with exclusive competence, ie the supply chain. is a strategic "consumer" of their results [34].

At the present stage of development of economics, the question is how to manage integrated enterprises without resorting to acquisitions, and use the principles of organizing the supply chain to achieve the goals of all counterparties, in partnership and independence.

The method of organizing the supply chain is a consistent description of the processes of radical change in the existing logistics system of the enterprise. The peculiarity of the supply chain design methodology is the focus on logistical maturity and achieving a synergistic effect by all enterprises participating in the supply chain. These are integration processes between enterprises, the purpose of which is not to unite into a single rigid structure (at the expense of different enterprises from different industries), but to promote the achievement of a synergistic effect through voluntary partnership and cooperation. The method consists in passing by enterprises of such stages.

1. Defining the goals and objectives of the projected supply chain.

- To acquaint members and potential partners with the concept of supply chain management and the system of requirements for logistics.

- Carry out a diagnostic analysis of the state of logistics activities and assessment (primary) of the degree of compliance with the requirements for logistics activities in accordance with the procedure of integrated assessment and determine the level of development of logistics activities.

- Define the purpose and objectives of each enterprise and the purpose of the logistics chain in general (ie to design the purpose of the supply chain at the level of each of the enterprises).

2. Selection of potential partners.

At this stage, the procedure of selecting potential partners is carried out to determine the most reliable for strategic cooperation. The procedure for selecting potential partners is similar to the procedure for selecting suppliers, except for some differences. The procedure is performed by the initiator of the supply chain (it can be a manufacturer or a distributor). First, the main potential partner - the consumer, then the partner - the supplier, then, if necessary - intermediaries. To participate in the selection of the project are allowed the best of each group of contractors (if the company already has procedures for their selection) or fill out a form for each of the group.

In each case, the set of criteria for selecting partners is specific, depending on the type of enterprise and the scale of production. The second stage ends with the announcement of the most successful potential partners about their participation in the further improvement of logistics activities and the supply chain in general.

3. Determining the current state of logistics and supply chain.

The third stage begins with the formation of the management body of the supply chain with advisory functions, which is financed from the funds of the participants in the supply chain. The head of this body, as a rule, is the general director of the enterprise-initiator. The analytical department consists of logisticians who report directly to the head of the department. The essence of this stage is that the participants submit reports on the assessment of the current state of logistics activities to the meeting of the supply chain council. There is an exchange of experience (including mutual requirements) in the form of a round table, where the analysis and adjustment of the goals and objectives of further development of logistics activities of each partner and the supply chain in general. The stage ends with the formulation of goals and objectives for further development, according to which each of the participants in the supply chain determines the desired state of its logistics activities and vision of the desired state of the supply chain.

4. Modeling of options and selection of a system of requirements to achieve the desired state of logistics activities of the participating company and the supply chain in general.

The analytical department presents the simulation results for examination to consultants and experts. Alternatives (no more than three for each supply chain participant) are considered and discussed at the supply chain board. The decision of the supply chain board approves the option of development of logistics activities, as well as an alternative in case of unforeseen circumstances. Accordingly, the selected system of requirements for logistics activities for each participant in the supply chain is approved.

5. Defining the budget, deadlines, resources, staff, risks and drawing up a project schedule.

Based on the selected development options, the logistics department of the enterprise together with the structural units prepares a draft budget of changes in accordance with the schedule of implementation of the system of requirements, indicating the necessary measures, deadlines, resources and staff involved. Variants of schedules and budgets are sent to the analytical department of the supply chain council, where they are checked for consistency and consistency and agreed in working order with each participant in the supply chain. This stage ends with the definition of the source of funding for change.

6. Implementation of the project to change the logistics and supply chain.

The essence of this stage should be presented in a set of repetitive activities for each participant in logistics activities. After the project implementation the results are summed up and the obtained results are compared with the desired ones, in case of deviation - the reasons are established and corrective measures are developed.

The selection of indicators is based on the integrated criterion of logistical maturity, which includes the following objects: personnel, technological processes, partnership, innovation. In the table. 1.4 presents indicators that relate to the main research objects in the field of logistics.

The selection of indicators depends on the subject of activity of enterprises, as well as market conditions for the operation of these enterprises. For example, there is a set of indicators whose values need to be improved (the order of design from the reverse). In the existing SCOR model, it would be necessary to select processes that

have such an indicator and specifically develop measures to improve them. In the proposed revision of the SCOR model such a role is assumed by an integrated indicator of logistical maturity with the central parameter "requirements for logistics activities", where on the basis of a given indicator choose certain requirements (with criteria for their implementation) [15].

That is, the company receives a standard of logistics activities for the development and comparison of measures in accordance with the system of requirements, rather than developing new measures each time. If it is necessary to improve certain processes, it is enough to consider the requirements that apply to them, and then perform the algorithm of supply chain design. Thus, it saves a lot of time to find and develop the necessary measures, and the quality of design solutions increases significantly.

Table 1.4

Analyzed objects and indicators of evaluation of logistics activities of enterprises

№	The analyzed parameter				
		Personnel	Technological processes	Partnership	Innovation
1	2	3	4	5	6
1	Evaluation indicators	The level of influence of logistics on the formation of competitive advantages	Technical condition of logistics processes infrastructure	Level of integration in order execution management	The level of innovation of logistics
2		The level of consideration of logistics concepts in making management decisions	Level of centralization of inventory management	The level of service provision by suppliers in terms of price, quality, terms of delivery,	Level of integration of functional information systems
3		Level of qualification of logistics managers	The level and structure of logistics costs	The level of logistics customer service in terms of quality, accuracy, reliability	The level of "virtuality" of stocks
4			The level of damage from damage, depreciation	Level of integration of planning systems	

As a result of introduction of a technique of designing of a supply chain it is provided:

- reducing the duration of the production cycle;
- improving the quality of delivery;
- optimization of logistics costs.

Reducing the duration of the production cycle is due to the integrated application of modern technologies of business modeling, "careful production", "Kaizen". The technology of "careful production" introduces a different understanding of quality management and control, in particular logistics solutions, allows to normalize the technological process, reduce the time of operations and optimize the batch of supplies. The method of "Kaizen" changes the role of the manager, allows not only to plan improvements in production, but also to successfully implement them through awareness of the strategic role of personnel of the organization. The requirement to outsource non-core activities also has a positive effect on reducing the length of the production cycle. Reduction of the "delivery time" indicator is due to the introduction of electronic data exchange EDI and automation of processes of reception, loading / unloading, warehousing and processing of goods together with the use of optimal delivery schemes and the use of logistics providers [41].

Optimization of logistics costs through the implementation of clear planning, organization of control over the implementation of decisions, and if necessary, regulation in all subsystems of logistics, is carried out through:

- reduction of stocks,
- transportation routing,
- refusal to work with many suppliers in favor of one,
- rationing of technological processes,
- development of optimal schemes of product delivery with the help of logistics providers.

These solutions will allow supply chain members to save their costs on material flow management and logistics operations. Due to the integration of logistics

requirements with the requirements of the quality system of the ISO-9000 series, there is an interpenetration and complementarity of logistics processes, which improves the quality of delivery in general. This applies to all subsystems of logistics (supply, production, marketing, transportation, warehousing). Due to the requirements to improve the quality of supply, the introduction of self-control in production, waste management, improving storage conditions and increasing the responsibility of the integrator of the logistics chain - improves the quality of processes and customer service.

7. Implementation of "exit" / "entry" of partners in the supply chain.

This procedure regulates the exit / entry of new members into the partnership. The need for "entry" and "exit" procedures is explained by the fact that in a partnership, participants become available trade secrets, secrets and technologies that are not available in normal interaction. In the event that neither partner has a claim against a partner wishing to withdraw from the partnership, the general rule is to withhold a certain proportion of the deductions for the development of the supply chain. These tools will be needed to find and develop other partners faster, to maintain the achieved efficiency of the logistics chain.

The methodology is interconnected, logically ordered, which improves business processes for the reorganization of the existing logistics system to achieve its desired state. The design is carried out not only within the enterprise (subsystem of logistics activities: procurement, production, distribution, transport, warehouse), but in conjunction with the logistics systems of partner companies (suppliers, consumers), helping to achieve not only the local goal of each contractor, but also the corporate goal of all participants in the supply chain [46].

Thus, with the help of logistics solutions, it is possible to achieve strategic goals of minimizing costs, maximizing added value and increasing the elasticity and adaptability of the supply chain. The effectiveness of such decisions will depend on the amount of financial and time effort, and on the potential generated by them for positive changes in the same finances, in duration, in elasticity, in customer loyalty,

in other manifestations of synergy. It depends on how justified the logistics strategy can be interpreted as a corporate strategy.

Consideration of logistics strategy as a corporate strategy in the work is motivated at the present stage by the following important reasons:

1) the concept of logistics is most suitable for use in the supply chain, which forms a mechanism for coordinating the value chain;

2) the structure of time used for production and delivery of the final product to the consumer - one of the indicators that significantly depends on the field of logistics;

3) logistics in a highly competitive environment can be considered as the most attractive and most effective factor in the formation of competitive advantages of enterprises;

4) logistics strategy can guarantee an optimistic outlook for the company.

In particular, the concept of logistics integration in the supply chain requires strategic decisions on:

a) the use of logistics outsourcing in relations between suppliers, manufacturers and distributors;

b) establishing partnerships between participants in the logistics chain, which will synchronize the supply, production and distribution and the relevant transport processes to maintain the desired stock levels;

c) formation of a distribution system capable of forming logistics services with highly efficient characteristics (high availability, low costs, individual approach).

Therefore, before designing processes in the supply chain, it is necessary to define common goals for all units, which are usually low costs or reduced time. Their identification and later implementation will be possible if: managers of enterprises change their attitude to the idea of partnership in the supply chain; When choosing a partner, enterprise managers will take into account the criteria of organizational and strategic culture of enterprises, and they are: a sense of trust, approach and plans of management staff related to the future development

of the enterprise, strategic adaptation - consistency of strategic directions of enterprise development. mutual role in achieving strategic goals.

The theoretical part of the thesis is devoted to supply chain management, which will mean the sequence of economic entities from suppliers of raw materials, parts, components and components to consumers of the final product (service), which, carrying out production, trade, logistics and other processes, are those that are directly related to the movement of material and corresponding information flows at established stages. A chain assembly that is unable to provide proper quality limits the supply capacity. Therefore, the urgent problem is to manage the quality of the entire supply chain, not its individual units. Chain participants should strive not to meet their own planned quality indicators, but to achieve the overall performance of the supply chain.

In accordance with the previously presented "rules of logistics" it becomes possible to define the concept of "supply chain quality management". Thus, supply chain quality management is a coordinated activity aimed at meeting the requirements for the quality of the supply chain: delivery of the desired product of the required quality, in the required quantity, at the right time, place and with minimal costs.

The practice of supply chain management proves the effectiveness of building and analyzing the business, based on an integrated consideration of all areas and junctions of different stages of the value chain, rather than optimizing the local management functions of your own enterprise. After all, highly efficient supply chains provide maximum satisfaction of demand for products (services) in the most flexible, reliable and less expensive way, which is the basis for sustainable development of the organization.

The advantages and disadvantages of ERP, MRP and DRP systems were also analyzed. The directions of improvement of information support for modeling of a supply chain are offered. The relationships and functions of supply chain management systems are defined. The components of the supply chain database are considered.

2. ANALYTICAL PART

Air Transportation Management Department				*NAU.20.07.42 003EN*		
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2.1 Analysis of activities of the transnational logistics company «KUEHNE + NAGEL»

With approximately 83,000 employees in approximately 1,400 locations in more than 100 countries, Kuehne + Nagel Group is one of the world's leading logistics companies. The company has a strong market position in the field of freight transport by sea, air, land transport and contract logistics, with a clear focus on high value-added segments, such as integrated logistics solutions based on IT.

The company was founded in Bremen, Germany by August Kuehne and Friedrich Nagel in 1890. The history of the Kuehne + Nagel Group begins in 1890 in Bremen, where Augustus Kuehne and Friedrich Nagel founded a forwarding agency.

The company initially focused on cotton shipping and consolidated freight shipping. Later, in 1902, the company began operations in the German seaport of Hamburg. In 1907, co-founder Frederic Nagel died, and August Kuehne took over his share in the company. In the early 1950s, Alfred Kuehne initiated the international expansion of the company, which resulted in the opening of Kuehne + Nagel branches in Toronto, Ontario and Montreal, Quebec. In 1963, Kuehne + Nagel acquired a majority stake in Athens and expanded into Italy. In 1975, the company was transformed into a holding company called Kuehne + Nagel International AG, based in Schindelegui, Switzerland. Kuehne + Nagel also expanded through the acquisition of freight companies: Domenichelli SpA (Italy), Van Vliet BV (Netherlands), Hollis Transport Group Ltd. (UK), Transportes Tres (Spain) and other companies in Denmark, Norway and Sweden. In 1980 KN Germany operated as the largest KN company in the world. In 1985, the management of Kuehne + Nagel developed a pan-European strategy for preparing the company for the single European market. The company's main priority was to expand its transport, warehouse and distribution network in Europe. This concept is called "KN Euro Logistics". In the early 2000s, Kuehne + Nagel entered the logistics services market in the Asia-Pacific region when the company entered into a strategic alliance with

Singapore-based SembCorp Logistics. In 2001, the company acquired USCO Logistics Inc. is a logistics service provider based in a warehouse in Hamden, Connecticut.

Today, Kuehne + Nagel Group offices are located around the world (see Figure 2.1). The company is based in Shindeleggi, Switzerland.

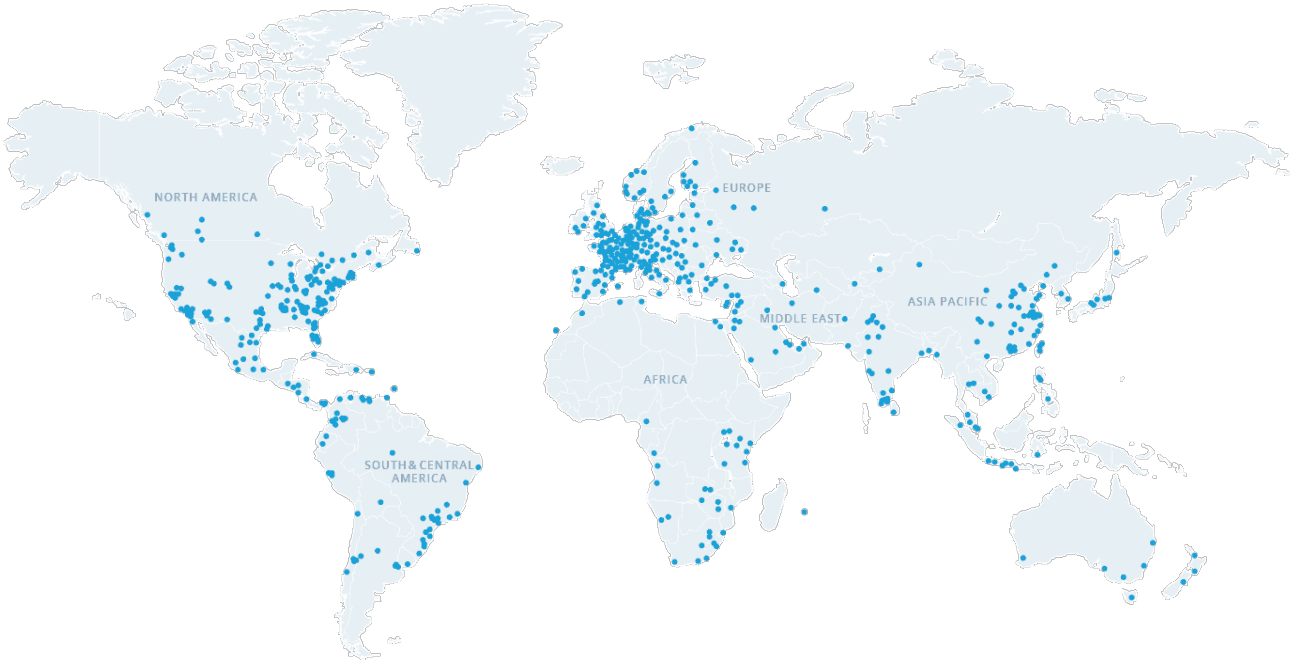

Fig. 2.1. Kuehne + Nagel Group offices around the world

Operational activities are carried out in the following geographical regions:

- Europe, the Middle East, Central Asia and Africa;
- North and South America;
- Asia-Pacific region.

The main activities and market position of the company are presented in fig. 2.2.

The mission of the Kuehne + Nagel Group sounds like “the global logistics network is our strongest asset. Commitment, integration and innovation are at the core of our business philosophy. Focusing on the needs of our customers, we offer integrated logistics solutions of exceptional quality and operational excellence - we are an extension of your business. "

Maritime logistics:

- Global Sea Freight Forwarder number 1
- Steady annual increase in freight traffic
- Strong partnerships with a wide range of the best maritime carriers

Aviation logistics:

- Global Freight Forwarder number 2
- Leader in innovative cargo flow management concepts
- • • Global Cargo iQ Phase 2 certification

Contract and integrated logistics:

- Global Contract Logistics Supplier number. 2
- World network of warehousing and distribution centers
- The world's leading provider of logistics services number 1

Automotive logistics:

- European top 5 provider, North and Central America - top 15 best providers, presence in the countries of the Cooperation Council of the Arab States of the Persian Gulf and Southeast Asia
- Leader in groupage, LTL, FTL, intermodal transport, and pharmaceutical transport
- Large own fleet and close partnerships with best-in-class carriers

Fig. 2.2. The main activities of Kuehne + Nagel Group

The history of "Kuhne + Nagel" in Ukraine began in 1992, and today the company employs about 450 employees. During this time, "Kuehne + Nagel Ukraine" has created a strong team of professionals, established long-term relationships with clients - leading Ukrainian and international companies, which are represented in Ukraine, created a network of branches in Ukraine. The main office is located in Kyiv, also offices are represented in Lviv and Odessa (see fig. 2.3).

Fig. 2.3. Network of offices and warehouses Kuehne + Nagel Ukraine

The organizational structure of the company is presented in fig. 2.4.

