MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL AVIATION UNIVERSITY
Faculty of Transport, Management and Logistics
Logistics Department

APPROVED
Head of the Department
Matveev V.V.
(signature, surname and name)
«07» November 2022

DIPLOMA THESIS

(EXPLANATORY NOTES)

OF GRADUATE OF ACADEMIC DEGREE

«MASTER»

THEME: **«Prospects for the implementation of logistics engineering solutions in the activities of a transport company»**

Speciality 073 «Management»

Educational and Professional Program « Logistics »

Done by Ivanets Ivan
(surname and name) (signature, date)

Supervisor Karpun O.V.
(surname and name) (signature, date)

Standards Inspector Kaban N.D.
(surname and name) (signature, date)

Kyiv 2022

МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ
Факультет транспорту, менеджменту і логістики
Кафедра логістики

ЗАТВЕРДЖУЮ
Завідувач кафедри логістики
Матвєєв В.В.
(підпис, П.І.Б)
«07» листопада 2022 р.

КВАЛІФІКАЦІЙНА РОБОТА

(ПОЯСНЮВАЛЬНА ЗАПИСКА)

ЗДОБУВАЧА ОСВІТНЬОГО СТУПЕНЯ

«МАГІСТР»

ТЕМА: «***Перспективи впровадження логістичних інжинірингових рішень в діяльність транспортної компанії»***

зі спеціальності 073 «Менеджмент»
(шифр і назва)
освітньо–професійна програма «Логістика»
(шифр і назва)

Здобувач: Іванець Іван Олександрович
(прізвище, ім'я та по батькові) (підпис, дата)

Науковий керівник: Карпунь О.В.
(прізвище та ініціали) (підпис, дата)

Нормоконтролер: Кабан Н.Д.
(прізвище та ініціали) (підпис, дата)

Київ 2022

NATIONAL AVIATION UNIVERSITY
Faculty of Transport, Management and Logistics
Logistics Department

Academic degree Master

Speciality 073 «Management»

Educational and Professional Program « Logistics »

APPROVED
Head of the Department

Matveev V.V.
(signature, surname and name)
«05» September 2022

TASK

FOR COMPLETION THE MASTER THESIS OF GRADUATE

Ivanets Ivan
(surname and name)

1. Theme of the master thesis: «Prospects for the implementation of logistics engineering solutions in the activities of a transport company» was approved by the Rector Directive №1225/ст. of September 05, 2022.
2. Term performance of thesis: from September 05, 2022 to November 30, 2022.
3. Date of submission work to graduation department: November 07, 2022.
4. Initial data required for writing the thesis: general and statistical information of the transport services market in Ukraine and transport company "Ukrtrans Garant", economic and financial indicators of the company's activity, literary sources on logistics engineering solutions, Internet sources.
5. Content of the explanatory notes: introduction; theoretical principles of logistics engineering in the activities of a transport company; research of the situation on the transport services market in Ukraine; analysis of the activities of the transport company "Ukrtrans Garant" on the market; development of a strategy for improving the activities of a transport company based on logistic engineering solutions; recommendations for the implementation of logistic engineering solutions in the activities of the transport company; the influence of logistic engineering solutions on the activities of the transport company "Ukrtrans Garant"; calculation of the efficiency and expediency of delimiting positions in the branches; conclusions.
6. List of obligatory graphic matters: tables, diagrams, graphs, schemes illustrating the current state of the problem and methods of solving them.

7. Calendar schedule:

№	Assignment	Deadline for completion	Mark on completion
1	2	3	4
1.	Study and analysis of scientific articles, literary sources, normative legal documents, preparation of the first version of the introduction and the theoretical chapter	05.09.22-28.09.22	Done
2.	Collection of statistical data, timing, detection of weaknesses, preparation of the first version of the analytical chapter	29.09.22-10.10.22	Done
3.	Development of project proposals and their organizational and economic substantiation, preparation of the first version of the project chapter and conclusions. Editing the first versions of maser thesis	11.10.22-28.10.22	Done
4.	Preparing the final version of the master thesis, checking by standards inspector	29.10.22-02.11.22	Done
5.	Approval for a work with supervisor, getting of the report of the supervisor, getting internal and external reviews, transcript of academic record	03.11.22-06.11.22	Done
6.	Submission work to Logistics Department	07.11.22	Done

Graduate_____
(signature)

Supervisor of the master thesis _____
(signature)

8. Consultants of difference chapters of work:

Chapter	Consultant (position, surname and name)	Date, signature	
		The task was given	The task was accepted
Chapter 1	Associate Professor, Karpun O.V.	05.09.22	05.09.22
Chapter 2	Associate Professor, Karpun O.V.	29.09.22	29.09.22
Chapter 3	Associate Professor, Karpun O.V.	11.10.22	11.10.22

9. Given date of the task September 05, 2022.

Supervisor of the master thesis: _____ Karpun O.V.
(signature of supervisor) (surname and name)

Task accepted for completion: _____ Ivanets I.O.
(signature of graduate) (surname and name)

ABSTRACT

The total volume of the explanatory note for the thesis «Prospects for the implementation of logistics engineering solutions in the activities of a transport company» is 117 pages and contains 30 figures, 10 tables and 93 sources used.

LOGISTICS ENGINEERING, LOGISTICS ENGINEERING SOLUTIONS, TRANSPORT COMPANY, STRATEGY OF TRANSPORT COMPANY, RADIO FREQUENCY IDENTIFICATION, INTERNET OF THINGS.

The thesis deals with the prospects for the implementation of logistics engineering solutions in the activities of a transport company.

The purpose of the research is to generalize the theoretical, analyze the practical and develop scientific and methodological recommendations for the implementation of logistics engineering solutions in the activities of a transport company.

The object of research is the activities of the transport company in the conditions of innovative solutions.

The subject of research is the implementation of logistics engineering solutions in the activities of a transport company.

The scientific innovation consists in the formation of the conceptual basis for the implementation of a logistics engineering solution in the activities of a transport company, the basis of which is the Internet of Things technology, which will increase the efficiency of the transport company.

Methods of research are scientific inquiry, empirical, analysis and synthesis, modeling, expert assessments, extrapolation of time series.

Materials of the thesis are recommended for use during scientific research, in the educational process and in the practical work of specialists of logistics departments.

CONTENTS

NOTATION

AIDC – Automatic Identification and Data Capture

AI – Artificial Intelligence;

AM – Additive Manufacturing;

AR – Augmented reality;

BOPIS – Buy online, Pick up in-store;

DCSA – Digital Container Shipping Association;

GPS – Global Positioning Systems;

HSI – Human Systems Integration;

IIoT – Industrial Internet of Things;

IoT – Internet of Things;

IPS – Integrated Product Support;

ISO – International Standardization Organization;

IT – Information Technology;

LCC – Life Cycle Cost;

NFC – Near field communication;

NPV – Net Present Value;

RFID – Radio Frequency Identification;

SaaS – Software as a Service;

SE – Systems Engineering;

WMS – Warehouse Management System;

WSN – Wireless Sensor Networks.

INTRODUCTION

In the world, there is a trend of continuous progress of research and innovation in various fields, and the field of logistics is no exception. The use of modern advanced technologies in logistics will ensure a high speed of execution of the necessary operations and a reduction of financial and labor costs, which will serve as a decisive factor in increasing the company's competitiveness and increasing profits. Innovative logistics is considered the most relevant component of logistics activity. It is a scientific tool for the rationalization of flow processes by introducing progressive innovations into the current and strategic management of market structures aimed at improving the quality of customer service, increasing the efficiency of flow processes and reducing the total costs of their implementation in order to achieve the final business results.

The issue of optimizing and increasing the efficiency of logistics channel management is relevant and in demand in the domestic literature, because the economic crisis and competition in the market of logistics intermediaries lead to the search for new innovative ways of working.

Logistics is a term in common use today, as it occupies an important place in supply chains, as well as competition between businesses. There are several definitions of logistics.

Logistics is the planning, control, organization and coordination of the flow of materials, information, energy, money and values in the logistics system. In addition to the implementation of these processes, logistics is also a discipline that synthesizes and uses modern knowledge and methods of several disciplines related to logistics to solve a given logistical problem. Logistics includes management of transportation, warehousing, stocks, personnel, organization of information systems and commercial activities of the enterprise, that is, an organic combination of the above areas of logistics into a single system.

Therefore, the goal of logistics is to provide products of the right quality and quantity to the specified destination at the right time from the right source, with the right method and equipment, and with the right minimum costs. The quality and availability of services offered by the logistics sector are of great importance for economic growth and increasing employment potential.

An effective market strategy for the functioning of an individual firm is built on the connections between the firm, the consumer and the competitor. As a rule, with an increase in the volume of production of goods, their cost price decreases. However, in conditions of oversaturation of the market with goods, it is impossible to achieve profitability in the activities of companies by focusing on increasing sales volumes only. In order to sell a product, it is necessary to distinguish it from similar products, to provide additional properties that better meet the needs of the consumer. This is facilitated by the market segmentation strategy. The market is becoming more and more sensitive to the quality of service, which increasingly affects the achievement of competitive advantages. Logistics is seen as a tool that makes it possible to take and maintain this position.

In recent years, globalization, increased competition on the world market, more complex products with a short life cycle, the constant desire to reduce costs and fluctuating consumer needs have given rise to new technologies and business processes, so the logistics sector today must be ready to meet new practical challenges in the future, and quick response to them will be the key to success for enterprises.

In general, the process of serving customers of a transport company consists in carrying out transport and forwarding work. In turn, the transport and forwarding robot consists in the fact that the cargo is accepted from the owner of the cargo, prepared for transportation and loaded into the vehicle, reloaded from one mode of transport to another, if necessary, stored in the appropriate place, unloaded from the vehicle and delivered recipient.

Transport service refers to activities aimed at delivering cargo and carrying out loading and unloading operations along the entire transportation route from the consignor to the consignee.

Conventionally, there are three groups of players in the logistics market:

1. Transport companies are companies engaged in cargo transportation and providing services on domestic and international routes. Their task is to deliver the cargo to the place specified by the client within the pre-arranged terms.

2. Transport and forwarding companies are also engaged in the organization of cargo transportation. They act as mediators between the client and the carrier, help in the search for the executor and transport that meet the criteria for cargo transportation, and provide forwarding services. This also includes online sites for searching for drivers and cargo.

3. Logistics companies that provide services for transportation, processing and, most importantly, storage of goods. A logistics company can become a profitable partner for those organizations that plan to expand sales markets, reduce the cost of goods by minimizing delivery costs, because, unlike previous players, they can distribute goods to the end consumer in the interests of the client. This type of service may include warehousing, distribution of goods to retail outlets, customer search, etc. A good logistics company can replace a similar service of an enterprise and provide a complete logistics chain from the producer to the consumer.

Transport companies most often own transport and lease it to transport forwarding and logistics organizations, and can also carry out transport themselves.

Therefore, the study of the perspective of the implementation of logistics engineering solutions in the activities of the transport company is a very relevant issue today.

Logistics engineering generally deals with the effective use of engineering methods to resolve logistics problems.

Logistics Engineering is a center service exercise, but provides benefit via improved efficiency and client satisfaction. The end customer can include another

process or perhaps work center within the manufacturing facility, a warehouse exactly where items are stocked or the ultimate customer who will use the product.

Information inaccuracy can adversely affect supply chain performances by lack of inventories, delay in delivery times, lost sales and decreased customer satisfaction. Real-time information is essential for making efficient and good decisions. Without real-time information about specific requirement or any kind of disturbances in supply chain (machine breakdown, human errors, rush orders, problems supplying required raw material or components, etc.) erroneous managerial decisions occur. Variation in production affects downstream members of internal supply chain (e.g. supply of parts to assembly line) and their planning and scheduling, and consequently could affect partners in supply chain.

Coordination, integration and particularly sharing information in real-time about resource constraints, plans and schedules with other supply chain members are very important.

The status and related information about each component in production must be monitored individually through its internal and external supply chain. The most of Ukrainian enterprises still use labor-intensive methods (enter data manually and using bar-code systems) for products-related data acquisition. Due to limitations in data acquisition and data interchange between shop floor and IT system, data is often unreliable and incomplete and needed production status information is unavailable at the right place and at the right time to make effective decisions. As a consequence of problems in existing methods of identifying and tracking parts and products, mislay of parts and products, schedule delay and late deliveries occur and costs increase. To solve this production management problem, automated data acquisition is necessary in order to enable the flow of required information to everyone who needs them through integrated enterprise system and supply chain. There is a need for an integral enterprise integration, and also external integration of enterprise with supply chain partners.

At today's level of IT systems, the integration of data is organized in data warehouses and new models and methods for data analysis and calculation of

expected business trends are the most significant in order to increase the effectiveness of IT systems. Also, it is very important to increase the speed of data transfer between the systems and to create conditions for the development of digital enterprise. The concept of digital enterprise is related to an enterprise in which the communication (exchange of information, messages, instructions, technical and technological documentation) between workers, workers and machines, and also machines to machines is performed digitally. RFID technology is one of the technologies that enable automatic object-to-object communication which is unique to digital manufacturing enterprises.

The purpose of the research is to generalize the theoretical, analyze the practical and develop scientific and methodological recommendations for the implementation of logistics engineering solutions in the activities of a transport company.

The object of research is the activities of the transport company in the conditions of innovative solutions.

The subject of research is the implementation of logistics engineering solutions in the activities of a transport company.

Achieving the set purpose requires solving the following tasks:

– conduct a research of the essence of the logistic engineering;

– consider RFID systems as one of the logistics engineering solutions;

– determine the advantages and disadvantages of the introduction of RFID systems in the activities of the transport company;

– conduct a research of the situation on the transport services market in Ukraine;

– to analyze the activities of the transport company "Ukrtrans Garant" on the market;

– develop a strategy for improving the activities of the transport company based on logistical engineering solutions;

– provide recommendations on the implementation of logistic engineering solutions in the activities of the transport company;

– determine the impact of logistical engineering solutions on the activities of the transport company "Ukrtrans Garant".

The scientific innovation consists in the formation of the conceptual basis for the implementation of a logistics engineering solution in the activities of a transport company, the basis of which is the Internet of Things technology, which will increase the efficiency of the transport company.

Research methods: historical-logical, systemic-structural approaches to the analysis of the economic state of the enterprise, comparative, graphic and tabular, as well as statistical methods. The use of a complex approach to the study of quality control, which allows obtaining a quantitative description of its impact on the activity and development of the enterprise.

CHAPTER 1
THEORETICAL PRINCIPLES OF LOGISTICS ENGINEERING IN THE ACTIVITIES OF A TRANSPORT COMPANY

1.1 Research of the essence of the logistic engineering

According to conducted research we have found several definitions of the terms “logistics engineering”.

Logistics engineering is usually a field of engineering specializing in the scientific organization on the purchase, transport, safe-keeping, distribution, and warehousing associated with materials and complete goods [50].

Logistics engineering generally deals with the effective use of engineering methods to resolve logistics problems (Fig. 1.1).

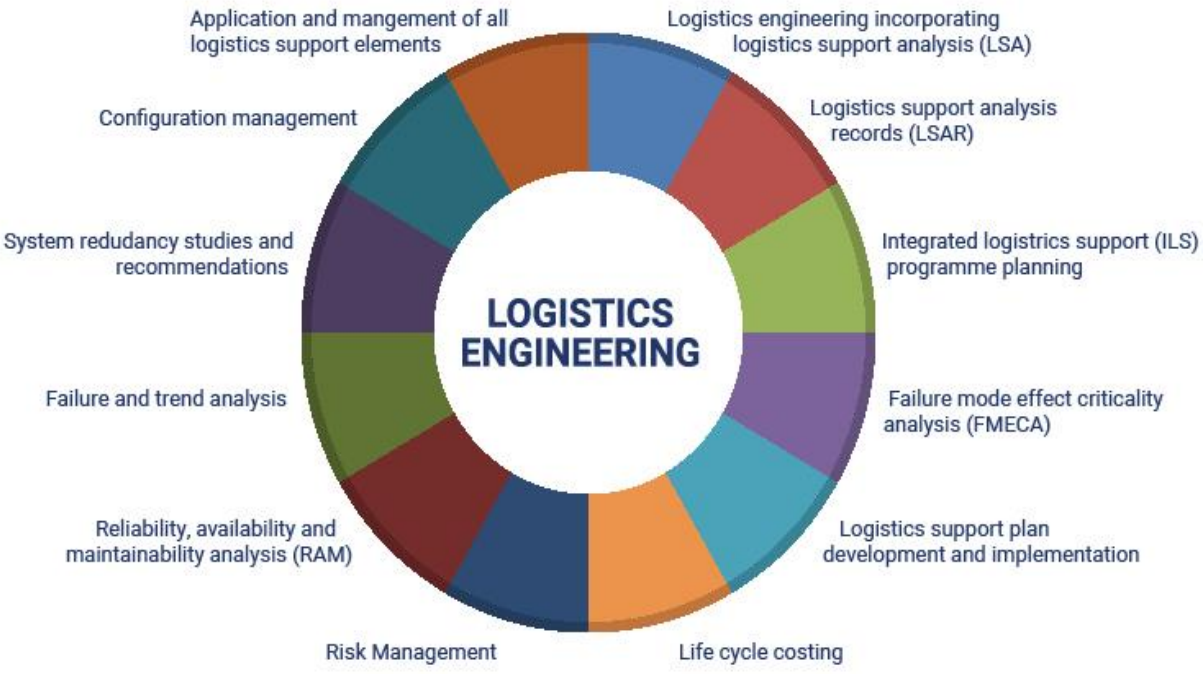

Figure 1.1 – Logistics engineering [30]]

Logistics Engineering is the professional engineering discipline responsible for the integration of support considerations in the design and development; test and evaluation; production and/or construction; operation; maintenance; and the ultimate disposal/recycling of systems and equipment (whole system life cycle) [49].

Logistics Engineering is a center service exercise, but provides benefit via improved efficiency and client satisfaction. The end customer can include another process or perhaps work center within the manufacturing facility, a warehouse exactly where items are stocked or the ultimate customer who will use the product.

Logistics Engineers are utilized throughout the entire system life cycle, from concept to disposal for the system life cycle stages as per ISO/IEC 15288 (Fig. 1.2).

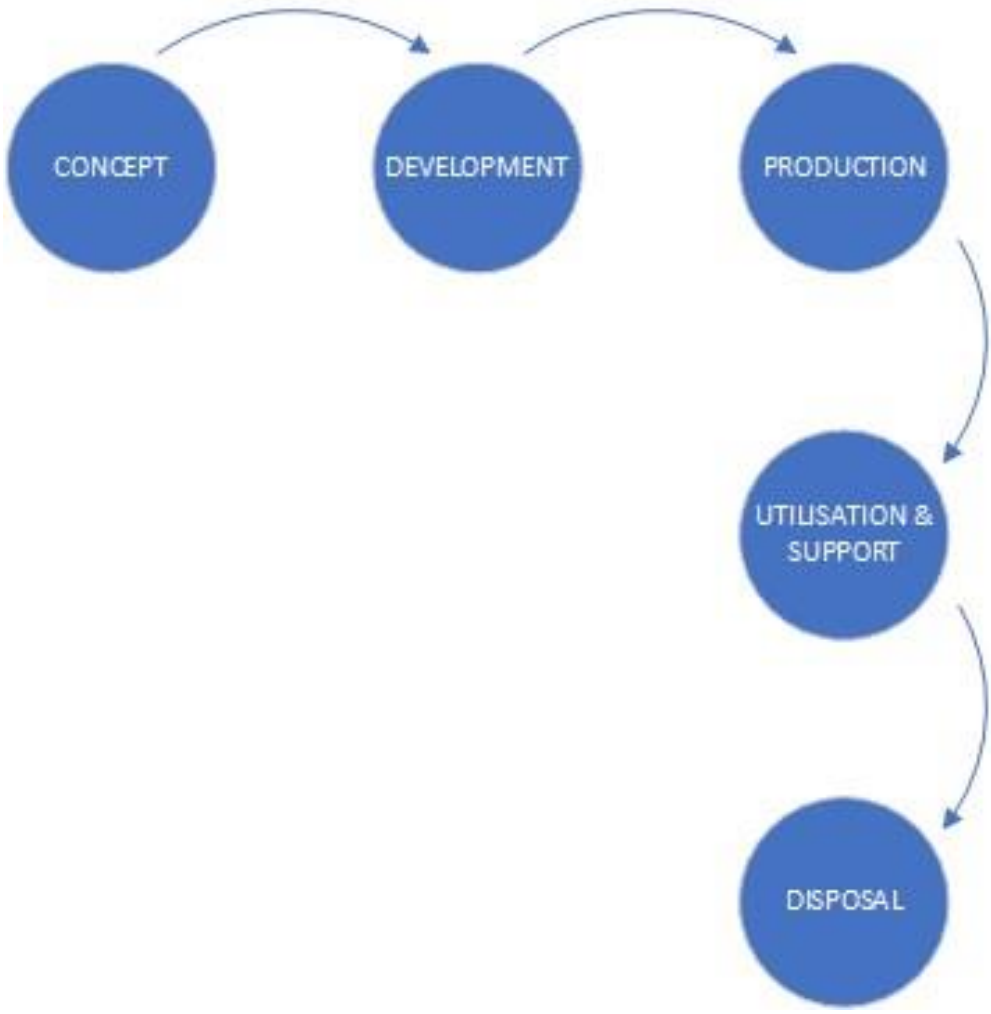

Figure 1.2 – ISO/IEC 15288 System Life Cycle Stages [49]

The roles and responsibilities that Logistics Engineers undertake over the system life cycle are both broad and specialized, see below for some examples of Logistics Engineers tasks (Table 1.1) [based on 30, 49].