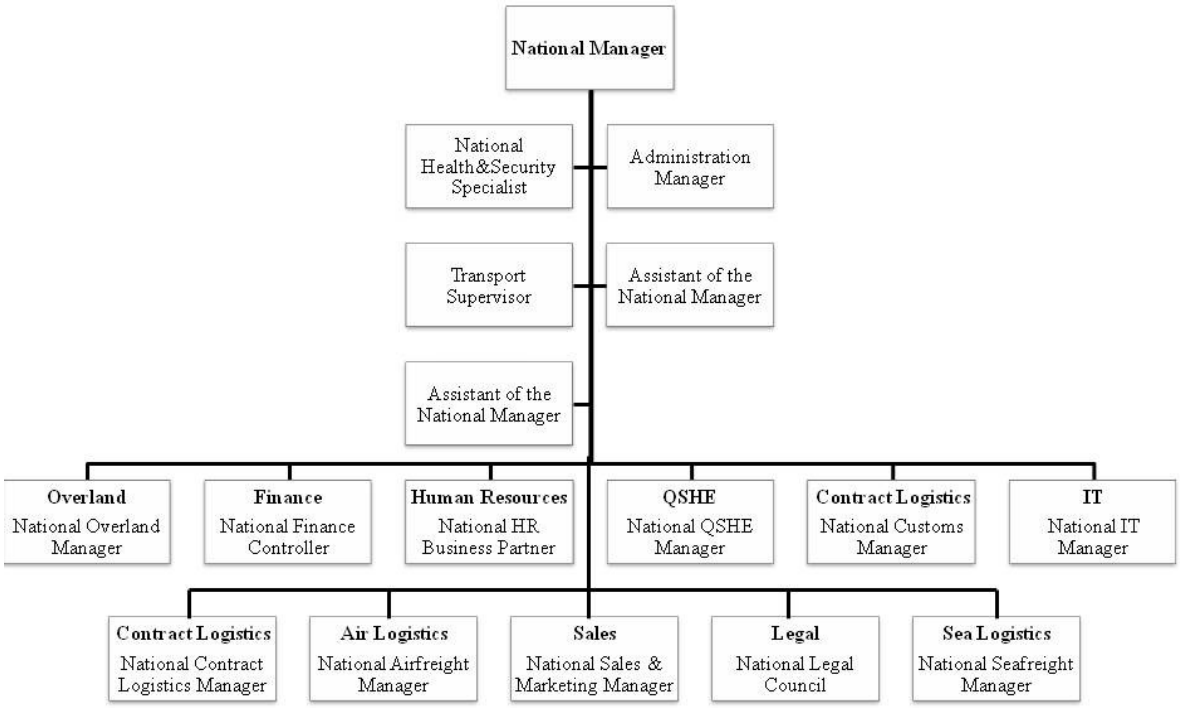

Fig. 2.4. Organizational structure of Kuehne + Nagel Ukraine

Business units and areas of business include: maritime logistics, air logistics, contract logistics, integrated logistics, ground transportation and brokerage services.

The functional divisions include: finance + controlling, personnel management, information technology, legal services and QSHE (quality, safety, health and environment).

Kuehne + Nagel Ukraine services are provided in quite different industries: aerospace, high-tech, hotel logistics, maritime logistics, etc. (see fig. 2.5).

One of the main trends in the modern logistics market is the use of innovative IT tools for visualizing processes, as well as monitoring the entire supply chain in real time. Therefore, the company's specialists have developed a special service KN Login, which will allow you to manage your cargo deliveries around the clock.

Aviation departments around the world of Kuehne + Nagel deliver more than 1.3 million tons of air cargo annually. The company covers key air traffic, as well as develops new transport solutions for the delivery of goods to more remote corners of the planet. The employees of Kuehne + Nagel provide a high level of service and

delivery of your air cargo as quickly as possible, safely and with minimum transport costs.

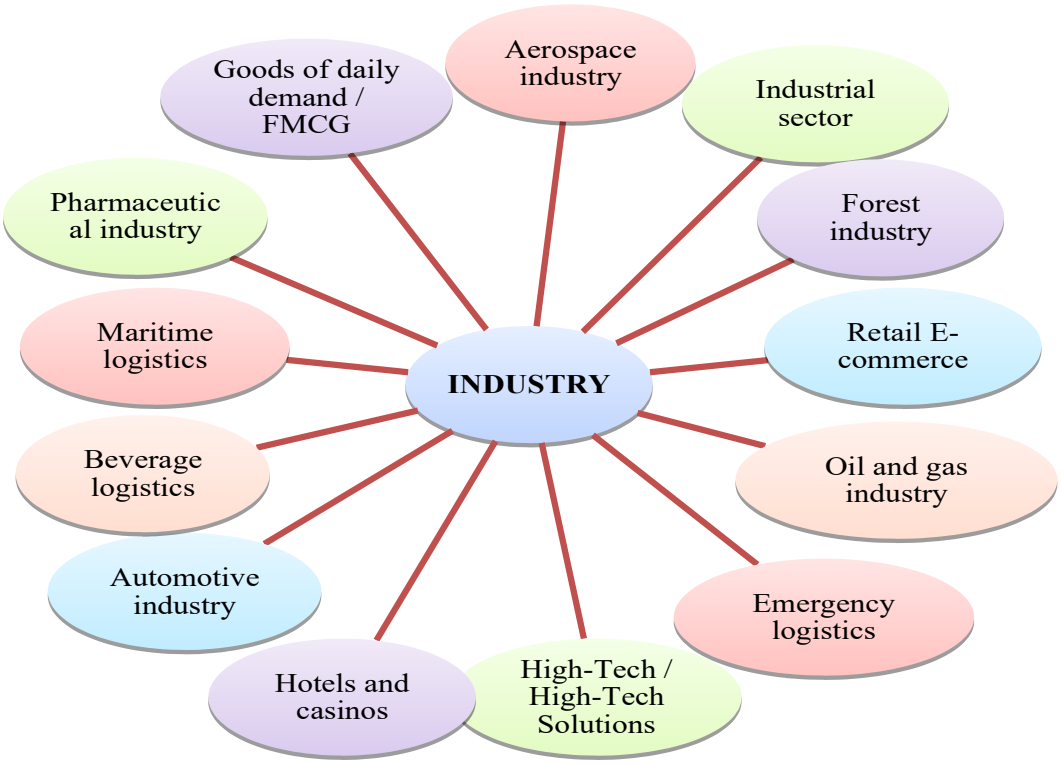

Fig. 2.5. Presence of Kuehne + Nagel Ukraine in various industries

The key services of the company Kuehne + Nagel in sea transportation are:

- export - import - transit of goods;
- container FCL transportation;
- transportation by prefabricated LCL containers;
- intermodal transportation (sea-air, sea-car);
- marine cargo insurance;
- consolidation of cargo in own warehouses located in the largest ports of the world;
- customs brokerage services;
- transportation of dangerous and oversized cargo;
- project logistics;
- door-to-door or port-to-port delivery.

Kuehne + Nagel is one of the world's leading providers of contract logistics services. The company operates in warehouses of more than 8 million square meters in more than 65 countries and has expertise in logistics solutions in contract logistics both globally and in Ukraine.

It has been operating in Ukraine since 1998 and operates more than 100,000 m2 of warehouse space, providing high-quality 24/7 services and using a modern warehouse operations management system that gives customers more flexibility and operational needs.

The company's mission: "Focusing on the needs of our customers, we offer high-quality integrated logistics solutions and production excellence; we are a continuation of your business."

Six key strengths that characterize the company:

- Entrepreneurial spirit;
- Logistics experts;
- Global network;
- Trusted brand;
- International standards and IT systems;
- Economical management and efficiency.

Kuehne + Nagel attaches equal importance to all six key strengths, but places a new strategic emphasis on "cost-effective management and cost-effectiveness":

"Economical management" is no other term for "cost reduction". In order to move forward, the focus should be on "smart savings".

"Smart savings" means the systematic redesign of the internal processes facing the customer using technology and systems. The company strives to simplify, automate and eliminate unnecessary processes at every level of our company.

Customers are at the heart of a business strategy and run the company in everything it does.

Technology is a key factor in mastering the customer's future requirements and increases efficiency.

Staff is the foundation of consumer value creation and makes us a leader in logistics initiative technologies and supply chain services.

The main competitors of the company are such transport-logistics and forwarding companies as "STS Logistics" (100%), "Polar Logistics" (67%), "Panalpina World Transport" (67%), "MSC Ukraine" (Ltd) (67%).), DHL Logistics (67%), Vesta (67%), Cma Cgm (67%), Formag Odessa (67%), International Cargo Service (33%), K- Line Ukraine "(33%)," Arete Ukraine LTD "(33%)," Ukr-China Logistics "(33%).

Traditionally, logistics companies in Ukraine are present mainly in large cities and occupy large areas, but in the regions this trend is represented by much lower indicators of both the region and the diversity of the companies themselves. This is primarily due to the weaker development of regional markets. Regarding the Ukrainian logistics market, the main competitors are such companies as DHL Ukraine, Zammler, Raben, Ekol, FM Logistic, Logistic Plus.

Kuehne + Nagel works with clients in B2B mode, so the company provides services to other companies, not end users. This area of activity is focused on the benefit (profit) from the provision of services or sale of goods, where the "objects" are services or goods, and "subjects" - organizations that interact in the market sphere. Here, organizations and (or) individual entrepreneurs act as "sellers" and "buyers" of services or goods.

Kuehne + Nagel Ukraine cooperates with other companies in the fields of pharmaceuticals and healthcare, oil and gas, FMCG (consumer goods), automotive and aerospace, high-tech goods, food services, forest products and industrial goods.

Top customers are companies such as Mondelez Corporation, Toyota Ukraine, Auchan, Lenovo, Budpostach, Indar, Indesit, Bosh, JTI, B.A.T. - Prulucky, Kraft food, H&M, Samsung, Jacobs, Loreal, Inditex, Intertop, Claas, BIC, Leroy Merlin and others.

2.2 Analysis of financial and production indicators of the «Kuehne + Nagel» company

Kuehne + Nagel, one of the world's leading providers of logistics services, again showed record results in 2019, according to the results of the annual report. The global economy is estimated to have grown by only 2.4% last year due to consistently low trade and investment activity, the lowest growth rate since the 2008 financial crisis. Geopolitical tensions and differences over trade policy are holding back international investment and causing some uncertainty. In 2019, world trade increased by only 1.0% compared to 3.7% in the previous year.

The net turnover of Kuehne + Nagel in the 2019 financial year grew by 1.5%, which is significantly higher than the market growth (see table 2.1).

Table 2.1

Performance indicators of the company Kuehne + Nagel during 2016-2019

№	Indicators	2016	2017	2018	2019
1	Turnover, million CHF	199885	22220	24825	25295
3	Net turnover, CHF million	16525	18594	20774	21094
4	Gross profit, million CHF	6550	7023	7709	7981
5	Total costs, CHF million	(5440)	(5873)	(6500)	(6152)
6	Earnings before interest, taxes, depreciation and amortization (EBITDA), million CHF	1110	1150	1209	1829
7	Operating income (EBIT), CHF million	918	937	987	1061
8	EBIT as a percentage of gross profit	14,0	13,3	12,8	13,3
9	Total number of employees at the end of the year	70038	75876	81900	83161

The company also improved its profit margins: EBIT grew by 7.5%. In fact, for the first time in the company's history, EBIT exceeded one billion. Due to the fact that Kuehne + Nagel pays special attention to customer service and profitability, continuous improvement of operating systems and their further digitization, the

company has managed to increase its market share in all business units. In general, Kuehne + Nagel have once again achieved its strategic goal - to grow twice as fast as the market of its transport networks.

In 2019, Kuehne + Nagel Group increased the number of employees on an annualized basis by 1261 or 1.5% from 81,900 to 83,161 employees. The number of full-time employees reached 78,448 against 77,416, which is an increase of 1,032 or 1.3%.

Maritime traffic increased by 3.6% to 4,861,000 TEU (see Table 2.2). Services in the transportation of goods with thermal regime in refrigerated containers and order management have significantly contributed to growth. Customers in the pharmaceutical and medical industries use Kuehne + Nagel to treat temperature-sensitive products. Exports from Asia to Europe and the United States, as well as intra-Asian trade, contributed to significant growth. In 2019, EBIT increased by 9.1% compared to the previous year, while the ratio of EBIT to gross profit (conversion rate) increased to 29.6% (2018: 28.2%).

Table 2.2

Performance indicators of the company Kuehne + Nagel in the field of maritime transport during 2016-2019

№	Indicators	2016	2017	2018	2019
1	Turnover, million CHF	7981	8805	9366	9751
3	Gross profit, million CHF	1416	1416	1482	1539
4	Total costs, CHF million	(951)	(979)	(1041)	(1054)
5	Earnings before interest, taxes, depreciation and amortization (EBITDA), million CHF	465	437	441	485
6	Operating income (EBIT), CHF million	445	414	418	456
7	EBIT as a percentage of gross profit	31,4	29,2	28,2	29,6
8	Number of operational staff	9154	9543	10025	10535
9	TEUs, thous.	4053	4355	4690	4861

Due to the global reduction in air traffic, the Kuehne + Nagel Group had to record a decrease in volume of 5.7% to 1,643,000 tons, thus ranking second as a global air transport provider (see Table 2.3). The level of EBIT to gross profit

decreased to 25.0% in 2019 (2018: 29.5%). EBIT decreased by 7.3% compared to the previous year.

Table 2.3

Performance indicators of the company Kuehne + Nagel in the field of air transportation during 2016-2019

№	Indicators	2016	2017	2018	2019
1	Turnover, million CHF	3935	4759	5620	5465
2	Net turnover, CHF million	3347	4080	4870	4653
3	Gross profit, million CHF	964	1036	1202	1317
4	Total costs, CHF million	(649)	(703)	(822)	(923)
5	Earnings before interest, taxes, depreciation and amortization (EBITDA), million CHF	315	333	380	394
6	Operating income (EBIT), CHF million	298	313	355	329
7	EBIT as a percentage of gross profit	30,9	30,2	29,5	25,0
8	Volume of traffic, thousand tons	1304	1570	1743	1643

The acquisition of Quick International Courier, an express carrier specializing in the pharmaceutical and aviation sectors, has a long-term positive impact.

The Kuehne + Nagel Group have acquired specific knowledge, skills and experience in industry and specific supply chains through various strategic programs. Organic growth in areas such as perishable goods transport, pharmaceutical and aerospace logistics, as well as mergers with other companies, continues determine the leading positions of the Kuehne + Nagel Group.

Visualization of the development of the volumes of sea and freight traffic makes it possible to see the rates of growth or decline (fig. 2.6).

On the other hand, the profit from the transportation of a unit of cargo by sea and air transport is approximately the same (see fig. 2.7, 2.8).

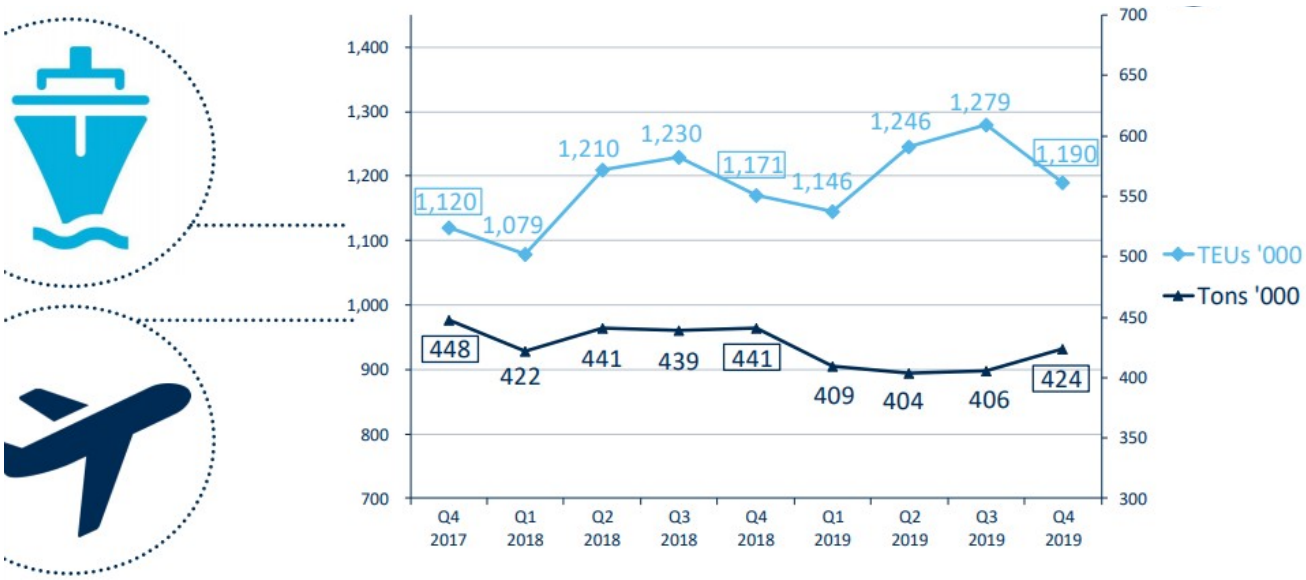

Fig. 2.6. Dynamics of traffic by sea and air transport by the Kuehne + Nagel company

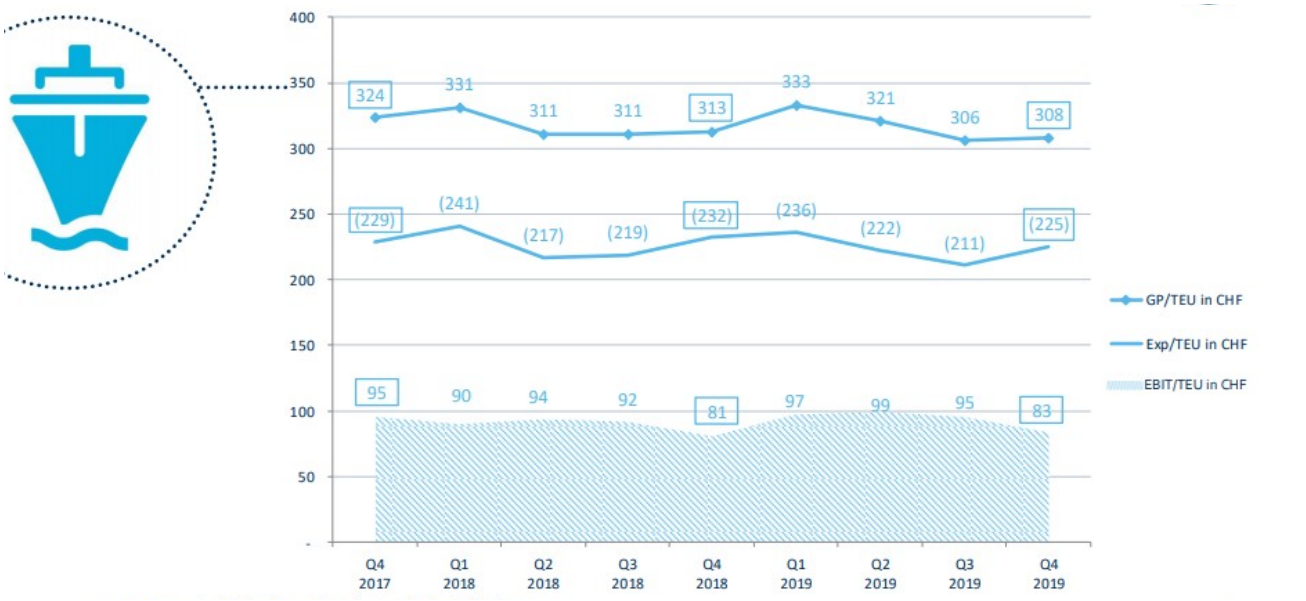

Fig. 2.7. Dynamics of profit per unit of cargo transported by sea by the Kuehne + Nagel Company

The net turnover of road transport increased by 1.7% in 2019 due to the strong performance of land transport in Europe (see table 2.4). The Group continues to expand its services through the acquisition of Joebstl Group in Austria with a strong position in the Eastern European market and the acquisition of Rotra in Belgium and the Netherlands to further intensify pan-European land transport.

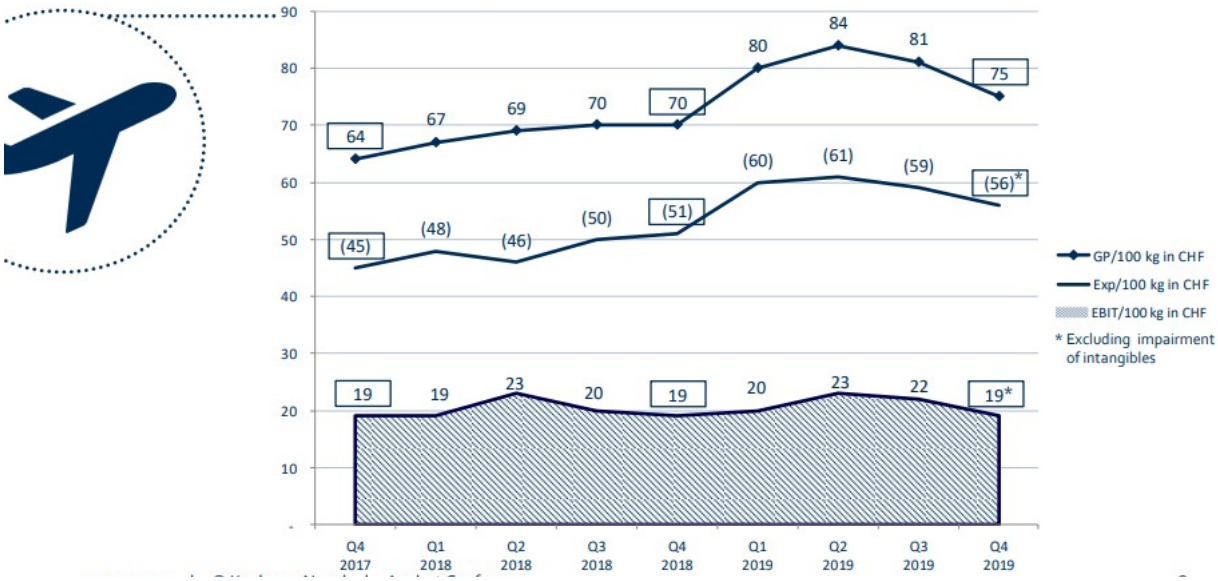

Fig. 2.8. Dynamics of profit per 100 kg of cargo transportation by air by the Kuehne + Nagel company

Table 2.4

Performance indicators of the Kuehne + Nagel in the field of ground transportation of the company during 2016-2019

№	Indicators	2016	2017	2018	2019
1	Turnover, million CHF	3130	3356	4009	4102
2	Net turnover, CHF million	2898	3117	3526	3586
3	Gross profit, million CHF	895	952	1088	1121
4	Earnings before interest, taxes, depreciation and amortization (EBITDA), million CHF	70	92	118	136
5	Operating income (EBIT), CHF million	28	49	76	78
6	EBIT as a percentage of gross profit	3,1	5,1	7,0	7,0
7	Number of operational staff	7894	8040	8456	8781

The ratio of key EBITDA efficiency to net turnover improved to 3.8% compared to 3.3% the previous year. EBIT increased to 78 million Swiss francs (2018: 76 million Swiss francs). The dynamics by quarters is presented in Fig. 2.9. With the expansion of services to industry solutions, the ground transportation department has significantly contributed to the success of the comprehensive logistics offer Kuehne + Nagel Group.

Fig. 2.9. Dynamics of indicators of the Kuehne + Nagel company in the field of road transport on a quarterly basis

The focus on specialized end-to-end solutions for industries such as automotive, high-tech, consumer goods, aerospace, pharmaceuticals, healthcare and e-commerce has been reflected in numerous new customer contracts. This led to (excluding currency impact) an increase in net turnover by 5.8% in 2019 (see table 2.5).

Table 2.5

Performance indicators of the Kuehne + Nagel company in the field of contract logistics during 2016-2019

№	Indicators	2016	2017	2018	2019
1	Turnover, million CHF	4939	5300	5830	5977
2	Net turnover, million CHF	4466	4814	5249	5398
3	Gross profit, CHF million	3275	3619	3937	4004
4	Profit before interest expense, taxes and depreciation charges (EBITDA), CHF million	260	288	270	814
5	Operating profit (EBIT), CHF million	147	161	138	198
6	EBIT as a percentage of gross income	4,5	4,4	3,5	4.9
7	Number of operating personnel	35866	39957	43694	43661
8	Warehouse area in m2	10021688	10631779	11587597	11388643
9	Idle area in m2	364035	283690	343081	336696
10	Idle area in%	3,6	2,7	3,0	3,0

Visualization of the dynamics of operational indicators of the contract logistics department is presented in fig. 2.10.

Fig. 2.10. Quarterly dynamics of the company's contract logistics activities of Kuehne + Nagel business units

In 2019, more than 100 new logistics projects were implemented for customers, which allowed the company to manage 11.4 million square meters of warehousing and logistics space worldwide. At the same time, Kuehne + Nagel Group has focused on its client portfolio, which allows it to engage other business units and uses scalable and sustainable logistics solutions. This has led to a change in the size of business in some European countries. This initiative will continue in 2020 and 2021. The restructuring of the product, real estate and customer portfolio, as well as the impact of the new international financial reporting standard IFRS 16 "Leases" in 2019 led to an increase in EBITDA to net turnover to 15.1% against 5.1% in 2018; EBIT increased by 43.5%.

Kuehne + Nagel has further strengthened its global leadership in integrated logistics. The group offers specialized end-to-end supply chain management solutions, in which logistics control towers are involved and management takes place in close contact with other business units, supporting customers in improving their

value chain. Integrated logistics experts develop, implement and manage solutions that streamline the customer's supply chain to make it a sophisticated, flexible and manageable demand.

As a pioneer in the industry, Kuehne + Nagel has also decided to proactively eliminate CO2 emissions from transport services provided by its suppliers - airlines, shipping lines and transport companies. Kuehne + Nagel aims to comprehensively neutralize CO2 (Scope 3 of the Greenhouse Gas Protocol - GHG) by 2030. As a first step, all cargo without containers (LCL) will be CO2-neutral from 2020.

Kuehne + Nagel's Net Zero Carbon program reinforces three areas of action: detection, reduction and compensation of CO2 emissions. The group has launched its own environmental projects in Myanmar and New Zealand and has invested in various environmental projects to offset CO2 emissions, in which carbon is taken from the atmosphere. The resulting emission quotas meet the highest international standards.

Kuehne + Nagel showed profitable growth in the third quarter of 2020, after the first half of the year, which was marked by a coronavirus pandemic. Taking into account currency adjustments, the company significantly improved key operating indicators in the third quarter.

Net turnover for the first nine months amounted to 14.8 billion Swiss francs, and EBIT - 790 million Swiss francs. Currency fluctuations had a significant negative impact on both net turnover (-5.7%) and EBIT (-5.9%) in the first nine months. Free cash flow increased by 31.4% in the first nine months (see table 2.6).

In the third quarter of 2020, revenue growth in the maritime transport sector reflected positive trends compared to the first half of the year. The improvement is due to the resumption of demand from small and medium-sized enterprises and increased imports to Europe and North America from Asia.

In the third quarter of 2020, the volume of container traffic increased by 10.4% to 1.2 million TEU compared to the second quarter. The division's net turnover amounted to almost 1.8 billion Swiss francs, and EBIT improved by 12.3% for the year to 137 million Swiss francs. The conversion rate was 36.2% (see table 2.7).

Table 2.6

Performance indicators of the Kuehne + Nagel company during 9 months 2020

№	Indicators	9 months 2020	9 months 2019	Δ	3 quarter 2020	3 quarter 2019	Δ
1	Net turnover, CHF million	14839	15838	-6,3%	5031	5238	-4,0%
2	Gross profit, million CHF	5516	5989	-7,9%	1866	1974	-5,5%
3	Earnings before interest, taxes, depreciation and amortization (EBITDA), million CHF	1399	1341	4,3%	600	472	27,1%
4	Operating income (EBIT), CHF million	790	794	-0,5%	371	283	31,1%
5	Free cash flow, CHF million	811	617	31,4%	428	254	68,5%

Table 2.7

Performance indicators of Kuehne + Nagel in the shipping sector during 9 months of 2020

№	Indicators	9 months 2020	9 months 2019	Δ	3 quarter 2020	3 quarter 2019	Δ
1	Net turnover, CHF million	5163	5633	-8,3%	1777	1894	-6,2%
2	Gross profit, million CHF	1051	1173	-10,4%	378	391	-3,3%
3	Operating income (EBIT), CHF million	304	357	-14,8%	137	122	12,3%

Process optimization through local customer service and operational service centers enables efficient cost management and contributes to the future expansion of Kuehne + Nagel's leading market position.

The improvement in market conditions in the third quarter of 2020, including the automotive sector and perishable goods, led to a larger-than-usual seasonal increase in aviation logistics compared to the second quarter. Crisis goods, on the other hand, have increasingly shifted to alternative modes of transport.

At 354,000 tones, air freight in the third quarter was 12.8% lower than in the same period last year, while net turnover increased by 8.7% to 1.2 billion Swiss

francs and EBIT by 89%. 9% to 169 million. This includes a positive one-time impact of 63 million Swiss francs due to the early settlement of the acquisition issue from 2018 (see table 2.8).

Table 2.8

Indicators of activity of the Kuehne + Nagel company in the field of air transportation during 9 months of 2020

№	Indicators	9 months 2020	9 months 2019	Δ	3 quarter 2020	3 quarter 2019	Δ
1	Net turnover, CHF million	3703	3503	5,7%	1243	1143	8,7%
2	Gross profit, million CHF	957	997	-4,0%	315	329	-4,3%
3	Operating income (EBIT), CHF million	350	263	33,1%	169	89	89,9%
4	Operating profit[1] (EBIT), CHF million	287	263	9,1%	106	89	19,1%

[1] Adjusted for the impact of 63 million Swiss francs due to early settlement of the acquisition from 2018

In fig. 2.11 we can see the dynamics of traffic by sea and air. The volume of maritime logistics for 9 months of 2020 is 7.7% less than the same period last year; the 3rd quarter of 2020 decreased by 5.1% compared to the 3rd quarter of 2019. Volumes of air logistics for 9 months of 2020 by 14.6% less than the previous year; the 3rd quarter of 2020 decreased by 12.8%.

The third quarter of 2020 was characterized by a significant increase in deliveries in the field of road transport compared to the previous quarter. In particular, the demand for domestic transport in European countries has reached pre-crisis levels. In North America, demand for all product segments except pharmaceuticals and healthcare and e-commerce remained well below the previous year; however, the market recovery has been evident since September.

The net turnover of the business unit in the third quarter decreased to 796 million Swiss francs, and EBIT - to 12 million Swiss francs. The constant very weak demand for exhibition logistics and event logistics had a significantly negative impact on the result (see Table 2.9).

Fig. 2.11. The volume of traffic of the Kuehne + Nagel company by sea and air transport on a quarterly basis

Table 2.9

Performance indicators of the Kuehne + Nagel company in the field of road transport during 9 months 2020

№	Indicators	9 months 2020	9 months 2019	Δ	3 quarter 2020	3 quarter 2019	Δ
1	Net turnover, CHF million	2380	2682	-11,3%	796	862	-7,7%
2	Gross profit, million CHF	812	846	-4,0%	274	269	1,9%
3	Operating income (EBIT), CHF million	38	62	-38,7%	12	17	-29,4%

In fig. 2.12 we can see the dynamics of operating profit of the Kuehne + Nagel company from road transport.

The increase in market share in pharmaceutical and medical services, as well as in e-commerce, as well as tight cost management led to a significant improvement in revenues in contract logistics in the third quarter of 2020 compared to the second quarter.

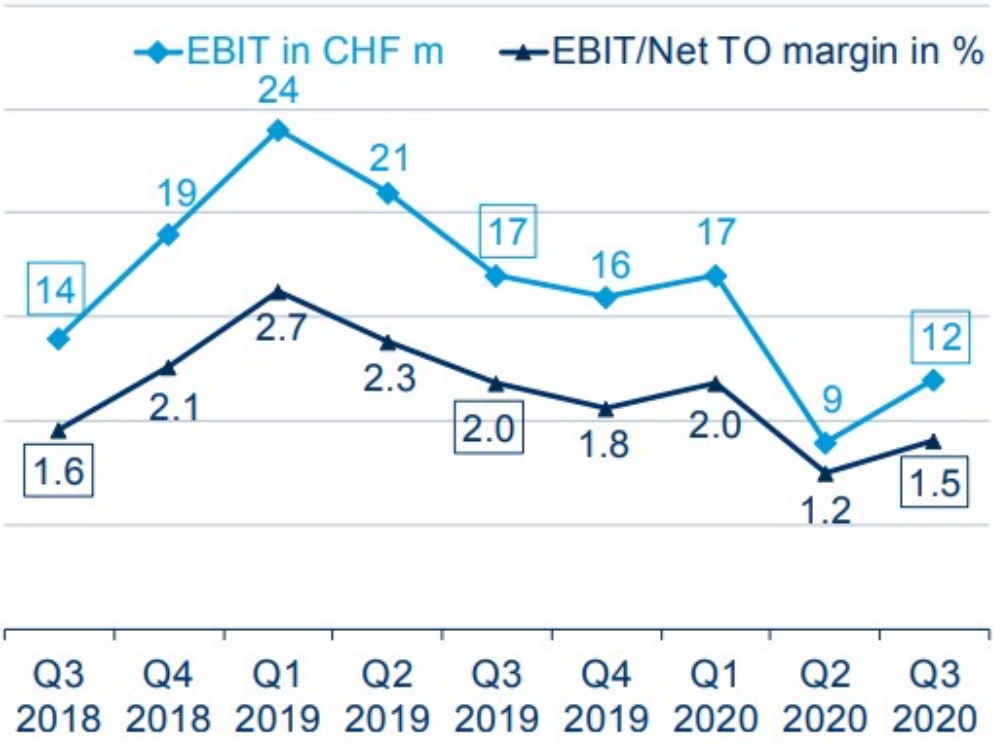

Fig. 2.12. Dynamics of operating profit of the Kuhne + Nagel company from road transport

The net turnover of the contract logistics business unit in the third quarter amounted to 1.2 billion Swiss francs, and the profit - 53 million Swiss francs (see table 2.10 and fig. 2.13). Given the large revenues in the third quarter of 2019 and 2020 and from the sale of real estate by 21 million Swiss francs and 4 million Swiss francs, respectively, EBIT increased by 44%.

Table 2.10

-Indicators in the field of contract logistics of the Kuehne + Nagel company during 9 months of 2020 (excluding real estate transactions)

№	Indicators	9 months 2020	9 months 2019	Δ	3 quarter 2020	3 quarter 2019	Δ
1	Net turnover, CHF million	3593	4020	-10,6%	1215	1339	-9,3%
2	Gross profit, million CHF	2696	2973	-9,3%	899	985	-8,7%
3	Operating income (EBIT), CHF million	98	112	-12,5%	53	55	-3,6%

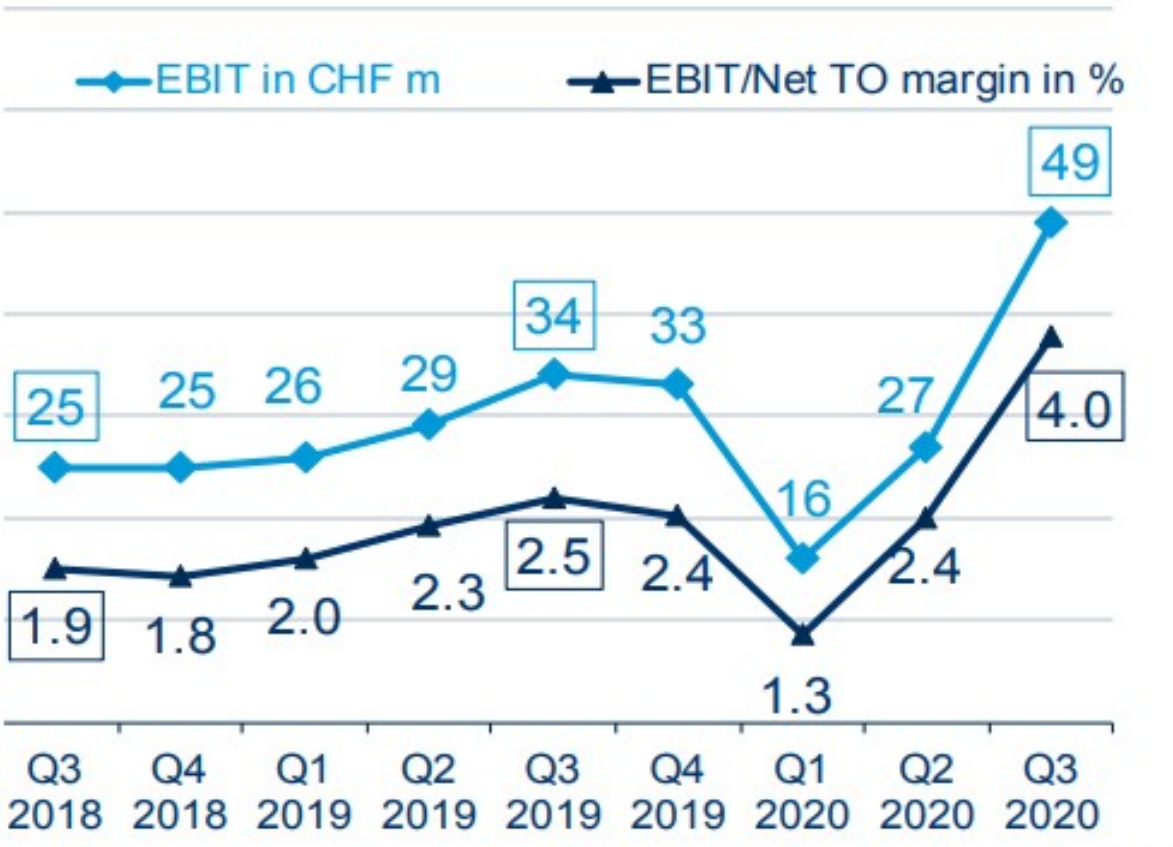

Fig. 2.13. Dynamics of operating profit of the Kuehne + Nagel company from contract logistics

The business unit continues to expand its e-commerce business, contributing to a significant portion of new business wins. For example, in Sweden, Kuehne + Nagel will operate a new distribution center for Amazon.

2.3. Analysis of logistics processes in supply chains of container transportation

With the rapid development of scientific and technological progress, trends of globalization and regionalization, with increased requirements for safety, in particular environmental safety, containerization of freight traffic is becoming not only high-quality technical solutions, but also a primary factor in the growth of world trade.

Containerization of cargo flows is the key to effective dynamic development of the transport and logistics complex of Ukraine and one of the most important reserves for increasing productivity and reducing the cost of freight traffic. A systematic approach to the integrated logistics management of container cargo flows is more effective than the separate management of individual logistics operations.

The attraction of container transportation has always been accompanied by an increasing concentration of shipping companies, stevedores and other players in the transport and logistics business in ports and the reorientation of their clients to work with international logistics providers. This business is not directly related to port transshipment, but the presence of logistics providers in the port and the completeness of the range of services they provide significantly affect the attractiveness of the port for cargo owners. The ports have to compete more with each other to ensure that large international logistics providers operate on their territory and provide services to customers. Thus, the supply chain is a complex system in which auxiliary functions can be implemented by both aggregated and specialized participants, serving the flow processes of the logistics cycle.

For the majority of Kuehne + Nagel's shipments, container shipping covers the entire length of the supply chain, from the delivery of raw materials to the industrial production of the final product. The entire production cycle of goods transported in a container involves a complex combination of business processes: from the extraction of raw materials to manufacturing, distribution and retail. It is the line operators, responding to the needs of the market, who will order container ships of increasing capacity for the transportation of containers across the territory of Ukraine.

Rapid growth trends in container handling and some declines are associated with a number of different reasons, illustrated in fig. 2.14.

The key task of management in the logistics chain is the optimal planning of the delivery of cargo in containers in order to minimize costs, delivery times and provide high-quality logistics services.