Table 1.1 – Some examples of Logistics Engineers tasks

№	Stages of system the life cycle	Logistics Engineers tasks
1	2	3
1	Concept, Development and Production Stages	When engaged early in the system or capability development, Logistics Engineers are responsible for the integration of support considerations in the design and development; test and evaluation; production and/or construction of the mission system (such as reliability, maintainability, availability, standardization etc.) and also the supporting infrastructure design aka support system design (including maintenance, personnel, facilities, support equipment, spares, supply chains, and supporting information/data).
2	Utilization & Support Stage	When engaged during the utilization stage, Logistics Engineers conduct iterative updates of the supportability analysis (established during the Concept, Design and Development stage). These updates arise due to the program of improvement (supportability optimization), obsolescence and mission system design changes.
3	Disposal Stage	When engaged during the disposal phase, Logistics Engineers assist disposal managers with the planning and staged disposal of systems.

There are several definitions for logistics within systems engineering (SE) and the definition used will determine what activities are considered part of logistics. The

SEBoK defines logistics as the science of planning and implementing the acquisition and use of the resources necessary to sustain the operation of a system [29].

The ability to sustain the operation of a system is determined by the inherent supportability of the system (a function of design) and the processes used to sustain the functions and capabilities of the system in the context of the end user. Fig. 1.3, below, shows a model of the SE aspects for consideration in logistics and logistics planning.

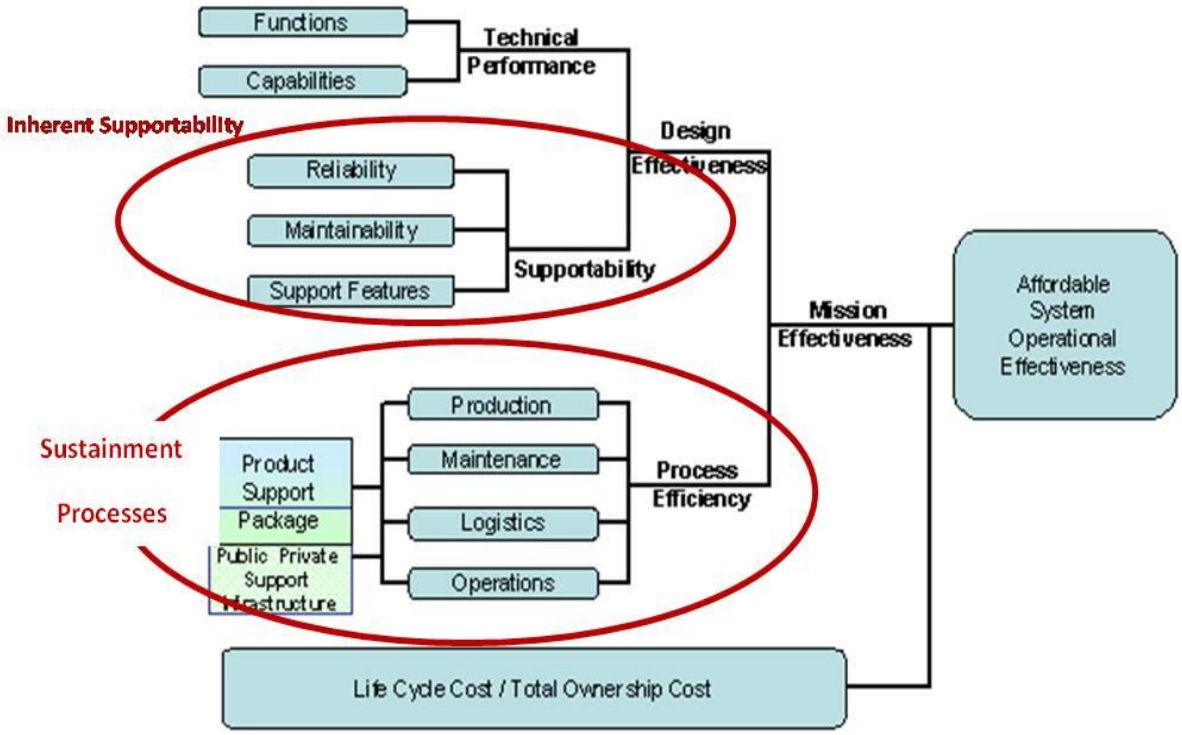

Figure 1.3 – Affordable System Operational Effectiveness [29]

The focus of sustainment planning is to influence the inherent supportability of the system and to plan the sustainment capabilities and processes that will be used to sustain system operations.

Influence Inherent Supportability (Operational Suitability).

Sustainment influence requires an understanding of the concept of operations (ConOps), system missions, mission profiles, and system capabilities to

understand the rationale behind functional and performance priorities. Understanding the rationale paves the way for decisions about necessary tradeoffs between system performance, availability, and life cycle cost (LCC), with impact on the cost effectiveness of system operation, maintenance, and logistics support.

There is no single list of sustainment considerations or specific way of grouping them as they are highly inter-related. They include: compatibility, interoperability, transportability, reliability, maintainability, manpower, human factors, safety, natural environment effects (including occupational health, habitability); diagnostics & prognostics (including real-time maintenance data collection), and corrosion protection & mitigation.

The following are key design considerations [29]:

1. Architecture Considerations – The focus on openness, modularity, scalability, and upgradeability is critical to implementing an incremental acquisition strategy. In addition, the architecture attributes that expand system flexibility and affordability can pay dividends later when obsolescence and end-of-life issues are resolved through a concerted technology refreshment strategy. Trade-offs are often required relative to the extent each attribute is used.

2. Reliability Considerations: – Reliability is critical because it contributes to a system's effectiveness as well as its suitability in terms of logistics burden and the cost to fix failures. For each system, there is a level of basic reliability that must be achieved for the system to be considered useful. Reliability is also one of the most critical elements in determining the logistics infrastructure and footprint. Consequently, system reliability should be a primary focus during design (along with system technical performance, functions, and capabilities). The primary objective is to achieve the necessary probability of operational success and minimize the risk of failure within defined availability, cost, schedule, weight, power, and volume constraints. While performing such analyses, trade-offs should be conducted and dependencies should be explored with system maintainability and integrated with the supportability analysis that addresses support event frequency (i.e. reliability), event

duration, and event cost. Such a focus will play a significant role in minimizing the necessary logistics footprint, while maximizing system availability.

3. Maintainability Considerations – The design emphasis on maintainability is to reduce the maintenance burden and supply chain by reducing the time, personnel, tools, test equipment, training, facilities and cost to maintain the system. Maintainability engineering includes the activities, methods, and practices used to design minimal system maintenance requirements (designing out unnecessary and inefficient processes) and associated costs for preventive and corrective maintenance as well as servicing or calibration activities. Maintainability should be a designed-in capability and not an add-on option because good maintenance procedures cannot overcome poor system and equipment maintainability design. The primary objective is to reduce the time it takes for a properly trained maintainer to detect and isolate the failure (coverage and efficiency) and affect repair.

Intrinsic factors contributing to maintainability are:

- Modularity – Packaging of components such that they can be repaired via remove and replace action vs. on-board repair. Care should be taken not to over modularize, and trade-offs to evaluate replacement, transportation, and repair costs should be accomplished to determine the most cost-effective approach.

- Interoperability – The compatibility of components with standard interface protocols to facilitate rapid repair and enhancement/upgrade through black box technology using common interfaces. Physical interfaces should be designed so that mating between components can only happen correctly.

- Physical accessibility – The designed-in structural assurance that components which require more frequent monitoring, checkout, and maintenance can be easily accessed. This is especially important in low observable platforms. Maintenance points should be directly visible and accessible to maintainers, including access for corrosion inspection and mitigation.

- Designs that require minimum preventative maintenance including corrosion prevention and mitigation. Emphasis should be on balancing the maintenance requirement over the life cycle with minimal user workload.

– Embedded training and testing when it is determined to be the optimal solution from a total ownership cost and materiel availability perspective.

– Human Systems Integration (HSI) to optimize total system performance and minimize life-cycle costs by designing systems and incorporating technologies that (a) require minimal manpower, (b) provide effective training, (c) can be operated and maintained by users, (d) are suitable (habitable and safe with minimal environmental and occupational health hazards), and (e) are survivable (for both the user and the equipment).

4. Support Considerations – Support features cannot be easily added-on after the design is established. Consequently, supportability should be a high priority early in the program's planning and integral to the system design and development process. Support features cut across reliability, maintainability, and the supply chain to facilitate detection, isolation, and timely repair/replacement of system anomalies. These include features for servicing and other activities necessary for operation and support including resources that contribute to the overall support of the system. Typical supportability features include diagnostics, prognostics, calibration requirements, many HSI issues (e.g. training, safety, occupational health, etc.), skill levels, documentation, maintenance data collection, compatibility, interoperability, transportability, handling (e.g., lift/hard/tie down points, etc.), packing requirements, facility requirements, accessibility, and other factors that contribute to an optimum environment for sustaining an operational system.

Planning Sustainment Processes.

Process efficiency reflects how well the system can be produced, operated, serviced (including fueling) and maintained. It reflects the degree to which the logistics processes (including the supply chain), infrastructure, and footprint have been balanced to provide an agile, deployable, and operationally effective system.

Achieving process efficiency requires early and continuing emphasis on the various logistics support processes along with the design considerations. The continued emphasis is important because processes present opportunities for improving operational effectiveness even after the design-in window has passed via

lean-six sigma, supply chain optimization, or other continuous process improvement techniques.

Sustainment Analysis (Product Support Package).

The product support package documents the output of supportability analysis and includes details related to the following twelve elements (links below are to excerpts from (NATO RTO 2001) [29]:

1. Product/information technology (IT) system/medical system support management (integrated life cycle sustainment planning).

- product/IT system/medical system support strategies;
- life cycle sustainment planning;
- requirements management;
- total ownership costs / life cycle costs planning & management;
- Integration and management of product support activities;
- configuration management;
- production & distribution;
- energy, environmental, safety and health management;
- policies & guidance;
- risk management.

2. Design Interface.

- reliability;
- maintainability;
- supportability;
- affordability;
- configuration management;
- safety requirements;
- environmental and hazardous materials requirements;
- human systems integration;
- calibration;
- anti-tamper;
- habitability;

- disposal;
- legal requirements.

3. Sustainment Engineering:

- failure reporting, analysis, and corrective action system;
- value engineering;
- diminishing manufacturing sources and material shortages.

4. Supply Support (materiel planning).
5. Maintenance Planning:

- reliability centered maintenance;
- maintenance concepts;
- levels of maintenance (level of repair analysis);
- condition-based maintenance;
- prognostics & health management.

6. Support Equipment.
7. Technical Data.
8. Manpower & Personnel.
9. Training & Training Support.
10. Facilities & Infrastructure.
11. Packaging, Handling, Storage, & Transportation.
12. Computer Resources.

Sustainment Implementation.

Once the system becomes operational, the results of sustainment planning efforts need to be implemented. SE supports the execution of the twelve integrated product support elements of a sustainment program that strives to ensure the system meets operational performance requirements in the most cost-effective manner over its total remaining life cycle, as illustrated in Fig. 1.4.

Once a system is put into use, SE is often required to correct problems that degrade continued use, and/or to add new capabilities to improve product performance in the current or a new environment. In the context of integrated product support, these SE activities correspond to the integrated product support (IPS)

element Sustaining Engineering. Changes made to fielded systems to correct problems or increase performance should include any necessary adjustments to the IPS elements, and should consider the interrelationships and integration of the elements to maintain the effectiveness of the system's support strategy.

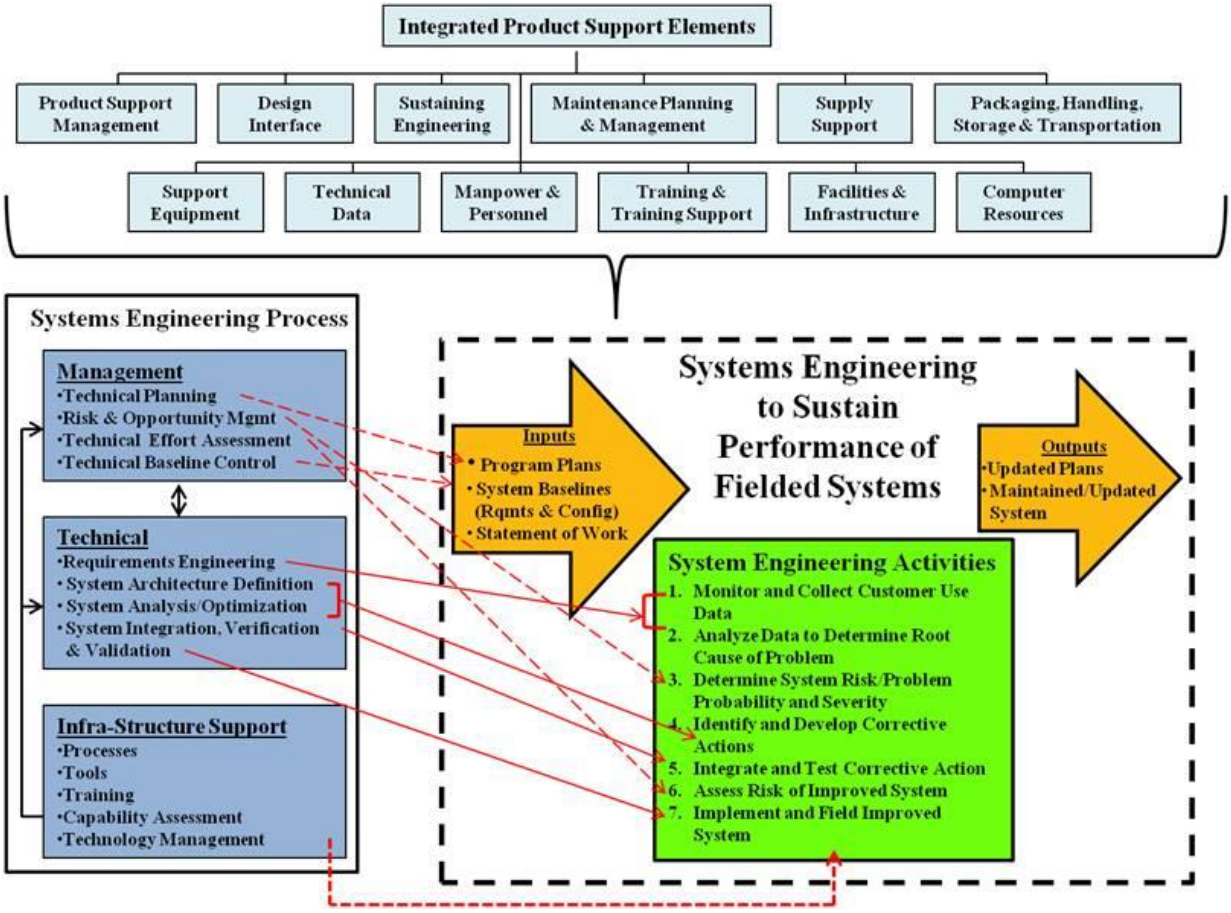

Figure 1.4 – Sustainment implementation illustration [29]

The degree of change required to the product support elements varies with the severity of the problem. Minor problems may require a simple adjustment to a maintenance procedure, a change of supplier, a training course modification or a change to a technical manual. In contrast, problems that require system or component redesign may require engineering change proposals and approvals, IPS element trade studies, business case analysis, and updates to the product support strategy. The focus is to correct problems that degrade continued use, regardless of the degree of severity.

Evolutionary systems provide a strategy for acquisition of mature technology; the system delivers capabilities incrementally, planning for future capability

enhancements. A system of systems perspective is required for these systems to synchronize the primary and sustainment systems.

1.2 Consideration of the RFID system as one of the logistics engineering solutions

RFID (Radio Frequency Identification) is a way to store and transmit information from a convenient label carrier to the desired location, using special devices [50]. Such identification marks make it easier to identify various objects: goods in the store, movable vehicles during transportation, help to determine their location, can identify people and animals, not to mention the wide range of identification of documents and property.

The electromagnetic wave received by the RFID tag from the antenna activates it, and it becomes possible to both write data to the tag and read data from the tag. The antenna thus serves as a multifunctional communication channel between the transceiver and the label, fully providing the processes of data transmission and reception.

Antennas of various shapes and sizes can be built into scanners, gates, turnstiles – in different means for working with RFID-tags, in order to provide access to information stored in the tags of goods, objects, people, vehicles, etc. – all, which moves through the coverage area of the scanner antenna, and has an RFID tag.

The antenna can work continuously and constantly read the labels in large numbers, constantly interrogating them, or can be turned on for a while at the signal from the operator. The antenna with the transceiver and the decoder are often in one common housing, so that the signal from the antenna would be immediately demodulated, decoded and transmitted via a standard interface to a PC for further processing of the received data.

The label itself usually contains an antenna, receiver, transmitter, and storage memory (Fig. 1.5). The label receives energy from the radio signal of the reader antenna or from its own power supply, after receiving an external signal, the label responds with its own signal, which contains certain identification information. So RFID tags are a kind of label, only smarter.

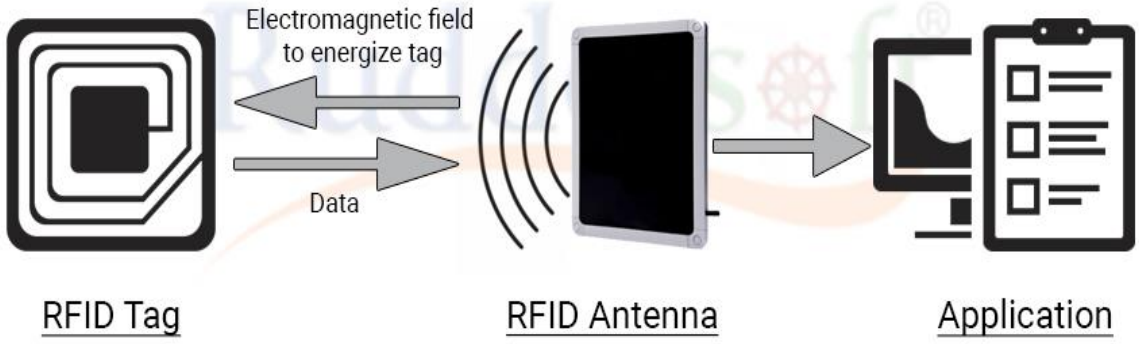

Figure 1.5 – Scheme of work of RFID system [40]

The passive RFID tag is able to work without its own power source, it receives power for power only from the scanner signal (Fig. 1.6). Such labels are smaller in size than active ones, lighter in weight, cheaper to manufacture, and have an unlimited service life – this is their main advantage.

The conditional disadvantage of a passive RFID tag is that a sufficiently powerful reader is required.

The active label is distinguished by the presence of a built-in battery or the need for a connected battery. Such labels interact with the scanner antenna at a greater distance than passive labels, because they require less power from the antenna during operation – this is the main advantage of active labels, they have a reading distance 2-3 times longer than passive labels, in addition, the active label can move at high speed through the scanner's range, and still have time to work.

Figure 1.6 – RFID tag

Both passive and active labels for write / read, single / multiple, can vary widely regardless of diet (Fig. 1.7).

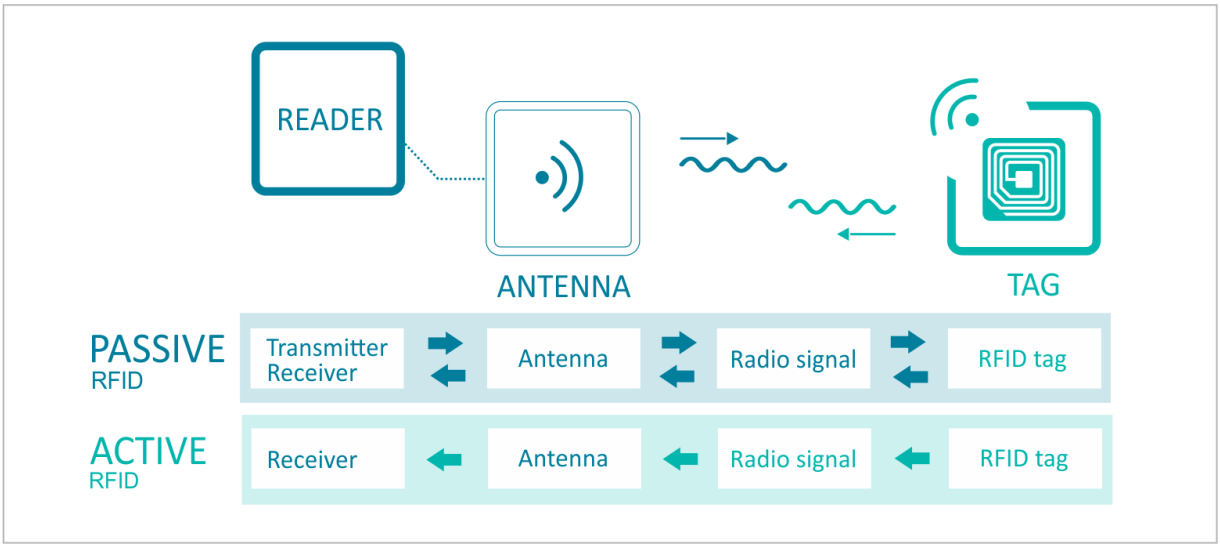

Figure 1.7 – RFID tags types [43]

The barcode is printed only once at the stage of production and packaging, and the information on the RFID tag can not only be completely changed, but also supplemented. Labels can be read in large numbers at once due to the anti-collision mechanism, which is difficult to achieve for graphic codes.

Writing on the label is quite fast, and graphic codes must first be typed, then printed and pasted, and even preserve the integrity of the image.

With RFID-IDs everything is easier, it is enough at the stage of production to "implant" the label in the package (not necessarily outside), then write data in a contactless way, and the label will be eternal (at least 1,000,000 interactions with the scanner antenna).