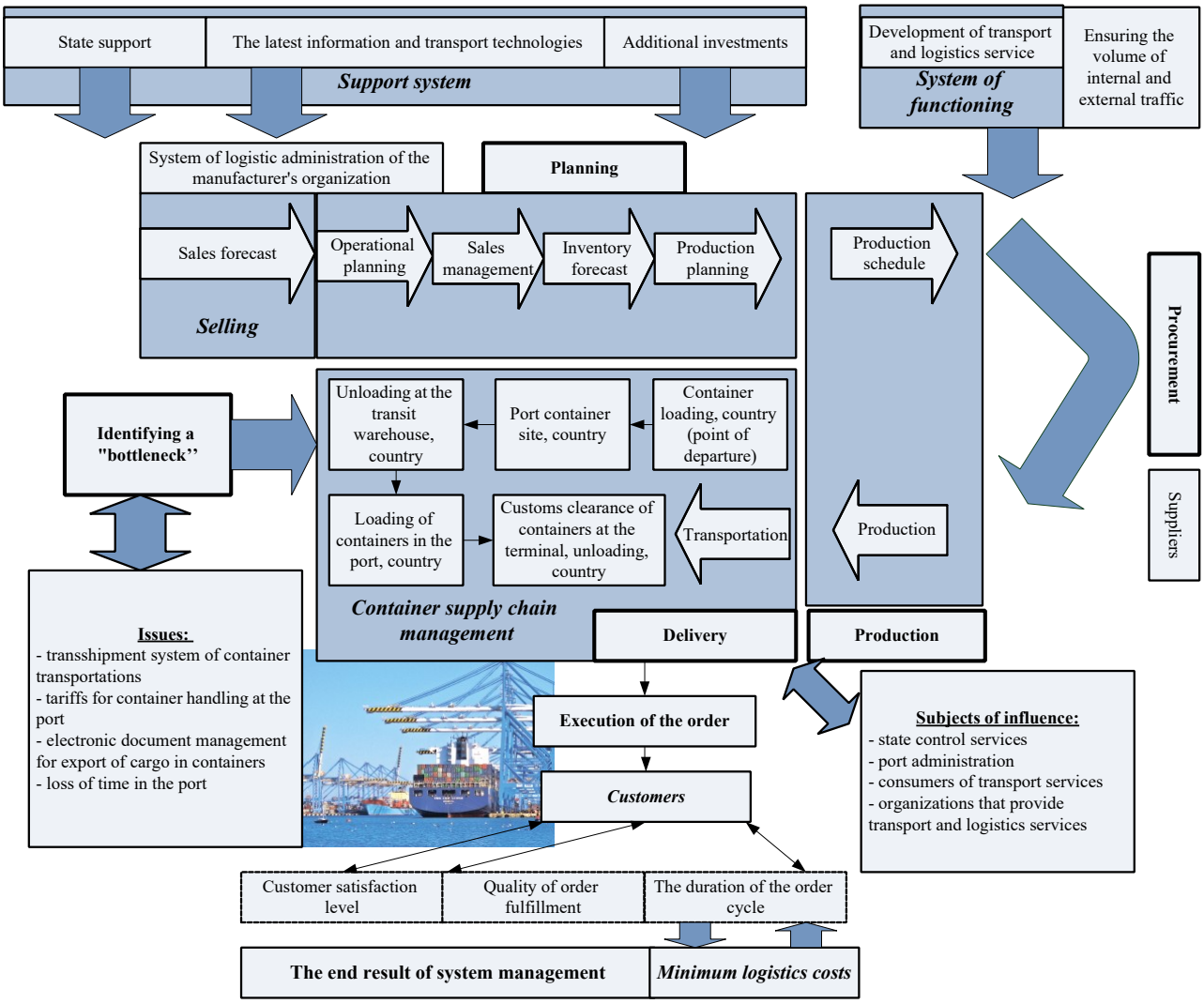

Fig. 2.14. Mechanism of integrated logistics management of container cargo flows

A freight container is a reusable unit of transport equipment intended for the transportation and short-term storage of goods without intermediate reloading, convenient for mechanized loading and unloading, loading and unloading (internal volume is 1 cubic meter and more).

A universal container is a reusable vehicle designed to accommodate and transport cargo by one or more modes of transport. The design of a universal container must ensure its mechanized loading and unloading.

Special container – a freight container for goods of limited range or for certain types of goods.

Closed container - a cargo container, the design of which includes all the main elements in a solid design with a door and / or hatches, tightly closed and provide protection of the internal space from the external environment. A closed container can have a roof or walls that can be removed or opened.

An open container is a freight container, the design of which includes one or more main elements: a roof, end or side walls or parts thereof. Open spaces in such a container, if necessary, may be covered with foil or other materials.

Container for transportation of bulk cargo without pressure of the "hopper" type - a container without doorways, has a device for unloading, located in the horizontal plane.

An insulated container is a specialized container whose walls, floor, roof and doors are covered or made of heat-insulating material, or made of a heat-exchange material, which limits heat exchange between the inside of the container and the environment.

Thermo-insulated container is an insulated container that does not have equipment for cooling or heating.

Reefer container with refrigerant, consumed - isothermal container, uses a cold source (for example, ice, dry ice with controlled or uncontrolled sublimation, liquefied gases with controlled or uncontrolled evaporation) and does not require external power supply.

Refrigerated container with machine cooling - isothermal container with refrigeration equipment (for example, mechanical compressor, absorption unit).

Heating container - an isothermal container with a heating system.

Refrigerated and heated container - an isothermal container with a refrigeration unit or coolant, consumable and heating unit.

The gross weight of the container is the sum of the own weight of the freight container and the permissible weight of the cargo can be loaded into the freight container.

Classification of containers:

- standard containers 20, 40 and 45 feet for general cargo (dry cargo): the strength of the frame is provided by steel and aluminum or plywood sheets with fiberglass cover. The container is completely closed and dustproof (fig. 2.15);

- refrigerated containers 20, 40, 45 feet for transportation of goods, strong influence of temperature: equipped with a refrigeration unit, capable of maintaining the temperature inside the container from -25 to + 25 ° C (fig. 2.16);

- Open top containers of 20 and 40 feet for transportation of oversized cargo. The walls are made of steel for strength. Open top container. The container is similar in every respect to a standard general-purpose container, except that it does not have a rigid surface (fig. 2.17);

- flatrak-containers of 20 and 40 feet for the transportation of heavy loads without side walls, the supporting frame is made of steel, thickness 30-50 mm, have mechanisms for fixing the load (fig. 2.18);

- tank containers for 20 and 30 thousand liters for the carriage of liquid, gaseous and bulk cargo (in fact, a tank on a rigid and solid frame). Transportation in a tank container is carried out mainly "from door to door" without intermediate overflow of products when changing the mode of transport (fig. 2.19).

Container transportation of goods is the transportation of various goods using containers - removable transport devices. Transportation of goods in containers can significantly reduce transport costs.

Container transportation of goods is used if the destination and points of departure are significantly removed from each other, or due to the lack of the possibility of another type of transportation. The service of delivery of goods in containers can also be used by those consignors whose price category of goods involves transportation only by containers.

Non-specialized information about container transportation of goods. A freight container for transportation is a reusable unit of transport equipment. The design of the cargo container ensures the safety of the transportation of goods by one or more modes of transport.

Fig. 2.15. Standard container

Fig. 2.16. Refrigerated container

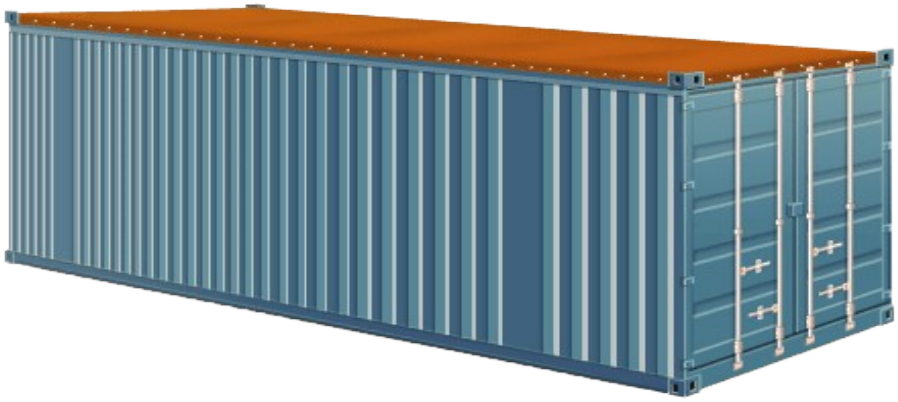

Figure 2.17. Open top container

Regardless of the purpose, all containers are standardized in terms of gross weight, dimensions, connecting dimensions, moreover, in terms of the design of connecting devices to the rolling stock of railways and road transport and to the gripping mechanisms of loading and unloading vehicles.

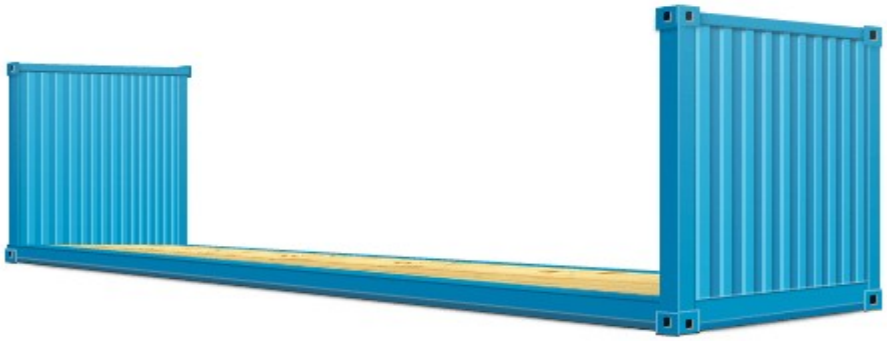

Fig. 2.18. Flatrack container

Fig. 2.19. Tank container

Every cargo is suitable for container transportation; the main thing is that they are approved for transportation by the appropriate rules. In containers, cargo is placed so as to avoid each deformation, friction of various kinds, as well as freezing or overheating of the cargo during loading, unloading and transportation. After loading the container, sealing and closing is carried out in the manner prescribed by the rules of containers and sealing of wagons. Upon arrival at the destination, the loaded containers are handed over only after an external examination of their definition and the state of compliance with the sender's seal.

Container transportation of goods is carried out by various types of transport. With this method of delivery, the turnover of vehicles is accelerated, the safety of goods is improved, and transportation costs are reduced. Container transportation of goods allows to speed up loading and unloading operations and transfer of goods to the recipient of the goods; save containers, supply non-transit consignments of

products directly from manufacturing firms, bypassing the warehouses of supply and sales organizations.

Kuehne + Nagel carries out container transportation, because the use of containers allows you to increase the efficiency of mixed (multimodal) freight transport, which allows you to reduce costs associated with transportation, transshipment and maintenance of goods.

It is customary for the Kuehne + Nagel company to calculate 20-foot and 40-foot containers containing up to 25 tons of cargo in the container transport market: they carry most of the industrial and food products.

The main advantages and disadvantages of container transportation are presented in ig. 2.20.

Advantages	Disadvantages
1) high productivity of cars and mechanisms at loading and unloading of freights; 2) complex mechanization of loading and unloading works; 3) the minimum downtime of vehicles under cargo operations; 4) good safety of transported goods (from weather conditions and theft); 5) reduction of costs for transport packaging; 6) low cost of transportation and processing of cargoes; 7) small labor costs for loading and unloading.	1) high cost of containers; 2) low static load of vehicles (less by 15-20%); 3) the need to return empty containers or search for goods to load them; 4) the need for powerful expensive reloading systems; 5) a complex system of accounting for the movement and operation of containers; 6) complication of the system of transportation organization.

Fig. 2.20. Advantages and disadvantages of container transportation

Note that the share of container and combined transport in total exports and imports of goods is insignificant. The level of containerization of Ukrainian exports in 2019 was 3.6% (3.0% of total exports of goods were sent in containers on seagoing vessels, 0.3% in containers on rail transport, and 0.3% in trucks).

The share of piggyback transportation of goods in railway cars on a sea vessel amounted to 0.9% of total exports, in trucks on a sea vessel - 0.7%.

The level of containerization of imports to Ukraine in 2019 was 9.9% (9.3% of total exports of goods were sent in containers on seagoing vessels, 0.3% in containers on rail transport, and 0.3% in trucks).

Making conclusion, we can notice that the analytical part of the thesis is devoted to the activities of the Kuehne + Nagel company, which provides a wide range of services. The main advantages that are the distinguishing feature of the Kuehne + Nagel company: fast delivery of transport to the place of loading, flexible pricing policy, reliability, constant monitoring of goods.

Kuehne + Nagel provides a complete logistics cycle, ie takes over warehousing, packaging operations, transportation by various modes of transport and its specifications, both in Ukraine and abroad. Thus geography of transportations is practically not limited. Also provides customs brokerage services and advice.

A study of the company's financial condition showed that Kuehne + Nagel is profitable and financially stable. A financially stable enterprise pays its obligations to the state, extra-budgetary funds, staff, and contractors on time. The main factors that determine the financial stability of the enterprise include the financial structure of capital (the ratio of borrowed and own funds, as well as long-term and short-term sources of funds) and the financing policy of individual components of assets (primarily non-current assets and inventories). It is worth noting that the financial stability of Kuehne + Nagel is its reliable and guaranteed solvency in normal business conditions and accidental changes in the market.

To date, the most common and modern method of transportation is containerized cargo. They are successfully used on both international and domestic transport arteries. Unconditional leadership in the field of logistics, this type of transportation has won through the use of containers.

Studies have shown that cargo in containers is easier to transport because they are better packed than general shipments. Transportation becomes cheaper because a fully loaded container makes the most economical use of cargo space, whether on a

ship, car or car. Therefore, the Kuehne + Nagel company pays great attention to container transportation. Container transportation reduces insurance costs, as individual shipments do not require individual processing.

Containers make direct transportation a logical and economical way to deliver goods. Therefore, there is the development of integrated mixed transport "door to door" or from warehouse to warehouse (railway - sea - highway, highway - air transport - highway).

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3. DESIGN PART

Air Transportation Management Department				NAU.20.07.42 004EN			
Done by:	*Viktoriia V. Mudryk*				Letter	Sheet.	Sheets
Supervisor:	*Yuliia V. Shevchenko*			*3. DESIGN PART*	D		
Standards Inspector	*Yuliia V. Shevchenko*				FTML 275 ОП- 202Ма		
Head of the Department	*Shevchuk D. O.*						

3.1. Identification of a problem in the market in the supply of technological equipment and calculation of the optimal size of supplies

There are many places today for the internationalization of supply chains. In order to prove the advisability of specializing in certain types of activities, it is necessary to know what the cost of the corresponding activity in a country importing certain goods or services will be in comparison with the cost of the corresponding activity in its own industries. It is worth remembering that creating a comparative advantage requires a relative, not an absolute, cost advantage. Japan was found to be a leader in five areas: automobiles and components, consumer electronics, metal and steel. Generally, managers and engineers (or the auto industry in Japan) innovate because they face intense global competition, where improving productivity is a key success factor. Thus, the creation of car assembly plants by the Japanese in Europe has become a factor in increasing productivity in most European countries due to the introduction of advanced technologies and stimulation of competition.

Technological equipment is an instrument of production, in which repair objects or materials, means of influencing them, and, if necessary, a source of energy are placed to perform individual parts of the technological process. Technological equipment intended for the mechanization of technological processes is part of the main production assets.

Today, when supplying technological equipment, namely, equipment for maintenance and repair stations Mitsubishi and Heavy Industries (fig. 3.1) from Japan / Malaysia in Ukraine and from the factories of the manufacturer in Holland / Belgium, there are a number of problems that are assigned to the shoulders of the Kuehne + Nagel logistics operator: calculating the optimal size of technical equipment, taking into account demand; supply of equipment elements occurs both from factories in Japan / Malaysia and from factories in some European countries. Thus, the question arises to make forecast calculations for demand in the supply

chain and calculate costs, taking into account various supply schemes for technological equipment.

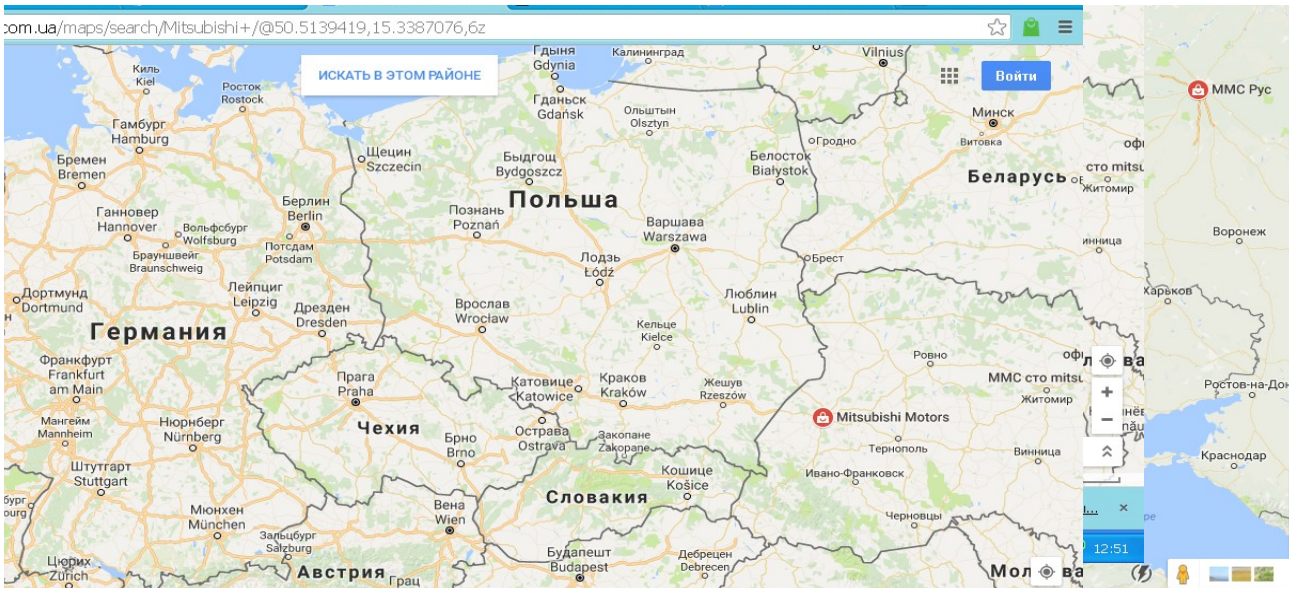


Fig. 3.1. Map of representative offices and points of technological equipment of Mitsubishi Heavy Industries

So, the calculation of the amount of required technological equipment primarily depends on the market demand for certain products. So, first, let us predict the required amount of Mitsubishi Heavy Industries equipment exported to European countries and distributed in the domestic market. The Winters model is used for forecasting (exponential smoothing method with three parameters reflecting trend and seasonality).

This model improves forecast accuracy when the time series includes trend and season fluctuations. Winters' model includes four equations:

- smoothing the original series:

$$L_t = \alpha \cdot \frac{y_t}{s_{t-s}} + (1-\alpha) \cdot (L_{t-1} + T_{t-1}); \quad (3.1)$$

- smoothing the trend:

$$T_t = \beta \cdot (L_t - L_{t-1}) + (1-\beta) \cdot T_{t-1}; \quad (3.2)$$

- seasonality assessment:

$$S_t = \gamma \cdot \frac{y_t}{L_t} + (1-\gamma) \cdot S_{t-s}; \tag{3.3}$$

- forecast for p periods ahead:

$$y_{t+p} = (L_t + p \cdot T_t) \cdot S_{t-s+p}, \tag{3.4}$$

where L_t - smoothing the series value;

α - data smoothing parameter;

y_t - the actual value of the indicator for the period t;

β - smoothing parameter to estimate the trend;

T_t - trend assessment;

γ - smoothing parameter to estimate seasonality;

S_t - seasonality assessment;

p - the number of periods for which the forecast is based;

s - duration of the period of seasonal fluctuations.