In addition, data written to the label, in whole or in part can be protected from reading or overwriting with a password if necessary – this is a reliable way to protect against forgery. In this case, the reading occurs at any position of the label in the area of the scanner – it is more convenient than the graphic code, which must be presented exactly to the scanner.

Currently, the field of application of information systems based on RFID technology is quite wide, especially in the field of business process automation, where there is a process of sequential replacement of bar coding technology. This is due to the fact that RFID systems have much more advantages than traditional bar coding systems. Among the main advantages of radio frequency identification technology are the following (Table 1.2) [based on 13, 15, 33, 40, 43, 52].

RFID belongs to a group of technologies referred to as Automatic Identification and Data Capture (AIDC). AIDC methods automatically identify objects, collect data about them, and enter those data directly into computer systems with little or no human intervention. RFID methods utilize radio waves to accomplish this.

At a simple level, RFID systems consist of three components: an RFID tag or smart label, an RFID reader, and an antenna.

RFID tags contain an integrated circuit and an antenna, which is used to transmit data to the RFID reader (also called an interrogator).

The reader then converts the radio waves to a more usable form of data. Information collected from the tags is then transferred through a communications interface to a host computer system, where the data can be stored in a database and analyzed later.

Table 1.2 – The main advantages of radio frequency identification technology

№	The main advantages	Description
1	2	3
1	The possibility of remote reading of information from radio frequency labels	The ability to read radio frequency labels that are inside the radiopaque packaging, which allows you to quickly determine the contents of packaging units (boxes, boxes, etc.) without opening them.
2	The ability to quickly read information from a large number of radio frequency labels	It allows quickly determine the contents of packaging units, even if there is a large number of labeled products inside the package, and these products can be the same or different. The allowable distance from the reader to the radio frequency label depends on the frequency range used and can reach tens of meters.
3	No strict requirements for the accuracy of positioning relative to the reader and the spatial orientation of radio frequency tags	It simplifies the automation of the reading process (reader antennas can be located in gates, doorways, special portals or portable RFID readers).
4	The ability to remotely record and overwrite information in radio frequency tags	The possibility of using radio frequency labels not only for automated accounting of marked products, but also to detect their unauthorized movement, including theft.
5	The ability to label not only the product range	Assign a unique number to each unit of the product with storage of information about the technological process of production and transportation.

Benefits of RFID systems [based on 71]:

– adds flexibility and intelligence in the process to improve service levels;

– allows to check shelves, boxes, and pallets on top without any eye contact;

– integrated automated receiving PCP in manufacturing enables you to continue without waiting for the receipt of the material;

– it enables to control the expiry date, automatic filling of missing files, inventory and returns control, and expediting checkout;

– reduces the total cycle time order until the goods delivery;

– reduces the errors made in deliveries of customers' orders;

– allows to read multiple tags and hence increases the reading speed instead of processing one bar code at a time;

– easy monitoring of all logistics operations along with increased security;

– increased speed and agility in locating materials;

– helps in avoiding tampering with recording of unique codes;

– makes it easy to manage products and materials with less manpower.

Real-world applications of RFID [based on 13, 15, 33, 40, 43, 52]:

– Agriculture. RFID is useful to track the movement and health of animals in the farm. It ensures that each animal in the farm is taking the correct food. Monitoring your cattle's health manually can be costly as well time consuming. However, with RFID you can achieve this automatically and without much expenditure.

– High-cost goods tracking. RFID has successfully managed to mitigate the challenge of high-cost goods security. With item-level tagging of high-cost goods with RFID, it's possible to track them right from the factory to the distribution center and ultimately to the store. Moreover, this process is both convenient and cost-effective.

– Defense. RFID also has a key application in defense. It's used for weapon and soldier's movement tracking. Moreover, it provides real-time information so it becomes easy to track down the location of a weapon. In the case of emergencies, RFID enables you to easily access the real-time database when it's not possible to take help of other battalions.

– Kiosks. RFID can also be used by the kiosks for managing resources or to interact with their customers. Rental kiosks use RFID tags to ensure that the customer

received their chosen movie rental. Apart from that it's also used for interactive media display in which an RFID reader interrogates the cards or badges.

– Library systems. RFID system in library helps in enhancing the efficiency of circulation operations. Libraries often use barcodes with proper positioning and line of sight. Whereas, with RFID tags you scan it from multiple angles which makes the check-in and check-out process way faster than that of barcode. We saw some of the major real-world applications of RFID technology in various

– RFID in supply chain management and logistics. Supply chain management and logistics are considered as the most fertile field as far as the applications of RFID is concerned. RFID in the supply chain plays a major role in enhancing the visibility right from the point of manufacturing, via supply chain, and most significantly from the back room to the floor, and ultimately to the exit door. RFID has a major say when it comes to inventory management, warehouse management, and retail sector. Let's see in detail about them all.

– Inventory management. Inventory management is an important element of supply chain management. It includes various aspects like monitoring, administering, controlling, storing, and ultimately using the materials for the sale of a product. Inaccuracy in inventory management is inevitable and is prevalent in many industries. The inaccuracy is nothing but the mismatch between the inventory records and the actual amount of product available for the sale. RFID technology can provide numerous benefits to improve the inventory management system. RFID tags have the capability to read through an item. Moreover, the person can scan several items at a time. These properties of RFID help to speed up the inventory management process and reduces human errors thus rendering a highly accurate inventory record.

– Warehouse management. Warehouses are simply storage area where you store different products received from the suppliers. These products are then distributed to the customers. Recently, RFID has emerged as a technology that supports warehouse management system for simpler supply chain and greater product intelligibility. With RFID technology you can automate important tasks which take place during receiving and shipping processes. RFID also increases efficiency of identification and

validation activities along with reducing human errors. RFID ensures identification of products at an instant and greater control over items in the warehouse. Due to this the supply chains now have a greater information flow as compared to the material flow. This further reduces currency cost.

– Retail sector. RFID technology has already started to revolutionize the retail sector. Wal-Mart a behemoth in retail sector is experimenting with the passive RFID tags of passive types to meet high consumer demand. RFID increases the product visibility in the retail inventory that helps in better inventory control and customer experience. This is highly relevant in larger stores that have facility of customers searching for their chosen products online which the store has the current stock available for sale. Secondly, RFID provides enhanced product identification by storing distinctive identification number.

1.3 Benefits and weak points of implementing RFID-systems in in the activities of a transport company

Logistics is getting, in the right way, the right product, in the right quantity, in the right place at the right time, for the right customer at the right cost.

The logistics concept is performed based on the activity flow of materials and products, from the point of supply to the point of consumption. There are different activities need to be taken into account in order to maintain the flexibility in a logistics system. Based on the importance of logistics management, these logistics activities are divided into primary and supporting activities.

Primary activities which are able to contribute to achieving logistics objective including Customer Service, Transportation, Inventory Management and Order Processing. Supporting activities which support the primary activities including Warehousing, Purchasing or Procurement, Materials Handling, Packing, Production Scheduling and Information Maintenance [based on 13, 15, 33, 40, 43, 52].

RFID technology provides a huge support in logistics by enabling visibility, which means that at any time, anyone can be able to access to inventory, orders and delivery points. RFID enables efficiency in logistics by shortening or eliminating the time-wasting manual processes. It also supports labor reduction by applying automatic processes, which using always-on fixed RFID readers and on-demand handheld readers. The visibility of RFID provides real-time data, this real-time nature is considered as a benefit in giving out the latest information, so the organization can make the best decision. Better visibility supports the reduction of operating costs, maximizes on-time deliveries and develops customer satisfaction.

Different advantages of RFID technology implementation in inventory control include automatic replenishment, automatic picking and stock routing and automatic order generation from current inventory.

Thanks to RFID ability of real-time tracking, the organization is able to control the real-time information of inventory and tracks on it respective locations, inventory can be replenished automatically when it reaches the reorder point.

Different RFID applications are implemented within warehouse, retail operations and supply chain. The technology is used in warehouse to replenish picking locations, cross-docking, etc; in retail operations to replenish shelves; in the supply chain to replenish inventory in different components in its physical network.

The Fig. 1.8 shows the benefits of RFID visibility in order to support timely information in the supply chain. The whole information cycle is effectively repeated. The figure shows the promising advantage of RFID in collecting automatically real-time information, which is a crucial benefit in item tracking and inventory management. Thus, it enables the reduction of labor cost, transportation and facilities cost when moving inventory in the supply chain, which leads to the reduction in business costs.

The real-time locator system in RFID technology enables organization to know information about employee location and inventory status. By this way, the firm can optimize the efficiency in order picking and stocking routes of employees. One of the software applications that utilizes this picking and routing benefit from RFID

technology is Warehouse Management System (WMS). RFID system provides real-time employee location information as aforementioned, which creates an ease in optimizing order picking schedules, for example, the item needed to be picked is identified quickly and easily, then the system is able to assign the closest worker to handle the item.

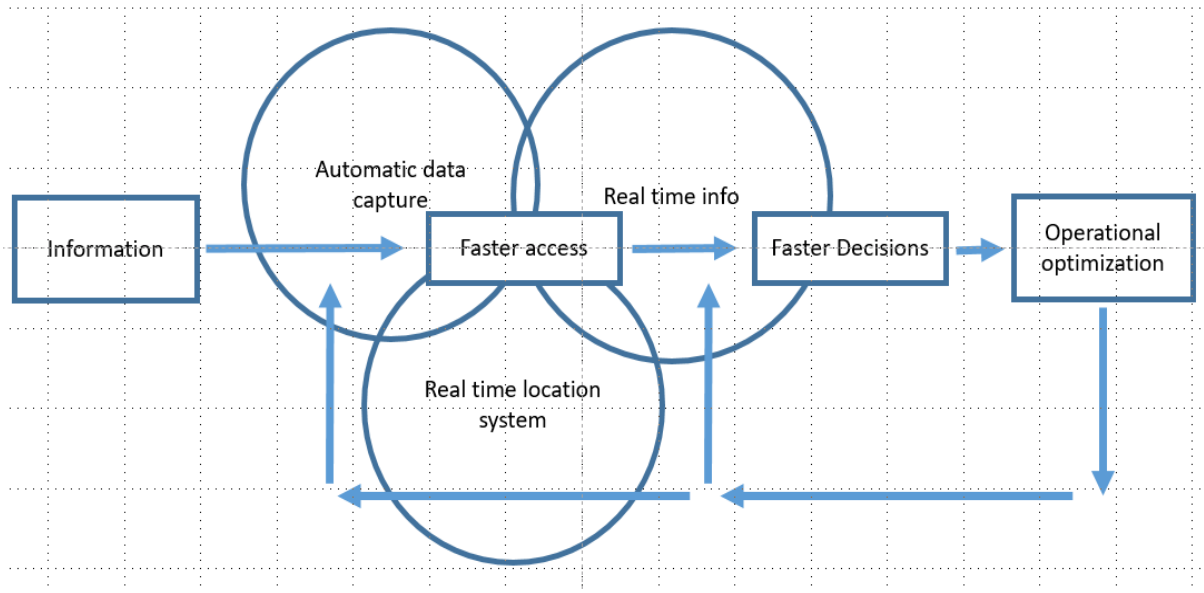

Figure 1.8 – Diagram, which shows the ability of RFID in providing timely information and visibility [based on 71]

The term cross-docking is used when inventory is received at the dock and then immediately transferred to the next shipment in order to reduce a great number of labor and time for storing, replenishment, picking and packing of the product. The ability to group different orders based on the latest inventory availability by using RFID called waves automatically. The accuracy in this order batching of waves can be optimized by the real-time ability of RFID technology, which perform an accuracy of inventory and immediately identify the needed secondary location for the inventory.

RFID technology creates an ease in product receiving process in warehousing, which allows the warehouse to automatically identify the accurate packages via the RFID tags attached to each package/item without human intervention. The firm is able to optimize an efficiency and effectiveness of warehousing process by

eliminating the physical checking process. Moreover, when it comes to cross-docking (the explanation of cross-docking is mentioned in the section above), RFID immediately identifies and informs the system the position of specific packages/products need to be prepared for the next order. Then, the system automatically reads the information of RFID tags attached to packages/products needed a cross-dock movement and assists them to the specific dock or place on the waiting vehicle. Another advantage of receiving process using RFID technology is that RFID can read accurately regardless packages/products position, while barcode can only be read when the packages are placed properly.

In the storage zone, RFID allows different tagged products or pallets to be identified from anywhere. This ability maximizes an efficiency of storage, replenishment and picking process from various types of storage racks. The ability in automatically identified items provides productivity and accuracy in picking and packing the correct items.

RFID technology ensures accuracy in the shipping process of different products by applying RFID readers at exists of the warehouse. After packages going through the RFID reader or portal, verification is made to ensure a correct order, accurate amount and on which outbound vehicle to be placed.

Order processing includes collecting, checking, entering and transmitting sales-order information. The advantages of RFID technology in order fulfillment perspective are also performed in some functions of inventory control and warehouse management above. RFID eliminates the inaccuracy such as sending items to wrong destination or involving in a delay in picking/sending items. The advantage supports the great reduction in logistics and organization cost. RFID tags allow accuracy in activities involved in picking, shelving, cross-docking and this ability is able to maximize the speed of these logistics processes.

The term “reverse logistics” means the return of used products, packaging materials, production disposal, other wastes, etc. RFID eliminates the information limitation of which products being returned. The RFID tags attached to each item allows organization to optimize the return handling process. Based on the information

contained in RFID tag on returned items, the system will automatically recalculate the current inventory and updates the latest information.

RFID technology requires a little or without the need of having people to scan individual item with a barcode scanner. In logistics perspective, RFID tags allow the organization to maximize efficiency in logistics processes by automatically checking shipment, optimize cross-docking, identify hundreds of items at the same time and immediately update the inventory system. Less human intervention leads to reduction in damages, decrease in labor cost and operation cost will also be reduced.

Shrinkage occurs when orders are misplaced, robbery caused by employees, poor performance on inventory management, etc. The automatically identify ability on individual products enables RFID to immediately identify whenever shrinkage occurs. Problems from shrinkage take up to 5 percent of stock. Therefore preventing such losses is essential in logistics cost improvement [71].

RFID technology has many advantages for the logistics and logistics activities, however, there are also issues and challenges, which creates reluctance in adopting the technology. The problems that organizations are facing include the security of RFID systems, privacy issues, high cost in RFID deployment, lack of global standards and regulations, environmental factors, lack of knowledge and experience, and data management (Table 1.3).

One of the most controversial issues of implementing RFID systems is the personal privacy protections of customers. By being able to record personal information of consumers, RFID technology has involved in personal privacy issues. The technology allows systems to develop consumers' personal details by recording their transactions when consumers make a purchase. RFID technology is able to record consumers' name, address, product purchased and other personal information. Based on the invisible reading of RFID tags ability, consumers can be "scanned" without their knowledge. Thus, by misusing the technology, the attacker is able to easily track on consumers with RFID tagged item after purchasing in order to obtain information such as their location or movement.

Table 1.3 – Problems in RFID-systems implementation and possibilities for solving the problem [based on 71]

№	Problems in RFID implementation	Possibilities for solving the problem
1	2	3
1	Security of RFID systems	Insignificant for a cargo handling complex, or is solved by a general improvement of the company's IT security.
2	Privacy issues	Insignificant for a cargo handling complex, or is solved by a general improvement of the company's IT security.
3	High cost in RFID deployment	The larger and more complex the cargo turnover, the faster the project pays for itself.
4	Lack of global standards and regulations	Use best commercial practices as long as they do not violate applicable law.
5	Environmental factors	Calculation of the layout of the antenna-tag pair for the planned cargo at the design stage.
6	Lack of knowledge and experience	Involvement in the project design of specialists in the field.
7	Data management	Improvement of IT systems.

These abilities of RFID technology aforementioned have led the technology to many concerns involved in consumer informational privacy issue, consumer’s physical privacy and consumer’s civil liberty. Thus, organizations, which implement RFID technology, should educate customers and consumers the limitation of the technology and ensure them that RFID tags are applied on item-level only.

Cost is one of the major challenges of implementing RFID technology. Since the technology requires high-cost implementation, organization must carefully concern about its need of adopting RFID technology. The success of RFID technology implementation is measured by its cost-benefit analysis.

The cost of RFID tags ranges between $0.3 and $0.6 [71]. The cost varies depending on different types of products, for example, RFID tags cost higher on luxury products than normal products. Thus, RFID tags' price is known as major influence on the adoption of the technology. However, not only RFID tags cost organization a great amount of investment, RFID system's hardware and software application are also expensive. Another cost needed to take into concern is employee training on new RFID technology. RFID technology is still seen as a developing technology, some organizations concerned about the high risk of fully investing in the technology.

Overall, implementing RFID technology requires a great investment. These major costs fall into tags, hardware and software application, consultancy fees and employee training.

Global standards allow barcode to be read by all retailers, unlike RFID, manufactures and retailers produce/use different types of tags that have various methods of communication. Different countries have different regulations applied to RFID frequencies and RFID power level, which leads to the impossibility of systems could be used among different countries.

For example, there is no global agreement on frequency used on RFID systems, different UHF bands are applied on different countries of the world. Thus, the lack of standards and uniform regulations of RFID technology leads to the low performance of interoperability between applications and devices around the world and RFID technology adoption.

In RFID frequencies, high frequency (HF) and ultra-high frequency (UHF) are known as the common use for RFID technology implementation. Unfortunately, these two frequencies are greatly impacted by specific type of environmental factors, which are water and liquids. Liquids are able to reduce the read range or prevent the communication between tags and readers by absorbing the RFID signals. Another environmental factor should be taken into account is metal. Metal is able to deflect the radio waves of RFID, however, this problem can be solved by creating a path so that radio waves can pass through the material. The other problem is that, if some

applications used in logistics process generate almost the same frequency as RFID applications, it creates bad performance of RFID technology. Fortunately, shielding RFID reader is able to prevent different frequencies from interfering with RFID signals.

RFID technology is still known as a complex technology, which requires essential knowledge and experience in implementation. Since the lack of expertise in the field, many small organizations have involved in difficulties in their initial project of piloting the technology. From customer perspective, the lack of knowledge about RFID technology might cause customer's disappointment in the cost of RFID. While bar code technology cost less than RFID technology, customer might become reluctant to use RFID technology.

80 % of companies implemented RFID technology involve in the problem of lacking skills, and employee training is also a huge challenge [52]. The experts in the field, who have RFID deployment experience, are hard to find. Thus, education of skills and knowledge related to RFID technology is critical in long run of RFID development.

Data management is a key issue of RFID technology implementation. Due to the high volume data from tagging individual product, strong data management is able to ensure this massive amount of data produced by RFID systems can be well-processed. Organizations are facing challenges in managing RFID data such as large quantities of data, data integration across multiple facilities.

As aforementioned, RFID systems can create large volume of data due to various tagged items, which leads to information overload. The technology requires the robust IT systems to handle this problem. Organizations that have multiple facilities located in different places and these facilities connect to one IT center, also involve in the same problem of information overload. The IT infrastructures not only manage the raw RFID data from these facilities but transfer these massive data to an IT center.

1.4 Chapter 1 summary

In this chapter, the theoretical foundations of logistics engineering in the activities of a transport company are considered.

First of all we made research of the essence of the logistic engineering. Logistics engineering generally deals with the effective use of engineering methods to resolve logistics problems. Logistics Engineers are utilized throughout the entire system life cycle, from concept to disposal for the system life cycle stages.

Then we considered the RFID system as one of the logistics engineering solutionsю RFID (Radio Frequency Identification) is a way to store and transmit information from a convenient label carrier to the desired location, using special devices. Such identification marks make it easier to identify various objects: goods in the store, movable vehicles during transportation, help to determine their location, can identify people and animals, not to mention the wide range of identification of documents and property.

The label itself usually contains an antenna, receiver, transmitter, and storage memory. The label receives energy from the radio signal of the reader antenna or from its own power supply, after receiving an external signal, the label responds with its own signal, which contains certain identification information. So RFID tags are a kind of label, only smarter.

The passive RFID tag is able to work without its own power source, it receives power for power only from the scanner signal (Fig. 1.6). Such labels are smaller in size than active ones, lighter in weight, cheaper to manufacture, and have an unlimited service life – this is their main advantage.

Currently, the field of application of information systems based on RFID technology is quite wide, especially in the field of business process automation, where there is a process of sequential replacement of bar coding technology. This is due to the fact that RFID systems have much more advantages than traditional bar coding systems.

CHAPTER 2
RESEARCHING THE POSSIBILITIES OF IMPLEMENTING LOGISTIC ENGINEERING SOLUTIONS IN THE ACTIVITIES OF THE TRANSPORT COMPANY

2.1 Research of the situation on the transport services market in Ukraine

Our analysis of the situation on the transport services market in Ukraine showed that in recent years the volume of transported goods by all types of transport ranged from 600 to almost 812 million tons. During the period under review, the maximum volume of transported goods was observed in 2011, the minimum – in 2020. According to the results of 2021, the volume of transported goods by all modes of transport amounted to 619.9 million tons (Fig. 2.1) [62].

The undisputed leaders for many years are rail and road transport. At the same time, the volume of road transport is constantly growing from 140 million tons in 2009 to a record 244 million tons in 2019. In contrast to the volume of transportation by rail, which has been steadily decreasing since 2011 (468.4 million tons), according to the results of activity, 312.9 million tons were transported in 2019, and only 305.5 million tons in 2020.

As of the end of 2019, the market shares of freight transportation were distributed as follows: 36% were carried out by road, and 46% by rail (which was a historical minimum).

The conducted study of the freight transportation market in terms of determining the volume of transportation services provided revealed a noticeable change in market shares. This is especially observed in the segmentation of the market on the basis of characteristics more characteristic of each type of transport of goods.

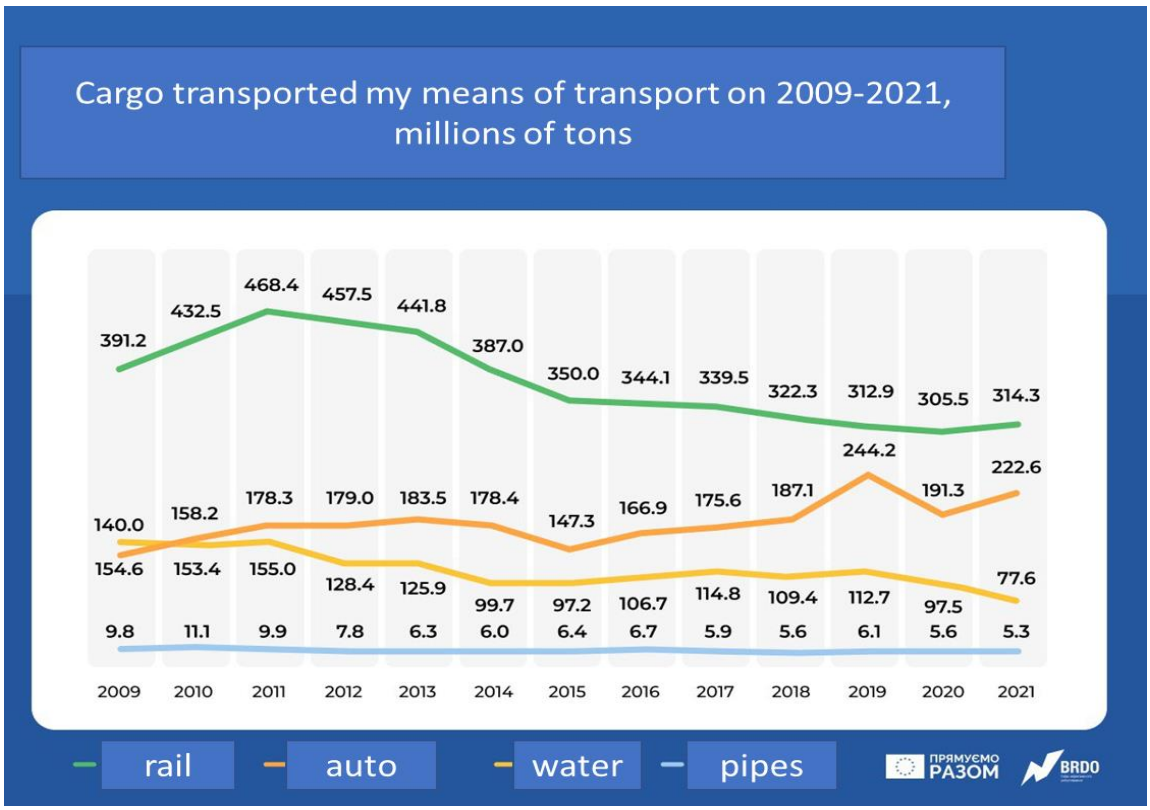

Figure 2.1 – Dynamics of cargo transportation by types of transport [62]

A similar trend was observed in the dynamics of changes in market shares of different modes of transport. In particular, without much change were:

– air transportation – less than 0.02% annually;

– water transport – about 1% annually;

– pipeline transportation – from 22% in 2009 to 16.7% in 2019.

According to the SSSU [67], in general, transport enterprises in 2021 increased freight traffic by 3.3% compared to 2020, that is, to 619.9 million tons. At the same time, rail transportation increased by 2.9% (to 314.3 million tons), road transportation increased by 16.2% (to 222.6 million tons), pipeline transportation decreased by 20.4% (to 77.6 million tons).

In general, according to the results of 2021, the shares of different types of transport in the total volume of freight transported were distributed as follows (Fig. 2.2) [62]:

– railway transport – 51 %;

– road transport – 32 %;

– water transport – 1%;

– pipeline transport – 16 %;

– air transport – 0.02 %.

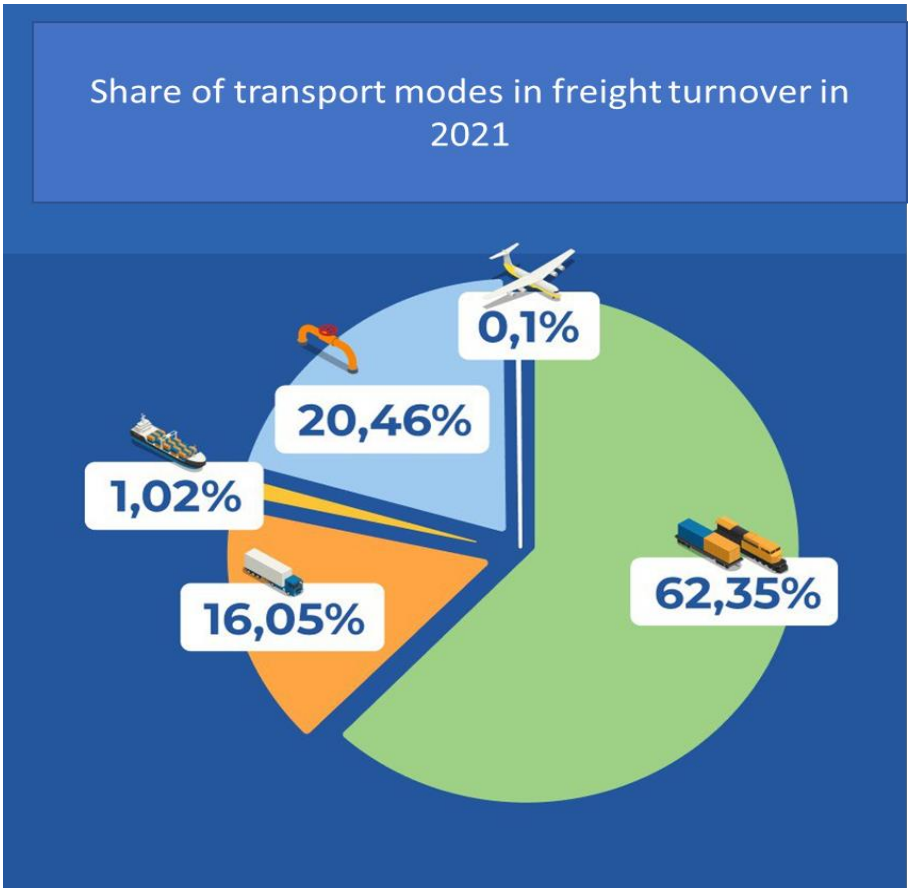

Figure 2.2 – Shares of transport modes in total freight transported [62]

Since each type of transport usually served the relevant sectors of the economy, such sharp changes in market shares may indicate the formation of extremely negative factors for the development of the national economy, which in turn may adversely affect the transport industry due to excessive load on roadways.

Summarizing the statistical data, we can say that in recent years, road transport has increased its market share by more than half (+57%), water transport, on the contrary, has lost almost half of the market share (-44%), a significant decrease in market share occurred in rail transport (-8%).

In view of the above, we can draw an intermediate conclusion: over the past ten years, road transport has demonstrated quite successful expansion in the freight

market of Ukraine, while its other competitors are weakening their positions. However, this trend is extremely threatening, because in terms of Ukraine's tasks and commitments towards the European Green Deal, rail and water transport should increase their market shares.

Next, we analyze the average distances of transportation by different modes of transport in Ukraine (Fig. 2.3) [62].

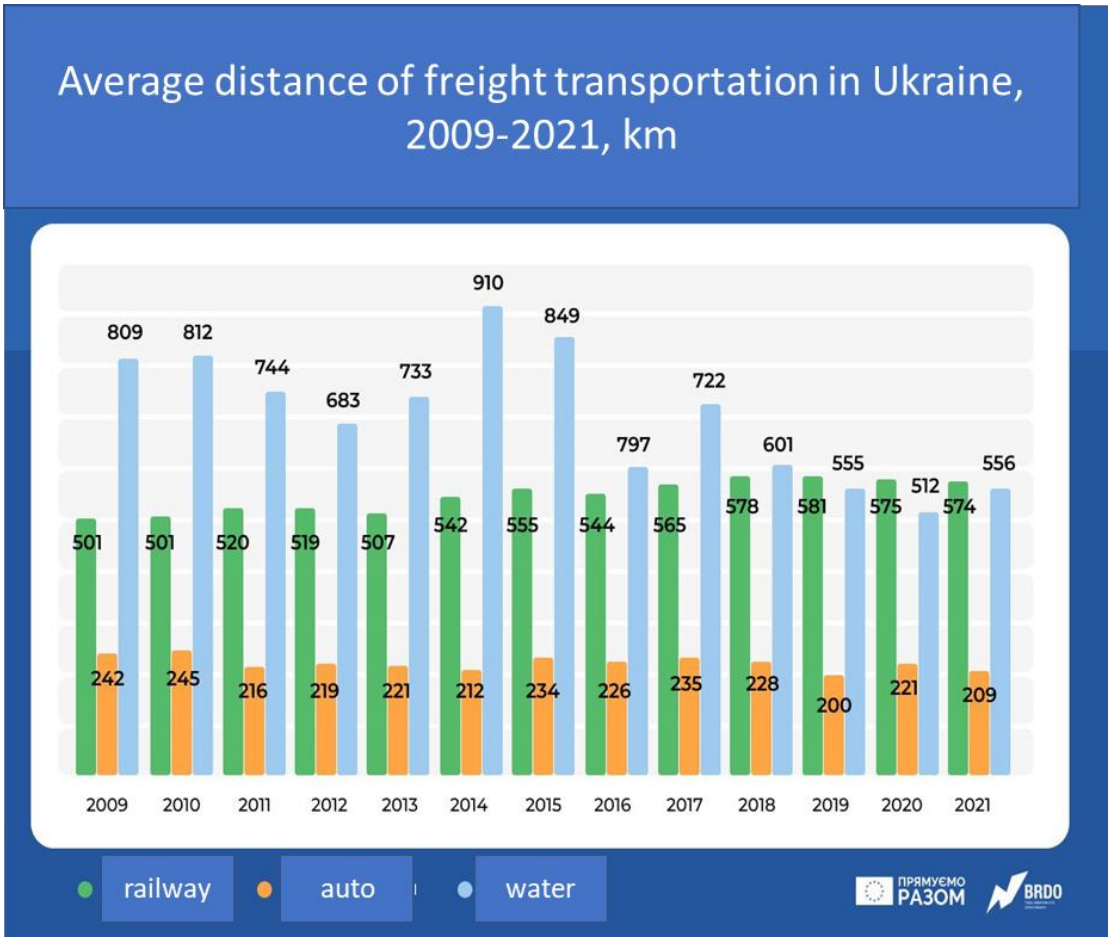

Figure 2.3 – Average distance of freight transportation in Ukraine [62]

The average distance of transportation by rail is more than 500 km, by road – more than 200 km. At the same time, it is worth noting that for rail transport this figure is growing annually, while for road transport it is constantly decreasing:

– in 2009 – 501 km by rail and 242 km by road;

– in 2019 – 581 km by rail and 200 km by road;

– in 2021 – 574 km by rail and 209 km by road.

Indicators of the average distance of water transport (2009 – 809 km, 2019 – 555 km, 2021 – 556 km) can be used as a certain benchmark, but its very small share practically does not affect the activity of current transport freight traffic.

The change in this indicator confirms the implementation of a scenario that negatively affects both the national economy and its environmental aspects:

– rail transport reduces its participation in short segments of logistics chains, while it is actively replaced by road transport;

– during road transportation, the load (i.e., the specific weight) of one conditional vehicle increases, which, taking into account the peculiarities of the national transportation market, can be interpreted as an increase in the load on the axle (and this in turn leads to the "destruction" of roads).

2.2 Analysis of the activity of the transport company "Ukrtrans Garant"

For more than 15 years, the logistics company "Ukrtrans Garant" has been organizing cargo transportation in Ukraine and abroad. Extensive experience in cargo delivery for legal entities and private individuals has allowed Ukrtrans Garant to develop a reliable logistics system and makes it possible to effectively cope with the tasks and ensure the efficiency and safety of cargo delivery from "door to door".

The company "Ukrtrans Garant" provides transportation in Ukraine and around the world, guarantees the safety of goods and demonstrates an understanding of the nuances, even in the most unusual cases [81].

The company "Ukrtrans Garant" offers the following types of services:

– international transportation;

– transportation in Ukraine;

– standard cargo transportation;

– groupage cargo transportation around the world;

– transportation of oversized and oversized agricultural and construction machinery;

– transportation of bulk cargo;

– oversized transportation;

– customs brokerage services;

– cargo insurance.

The company "Ukrtrans Garant" transports everything that can be transported. The main groups of goods with which the company works are shown in Fig. 2.4 [81].

The company's clients are both large enterprises and private individuals, and therefore the company does not focus on providing only one type of service, but constantly expands the range of its services.

The company "Ukrtrans Garant" cooperates with Ukrainian and foreign manufacturers and offers its customers:

- individual approach to each client;
- fast and high-quality transportation;
- selection of the optimal route;
- guarantee of delivery safety;
- large fleet of vehicles with different carrying capacity and body type;
- ideal ratio of quality and cost;
- wide range of services and coverage of countries – Ukraine, European and Asian countries.

Advantages of the company "Ukrtrans Garant":

- reduction of costs for the delivery of goods by passing transport in any direction in Ukraine;
- daily deliveries of more than 2000 tons of cargo in Ukraine allow us to improve the quality of our work every minute;
- delivery of goods is carried out in a timely manner, we also provide fast delivery of the car for loading;
- all cargoes are insured against accidents, theft and even late delivery;

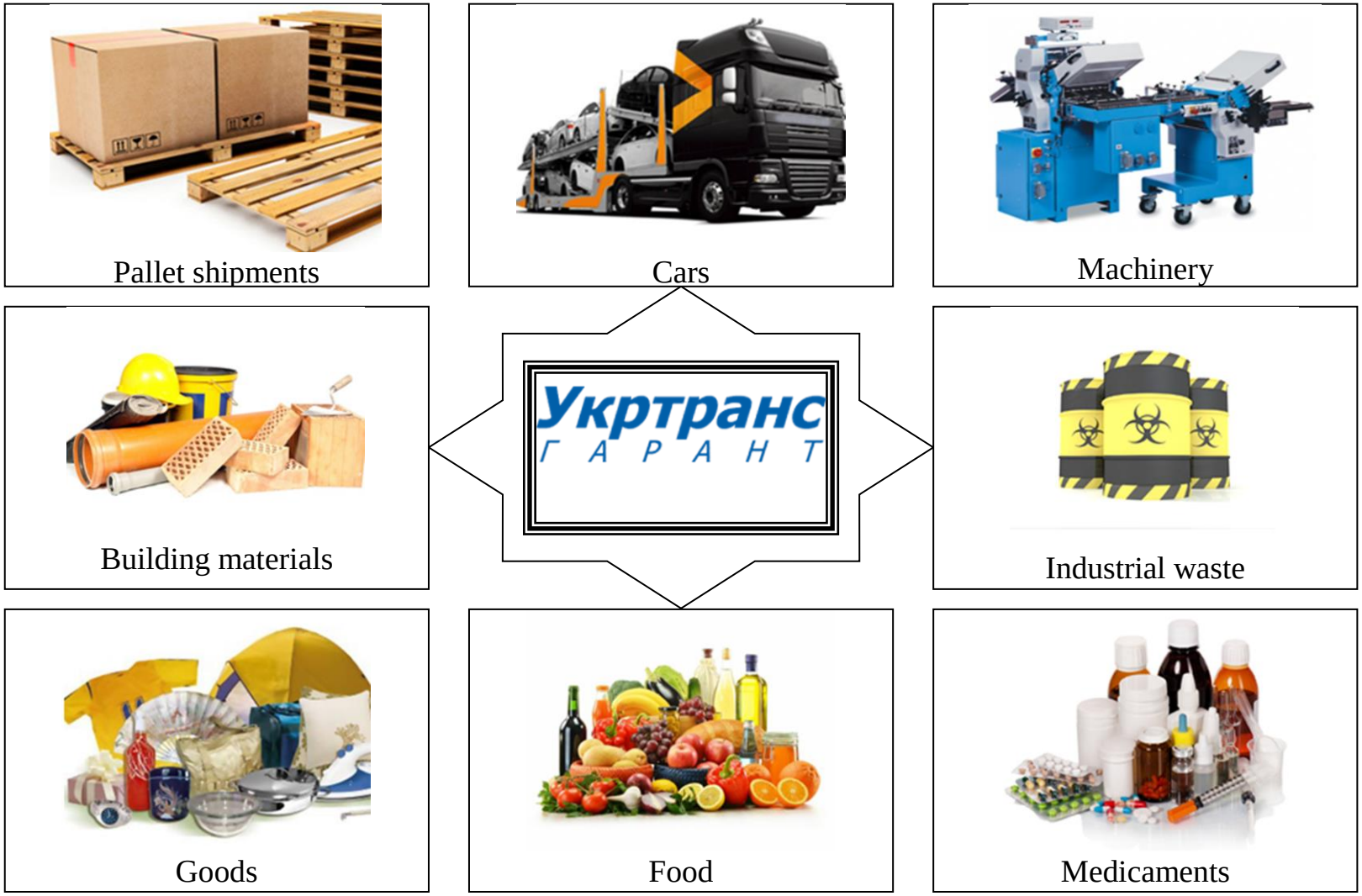

Figure 2.4 – Main groups of goods transported by Ukrtrans Garant

– delivery of goods both directly from the supplier to the customer, and through the central warehouse of the company "Ukrtrans Garant", which allows to reduce the customer's costs for the delivery of goods due to the optimization of the logistics of our company;

– execution of all necessary documents for the goods;

– vehicles of the company "Ukrtrans Garant" have the necessary certificates and permits to work in Ukraine and abroad.

Also, in addition to the delivery of goods from one city to another, the company "Ukrtrans Garant" works in the city. The company not only carries out apartment and office moves, but also transports construction equipment, as well as delivers various goods to consumers, if they do not yet have their own delivery service.

Quite often both individuals and companies need to deliver heavy and large loads in Ukraine, which, however, will not occupy the entire car. Therefore, they use the services of postal services. But the cost of delivery in such services is so high that it is unprofitable to send such goods or cargoes with their help.

But, in addition to postal parcels, there are also transportation of groupage cargoes, which can be ordered in logistics and transport companies. In Ukraine, one of the most popular companies providing the service of transportation of groupage cargo is "Ukrtrans Garant".

The company collects groupage cargoes at central warehouses in many cities of Ukraine. Then our experienced logisticians form trucks based on the delivery time, delivery direction, type of goods and its volume. As a result, the cargo goes to the right city together with the cargo of other customers. The client together pays for the services of the carrier company, logistics services, as well as paperwork and insurance. As a result, the cost of cargo delivery will be minimal compared to the similar cost of postal carriers.

Agricultural and construction machinery is a product that can be bought not in every city of Ukraine. This applies to both equipment of domestic manufacturers and imported special equipment.

Therefore, the company "Ukrtrans Garant" offers its services for delivery to Ukraine from China, Italy, Germany and other countries:

- tractors and mini-tractors;
- cranes;
- elevators;
- grain carriers and other machinery for agriculture and construction works.

But, in addition to the import of oversized and oversized special equipment to Ukraine (as well as export of equipment), the company transports tractors and combines, cranes and other equipment on the territory of our country.

The company "Ukrtrans Garant" also offers on a regular basis its services for the delivery of special equipment in Ukraine, as well as services for the international delivery of special equipment, to manufacturing companies that import, export and sell equipment for construction and agriculture in Ukraine.

For construction companies, food industry companies, agricultural enterprises, chemical industry enterprises and others, we offer to deliver with our help a variety of food and non-food bulk cargoes in Ukraine, as well as throughout Europe and Asia.

For this purpose, the fleet of Ukrtrans Garant has special vehicles designed for long-distance transportation:

- grain, cereals, sugar;
- sand, cement, gravel;
- dry fertilizers, etc.

Delivery of bulk cargo in Ukraine is made from any city directly from the place of loading to the place of unloading. You can order from us not only transport, but also logistics services, as well as cargo insurance and its storage in our warehouse on request.

The company also provides international cargo transportation of bulk cargo. The company's trucks are equipped with closed bodies or waterproof awnings, so your cargo will not suffer during a long trip neither from rain nor from snow.

When organizing a "turnkey" moving company "Ukrtrans Garant" adheres to 5 principles of work that 100% guarantee the safety of things:

1. Full financial responsibility for the safety of things. At the very beginning of the work a contract is signed. It clearly fixes the entire list of things and the company's responsibility to the client. The company guarantees that everything will arrive on time, safe and sound.

2. Thorough inventory of all things and optimization of the estimate. The manager will come to your home for free for a preliminary assessment of the number of things and calculate the estimate. He can answer all questions, decide which machine is needed, how many staff, time for packing and loading.

3. Packing of each item by special technology. The company has 27 packaging materials and 89 algorithms for careful packing of different types of things: furniture, fragile sets, household appliances, etc.

4. Our neat and careful movers. All movers undergo rigorous selection and training. The process of their work is monitored by the foreman and controls compliance with quality standards.

5. Own fleet of vehicles. 17 trucks with a carrying capacity from 2 to 30 tons allow you not to look for a car on the side, but to submit for loading directly from the parking lot when it is convenient for the client.

When moving abroad, the company takes care of customs clearance and paperwork:

- helps to pass customs;
- prepares a package of all necessary documents;
- the client can personally accompany the cargo;
- organizes transportation of pets;
- the client can track the movement of the car by GPS.

Customers' belongings can "wait" in the warehouse of the company "Ukrtrans Garant". After all, there are cases when the client urgently needs to vacate the apartment, and there is nowhere to transport things.

The company can leave customers' belongings in its warehouse and then deliver them to a new address.