Smoothing parameters must correspond the conditions:

$$0 \le \alpha \le 1; 0 \le \beta \le 1; 0 \le \gamma \le 1, \tag{3.5}$$

Before using equations (3.1 - 3.4) it is necessary to set the initial conditions. There are two options for choosing the initial conditions in the Winters model. In this thesis, we take the initial value for the smoothing series (L_{t-1}) equal to the average value for the first s observations. Then the initial conditions for the trend (T_{t-1}) are determined by the slope of the line formed by these observations. Seasonality coefficients for the initial conditions are calculated:

$$S_t = y_t / L_s, \tag{3.6}$$

where L_s - initial condition for data smoothing (the average value for the third year is chosen as the initial conditions for data smoothing);

y_t - the actual value of the indicator for the period t (that is t=1, 2, 3, 4).

Therefore, in order to ensure the smallest error of the forecast model, we will use the MS Excel function "Solver". The initial data for forecasting will be presented in table. 3.1.

Table 3.1

Sizes of sales of Mitsubishi Heavy Industries technological equipment by the Kuehne + Nagel operator for three years

№	Country of consumption	Year	Quarter	Sales size, units
1	2	3	4	5
1	Ukraine	2018	I	404
			II	429
			III	438
			IV	399
		2019	I	414
			II	434
			III	453
			IV	410
		2020	I	419
			II	444
			III	463
			IV	415
2	Lithuania	2018	I	204
			II	229
			III	238
			IV	200
		2019	I	214
			II	234
			III	253
			IV	210
		2020	I	219
			II	244
			III	263
			IV	215

Cont. table 3.1

1	2	3	4	5
3	Poland	2018	I	254
			II	279
			III	288
			IV	250
		2019	I	264
			II	284
			III	303
			IV	260
		2020	I	269
			II	294
			III	313
			IV	265
4	Romania	2018	I	304
			II	329
			III	338
			IV	300
		2019	I	314
			II	334
			III	353
			IV	310
		2020	I	319
			II	344
			III	363
			IV	315

According to the table 3.1 build a graph, which we present in fig. 3.2. The graph shows that the periodicity of seasonal fluctuations is 3, there is a tendency to increase the size of sales. Based on the data, we make forecasts for the next 2021.

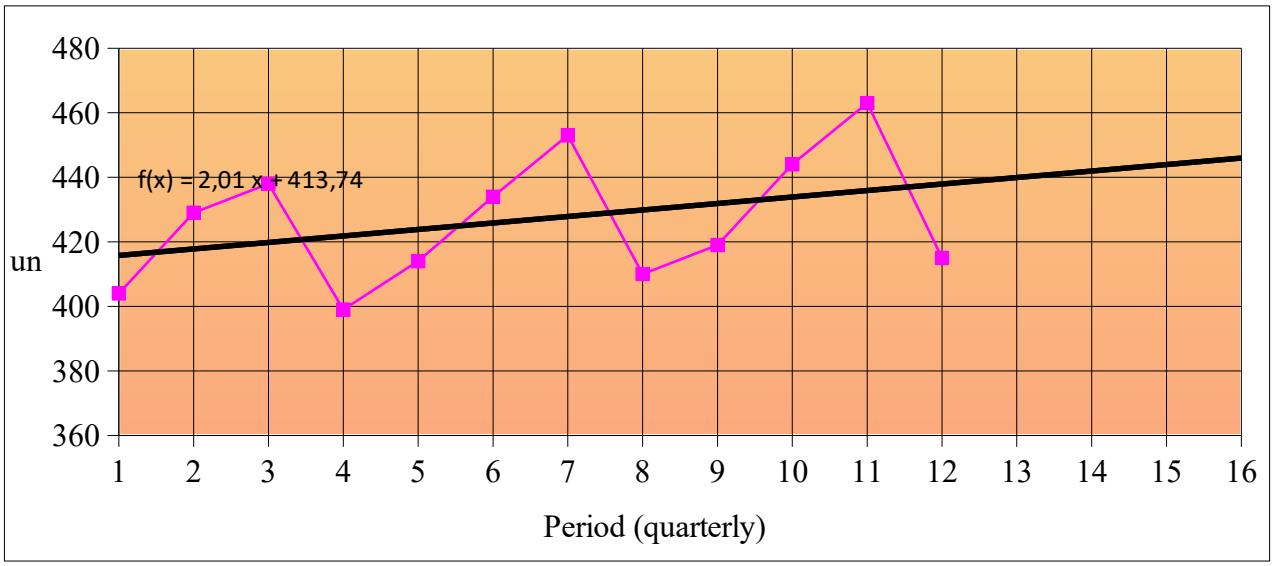


Fig. 3.2. Graph of data on the volume of sales for Ukraine for three years and a trend line

For the values of the size of sales of technical equipment "Mitsubishi Heavy Industries" for the first year, we determine the slope of the trend line. To do this, you need to assess the trend ($y_t^{'}=a_0+a_1 \cdot t_k$).

To the data of table. 3.1 and fig. 3.2 select the trend line by the method of least squares:

$$a_1=\frac{\sum (Y_i-\overline{Y})(t_i-\bar{t})}{\sum ¿¿¿}; \quad a_0=\overline{Y}-a_1\bar{t}; \overline{Y}=\frac{1}{n}\sum Y_i; \bar{t}=\frac{1}{n}\sum t_i \qquad (3.7)$$

Or use the MS Excel function: $y_t^{\square}= 2,1224\ t_k\ + 411,62.$

The results of the forecast of the size of sales (by the Winters method) for Ukraine will be presented in table. 3.2. In order to ensure the smallest error of the forecast model, it is necessary to choose the smoothing parameters most accurately. To do this, use the MS Excel tab "Solver". After finding the solution, we obtain the data presented in table 3.3 and show in fig. 3.4.

Table 3.2

Forecast of the size of sales of technological equipment (Winters method) for Ukraine

Year	Quarter	Period	Sales size, units	Trend, units	Data smoothing L, units	Seasonality S,	Trend smoothing T, units	Forecast, units	Difference
					0,4	0,5	0,8		
1	2	3	4	5	6	7	8	9	10
1	I	1	404	415,754		0,968			
	II	2	429	417,768		1,028			
	III	3	438	419,782		1,049			
	IV	4	399	421,796	417,5	0,956	2,014		
2	I	5	414	423,810	422,842	0,973	4,676	405,949	64,821
	II	6	434	425,824	425,457	1,024	3,028	439,294	28,031
	III	7	453	427,838	429,810	1,052	4,088	449,525	12,079
	IV	8	410	429,852	431,943	0,952	2,524	414,671	21,822

Cont. 3.2

1	2	3	4	5	6	7	8	9	10
3	I	9	419	431,866	432,864	0,971	1,242	422,900	15,206
	II	10	444	433,880	433,933	1,024	1,103	444,442	0,196
	III	11	463	435,894	437,146	1,055	2,792	457,452	30,775
	IV	12	415	437,908	438,251	0,950	1,442	419,016	16,131
4	I	13		439,922				426,799	
	II	14		441,936				448,553	
	III	15		443,950				462,502	
	IV	16		445,964				416,205	
Amount, units									190
Error, units									4,861337

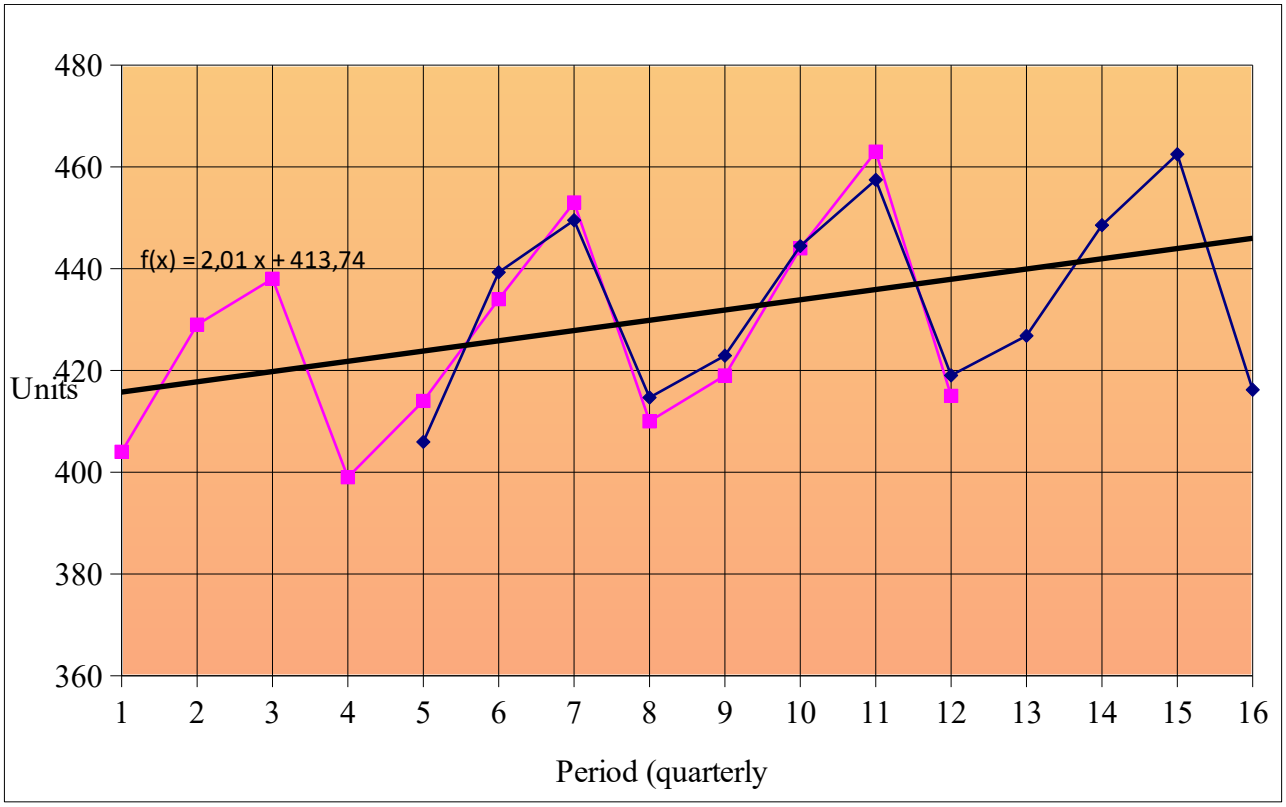


Fig. 3.3. Forecast of the size of sales of Mitsubishi Heavy Industries technological equipment by the method of Winters for Ukraine

Similarly, we will forecast the size of sales of technological equipment for Lithuania, Poland and Romania. We present only the adjusted results (tab. 3.4 - 3.6) of the forecast of technological equipment "Mitsubishi Heavy Industries" and their graphical interpretation (fig. 3.5 - 3.7).

Table 3.3

Adjusted data for the supply of technological equipment "Mitsubishi Heavy Industries" for Ukraine

Year	Quarter	Period	Sales size, units	Trend, units	Data smoothing L, units	Seasonality S,	Trend smoothing T, units	Forecast, units	Difference
					0,251	0,747	0,041		
1	2	3	4	5	6	7	8	9	10
1	I	1	401	415,754		0,968			
	II	2	428	417,768		1,028			
	III	3	434	419,782		1,049			
	IV	4	402	421,796	417,5	0,956	2,014		
2	I	5	411	423,810	421,606	0,978	2,101	405,949	64,821
	II	6	433	425,824	423,370	1,026	2,087	435,378	1,898
	III	7	449	427,838	427,051	1,058	2,153	446,347	44,263
	IV	8	412	429,852	429,155	0,955	2,151	410,185	0,034
3	I	9	416	431,866	430,544	0,974	2,119	421,964	8,785
	II	10	443	433,880	432,714	1,026	2,121	443,794	0,042
	III	11	459	435,894	435,555	1,062	2,151	459,974	9,159
	IV	12	417	437,908	436,862	0,951	2,116	418,205	10,272
4	I	13		439,922				427,781	
	II	14		441,936				448,217	
	III	15		443,950				463,815	
	IV	16		445,964				415,607	
Amount, units									140
Error, units									4,172425

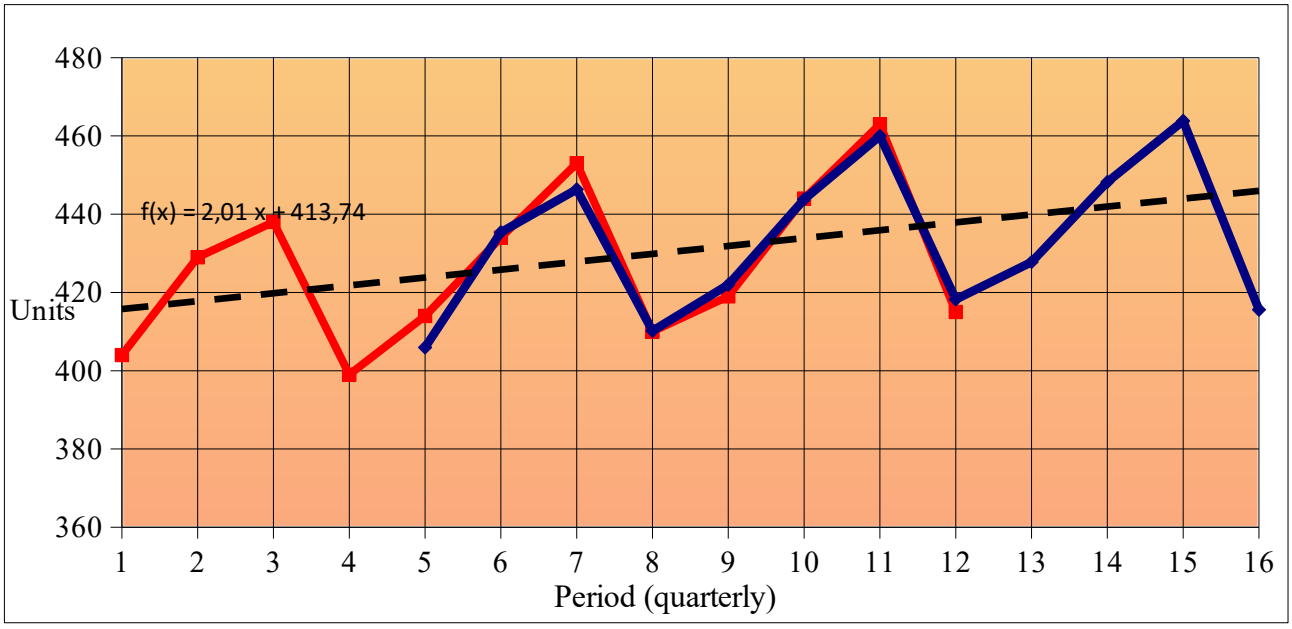


Fig. 3.4. Adjusted results of the forecast of technological equipment for Ukraine

Table 3.4

Adjusted forecast data of Mitsubishi Heavy Industries technological equipment for Lithuania

Year	Quarter	Period	Sales size, units	Trend, units	Data smoothing L, units	Seasonality S,	Trend smoothing T, units	Forecast, units	Difference
					0,247	0,747	0,063		
1	2	3	4	5	6	7	8	9	10
1	I	1	204	215,937		0,937			
	II	2	229	217,933		1,052			
	III	3	238	219,930		1,093			
	IV	4	200	221,926	217,75	0,918	1,997		
2	I	5	214	223,923	221,894	0,957	2,132	205,870	66,090
	II	6	234	225,919	223,649	1,048	2,108	235,600	2,560
	III	7	253	227,916	227,172	1,108	2,198	246,752	39,032
	IV	8	210	229,912	229,189	0,917	2,186	210,673	0,453
3	I	9	219	231,909	230,722	0,951	2,145	221,527	6,386
	II	10	244	233,905	232,876	1,048	2,146	243,962	0,001
	III	11	263	235,902	235,578	1,114	2,181	260,509	6,205
	IV	12	215	237,898	236,953	0,910	2,130	217,985	8,912
4	I	13		239,895				227,435	
	II	14		241,891				248,264	
	III	15		243,888				264,057	
	IV	16		245,884				215,569	
Amount, units									130
Error, units									4,025535

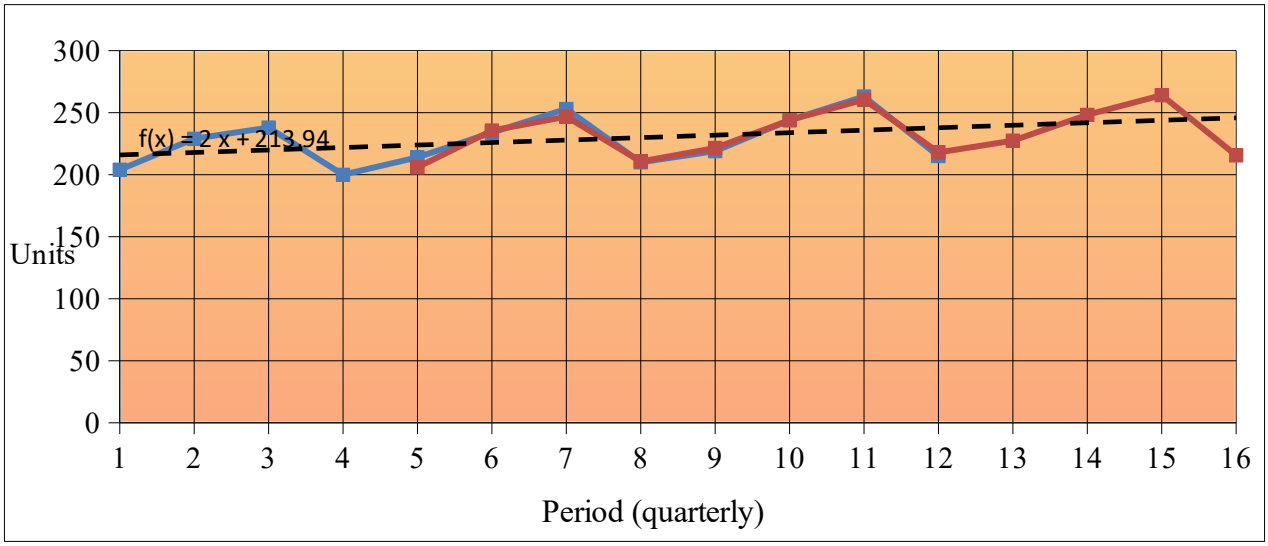


Fig. 3.4. Adjusted results of the forecast of technological equipment for Lithuania

Table 3.5

Adjusted forecast data for technological equipment of Mitsubishi Heavy Industries for Poland

Year	Quarter	Period	Sales size, units	Trend, units	Data smoothing L, units	Seasonality S,	Trend smoothing T, units	Forecast, units	Difference
					0,239	0,771	0,054		
1	2	3	4	5	6	7	8	9	10
1	I	1	254	265,937		0,949			
	II	2	279	267,933		1,042			
	III	3	288	269,930		1,076			
	IV	4	250	271,926	267,75	0,934	1,997		
2	I	5	264	273,923	271,788	0,966	2,107	255,894	65,708
	II	6	284	275,919	273,573	1,039	2,090	285,403	1,969
	III	7	303	277,916	277,104	1,089	2,168	296,512	42,097
	IV	8	260	279,912	279,078	0,932	2,158	260,759	0,575
3	I	9	269	281,909	280,565	0,960	2,121	271,715	7,369
	II	10	294	283,905	282,752	1,040	2,125	293,713	0,082
	III	11	313	285,902	285,461	1,095	2,157	310,336	7,099
	IV	12	265	287,898	286,825	0,926	2,113	268,092	9,560
4	I	13		289,895				277,516	
	II	14		291,891				298,184	
	III	15		293,888				314,029	
	IV	16		295,884				265,539	
Amount, units									135
Error, units									4,099689