According to paragraph 22.5 of the Traffic Rules of Ukraine, oversized cargoes are cargoes, the size or weight of which (including the car) exceeds the following limits:

- actual weight over 38 tons;
- length over 22 meters;
- height over 4 meters above the road surface;
- width more than 2.65 meters;
- the cargo protrudes beyond the rear dimension of the vehicle by more than 2 meters.

Their transportation is subject to a number of additional rules and restrictions.

There are 4 key differences in the transportation of oversized cargo from the company "Ukrtrans Garant":

1. Study the cargo and conduct a thorough preparatory stage.

2. Provides road closures and escort vehicles.

3. Prepares all accompanying documentation and coordinates the route with the police.

4. Organizes special equipment for loading and unloading.

The company conducts thorough logistical preparation, observing all legal norms. If necessary, we can provide escort vehicles, road closures and adjust special equipment for loading and unloading.

The company's specialists build routes taking into account all requirements.

Oversized transportation in the company is handled by a separate team of logisticians who know all the nuances and have already solved hundreds of similar problems before. That is why the company provides customers with the most qualified support and service on the market.

Construction companies, trade enterprises, military institutions and many other organizations often have to transport oversized machinery and equipment on the roads of Ukraine, Europe or Asia.

Oversized cargo transportation is a constantly necessary service for them, which is better to order from reliable partners – the logistics company "Ukrtrans Garant".

Oversized cargo transportation by the company "Ukrtrans Garant" is carried out by specialized vehicles designed to transport both long and heavy or other oversized equipment and machinery.

Ukrtrans Garant uses:

- low-frame platforms for long cargoes;
- trawls;
- tilt cars;
- telescopic platforms for transportation of cylindrical cargoes, etc.

Employees of the company think over the transportation route, coordinate it with the police and customs services, draw up all the necessary documents and deliver oversized machinery and equipment within the time specified in the contract.

For customers who are engaged in agriculture, or produce and sell various agricultural machinery, "Ukrtrans Garant" provides the service of transportation of tractors or their delivery to Ukraine, as well as the service of transportation or import of agricultural machinery from another country to Ukraine, export of machinery from Ukraine and transportation of agricultural machinery in the country.

Most often the company supplies agricultural machinery for dealers and direct buyers from China, Germany, Poland and other countries.

It can also be ordered transportation of tractor from one city to another (for example, for rent during the seasonal field work), as well as delivery of agricultural equipment to repair shops in case of breakdown.

To provide such services, specialized vehicles are used that have all permits for the transportation of such oversized equipment, as well as permits for international transportation.

For customers who are engaged in construction or sell construction equipment "Ukrtrans Garant" provides a service for the delivery of construction equipment by road in Ukraine and around the world. Transportation of construction equipment is an oversized transportation of goods, and therefore their implementation requires not only specialized vehicles, but also obtaining permits from various inspection

authorities. And as a full-cycle logistics company, Ukrtrans Garant undertakes to solve all arising issues during transportation:

- excavators;
- drilling machines;
- bulldozers;
- cranes;
- graders;
- stone crushers, etc.

"Ukrtrans Garant" delivers new and used construction equipment from supplier to buyer, as well as to construction sites, both in Ukraine and abroad. Most often, such oversized cargo transportation is ordered by large and small construction companies that rent special equipment, as well as dealers who purchase construction equipment in China, Russia, Germany, Italy, Turkey and other countries.

A separate type of oversized cargo transportation can be considered the delivery of transformers in the country and abroad. After all, for their transportation you need:

- a specialized vehicle capable of transporting huge transformer boxes, with many flammable wires, heavy and bulky;
- to issue permits in the police and customs services of different countries for oversized cargo transportation;
- to draw up a lot of special documents for the transportation of transformers, because such cargo is considered dangerous, and therefore requires increased safety conditions during transportation;
- coordinate with the relevant authorities the date, time and route of the car with a transformer, and much more.

Therefore, it is not just difficult, but almost impossible to transport a large transformer of a construction company or dealer on your own. Independent oversized cargo transportation can result in huge monetary losses simply from ignorance of the rules of their implementation.

There are customers who need to transport over long distances a single, inseparable cargo of large weight. At the same time, the volume of such cargo will

not always be as large, and it will be very expensive to order trucks with a tonnage of up to 22 tons. Therefore, the company "Ukrtrans Garant" offers customers a compromise – a service for the transportation of heavy cargo.

Heavy loads are loads that exceed the permissible load on the axles or the entire rolling stock of the car. That is, a load weighing 3 tons, which is easily placed in a car with a carrying capacity of 2 tons, will be considered heavy. You can, of course, choose a car with a larger tonnage for such cargo. But most often it costs much more than the registration of various permits for oversized cargo transportation of heavy cargo.

The company "Ukrtrans Garant" carries out oversized cargo transportation of heavy cargoes both in Ukraine and in Europe and Asia. Delivers cargoes to Poland, Georgia, Turkey, Germany, France, the Netherlands, Italy. Also can deliver heavy cargoes from China and other Asian and European countries. We take care of all the permits.

For customers engaged in construction, electrical work, drilling, or for those who have their own sawmill, Ukrtrans Garant offers a service for the transportation of long items. The company's vehicles are capable of transporting long loads at any distance both in Ukraine and in Europe or Asian countries.

For the transportation of long items in the company's fleet there are vehicles with a cargo compartment length of up to 22 meters. But not always ordering such vehicles will be profitable for the customer. If the cargo can be easily placed in a regular gazelle or in another car, and it will protrude more than 2 meters beyond the car, the company will also undertake to transport such cargo, which will be cheaper for the customer.

Transportation of long cargoes is carried out by the company "Ukrtrans Garant" in a short time, in compliance with all the rules of transportation, with the necessary documents and without claims from the police and customs services.

With the company "Ukrtrans Garant" transportation of long cargoes is not difficult at all, especially for the customer, as the company takes care of all the

solutions of arising issues: from the selection of suitable vehicles to the coordination of the transportation route with the police and customs.

"Ukrtrans Garant" has its own fleet and proven vehicles anywhere in Ukraine. Its fleet includes 37 vehicles with a carrying capacity from 2 to 20 tons. The company also has its own proven base of more than 550 vehicles throughout Ukraine. Therefore, it is able to quickly find the right car for any cargo, regardless of the delivery route.

The company concludes an agreement with customers on responsibility for the safety of the cargo and guarantee that everything will arrive intact. Cargoes, the value of which exceeds 100 000 UAH, are insured additionally.

Ukrtrans Garant is ready to take responsibility for accurate and fast loading / unloading. If you do not have your own resources to organize loading / unloading, we will take this part of the work on ourselves.

For road freight transportation in Ukraine there is a fleet of the company, consisting of more than 80 own and more than 520 rented vehicles located in different cities of Ukraine, Europe and Asia. These are small tents and covered gazelles, and huge dump trucks, grain trucks, container trucks, refrigerators, and trucks designed to transport long items and oversized cargo.

The company "Ukrtrans Garant" organizes cargo transportation (Ukraine) weighing from 1 ton to infinity. The vehicles are designed for carrying capacity from 1.5 tons to 22 tons, with a cargo compartment volume of up to 120 sq.m. But, if customers need to transport goods of even greater weight or volume, the company easily sends several trucks for one customer in any direction.

Let's start the analysis of the production and financial performance of Ukrtrans Garant with the analysis of the number of transportations. In general, the number of transportations of the company each month can be quite different.

Let us analyze the data on the average number of cargo transportation per year (Table 2.1 and Fig. 2.6).

Table 2.1 – Average number of transportations performed by Ukrtrans Garant

№	Indicators	2015	2016	2017	2018	2019	2020	2021
1	2	3	4	5	6	7	8	9
1	Number of transportations, units	672	780	816	732	696	864	899
2	Absolute change, units	–	108	36	-84	-36	168	35
3	Relative change, %	–	16,1	4,6	-10,3	-4,9	24,1	4,1

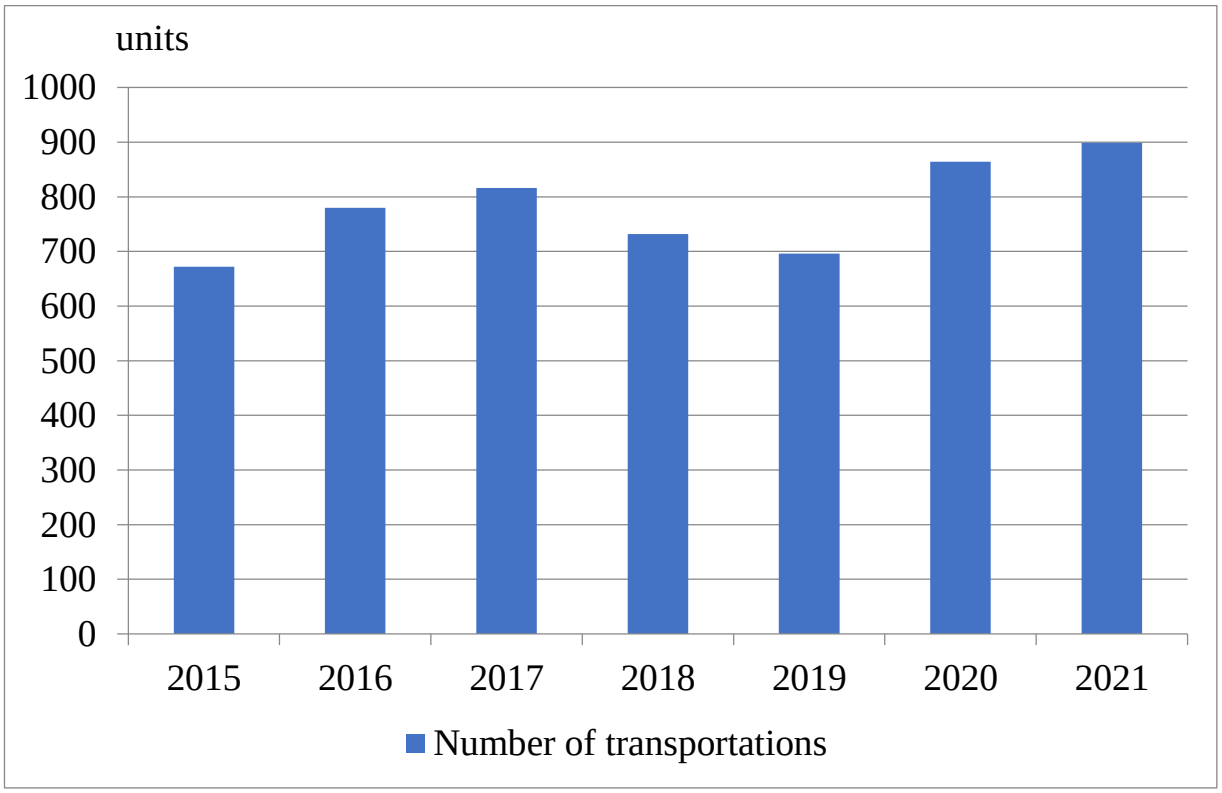

Figure 2.6 – Dynamics of the average number of shipments per year

We can see that, like all companies in Ukraine, Ukrtrans Garant has slightly reduced the number of its transportations according to the results of 2018-2019. However, today the company has overcome the crisis and is successfully developing.

The property of Ukrtrans Garant consists of fixed and current assets. The sources of property formation are revenues received from the services provided.

All profits received by the company as a result of financial and economic activity, after payment of taxes and other payments to the budget, settlements with

bank institutions, remain at the disposal of the company and are subject to distribution in accordance with the Charter of the company.

Statistical data on income, expenses and revenues of Ukrtrans Garant are presented in Table 2.2.

Table 2.2 – Key financial indicators of "Ukrtrans Garant" company

№	Indicators	2015	2016	2017	2018	2019	2020	2021
1	2	3	4	5	6	7	8	9
1	Revenues from services, UAH	2520000	2925000	3061632	4119696	6528480	8104320	8432991
2	Relative change, %	–	16,1	4,7	34,6	58,5	24,1	4,1
3	Operating expenses, UAH	1915200	2208375	2296224	3501742	5549208	6564499	6746393
4	Relative change, %	–	15,3	4,0	52,5	58,5	18,3	2,8
5	Operating profit, UAH.	604800	716625	765408	617954	979272	1539821	1686598
6	Relative change, %	–	18,5	6,8	-19,3	58,5	57,2	9,5

For greater clarity, we present the data of Table 2.2 in the form of diagrams shown in Fig. 2.7.

As can be seen from the above data, the revenues of Ukrtrans Garant have been continuously growing from year to year, despite the fact that in 2018 there was a decrease in the number of transportations performed.

At the same time, we see that the profit in 2018 also slightly decreased due to the need to reduce margins to retain customers. But in subsequent years, the company

again reached positive dynamics in all financial indicators of its activities. The highest rate of profit growth was observed in 2019.

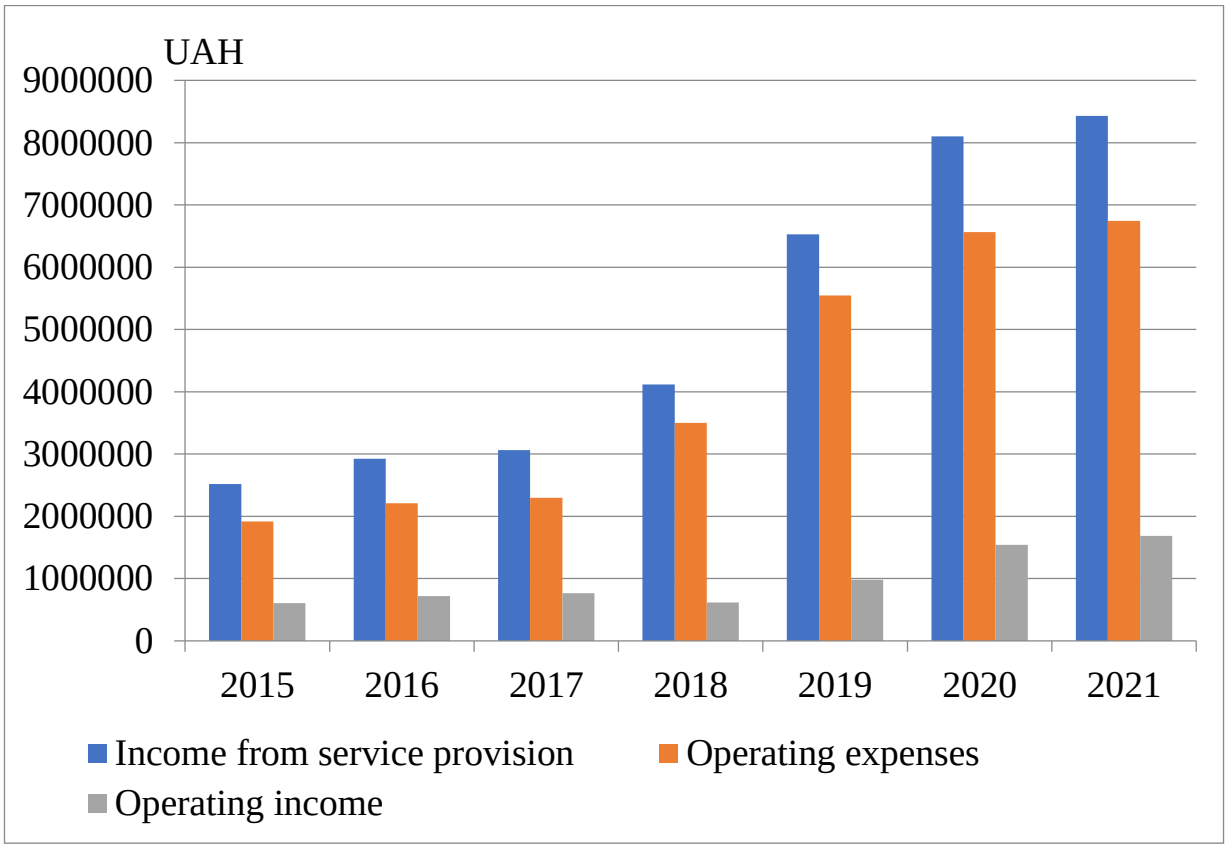

Figure 2.7 – Dynamics of the main financial indicators of Ukrtrans Garant Company

In general, the analysis of the production and financial performance of Ukrtrans Garant has shown that the company has effectively overcome the crisis in the Ukrainian market and continues to operate at a fairly profitable level.

2.3 Innovative solutions in the activities of transport companies

Technological innovations are playing an increasingly important role in all sectors of the economy, and logistics and supply chain management cannot stay away from this process.

This conclusion is made by European experts, the authors of the article «Top 10 Supply Chain and Logistics Technology Trends in 2020 logistics technology trends» [44].

In their opinion, innovations in the logistics sector are associated not only with the desire of logistics companies to introduce new technologies in order to keep up with the development of the industry – to a large extent, this is required by logistics customers – representatives of trade business and large industrial enterprises that require their goods or services to come to the customer faster and at lower cost.

According to the research, we can highlight the most important innovative solutions for logistics and transport companies.

1. Supply chain management in real time.

Real-time supply chain (SCV) is no longer a "technology gimmick" or a "fad" in logistics: in 2019, many companies began to implement it, in 2020 it will become necessary almost everywhere.

Real-time data is now more in demand by more and more customers, and this means that logistics and supply chain management businesses will need to focus on it. Currently, a large number of startups have emerged whose solutions provide supply chain transparency, provide technology that facilitates rapid response to changes, allowing companies to use real-time data.

Such data includes traffic patterns, weather conditions in a particular area right down to the condition of roads or access roads to ports, allowing for optimized delivery routes. In 2019, studies have shown that logistics companies using fully integrated supply chains are 20% more efficient than their competitors.

You can't talk about supply chain management without mentioning the Internet of Things (IoT) technology, which is a crucial asset for tracking supplies. Connecting IoT devices at different sites allows warehouses to track the movement of equipment, vehicles and goods through cloud services. At the same time, IoT-based container management is also simplified through real-time monitoring, improved fuel efficiency, preventive maintenance, and enhanced container operations instead of reactive ones.

Due to this, another trend will surely be closer cooperation between IoT startups and logistics companies. One of the most recent examples is Hapag-Lloyd, which chose IoT startup Globe Tracker to create its new real-time container monitoring system called Hapag-Lloyd Live.

In 2020, look forward to new partnerships with IoT startups as the sector begins to demand real-time customer tracking.

Growing importance of new models and new market players

It should be noted that the future of logistics is shaped not only by new technologies: the role of new business models and new players in the industry is equally important. Often driven by startups, new systems incorporating elements of the sharing economy (sharing) are rapidly gaining popularity.

Without much experience with logistics assets, start-ups tend to focus on the "lighter" parts of the supply chain, becoming, for example, digital freight forwarders. Thanks to more flexible operations, they can offer more attractive prices while ensuring transparency of the logistics process.

That's the case for Uber, which launched its Uber Freight feature in the U.S. in 2017 and expanded to Europe and Canada last year in a bid for a more efficient global freight market. Uber Freight, according to Uber, is one of its most promising ventures: during an August call with investors, Uber CEO Dara Khosrowshahi said that

"Uber Freight continues to show impressive growth and significant progress in the second quarter despite soft market conditions."

Even the industry's own customers see potential in freight forwarding: Amazon plans to expand its own warehousing and transportation expertise to develop its own delivery capabilities. The company has already made great strides with the development of Prime Air, a drone service it is building to create all-electric drones capable of flying up to 15 miles and delivering packages weighing less than five pounds to a customer in less than 30 minutes.

In addition, the company is reportedly importing new Amazon-branded intermodal containers from China. In addition, the company announced the Amazon

Flex platform, which uses on-demand contract drivers to accelerate the expansion of the Prime One Day delivery program.

Amazon also announced its new robotic products heading to hundreds of service centers around the world. One of these products is the Pegasus sorting system, which has covered two million miles to date and has already reduced the number of mis-sorted goods by 50%, while maintaining the safety features of the existing drive system.

In addition, the e-commerce giant is testing Amazon Scout, which is designed to safely deliver parcels to customers using small autonomous delivery vehicles. In addition, Amazon CEO Jeff Bezos said that the company has invested $ 700 million in Rivian, an electric vehicle startup, which will produce 100 thousand electric vans for the delivery of Amazon goods.

Another great example of the company's impact on the industry is Flexport, a specialized cloud-based freight forwarding software and data analytics platform. Early last year, the company received funding of $1 billion. Earlier last year, the company received $1 billion in funding and plans to launch an operating system for global trade that includes a strategic operating model for global freight forwarding and combines the best of all supply chain technologies.

With so many future technological advancements being developed, it is clear that this is one of the logistics technology trends to watch out for in 2020.

2. Robotization of warehouse operations.

There is no doubt that warehouse operations have undergone significant changes in recent years – and with the gradual integration of technology, this is one trend in logistics technology that is likely to continue. One obvious innovation is warehouse robotics, a rapidly growing field.

According to the Global Customer Report 2019, warehouse robotics testing has increased by 18% compared to last year. The Boston Dynamics mobile warehouse robot called Handle is one of the prime examples: the company has developed a fully autonomous compact device that can access any hard-to-reach places, and at the same time has an extended viewing area.

Thanks to this, the robot can quickly unload trucks, stack pallets and move boxes for the entire warehouse. Also, both wearable technologies and driverless vehicles or multifunctional robots can increase the efficiency and speed of warehouse processes.

For example, GreyOrange and Locus Robotics are already using robots that move around the warehouse independently. Thanks to machine learning technologies and sensors that provide the utmost accuracy and ease of tracking, a large number of autonomous robots will appear in modern warehouses in 2020.

3. Artificial and augmented intelligence.

Over the past few years, the logistics industry has begun to integrate artificial intelligence (AI) solutions into its operations, including intelligent transportation, route planning and demand planning, and this is just the beginning.

We expect shippers, carriers, suppliers and consumers to benefit from these trends in logistics technology as they continue into 2020. Along with artificial intelligence, augmented reality and augmented intelligence will probably be used no less actively.