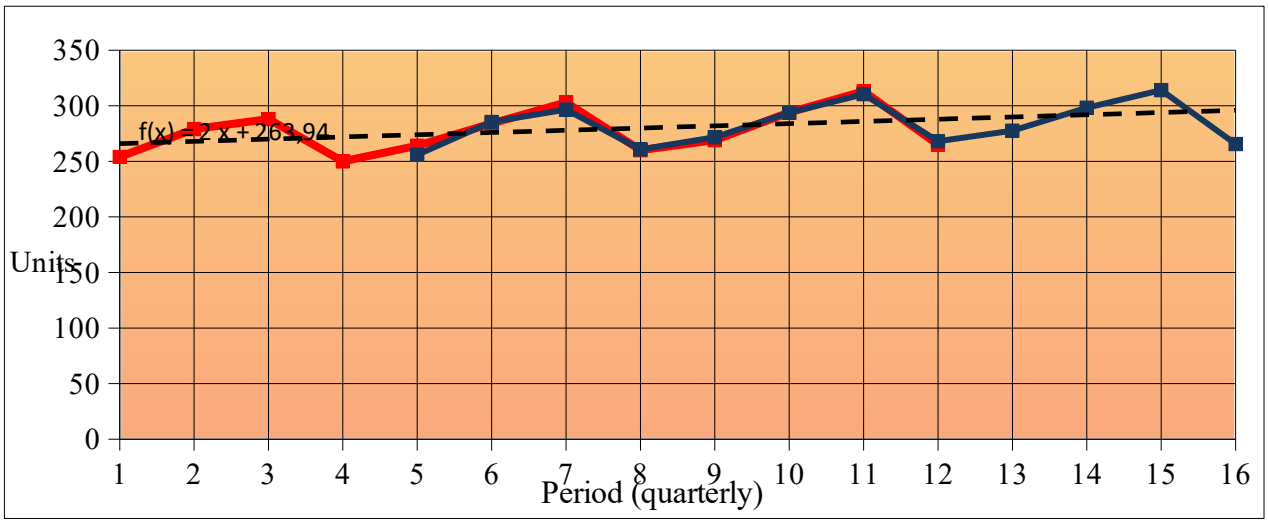


Fig. 3.5. Adjusted forecast results for Poland

Table 3.5

Adjusted forecast data for technological equipment of Mitsubishi Heavy Industries for Romania

Year	Quarter	Period	Sales size, units	Trend, units	Data smoothing L, units	Seasonality S,	Trend smoothing T, units	Forecast, units	Difference
					0,232	0,789	0,047		
1	2	3	4	5	6	7	8	9	10
1	I	1	304	315,937		0,957			
	II	2	329	317,933		1,035			
	III	3	338	319,930		1,064			
	IV	4	300	321,926	317,75	0,944	1,997		
2	I	5	314	323,923	321,712	0,972	2,089	305,910	65,446
	II	6	334	325,919	323,518	1,033	2,076	335,266	1,603
	III	7	353	327,916	327,048	1,076	2,145	346,343	44,311
	IV	8	310	329,912	328,995	0,943	2,135	310,804	0,646
3	I	9	319	331,909	330,450	0,967	2,103	321,845	8,094
	II	10	344	333,905	332,657	1,034	2,108	343,539	0,213
	III	11	363	335,902	335,364	1,081	2,136	360,226	7,693
	IV	12	315	337,898	336,724	0,937	2,100	318,148	9,909
4	I	13		339,895				327,556	
	II	14		341,891				348,131	
	III	15		343,888				364,021	
	IV	16		345,884				315,509	
Amount, units									138
Error, units									4,152031

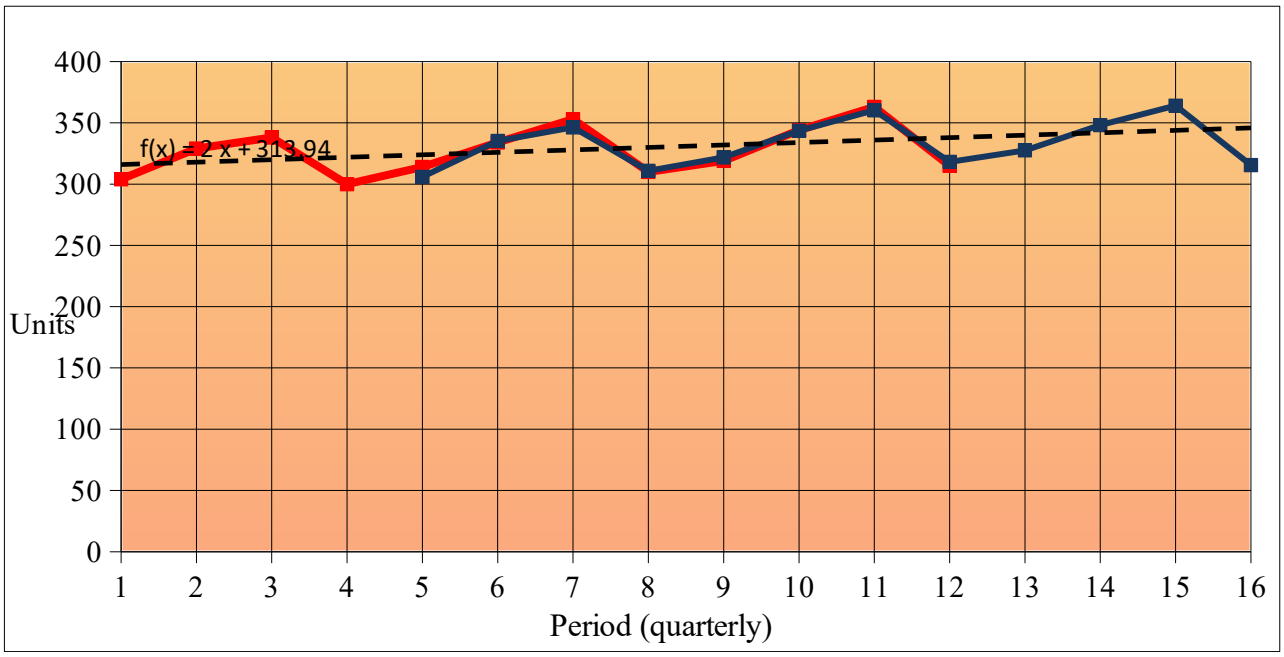


Figure 3.6 - Adjusted forecast results for Romania

Thus, the calculations performed by the Holt-Winters method allowed us to determine the amount of technological equipment of the company "Mitsubishi Heavy Industries" for consumer countries. The forecast model based on the Holt-Winters method is adequate and can be used to determine the forecast values of the number of sold products for future periods. This will allow us to make the following calculations regarding the transportation scheme and the cost of delivery.

3.2. Calculation of the intensity of supplies of components for technological equipment

We will find the general demand for components (tire-mounting equipment, balancing equipment, lifting equipment) for Mitsubishi Hevy Industries on the basis of a forecast of demand for finished products (auto service technological equipment).

The supply of tire fitting equipment can be carried out from Japan or Malaysia, the supply of balancing equipment - from Belgium or Holland, lifting equipment - from Ukrainian suppliers. So, let's calculate the frequency of delivery, taking into account the cost of container freight.

Note that delivery from Japan or Malaysia can be carried out on EXW condition. Delivery from Belgium or Holland - according to the FCA term. The new delivery terms for Incoterms 2020 are presented in Fig. 3.7. Delivery of lifting equipment is carried out from the warehouses of Ukrainian suppliers (suppliers are located in Kherson). When delivering goods from Japan / Malaysia, sea + road modes of transport are used. When choosing the delivery volumes, we take into account that the goods should be no more than a 2-quarter demand period.

When planning the optimal delivery option, it is necessary to take into account that the cost of products depends on the volume of purchased products, that is, there are wholesale discounts.

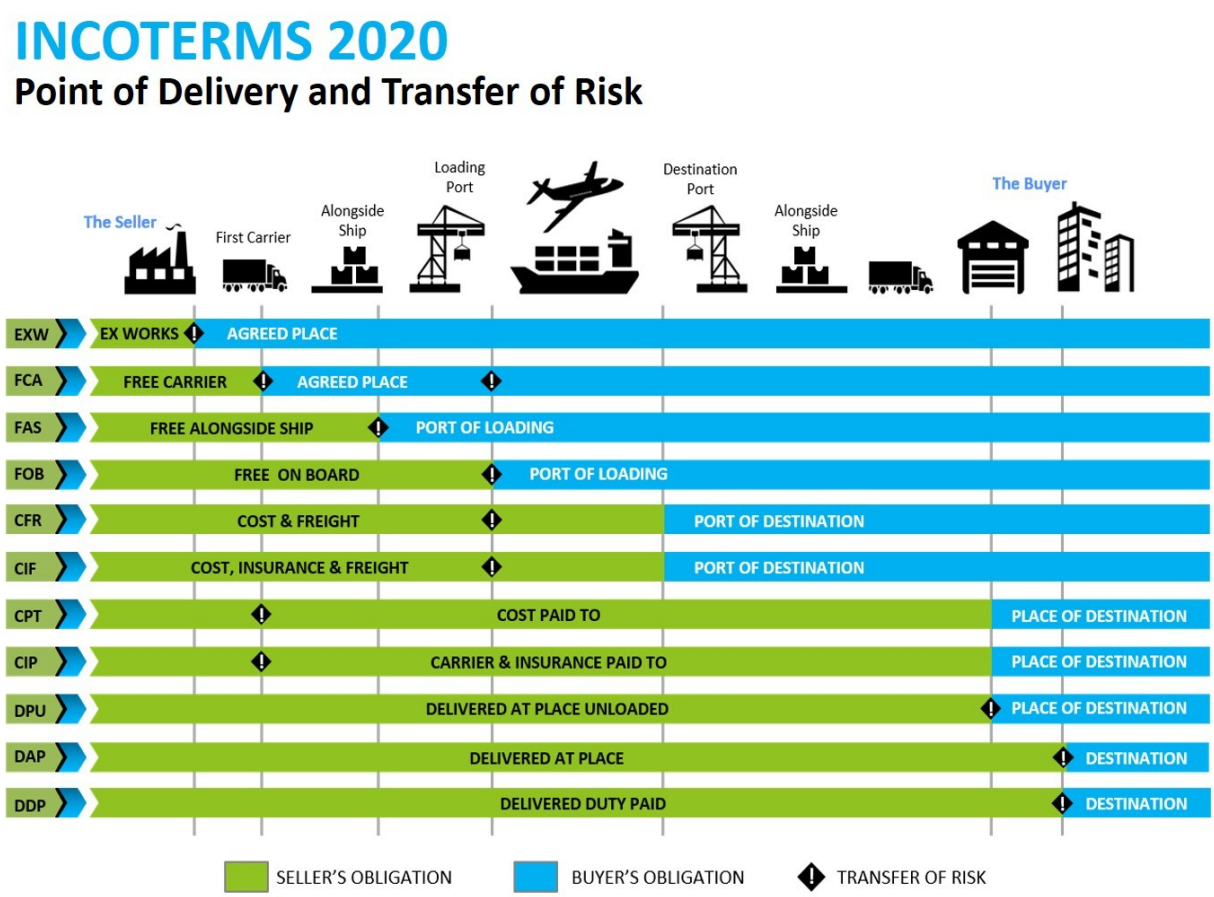


Fig. 3.7. INCOTERMS 2020 responsibility matrix

When calculating an integrated supply chain of technological equipment, it is necessary to take into account both the characteristics of containers and packaging, and cost indicators, we will present in table. 3.6 - 3.11.

Table 3.6

Characteristics of containers

			Container UK-3		
			External dimensions	Internal dimensions	The size of the door
Container, kg	600	Length, m	2,100	1,980	
Cargo weight, kg	2 400	Width, m	1,325	1,225	1,225
Volume, cubic meters m	5,16	Height, m	2,400	2,128	2,090
			Container UK-5		
			External dimensions	Internal dimensions	The size of the door

Cont. table 3.6

Container, kg	950	Length, m	2,100	1,950	
Cargo weight, kg	4050	Width, m	2,650	2,504	1,950
Volume, cubic meters m	10,40	Height, m	2,400	2,128	2,100
			Standard container (20 feet)		
			External dimensions	Internal dimensions	The size of the door
Container, kg	2200	Length, m	6,06	5,90	
Cargo weight, kg	21700	Width, m	2,44	2,35	2,34
Volume, cubic meters m	33,3	Height, m	2,59	2,40	2,29
			Standard container (40 feet)		
			External dimensions	Internal dimensions	The size of the door
Container, kg	3980	Length, m	12,19	12,03	
Cargo weight, kg	26500	Width, m	2,44	2,35	2,34
Volume, cubic meters m	67,2	Height, m	2,59	2,40	2,29

Table 3.7

- The cost of road transport Kuehne + Nagel operator

For domestic transportation in Ukraine, UAH / t.-km.				For int. transportation (from / to Ukraine), USD / t.-km.			
Less than 2 tons	From 2 to 6 tons	From 6 to 14 tons	More than 14 tons	Less than 2 tons	From 2 to 6 tons	From 6 to 14 tons	More than 14 tons
1	2	3	4	5	6	7	8
1,51	0,99	0,64	0,30	0,68	0,27	0,12	0,07
For domestic transport within European countries, euro / t.-km.				For domestic transportation within the FSR (Former Soviet Republics) country (except Ukraine), USD / t.-km.			
1,02	0,89	0,55	0,25	0,15	0,11	0,09	0,05
For domestic transportation within the countries of South-East Asia, USD / t.-km.							
0,10	0,09	0,05	0,01				

Table 3.8

The cost of transportation by rail Kuehne + Nagel operator

For international transport from European countries, euro / t.-km.				For international transportation to FSR (Former Soviet Republics) countries (except Ukraine), USD / t.-km.			
0,84	0,64	0,51	0,21	0,52	0,45	0,33	0,21

Table 3.9

Distance between the manufacturer's warehouse and the seaport of the country of origin, km

The Netherlands, a port in Amsterdam	Belgium, port of Antwerp	Japan, port of Yokohama	Malaysia, a port in Kuala Lumpur
600	500	90	100

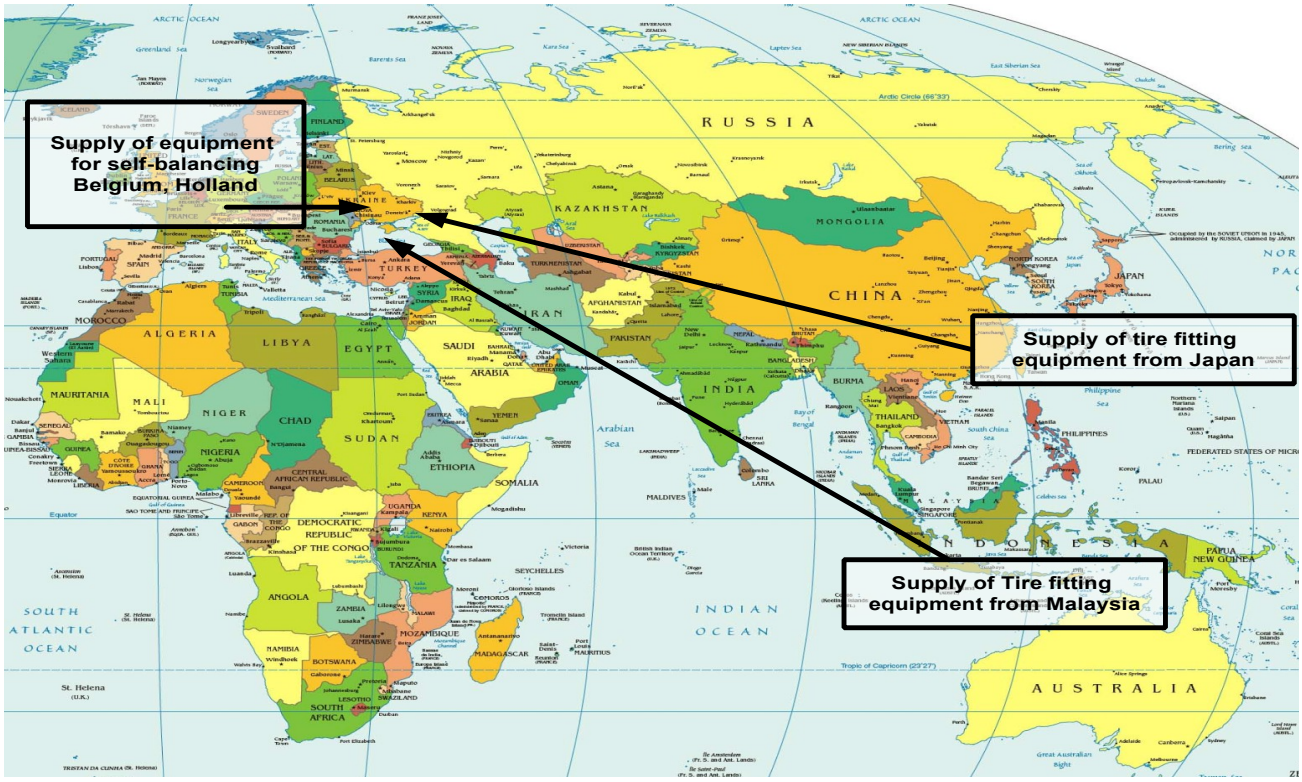
Table 3.10

The cost of freight container / part, euros *

	UK-3	UK-5	20 feet	40 feet
Total cost, euros	104	204	504	1004
Part, USD / 100 kg	17,3	18	14,25	14,2

The cost of transportation by sea to take as 0.1 USD / t.-km.

The delivery map of tire-mounting and mounting equipment, balancing equipment, lifting equipment for Mitsubishi Hevy Industries representative offices by the Kuhne + Nagel logistics operator is shown in Fig. 3.8.



Fi. 3.8. Map of delivery of tire-mounting equipment and equipment for auto balancing to car services "Mitsubishi Heavy Industries"

The graphically integrated supply chain of technological equipment for the Mitsubishi Heavy Industries car services in the countries of Ukraine, Lithuania, Poland and Romania by the logistics operator Kuehne + Nagel can be represented as follows (fig. 3.9).