Augmented intelligence combines human intelligence with automated processes of artificial intelligence. For example, in logistics planning, the use of augmented intelligence may even surpass the use of AI alone, as it combines the capabilities of people (experience, responsibility, customer service, flexibility, common sense, etc.) with artificial intelligence technologies, which will be left to perform repetitive and heavy work.

According to Gartner, augmented intelligence will create $2.9 trillion in business value and lead to an increase in productivity of 6.2 billion hours globally by 2021.

Logistics companies can be expected to implement more intelligence-enhancing solutions that will ultimately enable logistics professionals to do their jobs faster, reducing errors and saving money.

3. Digital twins.

Digital twins (digital copies of a physical object or process) are arguably one of the most exciting trends in logistics technology to watch in 2020. Many logisticians know that products will never be the same as their computer models.

Modeling in its current state doesn't take into account how parts wear out and are replaced, how wear and tear accumulates in structures, or how owners make changes to meet their changing needs.

However, digital twin technology changes this once and for all: the physical and digital worlds can now be merged into one, allowing us for the first time to interact with a digital model of a physical object or part in the same way as their physical counterparts. The potential uses of digital twins in logistics are enormous.

In the transportation sector, digital twins can be used to collect product and packaging data and use this information to identify potential inefficiencies and recurring trends to improve future operations.

Warehouses and businesses can also use this technology to create accurate 3D models of their centers and experiment with layout changes or the introduction of new equipment to see their impact. Alternatively, logistics centers can create digital twins and use them to test different scenarios and improve efficiency. In addition to this, delivery networks could use this technology to provide real-time information that will improve delivery times and further assist autonomous vehicles on their routes. It will be interesting to see what other efficient uses of logistics will develop in the coming year.

5. Blockchain.

Since its introduction in 2008, blockchain has become one of the buzzwords in any industry. Unfortunately, the complex concept of blockchain is difficult for many logisticians to understand, and despite its great potential, it has not developed much. In addition, many logisticians are tired of the very frequent use of this term.

As you know, blockchain is an "open ledger of transactions" distributed between computers on a network. Since everyone in the shared blockchain has access to the same transaction ledger, there is complete transparency, which makes it impossible for users to hack the system and thus eliminates the need for third parties.

In the logistics industry, blockchain could simplify the exchange of sensitive data for different carriers or shippers; and companies could create trade finance and

supply chain solutions, There are already pilot projects successfully applying blockchain in logistics.

For example, CargoX is one startup that is fully dedicated to introducing blockchain into the logistics industry by using the public Ethereum network to securely verify document transactions. Also, Warren Buffett's UPS and BNSF Railway have joined the blockchain in a transport alliance. Another example is the blockchain joint venture between Maersk and IBM called TradeLens.

В даний час до платформи приєдналися п’ять з шести найбільших перевізників світу, і більше половини морських контейнерних перевезень в світі в даний час здійснюються в рамках TradeLens. Але для того, щоб ефективно прийняти блокчейн, логістичні компанії повинні оцифровувати, стандартизувати і очистити свої дані. Це дозволить впровадити загальногалузевий стандарт і сформувати екосистему партнерів по ланцюжку поставок, щоб використовувати стандарт в загальній, невирішеною середовищі блокчейна.

6. Data standardization and advanced analytics.

Traditionally, data in logistics has always been completely siloed. Companies store data in whatever location and application is convenient for them, which leads to a fragmented ecosystem, inefficient operations and makes it difficult to digitize operations.

One of the biggest trends in logistics technology in 2020 that we've identified indicates that data in silos will no longer be suitable for companies that want to keep up with the changing times.

For example, new data standards are finally being created in the container shipping industry, thanks to the emergence of the Digital Container Shipping Association (DCSA) in 2019. The DCSA's mission is to create common information technology standards for digitization and interoperability to make the shipping sector more efficient for both customers and shipping lines. Only a few months after its launch, the organization released its first industry draft, which details new industry standards for data processing processes used in container delivery.

However, DCSA represents only a movement to standardize data in the container shipping sector, and it will take time for the association to develop new standards covering the various sub-sectors of shipping. Meanwhile, Traxens, an IoT company providing valuable data and services to the supply chain industry, has announced that it has led the development of the first standards for the exchange of smart containers.

Elsewhere, logistics still has to work hard to solve the problem of data inconsistency, leading many young startups to focus on building predictive and advanced analytics platforms as a solution.

These logistics startups are helping large companies cleanse and digitize their data, allowing them to then use that data for advanced analytics and predictive optimization. These include improved supply chain visibility, demand forecasting, proactive line-haul planning, predictive maintenance, detection of unforeseen conditions and improved last-mile delivery. When data is standardised and digitised across the logistics industry, all companies stand to benefit enormously.

8. Autonomous vehicles.

Although autonomous vehicles – whether driverless trucks or drones – are closely linked to the near future of logistics, we are likely to see it only in the testing phase during 2020. Nevertheless, one of the most talked about trends in logistics technology lately.

For example, UPS Ventures has invested in TuSimple, an autonomous vehicle company, and the two companies are testing self-driving trucks in the U.S. to determine if these vehicles can improve service and efficiency across the UPS network. This means that UPS and TuSimple join companies such as Daimler, Tesla, Starsky Robotics, Einride and Embark, which aim to have trucks deliver goods without human assistance.

With more and more drones being considered for small package delivery, it's no surprise that 2020 will see more trial runs and pilot projects. In fact, Alphabet's Wing, the first officially approved drone in the US, already made its first delivery last year, and UPS may well become the first company to operate drones on a nationwide scale.

9. Increased investment in logistics startups by venture funds.

In 2019, venture capital firms invested a lot in promising logistics startups. We have already mentioned the famous Flexport investment of $1 billion, but that's not all. In San Francisco, KeepTruckin, a company that manages truck fleets around the world, received $ 149 million in Series D funding.

Another striking example of this trend is Atlanta-based Roadie, which was invested $37 million by Warren Stevens' retailer The Home Depot, as well as former Alphabet CEO Eric Schmidt and other investors.

In turn, the food delivery service Postmates received about $ 1 billion in investments, while it was potentially valued at $ 2.4 billion. Meanwhile, in the warehousing industry, as mentioned, the creator and leader in warehousing, FLEXE, received $43 million in Series B funding.

Many of the venture funds have invested millions of dollars in new technologies developed by innovative startups or even acquired them themselves. Thus, logistics companies can now leverage their capabilities by conducting research and development through their new partners. Giants such as UPS see great advantages in such close cooperation: in early 2019, the company made a small investment in the automotive company TuSimple to test self-driving cars with trailers in Arizona and understand how they can enrich its experience.

Maersk also recently announced that it is joining fellow shipping giants CMA CGM and MSC to invest capital in Traxens, a data and services platform for the supply chain industry. Significantly, e-commerce players are also looking to get in on the action, with omnichannel shopping platform Shopify acquiring 6 River Systems, a provider of collaborative warehouse robotics solutions, for example.

The race for innovation has also prompted Singapore's sovereign wealth fund Temasek to partner with transport giant Kuehne + Nagel to create a $50 million venture fund for logistics and supply chain startups. There are also companies that want to expand their technology portfolio on their own. For example, C.H. Robinson Worldwide, the largest freight broker in North America, has announced that it will

double its spending on technology to $1 billion in order to expand and develop its services to compete with digital startups.

Additionally, in a bid to quickly adapt to digital innovation, Deutsche Post DHL Group announced in October 2019 that it plans to invest $2.2 billion in digital initiatives through 2025. With so many partnerships formed over the past year, it will be interesting to see what solutions result from these investments.

10. Sustainable development based on technology.

Sustainability is a trend that permeates all industries, and logistics is no exception. Last mile delivery in particular has traditionally been very time and energy intensive, so it also provides many opportunities for fresh and smart approaches. To reduce the negative impact on the environment, companies are using a variety of technologies, from real electric vehicles to AI-based software that calculates the route with the lowest emissions.

Amazon recently announced its "Climate Commitment", according to which it intends to achieve the goals set out in the Paris Climate Agreement 10 years earlier. By doing so, the company hopes to encourage other businesses to join it, as well as to become a company that does not use cars and other mechanisms that emit carbon dioxide in its activities by 2040 and promotes renewable energy sources instead. To do this, Amazon has signed a contract for the launch of the Rivian electric vehicle for the supply of 100 thousand electric vans.

Deutsche Post, the world's largest courier company, has also allocated $ 552 million for the production of light electric cargo vehicles and microelectronic devices. Partnership with a Chinese manufacturer will allow to create up to 100 thousand street scooters per year. Similar trends in logistics technologies are observed throughout the transportation sector. Most recently, more than 60 commercial groups, including Maersk, have launched an initiative aimed at using zero carbon vessels and marine fuels on the high seas by 2030. These efforts are fundamental not only because of their direct impact, but also because they inspire the entire industry to adopt a sustainable mindset.

Thus, we can argue that the introduction of cloud technologies into business processes has accelerated the digitalization of supply chains. This allows taking into account the amplitude of instability and responding quickly to possible deviations or disruptions in supply chains. Transport enterprises are modernizing their supply chains as a digital supply network that integrates the physical flows of products and services, and provides affordable, efficient, safer, infinitely scalable solutions that can be easily integrated with existing systems. The cloud supply chain management market is expected to reach USD 8.61 billion by 2026 from the current level of USD 4.58 billion in 2020, at a CAGR of 11.09% during the forecast period (2021-2026) [39].

The transport industry is extremely important for economic growth, they are interdependent and quality development, ensuring the competitiveness of transport enterprises and services can ensure the introduction of innovations [74]. Cloud computing is rapidly evolving to support collaborative Transportation management solutions (TMS), as well as other aspects, such as: network capacity search, navigation, reliable visibility, scenario management, support functions, including cargo payment and audit.

In European countries today, cloud computing is perceived as the main source of cost savings, which improves the management process and allows you to quickly and efficiently access innovative solutions in the supply chain organization [42]. An example is the use of the so-called "software as a service" (Software as a Service – SaaS), as a certain model that helps to present supply chains at different scales. Thus, according to Cisco Systems, in 2021, Software as a Service (SaaS) was installed 380 million times worldwide [39].

The introduction of the latest technologies such as virtual and augmented reality, 3D printing and modeling creates additional opportunities. On the other hand, big data analytics, cloud technologies, cybersecurity, IoT, miniaturization of electronics, AIDC, RFID, robotics, drones and nanotechnologies, M2M and BI can be opportunities for transport companies [93], but can also be an additional source of risks. Obvious advantages are identified from the implementation of Industry 4.0,

namely: increased flexibility, quality standards, efficiency and productivity, which will better meet the needs of consumers, creating value through the constant launch of new products and services. Moreover, collaboration between machines and humans can have a social impact on the lives of workers of the future, especially in terms of optimizing decision-making [93].

Advanced logistics companies are using a new generation of robots (collaborative robots or co-bots) that are safer, smarter and can work side by side with humans. For example, Amazon, one of the most significant players in e-commerce, uses several types of robots (palletizers, robot stackers, and actuators) in its warehouses, which perform various activities such as picking heavy items and preparing goods for shipment or storage. Amazon currently has 200,000 robots in its warehouse. In 2020, the company invested $40 million in a new 350,000 square foot robotics innovation center in Massachusetts, which will significantly stimulate the market in the future [39].

Increasing investments in the Internet of Things (IoT), a revolutionary technology that shows promising potential for the supply chain, is expected to drive the market. According to a Kenco Group survey, 56% of supply chain leaders said they plan to invest in sensors and IoT in the coming years. In the same survey, 40% of respondents reported that they intend to invest in blockchain technologies [39].

Major market trends show significant growth in retail, especially e-commerce [51], as most key players are using cloud technologies to transform their supply chains with better visibility and data-driven insights. The integration of technology focuses on modulating the customer journey and delivering significant improvements.

Buy online, Pick up in-store (BOPIS) technology made a massive breakthrough in 2019 as it helped to increase store traffic. For example, Walmart, the largest retailer in the United States, has also deployed pickup towers in stores and used technologies that support BOPIS: cloud computing software, devices, and mobile architectures linked to inventory and supply chain data that allow store websites and employees to coordinate online orders, in-store inventory, and in-store delivery, which in turn drives the market [39].

Customer retention has become more important than before due to the increase of players in the market with the growth of e-commerce, this has also been facilitated by the restrictions imposed by the COVID-19 pandemic [51]. Cloud computing helps improve the customer experience as it collects and analyzes data from multiple sources, identifies patterns and forecasts needs, and offers on-demand services. It also gives retailers access to all business content from core business applications to provide customers with timely responses and exceptional service, thereby increasing their competitive position in the market. Automation tools also improve inventory distribution and management by digitizing information and using analytics and report visualization. Thus, it allows to automate the chain from the incoming operator for inventory management and distribution to reconciliation at the store level. This results in lower operating costs, an easier and faster way to reconcile invoices and improved fill rates by reducing reorder times.

Logistics enterprises are widely using the integration of information flow through supply chain management software, packaging, material handling, warehousing, freight forwarding, returned goods management and brokerage.

Among the latest innovative products in the field of supply chain:

Oracle Logistics Digital Assistant from Oracle Corporation, an AI-powered virtual assistant for Oracle Cloud Logistics, helps customers and employees have easy access to the status and progress of an order, track a shipment without navigating through the Oracle Transportation Management (OTM) application or understanding the correlation of complex data.

Infor, the leader in business cloud software, has partnered with alliance partner Elvenite to deliver a combination of modern technology and successful, reliable Nordic food fulfillment solutions based on the Infor Cloud Suite Food and Beverage, helping customers in the food industry make smarter decisions that increase Infor's competitive edge.

Supply chain innovations are relevant in all sectors of the economy. Well-known distributors and healthcare providers in the region are partnering with technology providers to make their supply chain capabilities more agile by implementing cloud

services for faster response through reduced lead times and improved service with lower overall costs. For example, in 2019, McKesson Corporation [39], which is a provider of logistics services, patient access support and specialty pharmacy solutions, has partnered with TrakCel, a developer of software for medical supply chain tracking and traceability systems.

Hence, the cloud supply chain management market is highly concentrated and controlled by dominant players such as: Oracle Corporation, SAP SE, Descartes Systems Group Inc, Infor Inc. and IBM Corporation. Having a significant market share, the major players are focused on expanding their customer base in other countries using joint initiatives to strengthen their market position and increase profitability. However, innovative products provide a significant boost to SMEs by promoting and increasing their market presence, securing new contracts and entering new markets. This ensures the development of competition, the growth of service quality and efficiency.

2.4 Chapter 2 summary

This section analyzes the situation on the transport services market in Ukraine. Our analysis showed that in recent years the volume of transported goods by all types of transport ranged from 600 to almost 812 million tons. During the period under review, the maximum volume of transported cargo was observed in 2011, the minimum – in 2020. According to the results of 2021, the volume of goods transported by all modes of transport amounted to 619.9 million tons.

In addition, it was concluded that over the past ten years, road transport has demonstrated quite successful expansion in the Ukrainian freight market, while its other competitors are weakening their positions.

The activity of the company "Ukrtrans Garant", which has been organizing cargo transportation in Ukraine and abroad for more than 15 years, was also analyzed.

The company "Ukrtrans Garant" cooperates with Ukrainian and foreign manufacturers and offers its customers: an individual approach to each client; fast and high-quality transportation; selection of the optimal route; guarantee of delivery safety; a large fleet of vehicles with different carrying capacity and body type; the ideal ratio of quality and cost; a wide range of services and coverage of countries.

Advantages of the company "Ukrtrans Garant": its own fleet; 100% delivery of the car; transportation of all types of cargo; transportation of groupage cargo and reloading with payment in one direction.

The analysis of the production and financial performance of Ukrtrans Garant has shown that the company has effectively overcome the crisis in the Ukrainian market and continues to operate at a fairly profitable level.

In addition, innovative solutions in the activities of transport companies were explored. It was noted that technological innovations play an increasingly important role in all sectors of the economy, and logistics and supply chain management also cannot stay away from this process.

Innovations in the logistics sphere are associated not only with the desire of logistics companies to introduce new technologies in order to keep up with the development of the industry – to a large extent, this is required by logistics customers – representatives of trade business and large industrial enterprises, who demand that their goods or services come to the customer faster and at lower cost.

Thus, we can say that the introduction of cloud technologies in business processes has accelerated the digitalization of supply chains. This allows taking into account the amplitude of instability and responding quickly to possible deviations or disruptions in supply chains. Transport enterprises are modernizing their supply chains as a digital supply network that connects physical flows of products and services, and provides affordable, efficient, safer, infinitely scalable solutions that can be easily integrated with existing systems.

CHAPTER 3
RECOMMENDATION FOR THE IMPLEMENTATION OF LOGISTICS ENGINEERING SOLUTIONS IN THE ACTIVITIES OF THE TRANSPORT COMPANY

3.1 Development of a strategy for improving the activities of a transport company based on logistic engineering solutions

The use of principles and methods of strategic management of the transport company depends on the scale of application of strategic management models. In the context of globalization, many companies begin to move away from open competitive rivalry, which was based on advantages in the process of organizing sales, and move to innovation and investment competition, which is based on improving technological, information and infrastructure business assets. New models of strategic management are emerging, based on flexibility and adaptability of business management, which allows to reorganize quickly and timely in accordance with market changes.

Thus, the choice of the model of strategy for managing the activities of the transport company is determined by the content of its stages, which can be divided as follows:

- determination of the mission (goals, priorities) of strategy development;
- assessment of conditions and factors of the external market environment;
- determination of the target, functional, organizational and resource potential of the company for the formation and implementation of the strategy;
- formation of the strategy, as well as mechanisms for its implementation;
- evaluation of results with simultaneous monitoring of strategy implementation;

– assessment of the new positioning of the company in the market of goods and services, achieved due to the strategy.

A generalized model of the strategy for managing the activities of a transport company based on logistics engineering solutions is presented in Fig. 3.1.

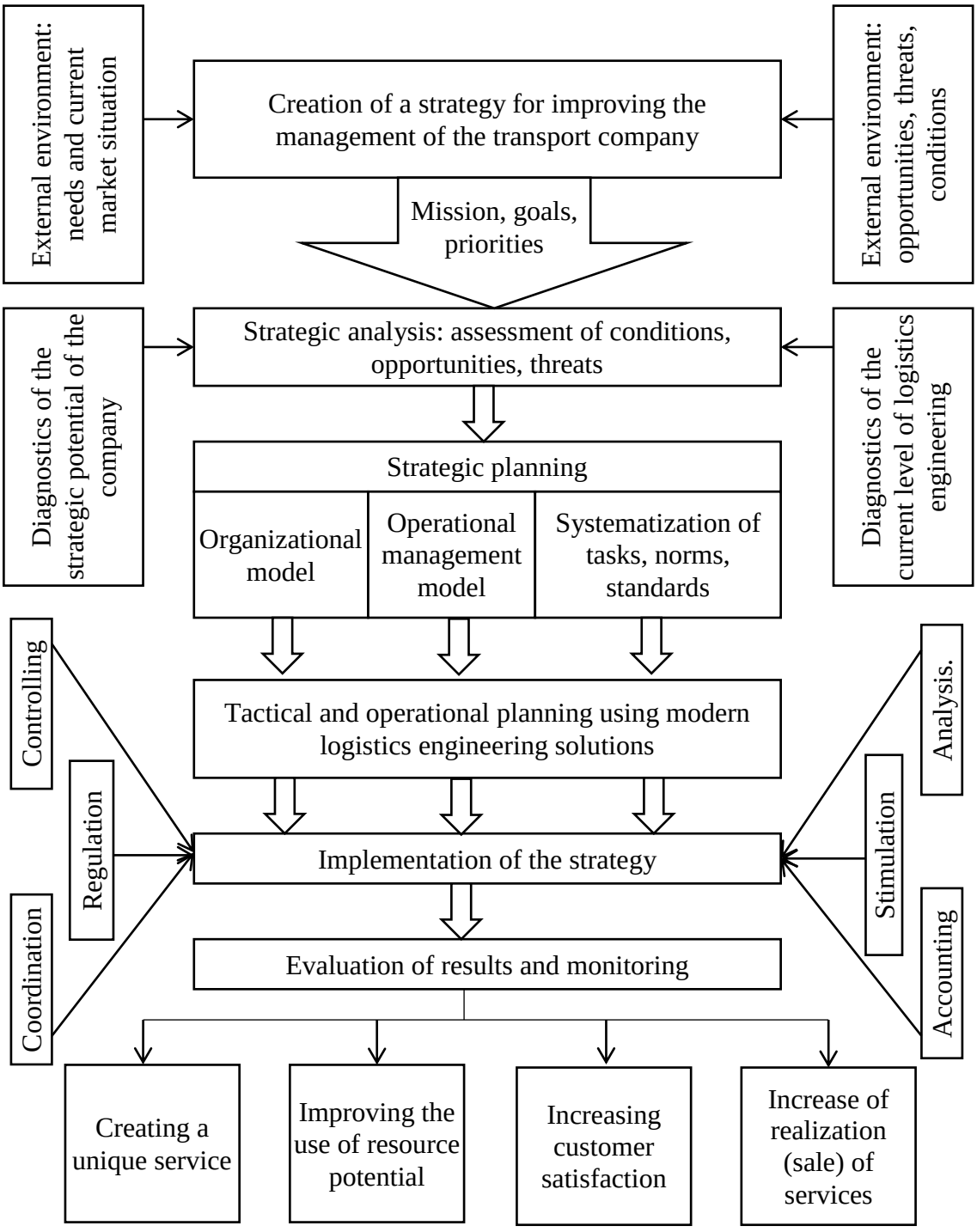

Figure 3.1 – Model of transport company management strategy based on logistics engineering solutions [based on 89]

Studies have shown that different types of enterprises (small, medium or large) have different opportunities to form competitive advantages, which is why they are forced to apply different models of strategic management. At the same time, the capabilities of large companies (material, informational, intellectual, etc.) make it possible to choose more complex integrated models of strategies. Medium and small enterprises have the opportunity to choose only simplified models, that is, those aimed at solving the strategic tasks of the company.

The systematization of practical experience shows that small and medium-sized companies usually apply a model, the goals of the strategy, which are in the sphere of economic interests, which are not always clearly defined and difficult to consciously manage, because their adoption can occur alone. Usually, such enterprises do not assess the nature of changes in the market environment, factors of scientific and technological progress and globalization trends. Nevertheless, the management of medium and small companies is forced to solve strategic tasks at the expense of previously acquired experience, database analysis, and sometimes intuition.

The mechanism of implementation of strategic objectives of small and medium-sized companies usually focuses on operational market information. Thus, competitive advantages are formed not due to the uniqueness of the company's strategy, but due to the successful use of the current market situation. The development of small and medium-sized enterprises is ensured by the flexibility of management and quick response to the market situation. The need for strategic management of activities in such companies is directly proportional to the level of uncertainty of market information, as well as the problems that arise under the influence of the external environment of the company.

The model of strategic management of large enterprises is fundamentally different. Usually, all stages of strategic management are inherent in it, while the peculiarity of implementation and characteristics of the company's strategic tasks stem from the concept of strategic management of a large company, which can be systematized by elements, namely [based on the 89]:

– the main guideline (idea) that reflects the focus and uniqueness of the developed strategy;

– description of the main components of the strategy: parameters, opportunities, advantages, limitations, conditions of implementation, threats, motives, etc;

– systematization of consumers: target groups, their interests, etc., that is, everything that affects the company's communications and its sales policy;

– relations with partners that determine the investment and structure of the company's capital investment;

– financial policy, which includes risks and profit distribution system;

– relations with partners and regulatory organizations: fulfillment of obligations, labor and environmental protection, territory development, etc;

– a system of balanced indicators, i.e. the formation of corporate culture standards aimed at ensuring that no matter what changes in the market or the complexity of innovation occur, high social values and corporate culture should remain unchanged.

Thus, developing a strategy to improve the management of a transport company's operations based on logistics engineering solutions revolves around making important decisions such as operating costs and investments that can reduce logistics costs.

Let us consider some tips that will help to easily develop a strategy for improving the management of the transport company's activities based on logistics engineering solutions [based on 47].

1. Analysis of existing processes and management systems.

First, current operations and management systems need to be reviewed. This is a critical step as it involves a review of existing capabilities. It is imperative to be accurate, as this will be the basis of the future strategy to improve the management of the transport company's operations.

You need to record all the equipment that the company has. The number of staff, their responsibilities and processes should also be recorded. This will help to look at existing procedures and check what is actually happening. There are likely to be

discrepancies between what is happening and what the procedures should actually be. You can also interview staff and get a picture of the operations being performed. This will help to find out what procedures the staff use and how they work.

The first step of the strategy to improve the management of the transport company should be to document the existing situation. After all, it is impossible to change anything until you know what is actually happening.

2. Determination of storage space.

Documenting in advance what is happening in the company will help to prepare for an effective analysis of the requirements for a new management system. This means planning and forecasting the necessary development and determining the directions for the future. You can use previous data on transport volumes, existing process failures, etc. to make accurate estimates and choose an adequate management strategy.

3. Finding weaknesses.

You need to find areas and processes where you can improve your work. Operational notes that were made earlier will help to analyze the situation and find critical areas that need improvement.

It may be necessary to hire more staff or upgrade the infrastructure to handle a certain type of product. To make sure of this, you need to look at the existing facilities, processes and equipment. It is necessary to look for effective solutions that can help overcome the shortcomings in the management of the transport company.

4. The management system of the transport company.

Finding the right management system is crucial to ensure that the strategy is ready for the future. If the right tools are available, the management system will help the staff to solve all problems that may arise in time.

The management system lays the foundation for optimizing labor and operations before taking a step further to warehouse automation.

5. Automation of the transport company's activities.

To make sure that the existing supply chain is future-proof, it is necessary to choose automation of the transport company's management. Various technologies can

be used, including cloud applications, robotics, etc. Automation of transport company management helps to eliminate all possible human errors during operations.

Below are the benefits that a company can get by investing in automation of its operations management:

– increase in the speed of processing orders, packing and sending them to customers;

– reducing the cost of operations by replacing manual operations with repetitive tasks;

– optimization of the use of the transport fleet, due to a more accurate organization of work.

6. Establishing indicators of success.

It is important to realize the need for change before it is too late. This will help to prepare for all situations in advance. If company employees are constantly busy fulfilling their orders, it will be impossible to implement new technologies and business requirements. That's why you need to set internal standards.

You can set control goals for individual processes and departments, as well as high-level indicators. This will help to organize everything efficiently. If it is found that it is difficult to achieve the benchmarks, you need to change or update existing operations accordingly. Proactively addressing all performance issues and overcoming them will help minimize costs/orders.

7. Identification of alternative solutions.

If the implementation of the strategy does not go as planned, new alternative solutions to these problems should be considered. It is necessary to constantly look for ways to eliminate shortcomings in the management of the transport company.

8. Evaluation of new plans.

When evaluating a financial plan, the following points should be taken into account:

– total cost of operations;

– taxes;

– time value of money.

When conducting a qualitative analysis, you need to consider the following:

– personnel safety;

– ease of adaptation to changes;

– the possibility of damage to goods.

9. Regularly update plans based on evaluations.

Following the evaluations, a formal strategy for improving the management of the transport company should be adopted.

It should be understood that a strategic plan is always a work in progress and will still need to be amended. In fact, the strategy should always be updated as data is collected. Updating the plan will also ensure effective operation.

Developing a strategy to improve the management of a transport company's operations is very important to increase its efficiency. With the tips discussed above, it is possible to make the existing supply chain ready for the future.

3.2 Recommendations for the implementation of logistic engineering solutions in the activity of the transport company

Logistics, manufacturing, transportation and supply chains are experiencing rapid and unprecedented transformations today. The future of these industries is tied to innovation and technology.

Technology has always been the driving force behind logistics. Today, logistics and transport companies offer a fairly wide range of technological and engineering solutions.

Until recently, people were looking for ways to transport goods faster, in larger volumes and more economically. These problems were solved in the first place with the help of the invention of the railway, cars (including trucks), modern ships and airplanes. The invention of the computer, the Internet and related technologies became a real revolution in logistics. Web technologies, programs and transport

management systems appeared. But currently, the logistics industry is experiencing another revolution.

The latest technology is mostly about speed, accuracy, security and continuous supply. They include 3D printing, drone delivery, and the Internet of Things. Driverless vehicles add to this promising reality.

For the possibility of developing proposals for the implementation of a logistics engineering solution in the activities of a transport company, investigate these technologies in more detail.

1. 3D printing or Additive Manufacturing (AM).

The concept of 3D printing itself has been around since the 1980s, but it's only now that the technology has become a reality and become available on a relatively mass scale. This revolutionary technology allows virtually any company to inexpensively create devices or device parts from metals, plastics, mixed materials, and even human tissue.

How will this affect logistics and supply chain management? Additive manufacturing, or 3D printing, significantly expands the production process, making it independent of specialized factories and enterprises. This will allow manufacturers to "print" the necessary products and various types of components on demand, which will shorten supply routes, eliminating the need to store a large volume of finished products in warehouses.

The use of 3D printing will lead to radical changes in the logistics sector. Logistics companies will supply raw materials instead of many finished products and will be able to provide 3D printing services at delivery points, which will become an additional source of income (Fig. 3.2).

Additive manufacturing, in its broadest sense, can affect the supply chain from the design stage of a product to its delivery to end users. All related activities can improve efficiency through exposure to AM.

Let's consider five main principles that shape the advantages of using additive manufacturing in logistics:

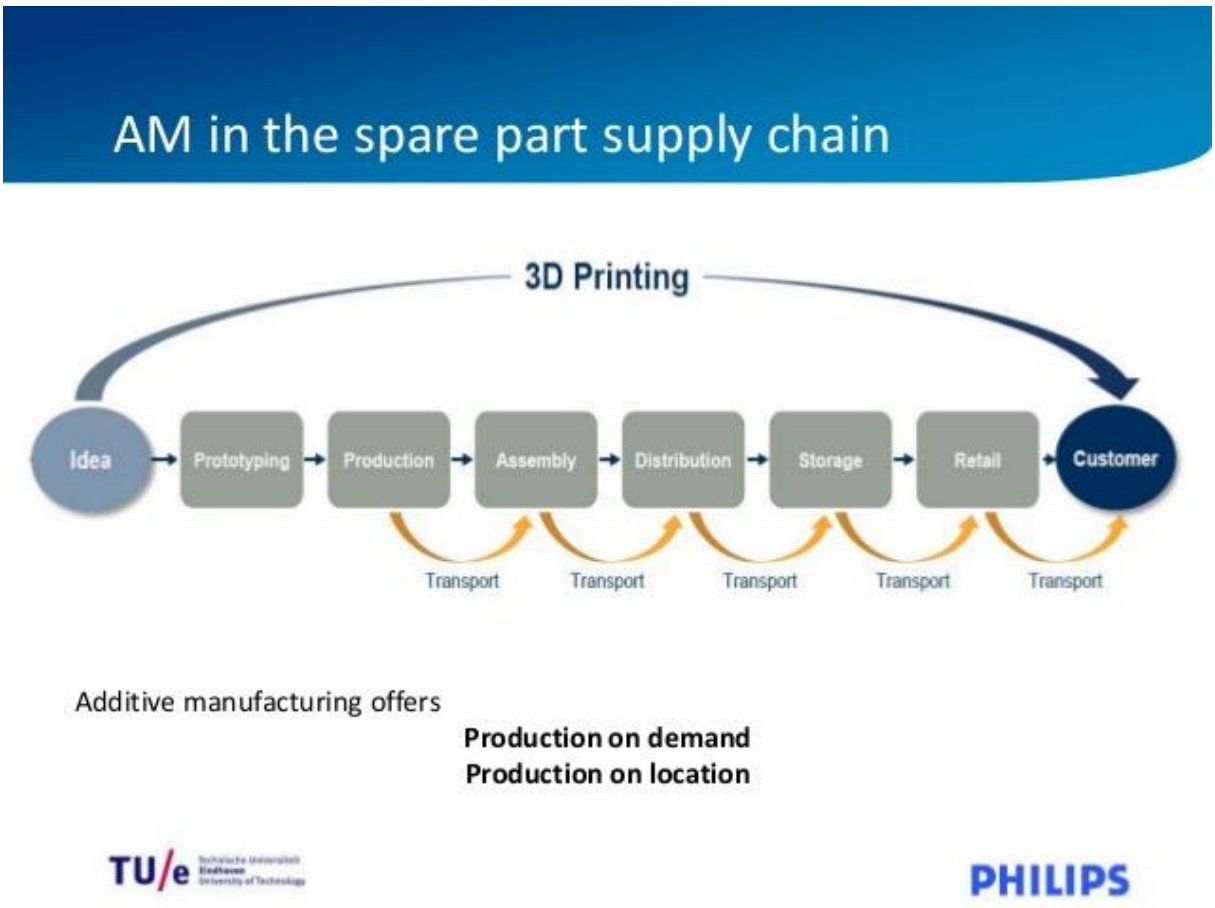

Figure 3.2 – Additive manufacturing on the example of the supply chain of spare parts [2]

1. Product design: Additive manufacturing allows for lightweight products with complex designs and functions. It can reduce the number of parts by combining them together into a single structure. However, there are currently limitations to the amount and type of materials available for production.

2. Device design: The design of the printer itself is important, and how it can affect the use of ancillary equipment that is required for traditional production.

3. Production line design: This concerns the allocation of resources (e.g. materials) and process automation, and how the AM system will be integrated into the work process.

4. Space design: Additive manufacturing systems offer significant advantages in terms of energy consumption, fewer fixtures, lower equipment and tooling costs, lower moving costs, fewer and less skilled operators, and lower inventory levels.

5. Supply chain design: the use of AM involves the construction of new business models, the emergence of a new industry for the production of AM equipment, the organization of mass customization, on-demand production, shorter delivery times, and more.

These five basic principles are presented in Fig. 3.3. They define the structure of supply chains and how additive manufacturing can affect them. In general, it is believed that building a new model where AM affects traditional supply chains will contribute to increasing their overall efficiency.

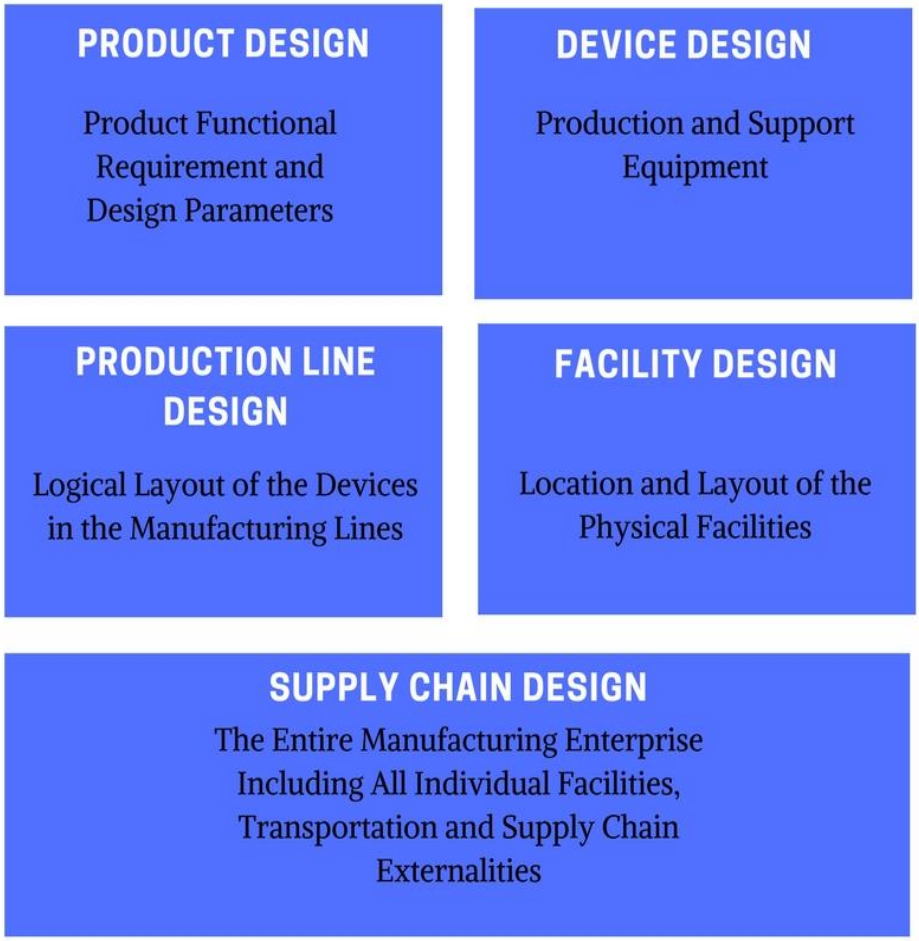

Figure 3.3 – Five basic principles to determine the benefits of Additive Manufacturing [2]

2. Internet of Things (IoT) and Industrial Internet of Things (IIoT).

Currently, tracking goods and services in transit is one of the problems. The use of the Internet of Things, along with the use of "cloud" GPS systems, will allow

tracking of individual consignments of goods and their condition. The Internet of Things is based on the use of radio frequency identification (RFID) chips that "communicate" with each other. The microcircuits attached to individual elements of the consignment transmit such data as product identification, location, temperature, pressure and humidity, etc.

Notification will be received about any negative action, which will allow prompt prevention of cargo damage or theft. The chip can signal the onset of adverse weather conditions, such as high temperature or humidity. It can also transmit data on road conditions and parameter-specific data such as average travel speed and traffic patterns, return information. Management of supply chains and transportation is a topical topic for logistics managers and directors. Therefore, logistics companies that will apply this technology will benefit greatly and will be able to obtain an increased number of satisfied customers.

Such technology is currently being actively implemented by logistics operators in the USA and the countries of the European Union.

Transportation is the second largest market in terms of IoT usage. Transportation and logistics companies in the world today are gaining significant value chain benefits with advanced IoT-based communication and monitoring systems.

The conducted analysis of the general evolution of the Internet of Things in transport and logistics reveals the growing use of digital technologies in the supply chain. Players who currently do not have a digital strategy are actively starting to develop and introduce it. It is clear that the Internet of Things plays an important role here.

This also applies to the four basic principles of forming a connected logistics system: IT security, communication systems, supply chain monitoring systems and vehicle/vehicle tracking. Along with Cloud Technologies and Big Data, the Industrial Internet of Things is a driving force in unified logistics, with cargo monitoring leading the way (Fig. 3.4).

Figure 3.4 – Four basic principles of a connected logistics system [8]

The basis of the Internet of Things or IoT is a large amount of data that is collected, aggregated and exchanged in a certain way (Fig. 3.5). The main goal here is to increase the level of automation at all possible levels. In the Industrial Internet of Things, data is critical, and this is causing changes in the tasks performed by employees in Industry 4.0, with the result that automation leads to the reduction of certain types of work, but at the same time requires the emergence of new skills.

The Industrial Internet of Things is part of the Internet of Things. The goal of the Industrial Internet of Things is not to completely replace human labor, its main goal is to improve and optimize it in a certain way, for example, by creating new sources of income and business models with a large role of data and its analysis.

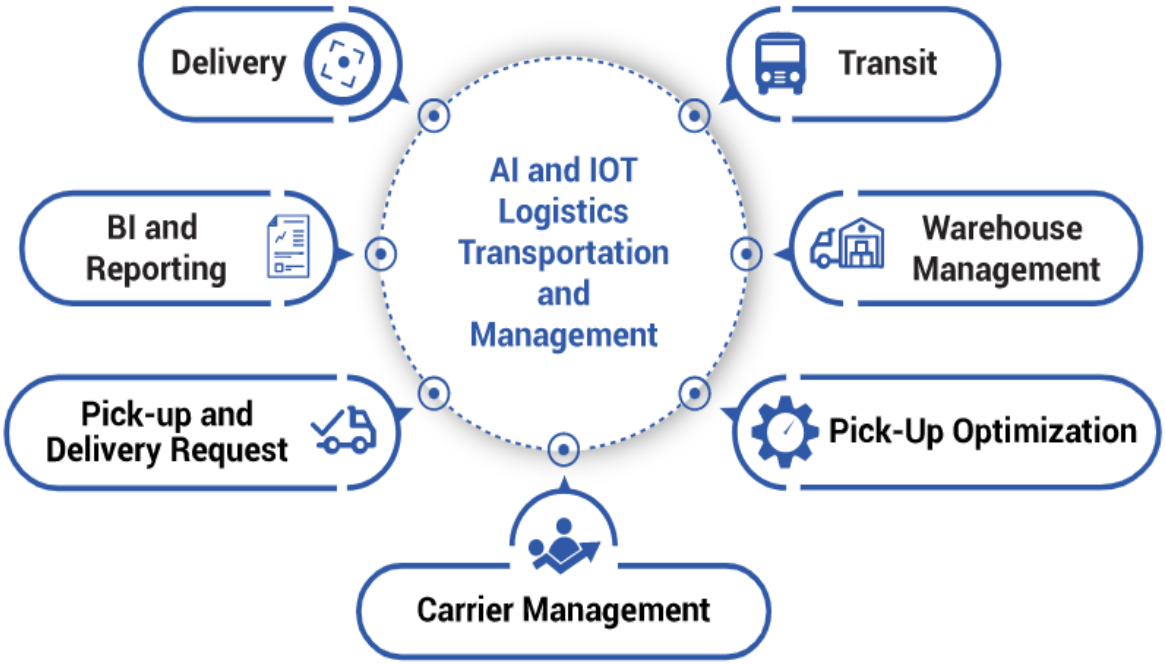

Figure 3.5 – The basis of the Internet of Things is a large amount of data that is collected, aggregated and exchanged in a certain way [21]

Intelligent adjustment of the main connections between machines allows timely attention to problems in the process of managing supply chains, in particular in the process of transportation. The level of security of operations is also increased due to the reduction of risk factors.

The Industrial Internet of Things takes the benefits of the Internet of Things to a higher level in general, as well as for high-responsibility industries where human error can lead to huge risks. The level of precision that can be achieved with IoT is one of the biggest advantages, making this technology one of the most desirable in logistics.

In the coming years, IIoT will likely force more unified protocols and device architectures that will allow machines to communicate seamlessly and thus improve interoperability.

3. Use of drones.

A drone is an unmanned aerial vehicle that can be controlled remotely or made to fly autonomously using programmed flight paths built into its system. Drones are small, light, cheap to operate and can fly where other modes of transport cannot be

used. The experience of using such a technique already exists in the United Arab Emirates.

Examples of drones that deliver parcels to the addressee are shown in Fig. 3.6.

Figure 3.6 – Examples of drones delivering parcels

It is believed that in the near future, 3PL operators will use drones to quickly deliver small packages both in cities and in remote areas. Thanks to their high speeds and accuracy, it is possible to shorten the supply chain and significantly reduce transportation costs. Consequently, courier companies may be out of business. The only point that prevents the widespread use of this technology is the issue related to government regulation, air traffic safety, and the permitted size and weight of the drone.

4. Cars without a driver.

Although driverless vehicles are still in the testing phase, they have shown great potential as logistics and supply chain management tools. The ability of driverless vehicles to sense their surroundings and navigate without too much human intervention makes these futuristic trucks ideal for delivering goods to customers. A large part of the transport costs is the salary of the driver and forwarder. Transport and logistics companies that have their own fleet will be able to significantly reduce overhead costs by using driverless vehicles for delivery.