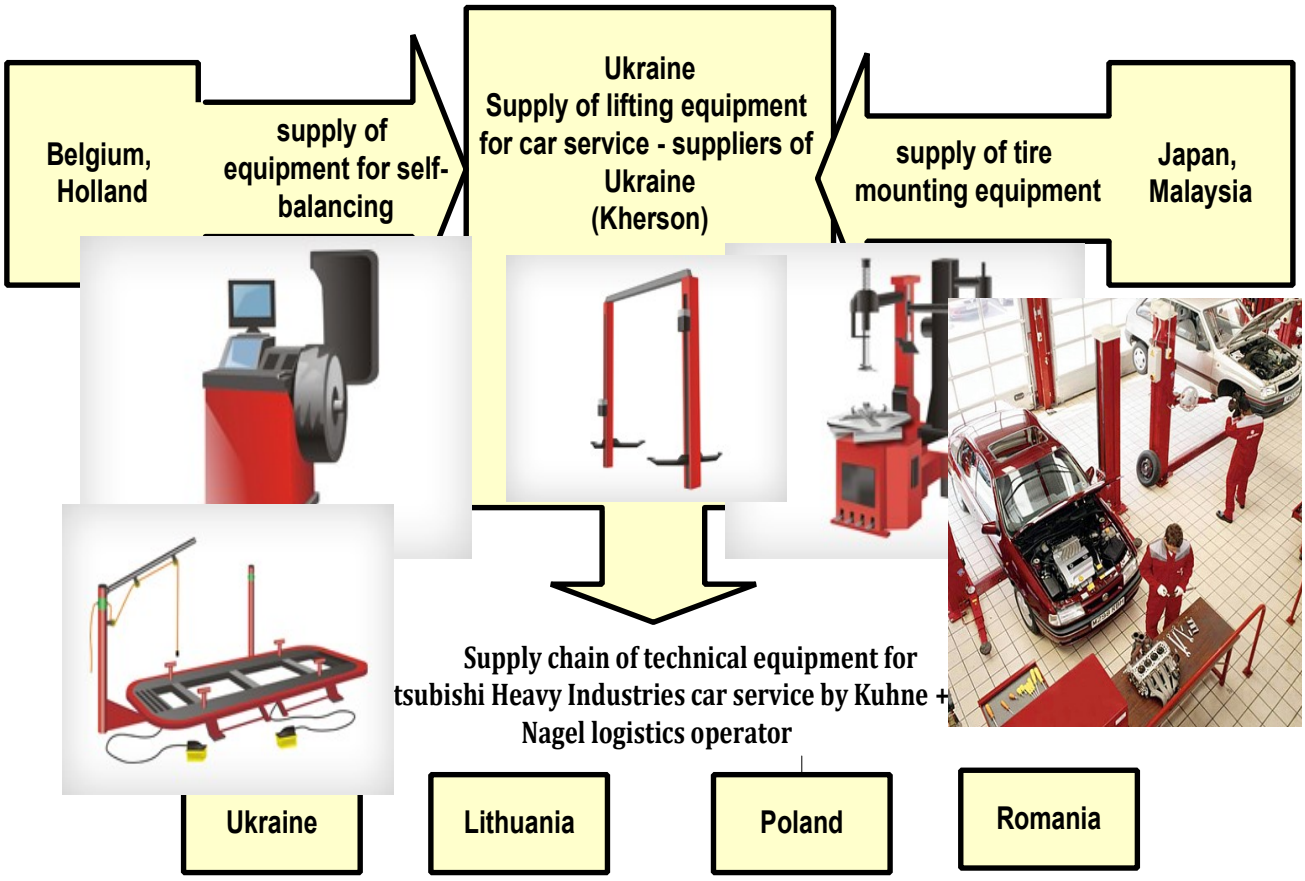


Fig. 3.9. The integrated supply chain of technological equipment for the Mitsubishi Heavy Industries car services in the countries by the logistics operator Kuehne + Nagel

The total cost of freight containers of different types from Japan / Malaysia (quarterly delivery) will be presented in table. 3.11.

Table 3.11

Total freight costs of different types of containers from Japan / Malaysia (quarterly delivery)

№	Quarter	Total weight of equipment, kg	Type of containers and required number			
			UK-3 M_{UK-3} = 2400 kg	UK-5 M_{UK-5} = 4050 kg	20 футовий M_{20F} = 21700 kg	40 футовий M_{40F} = 26500 kg
1	2	3	4	5	6	7
1	I	1100	0,46	0,27	0,05	0,04
2	II	1150	0,48	0,28	0,05	0,04
3	III	1250	0,52	0,31	0,06	0,05
4	IV	1100	0,46	0,27	0,05	0,04
5	Cost of freight for a part of a container, usd/100 kg		17,3	18	14,25	14,2
6	General freight cost for the first quarter, USD		190,3	198	156,75	156,2
7	General freight cost for the second quarter, USD		198,95	207	163,875	163,3
8	General freight cost for the third quarter, USD		216,25	225	178,125	177,5
9	General freight cost for the VI quarter, USD		190,3	198	156,75	156,2
10	General freight cost per year, USD		795,8	828	655,5	653,2

The calculation of the total cost of containers freight of different types from Japan / Malaysia twice a year is presented in table. 3.12.

Table 3.12

Total freight costs of different types of containers from Japan / Malaysia (twice per year)

№	Quarter	Total weight of equipment, kg	Type of containers and required number			
			UK-3 M_{UK-3} = 2400 kg	UK-5 M_{UK-5} = 4050 kg	20 feet M_{20F} = 21700 kg	40 feet M_{40F} = 26500 kg
1	2	3	4	5	6	7
1	I + II	2250	0,94	0,56	0,10	0,08
2	III+ IV	2350	0,98	0,58	0,11	0,09
3	The cost of part of the freight of the container USD / 100 kg		15,5	16,3	13,25	13
4	General freight cost for I + II quarter, USD		348,75	366,75	298,125	292,5
5	General freight cost for the III and VI quarters, USD		364,25	383,05	311,375	305,5
6	General freight cost per year, USD		713	749,8	609,5	598

The savings on freight is 262 USD. (fig. 3.10).

Fig. 3.10. Comparison of containers freight for transportation of technical equipment depending on the number of deliveries

So, according to the results, it turns out that the optimal supply is twice a year. Note that the supply of tire mounting equipment can be performed from Japan or Malaysia, the supply of balancing equipment - from Belgium or the Netherlands, lifting equipment - from Ukrainian suppliers.

3.3. Calculation of total costs for transportation of technological equipment from Japan and Malaysia

In the table. 3.13 and 3.14 we will present calculations of total costs for transportation of tire fitting equipment from the warehouse-manufacturer of Mitsubishi Heavy Industries in Japan and Malaysia to the warehouse "Kuhne + Nagel" in Kyiv. In fig. 3.11 present a comparison of costs depending on the place of transportation.

Table 3.13

Costs of transportation of tire fitting equipment from Japan to Ukraine

Calculated period	Distance between the manufacturer's warehouse and the seaport, km	The cost of road transport within the countries of Southeast Asia, USD / t.-km	Delivery costs from the manufacturer to the port in Surabaya, USD	Distance between Yokohama (Japan) and Madras (India), km	The cost of transportation by sea, USD / t-km	Costs of transportation by sea, USD	Distance between Madras (India) to the border with Tajikistan, km	The cost of road transport within the countries of Southeast Asia, USD / t.-km	Transportation costs from Madras to Tajikistan, USD
1	2	3	4	5	6	7	8	9	10
I+II quarters	90	0,09	18,225	3750	0,1	843,75	3000	0,09	607,50
III+IV quarters	90	0,09	19,04	3750	0,1	881,25	3000	0,09	634,50

Cont of the table 3.13

Distance from the border of Tajikistan to the border of Ukraine, km	The cost of road transport within the FSR countries, USD / t-km	Transportation costs within the FSR countries, USD	Transportation distance within Ukraine, km	The cost of transportation within Ukraine for int. transportation, USD / t-km	The cost of transportation within Ukraine as an international delivery, USD	Delivery cost from Indonesia (port Tanyungperak) to Ukraine (Kyiv)
11	12	13	14	15	16	17
3375	0,11	835,31	600	0,27	364,50	2669,29
3375	0,11	872,44	600	0,27	380,70	2787,92
					Total costs	5457,21

Table 3.14

Transportation costs of tire fitting equipment from Malaysia to Ukraine

Calculated period	Distance between the manufacturer's warehouse and the seaport, km	The cost of road transport within the countries of South-east Asia, USD / t.-km	Delivery costs from the manufacturer to the port of Kuala Lumpur, USD	Distance between Kuala Lumpur (Malaysia) and Madras (India), km	The cost of transportation by sea, USD / t-km	Costs of transportation by sea, USD	Distance between Madras (India) to the border with Tajikistan, km	The cost of road transport within the countries of South-east Asia, USD / t.-km	Transportation costs from Madras to Tajikistan, USD
1	2	3	4	5	6	7	8	9	10
I+II quarters	100	0,09	20,25	2250	0,1	506,25	3000	0,09	607,50
III+IV quarters	100	0,09	21,15	2250	0,1	528,75	3000	0,09	634,50

Distance from the border of Tajikistan to the border of Ukraine, km	The cost of road transport within the FSR countries, USD / t-km	Transportation costs within the FSR countries, USD	Transportation distance within Ukraine, km	The cost of transportation within Ukraine for int. transportation, USD / t-km	The cost of transportation within Ukraine as an international delivery, USD	Delivery cost from Indonesia (port Tanyungperak) to Ukraine (Kiev)
11	12	13	14	15	16	17
3375	0,11	835,31	600	0,27	364,50	2333,81
3375	0,11	872,44	600	0,27	380,70	2437,54

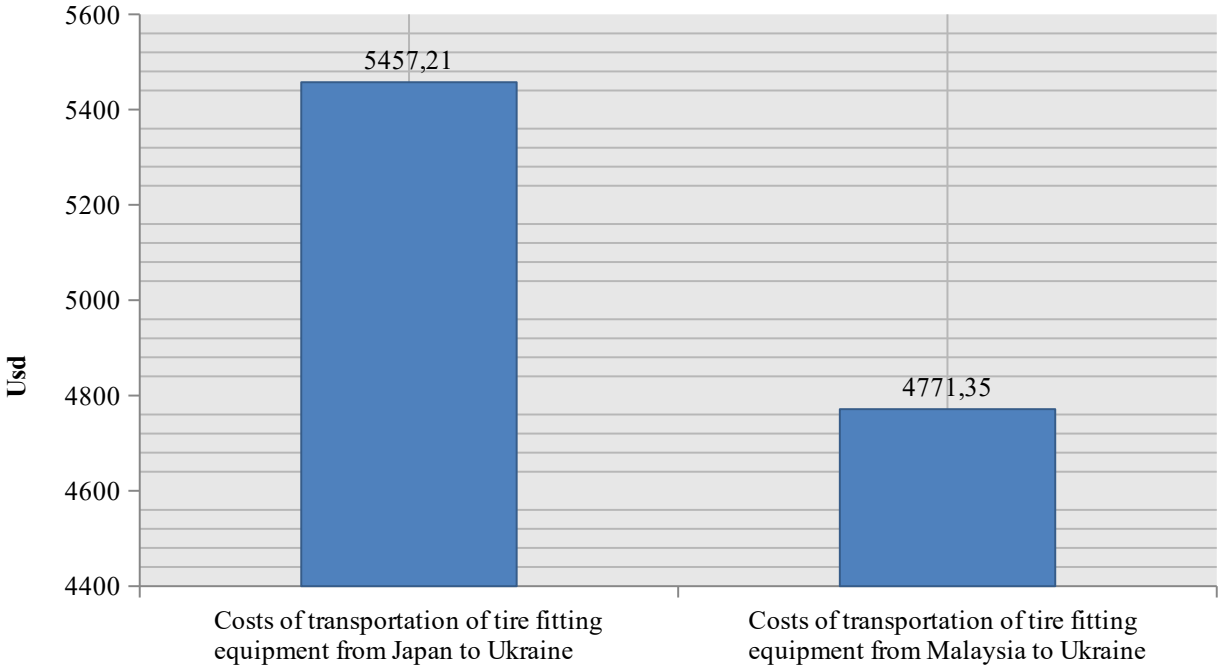


Fig. 3.11. Comparison of transportation costs depending on the location of the manufacturer

According to the estimated costs, it is clear that the optimal supply of tire fitting equipment from the plant of Mitsubishi Heavy Industries, located in Malaysia, as transportation costs are 4771.35 Usd, which is 685.86 Usd. Less than supplying products from Japan. The total annual cost of transportation and freight of containers is: 4771.35 + 2670.3 = 7441.65 Usd.

3.4. Calculation of total costs for transportation of technological equipment from manufacturing plants in Belgium and the Netherlands

Balancing equipment is transported from Belgium or Holland. Calculation of the required number of components makes it possible to find the required number of containers. The calculation results for the proposed types of containers and the frequency of shipments are presented in table 3.15 and 3.16.

Table 3.15

Total freight costs of different types of containers from Belgium / Holland (quarterly delivery)

Quarter	Total weight of equipment, kg	Type of containers and required number			
		UK-3 M_{UK-3} = 2400 kg	UK-5 M_{UK-5} = 4050 kg	20 feet M_{20F} = 21700 kg	40 feet M_{40F} = 26500 kg
I	210	0,09	0,05	0,01	0,01
II	220	0,09	0,05	0,01	0,01
III	220	0,09	0,05	0,01	0,01
IV	200	0,08	0,05	0,01	0,01
Cost of freight for a part of a container, usd/100 kg		17,3	18	14,25	14,2
General freight cost for the first quarter, USD		36,33	37,8	29,925	29,82
General freight cost for the second quarter, USD		38,06	39,6	31,35	31,24
General freight cost for the third quarter, USD		38,06	39,6	31,35	31,24
General freight cost for the VI quarter, USD		34,6	36	28,5	28,4
General freight cost per year, USD		147,05	153	121,125	120,7

Table 3.16

Total freight costs of different types of containers from Belgium / Holland (twice per year)

Quarter	Total weight of equipment, kg	Type of containers and required number			
		UK-3 M_{UK-3} = 2400 kg	UK-5 M_{UK-5} = 4050 kg	20 feet M_{20F} = 21700 kg	40 feet M_{40F} = 26500 kg
I + II	430	0,18	0,11	0,02	0,02
III+ IV	420	0,18	0,10	0,02	0,02
The cost of part of the freight of the container USD / 100 kg		15,5	16,3	13,25	13
General freight cost for I + II quarter, USD		66,65	70,09	56,975	55,9
General freight cost for the III and VI quarters, USD		65,1	68,46	55,65	54,6
General freight cost per year, USD		131,75	138,55	112,625	110,5

So, according to the results, it turns out that the optimal supply is twice a year. Savings on freight is almost 50 USD.

In fig. 3.12 we will present a comparison of freight containers for transportation of auto balancing equipment from Belgium / Netherlands depending on the number of deliveries.

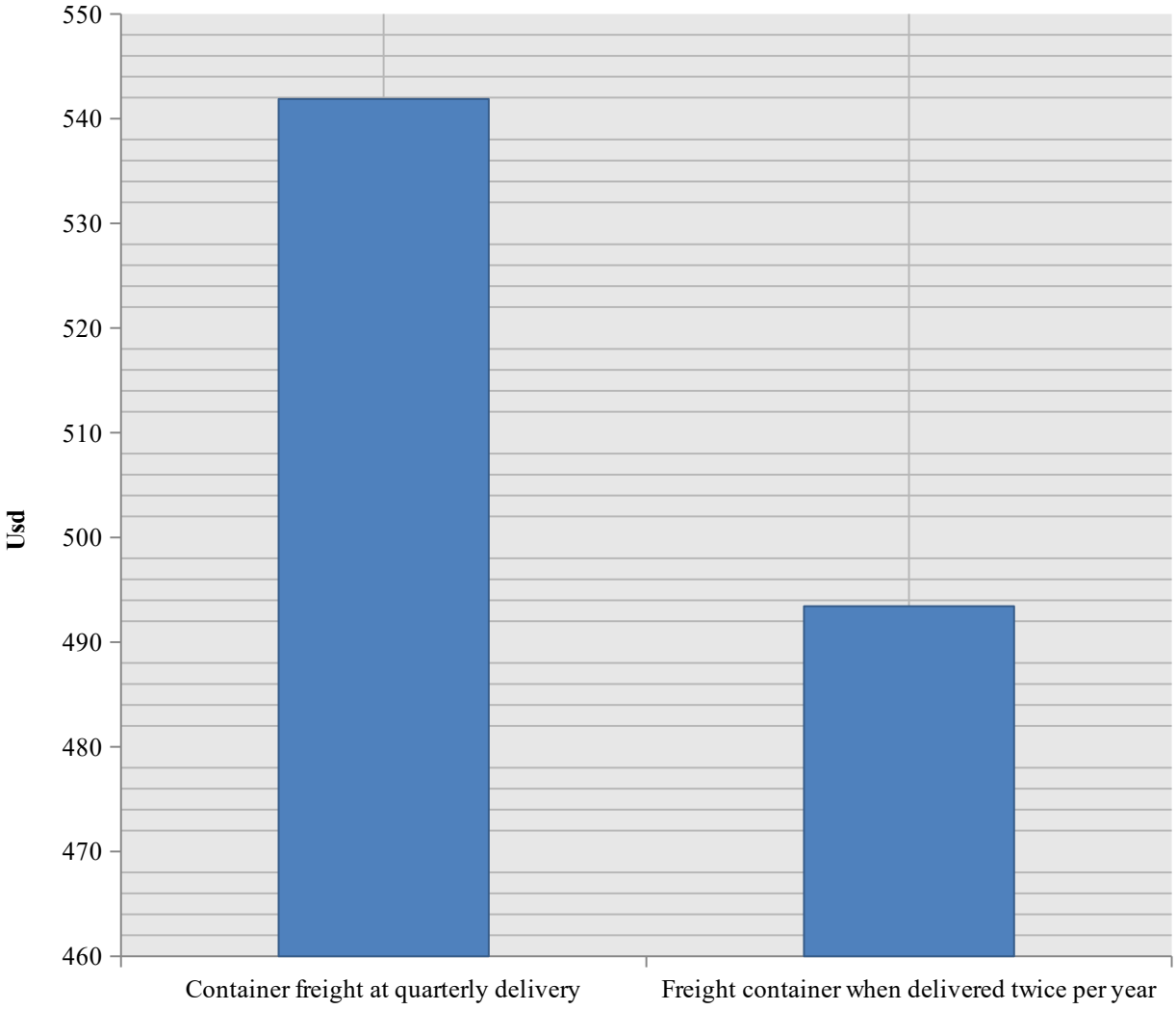


Fig. 3.12. Comparison of freight containers for transportation of auto balancing equipment from Belgium / Netherlands depending on the number of deliveries

Next, we will perform transport calculations. Note that we will make calculations for both producing countries. The costs will be minimal and will determine the manufacturer with whom we enter into a contract. In the table 3.17 and 3.18 present the calculations of the total costs for transportation of auto balancing equipment from the manufacturer Mitsubishi Heavy Industries in Belgium and the Netherlands to the Kuehne + Nagel warehouse in Kyiv.

Comparison of delivery schemes at the cost of transportation depending on the location of the manufacturer will be presented in Fig. 3.13.

Table 3.17

- Costs for transportation of equipment for auto balancing from the "Mitsubishi Heavy Industries plant " in Belgium to Ukraine

Indicators	Car. transport between the manufacturer's warehouse to a port in Belgium	Sea transport between ports in Belgium and Poland	Road transport between the port in Poland to the border with Ukraine	By rail between the port in Poland to Kiev	Road transport between the manufacturer's warehouse in Belgium and to the border with Ukraine	By rail between the manufacturer's warehouse in Belgium and to Kyiv	By road transport within Ukraine	Total costs for transportation, USD
Distance, km	500	1875	825	1200	1500	1500	375	
Transportation cost, USD / t.-km	1,275	0,1	1,275	1,008	1,275	1,008	0,19	
Option 1								1685,9
I + II quarter	274,13	80,625	472,30625				30,6375	857,69
III + IV quarter	267,75	78,75	451,7875				29,925	828,21
Option 2								1790,04
I + II quarter	274,13	80,625		520,128			30,6375	905,52
III + IV quarter	267,75	78,75		508,032			29,925	884,46
Option 3								1666,13
I + II quarter					802,375		30,6375	833,01
III + IV quarter					803,25		29,925	833,12
Option 4								1729
I + II quarter						865,6		865,6
III + IV quarter						8633,4		863,4

Table 3.18

Costs of transportation of equipment for self-balancing from the "Mitsubishi Heavy Industries" plant in Netherlands to Ukraine

Indicators	By road from the manufacturer's warehouse to the port in the Netherlands	Sea route between ports in the Netherlands and Poland	By road between the port in Poland to the border with Ukraine	Rail transport between the port in Poland to Kiev	Road transport between the manufacturer's warehouse in the Netherlands and to the border with Ukraine	By rail between the manufacturer's warehouse in the Netherlands and to Kyiv	Road transport within Ukraine	Total costs for transportation, USD
Distance, km	600	1775	825	1200	1350	1350	375	
Transportation cost, USD / t.-km	1,275	0,1	1,275	1,008	1,275	1,008	0,19	
Option 1								1755,78
I + II quarter	328,95	76,325	452,30625				30,6375	888,22
III + IV quarter	321,30	74,55	441,7875				29,925	867,56
Option 2								1889,85
I + II quarter	328,95	76,325		520,128			30,6375	956,04
III + IV quarter	321,30	74,55		508,032			29,925	933,81
Option 3								1523,63
I + II quarter					740,1375		30,6375	770,78
III + IV quarter					722,925		29,925	752,85
Option 4								1556,68
I + II quarter						785,144		585,14
III + IV quarter						771,536		571,54

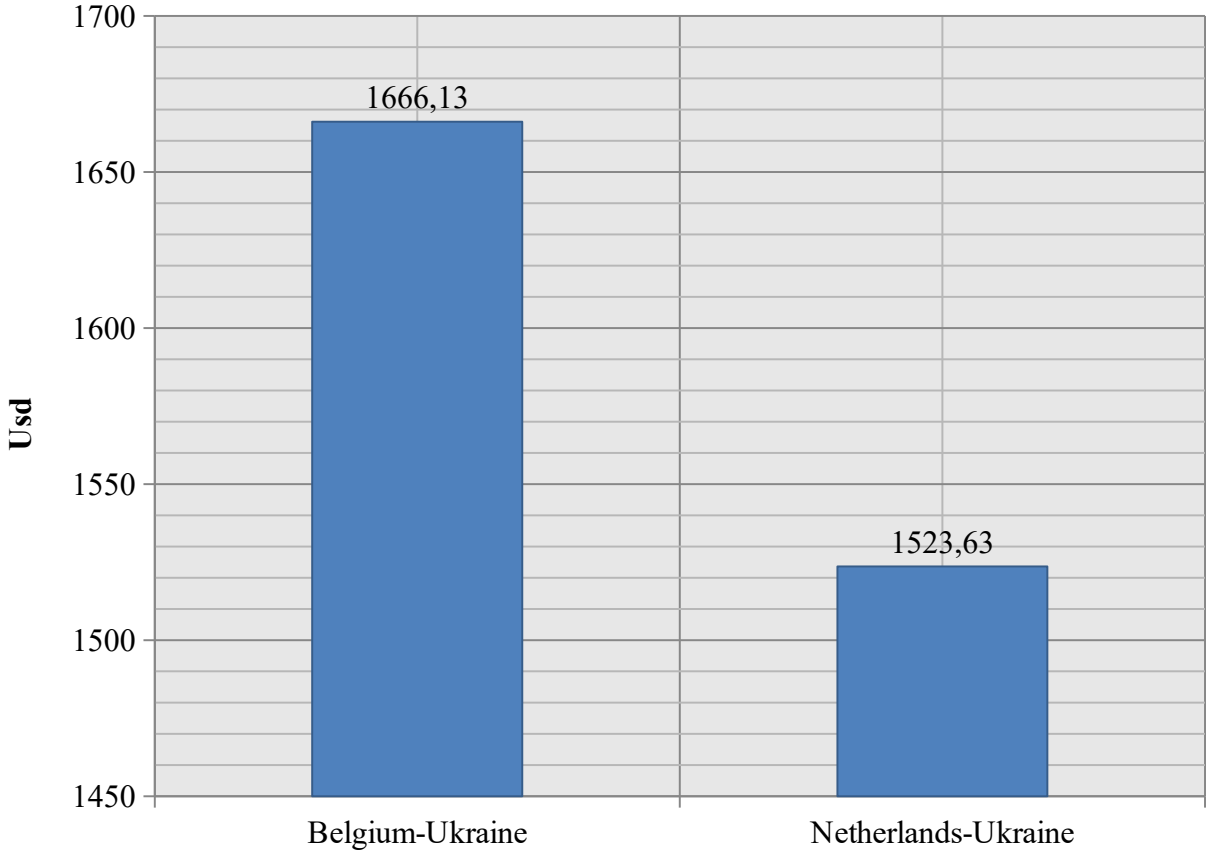


Fig. 3.13. Comparison of delivery schemes by transportation cost depending on the location of the Mitsubishi Heavy Industries plant in Belgium and the Netherlands

The estimated costs show that it is optimal to supply auto balancing equipment to car service companies from the Netherlands by road, as transport costs are 1523.63 Usd, which is 142.5 Usd less than to supply the same option from Belgium.

3.5. Calculation of total annual costs in the supply chain of technological equipment

The calculation of the total annual costs will be made taking into account the component costs for the supply of tire mounting equipment, balancing equipment, lifting equipment from the plants of the manufacturer Mitsubishi Heavy Industries. Regarding the supply of lifting equipment from Ukrainian suppliers, we calculate the

cost of transportation. The distance between Kherson and Kyiv is 530 km. The cost for domestic road transport in Ukraine is 0.18 Usd / t.-km. Therefore, transportation costs are:

- for the first + second quarter = 190.8 Usd.

- for the III and IV quarters = 190.8 Usd.

The total annual costs for the purchase of "other raw materials", transportation and freight of containers is: 381.6 Usd.

In total = 7441.65 + 2017.05+ 381.6 = 9840.3 Usd.

In fig. 3.14 present a model of the movement of material flows in the supply chain, taking into account financial and information flows.

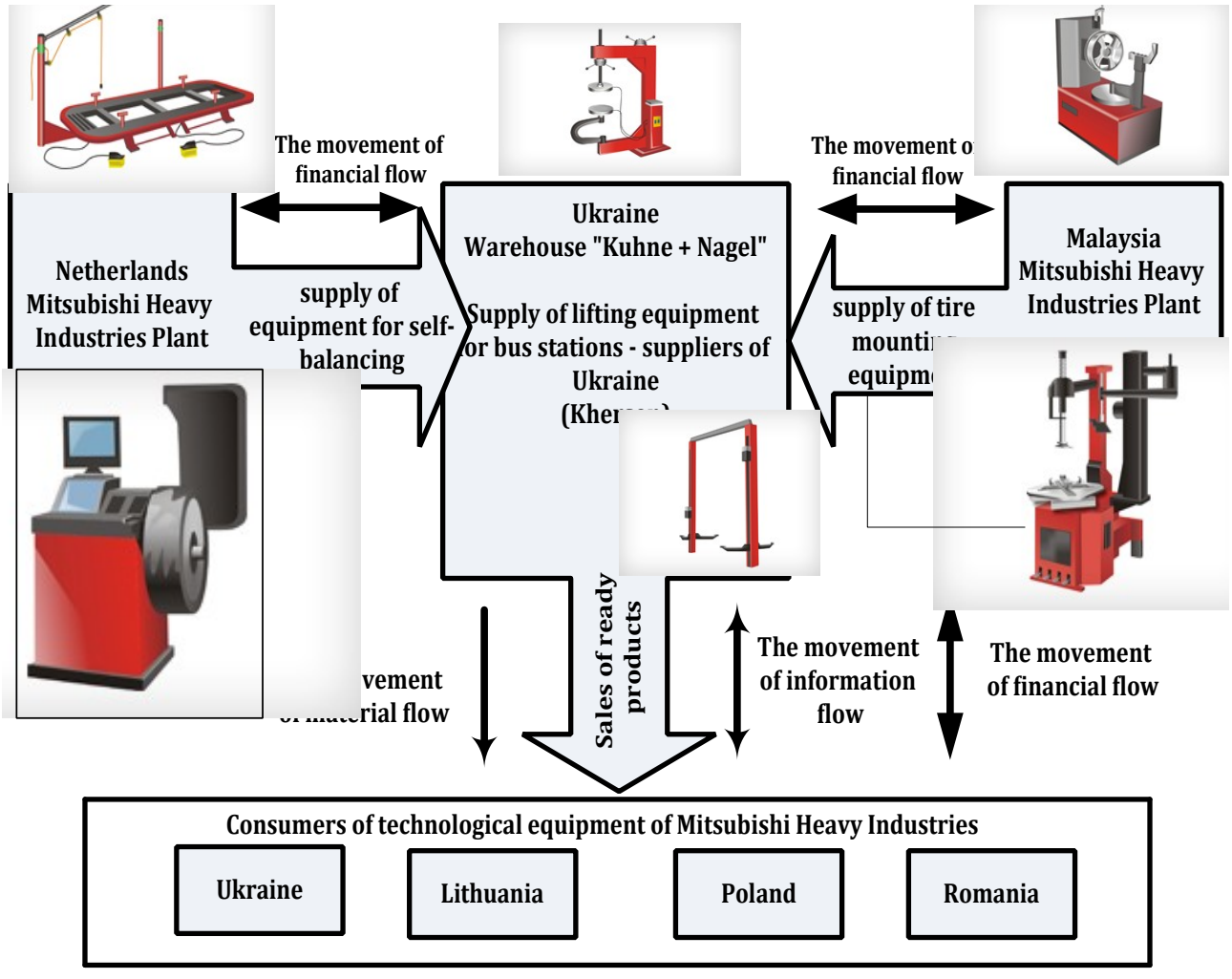


Fig. 3.14. Model of material flows in the supply chain, taking into account financial and information flows

It should be noted that the best option for the supply of raw tire fitting equipment for car service "Mitsubishi Heavy Industries" is from a manufacturer in Malaysia (instead of Japan), balancing equipment - from the Netherlands and lifting equipment - from Ukraine.

Thus, the total cost in the supply chain of technological equipment to the warehouse "Kuehne + Nagel" is 9840.3 USD. To calculate the optimal size of the supply of technological equipment for car service company "Mitsubishi Heavy Industries" was used Winters model (exponential smoothing method with three parameters that reflect the trend and seasonality). This model allows you to increase the accuracy of the forecast, when the time series includes the trend and seasonal fluctuations.

The project part of the thesis is devoted to the design of delivery schemes of technological equipment "Mitsubishi Heavy Industries". There were a number of problems on the shoulders of the logistics operator Kuehne + Nagel in the supply of technological equipment, namely equipment for Mitsubishi Heavy Industries maintenance and repair stations from Japan / Malaysia to Ukraine and from the Netherlands / Belgian plants. In the work, forecast calculations on the demand in the supply chain and the calculated costs, taking into account the different supply schemes of technological equipment were made.

The calculations performed by the Holt-Winters method allowed to determine the amount of technological equipment of the company "Mitsubishi Heavy Industries" for the countries-consumers of products (Ukraine, Lithuania, Poland, Romania). The forecast model based on the Holt-Winters method is adequate and can be used to determine the forecast values of the number of sold products for future periods. This will allow us to make the following calculations regarding the transportation scheme and the cost of delivery. Note that further calculations were made only for the consumer market in Ukraine.

An integrated supply chain of technological equipment for Mitsubishi Heavy Industries car services in the countries of consumption was built by the logistics operator Kuehne + Nagel.

According to the costs received, it is clear that the optimal supply of tire fitting equipment from the plant of Mitsubishi Heavy Industries, located in Malaysia, as transportation costs are 4771.35 dollars, which is 685.86 dollars. less than supplying products from Japan. The total annual costs for the purchase, transportation and freight of containers is: 4771.35 + 2670.3 = 7441.65 dollars.

The calculation of the cost of supplying auto balancing equipment to car service companies showed that it is advisable to supply from the Netherlands by road, as transport costs are 1523.63 dollars, which is 142.5 dollars less than to supply the same option from Belgium.

Thus, the total cost in the supply chain of technological equipment from manufacturers to the warehouse "Kuehne + Nagel" in Ukraine is 9840.3 dollars.

Thus, supply chain management is a set of approaches that helps to effectively integrate suppliers, manufacturers, distributors and vendors. SCM, taking into account customer service requirements, allows you to ensure the availability of the right product at the right time in the right place with minimal costs.

SUMMARY

Air Transportation Management Department				*NAU.20.07.42 004EN*		
Done by:	*Viktoriia V. Mudryk*			SUMMARY	Letter: D	Sheet.: 109 / Sheets: 4
Supervisor:	*Yuliia V. Shevchenko*					
Standards Inspector	*Yuliia V. Shevchenko*					
Head of the Department	*Shevchuk D. O.*					

FTML 275 ОП- 202Ма

The theoretical part of the thesis is devoted to supply chain management, which will mean the sequence of economic entities from suppliers of raw materials, parts, components and components to consumers of the final product (service), which, carrying out production, trade, logistics and other processes, are those that are directly related to the movement of material and corresponding information flows at established stages. A chain assembly that is unable to provide proper quality limits the supply capacity. Therefore, the urgent problem is to manage the quality of the entire supply chain, not its individual units. Chain participants should strive not to meet their own planned quality indicators, but to achieve the overall performance of the supply chain.

In accordance with the previously presented "rules of logistics" it becomes possible to define the concept of "supply chain quality management". Thus, supply chain quality management is a coordinated activity aimed at meeting the requirements for the quality of the supply chain: delivery of the desired product of the required quality, in the required quantity, at the right time, place and with minimal costs.

The practice of supply chain management proves the effectiveness of building and analyzing the business, based on an integrated consideration of all areas and junctions of different stages of the value chain, rather than optimizing the local management functions of your own enterprise. After all, highly efficient supply chains provide maximum satisfaction of demand for products (services) in the most flexible, reliable and less expensive way, which is the basis for sustainable development of the organization.

The advantages and disadvantages of ERP, MRP and DRP systems were also analyzed. The directions of improvement of information support for modeling of a supply chain are offered. The relationships and functions of supply chain management systems are defined. The components of the supply chain database are considered.

The analytical part of the thesis is devoted to the activities of the company " Kuehne + Nagel ", which provides a wide range of services. The main advantages

that are the distinguishing feature of the company " Kuehne + Nagel ": fast delivery of transport to the place of loading, flexible pricing policy, reliability, constant monitoring of goods.

Kuehne + Nagel provides a complete logistics cycle, ie takes over warehousing, packaging operations, transportation by various modes of transport and its specifications, both in Ukraine and abroad. Thus geography of transportations is practically not limited. Also provides customs brokerage services and advice.

A study of the company's financial condition showed that Kuehne + Nagel is profitable and financially stable. A financially stable enterprise pays its obligations to the state, extra-budgetary funds, staff, and contractors on time. The main factors that determine the financial stability of the enterprise include the financial structure of capital (the ratio of borrowed and own funds, as well as long-term and short-term sources of funds) and the financing policy of individual components of assets (primarily non-current assets and inventories). It is worth noting that the financial stability of " Kuehne + Nagel " is its reliable and guaranteed solvency in normal business conditions and accidental changes in the market.

To date, the most common and modern method of transportation is containerized cargo. They are successfully used on both international and domestic transport arteries. Unconditional leadership in the field of logistics, this type of transportation has won through the use of containers.

Studies have shown that cargo in containers is easier to transport because they are better packed than general shipments. Transportation becomes cheaper because a fully loaded container makes the most economical use of cargo space, whether on a ship, car or car. Therefore, the company "Kuehne + Nagel" pays great attention to container transportation. Container transportation reduces insurance costs, as individual shipments do not require individual processing.

Containers make direct transportation a logical and economical way to deliver goods. Therefore, there is the development of integrated mixed transport "door to door" or from warehouse to warehouse (railway - sea - highway, highway - air transport - highway).

The project part of the thesis is devoted to the design of delivery schemes of technological equipment "Mitsubishi Heavy Industries". There were a number of problems on the shoulders of the logistics operator Kuhne + Nagel in the supply of technological equipment, namely equipment for Mitsubishi Heavy Industries maintenance and repair stations from Japan / Malaysia to Ukraine and from the Netherlands / Belgian plants. In the work, forecast calculations on the demand in the supply chain and the calculated costs, taking into account the different supply schemes of technological equipment were made.

The calculations performed by the Holt-Winters method allowed to determine the amount of technological equipment of the company "Mitsubishi Heavy Industries" for the countries-consumers of products (Ukraine, Lithuania, Poland, Romania). The forecast model based on the Holt-Winters method is adequate and can be used to determine the forecast values of the number of sold products for future periods. This will allow us to make the following calculations regarding the transportation scheme and the cost of delivery. Note that further calculations were made only for the consumer market in Ukraine.

An integrated supply chain of technological equipment for Mitsubishi Heavy Industries car services in the countries of consumption was built by the logistics operator Kuhne + Nagel.

According to the costs received, it is clear that the optimal supply of tire fitting equipment from the plant of Mitsubishi Heavy Industries, located in Malaysia, as transportation costs are 4771.35 dollars, which is 685.86 dollars. less than supplying products from Japan. The total annual costs for the purchase, transportation and freight of containers is: 4771.35 + 2670.3 = 7441.65 dollars.

The calculation of the cost of supplying auto balancing equipment to car service companies showed that it is advisable to supply from the Netherlands by road, as transport costs are 1523.63 dollars, which is 142.5 dollars less than to supply the same option from Belgium.

Thus, the total cost in the supply chain of technological equipment from manufacturers to the warehouse "Kuhne + Nagel" in Ukraine is 9840.3 dollars.

Thus, supply chain management is a set of approaches that helps to effectively integrate suppliers, manufacturers, distributors and vendors. SCM, taking into account customer service requirements, allows you to ensure the availability of the right product at the right time in the right place with minimal costs.

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Appendix A

Functions of the supply chain management system

№ п/п	Type of system	Functions
1	**2**	**3**
1	Enterprise Resource Planning (ERP)	- management of transaction data of the enterprise, ie data on receipt of orders, accounting, delivery, etc.
2	Material Resource Planning System (MRP)	- analysis of the plan of production of finished products needed to meet demand; - analysis of stocks of raw materials, work in progress and finished products; - formation of requirements for the supply of raw materials, components, materials
3	Finished Product Distribution Planning System (DRP)	- analysis of the availability of finished products for transportation; - determination of the balances of finished products at factories and distribution centers; - determination of the size of the reserve stock of finished products, the level of stocks and the point of replenishment of stocks; - choice of distribution channel, mode of transport, carrier
4	Demand forecasting and order management system	- forecasting the demand for finished products; - long-term forecasting of market development; - planning the structure of the range of finished products
5	Production calendar optimization systems	- distribution of orders for equipment; - calculation of equipment replacement time; - inventory management of work in progress
6	Distribution scheduling optimization systems	- delivery of goods to consumers; - distribution of products by distribution centers; - optimization of the order of deliveries
7	Production planning optimization systems	- definition of the basic plan of production; - selection of optimal technologies; - distribution of resources at different stages of production; - determination of inventories of work in progress; - determination of time for reconfiguration of equipment; - choice to "buy or make"
8	Distribution planning optimization systems	- determination of locations of distribution centers; - analysis of demand for finished products by region; - definition of the concept of warehousing and transportation
9	Tactical optimization system	- determanation of an integrated supply, production and sales plan for 12 months
10	Strategic optimization system	- creation of new production facilities; - forecasting the price for the purchase of resources; - construction of a supply chain for a new product