An example of an autonomous ground vehicle with parcel compartments is shown in Fig. 3.7.

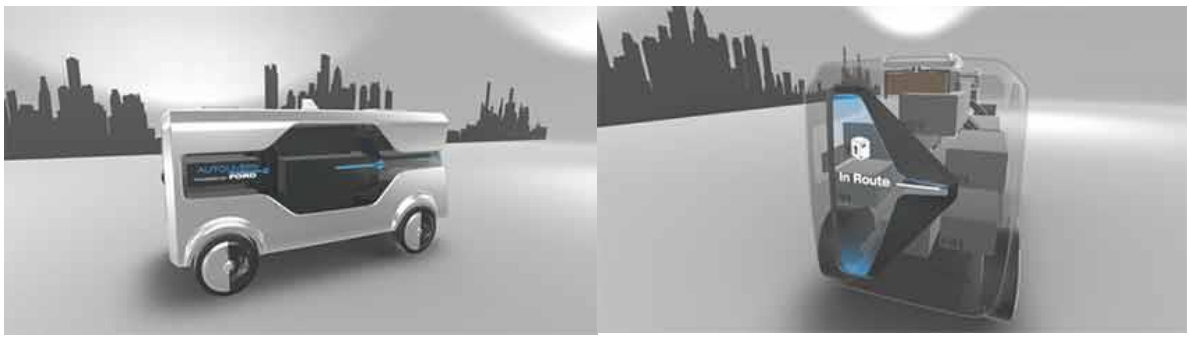

Figure 3.7 – Unmanned truck from which a drone takes off

Another advantage of using driverless vehicles is that they themselves are better drivers than humans, thanks to hard algorithms and rules programmed: the risk of an accident will be almost zero. They won't lose concentration, sleep or talk on the phone or text while driving.

However, the vehicles in use today are not yet fully autonomous. Current regulations and technologies do not yet allow the use of autonomous vehicles on roads without drivers. According to the legislation of many countries, including Ukraine, the driver must still be behind the wheel to monitor the situation on the road and analyze possible risks. However, it is expected that all this may change in the future.

This type of technology can bring many benefits to logistics. Automated vehicles can revolutionize the supply chain and help save time as well as reduce costs. In addition, unmanned technologies can help reduce accidents and help the environment by reducing fuel consumption.

5. Artificial intelligence and augmented reality.

New technologies such as artificial intelligence (AI) have affected most industries, and logistics is no exception. It can be argued that the development of artificial intelligence has revolutionized the field of logistics. The technology's most significant advances include warehouse automation, autonomous vehicles, predictive analytics, and smart roads. This powerful technology offers to automate and simplify numerous processes, helping companies save time and money.

Augmented reality (AR) is able to provide a direct or indirect representation of the real world using augmented elements of the computer's perception of reality,

including sound and video. AR provides an enhanced view of the surrounding world in real time and makes the logistics operator more aware of the environment. In the future, employees of logistics companies will be able to use AR technology in the form of wearable devices to obtain important information about the cargo they are handling, such as content, weight and location. It is clear that such visibility through AR technology will improve cargo handling, increase delivery speed and reduce overall costs.

As research has shown, in the field of warehousing, artificial intelligence is used to forecast demand, change orders, and manage cargo in transit. Businesses can adjust their orders according to these forecasts and deliver in-demand products to local warehouses as needed. If there are multiple warehouses in the supply chain, AI can combine them to find the best option for transporting inventory. Accordingly, if companies can predict demand for certain products and plan logistics in advance, they can improve their service, reduce transportation costs, and save a lot of money.

Another application of artificial intelligence in the logistics industry is smart roads. Several companies are currently working on their construction. Smart roads are expected to help improve road safety and reduce supply chain delays caused by adverse weather conditions by speeding up deliveries [45].

Smart roads are planned to be equipped with solar panels and LED lights. The solar panels will be used to generate electricity and prevent the roads from being slippery during the winter months as they have the ability to heat up. LED lights will notify drivers of changing road conditions. Smart roads will be able to provide very valuable information for businesses that use them to transport their products. Roads with fiber-optic sensors connected to the Internet will be able to determine traffic volume and traffic patterns, as well as warn drivers of upcoming traffic jams. They can also sense when vehicles are leaving the road or when an accident has occurred and alert emergency services.

Another advantage of artificial intelligence in logistics is the improvement of interaction with customers. AI can provide better customer service through personalization and product suggestions based on customers' buying habits and

personal preferences. Customers will be able to appreciate a more personalized approach to service and will become more loyal to the company.

Based on the conducted research, we can draw several conclusions. For decades, the field of transportation, warehouse and order fulfillment management remained at the level of "prehistoric" technologies in the form of isolated warehouses, inefficient processes and limited information availability. However, technology has changed as the business processes performed in the supply chain have changed. Modern technologies provide small and medium-sized enterprises with the opportunity to use innovative tools to provide end-to-end tracking, visualization and processing of cargo.

At the moment, many factors suggest that the technologies used in the supply chain need to be expanded and changed. The reasons for this are problems with the end users of goods and the capacity of supply chains.

Before the advent of the Internet, users did not have the opportunity to buy goods outside of stores and catalogs. Businesses were focused on the process of providing the right product at the right place at the right time. Today, users want to have any product in any city and at any time. It seemed impossible, but the vast majority of companies have learned to use customer demand thanks to the efficiency of modern technologies in supply chains. If there is a delay in any part of the supply chain, it leads to problems and delays in other parts, which can ultimately lead to customer dissatisfaction and can also result in lost profits.

Many transport companies follow the principle of transporting goods with fewer trucks with a larger volume of cargo trailers. But it must be taken into account that in this case the delay of transport creates big problems in the supply chain, which can lead to the inability of the end user to cope with his commercial situation. At the same time, the number of underloaded and empty flights is increasing.

Thus, today's technologies in supply chains are not efficient enough. The use of modern technologies will significantly change the situation.

Taking into account all the above, the project recommendation will be the implementation of a logistics engineering solution based on the combination of

several latest technologies, which will make it possible to ensure the greatest efficiency in the management of the transport company.

After all, as studies have shown, technological tools provide a viable and long-term basis for reducing human intervention and errors. Rethinking supply chain design and operations with a logistics engineering solution will help overcome barriers and close gaps in product supply chains.

The basis of the proposed logistics engineering solution should be IoT technology, which in a broad sense means technology that provides communication between various objects without human intervention, with the subsequent provision of recommendations or services. IoT functions are widely used for data collection and processing, planning and decision-making, as well as development of recommendations and services.

The use of IoT as the main element of a logistics engineering solution in the activities of a transport company, which includes a series of processes (Fig. 3.8).

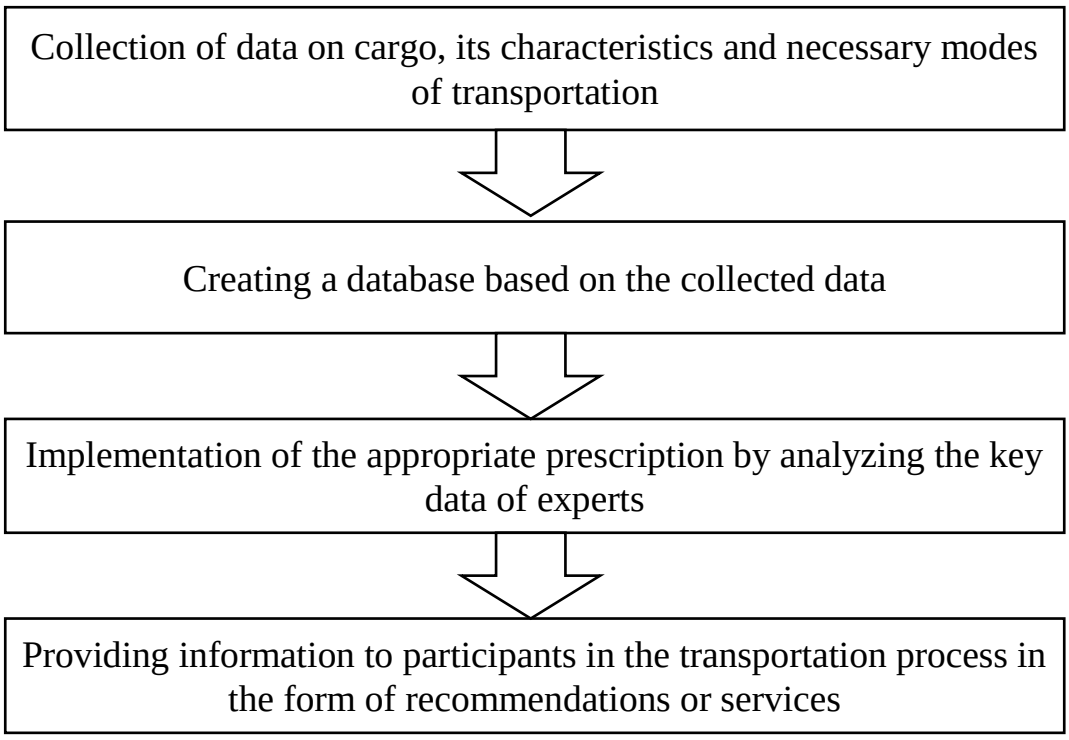

Figure 3.8 – The sequence of processes for using IoT as the main element of a logistics engineering solution

The architecture of the proposed logistics engineering solution based on IoT can be divided into the following levels (Fig. 3.9):

– sensory layer, that is, the level of perception of information for its recognition;

– network layer for data transmission and reception;

– application layer for direct supply chain management.

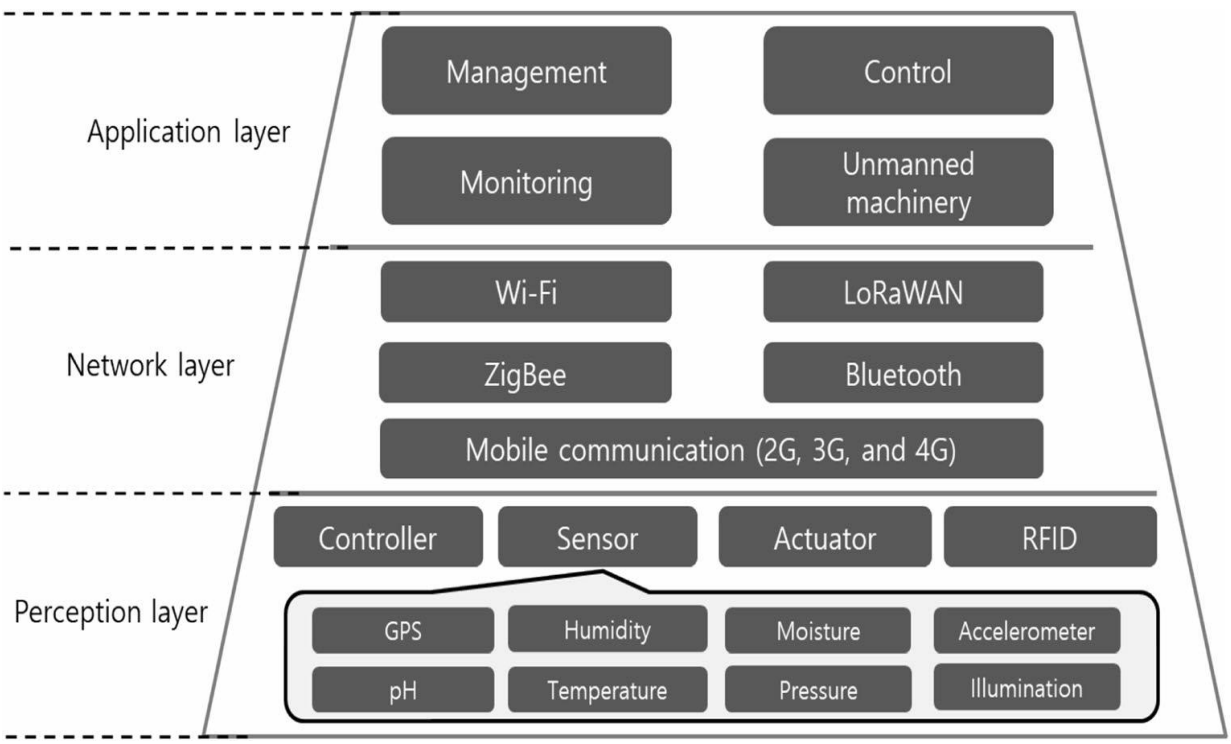

Figure 3.9 – Architecture of the proposed logistics engineering solution based on IoT

Typically, at the sensor level, sensor nodes are installed on various objects, such as loads, pallets, vehicles, etc., to perceive various parameters in real time. The measured data is transmitted to the local gateway, and at the network level, the local gateway receives the data and uploads the sensor data to the cloud through various wireless sensor networks (WSNs). This system can be applied to various processes in the product supply chain, including organization, management, monitoring and control.

Therefore, the key task of the sensory level is to recognize the physical properties of the object. The sensing layer consists of various sensors, WSN, control, RFID, etc. The main sensors used are sensors of temperature, humidity, oxygen, pressure, etc. There are various IoT sensing technologies such as WSN, NFC, RFID, image processing and global positioning systems (GPS) (Fig. 3.10). They usually automatically send data to a decision center in the form of digital signals.

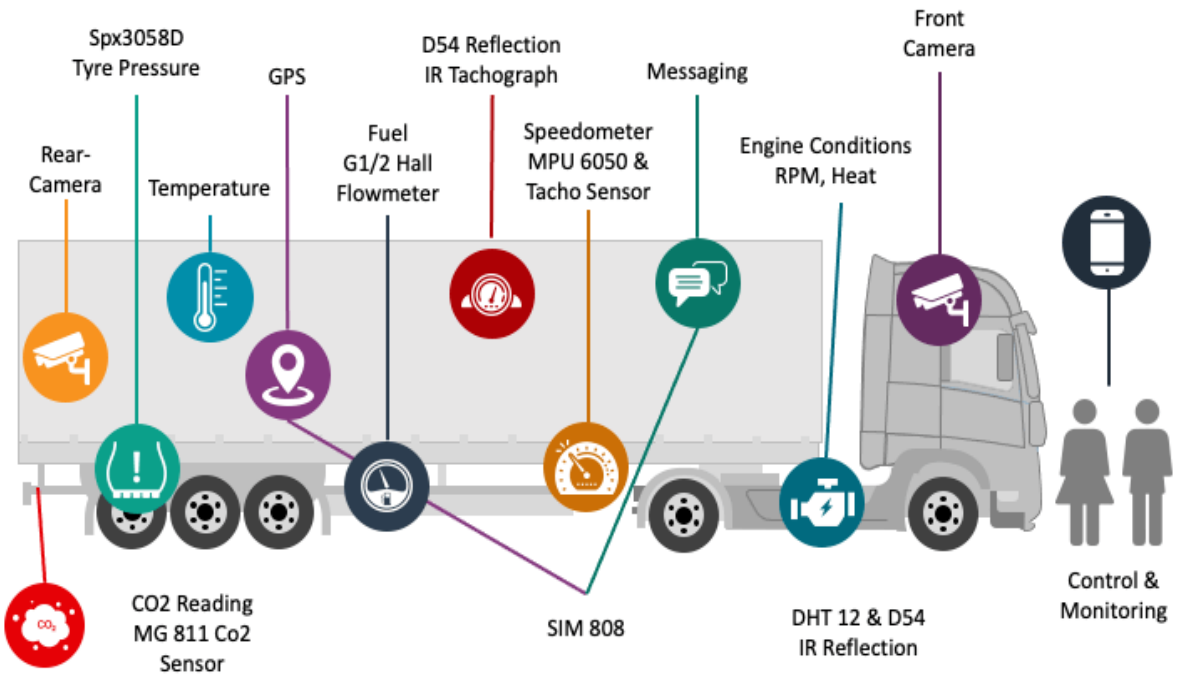

Figure 3.10 – Sensors collecting information during transportation

The information collected by the sensors is simply processed by the embedded device and uploaded to the upper layer through the network layer to create a database and analyze big data.

The network layer processes the data received in real time from the sensor layer and transmits the data remotely to the application layer using the telecommunication network, local area network and the Internet. The network layer has a microprocessor or microcontroller that uses a communication module to send data collected at the sensor layer to the application layer using data transfer media. In addition, there are several means of data transmission, such as mobile communications, Wi-Fi, Bluetooth, NFC, Global System for Mobile Communications, ZigBee, and general

packet radio services. Thus, the network layer not only transmits the various types of data collected at the sensor layer to the application layer, but also controls the commands that the application layer transmits to the sensor layer so that the associated devices at the sensor layer can be activated.

The application layer is the intelligent processing device that applies the data processed at the network layer and is the highest layer of the IoT layer architecture. This level includes various intelligent systems such as data management in the product supply chain; cargo monitoring and control; early warning and diagnosis of possible failures; etc.

In addition, the application layer mainly processes and analyzes data, evaluates the system, predicts future trends in the system, makes decisions based on past data sets, and sends prescriptions to end users. In this way, losses can be minimized by properly addressing problems that may arise in the supply chain at an early stage, and the efficiency of its management can be maximized, thereby contributing to increased revenues for the transport company and all its business partners.

3.3 The influence of logistic engineering solutions on the activity of the transport company "Ukrtrans Garant"

The costs associated with the implementation of the proposed logistics engineering solution in the transport company's operations, such as capital investment in technology, its operability, energy, fuel, labor, etc. should be minimized to make our project proposal profitable for the transport company Ukrtrans Garant.

IoT-enabled Big Data can help in this aspect by creating cost patterns in the data warehouse and showing predictive and prescriptive solutions for better decision-making using machine learning algorithms. In addition, the high level of quality and safety of goods for end users at any time, anywhere increases visibility

and interaction in the supply chain, which will also contribute to significant benefits.

To calculate the economic effect of our project proposals for Ukrtrans Garant, we will calculate the NPV of the project.

NPV is the net present value of a project, i.e. the sum of the discounted values of a stream of payments brought to the present day. NPV is the difference between all cash receipts and all expenditures brought to the current moment in time. The standard formula for calculating the NPV of a project is as follows:

$$NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+R)^t}, \quad (3.1)$$

where *n*, *t* – number of time periods (usually number of years);

CF – Cash Flow;

R – discount rate.

That is, in order to calculate the economic effect of our project proposals, it is necessary to calculate the total costs that Ukrtrans Garant will incur for their implementation, as well as to predict the possible income that the company will receive from integrated logistics support.

The project period will be 3 years, starting from 2023. This will be the year of the project start.

First of all, let's consider the benefits that Ukrtrans Garant can get from our project proposal. The benefits that the company can get from the proposed logistics engineering solution are summarized in Fig. 3.11 and 3.12. In general, logistics engineering solutions based on the Internet of Things in the management of the transport company's activities increase its efficiency, reduce the amount of resources and, accordingly, reduce the final cost of production.

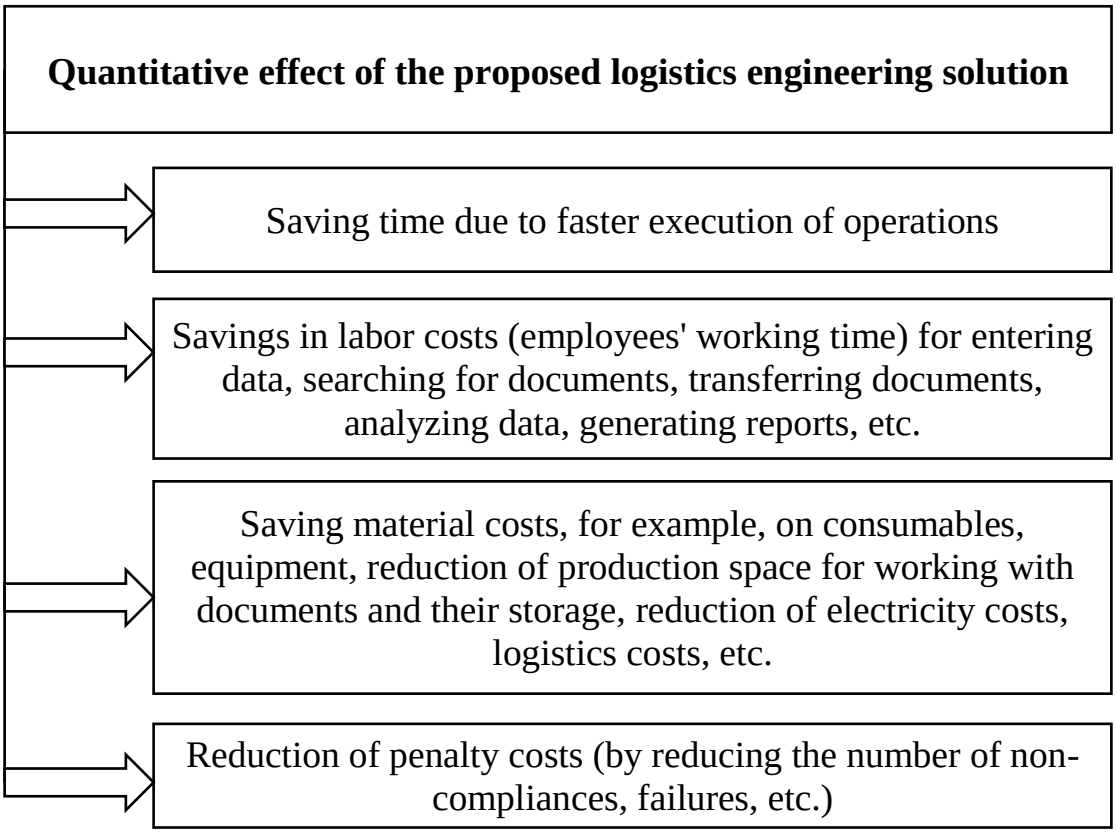

Figure 3.11 – Quantitative components of the effect of the proposed logistics engineering solution

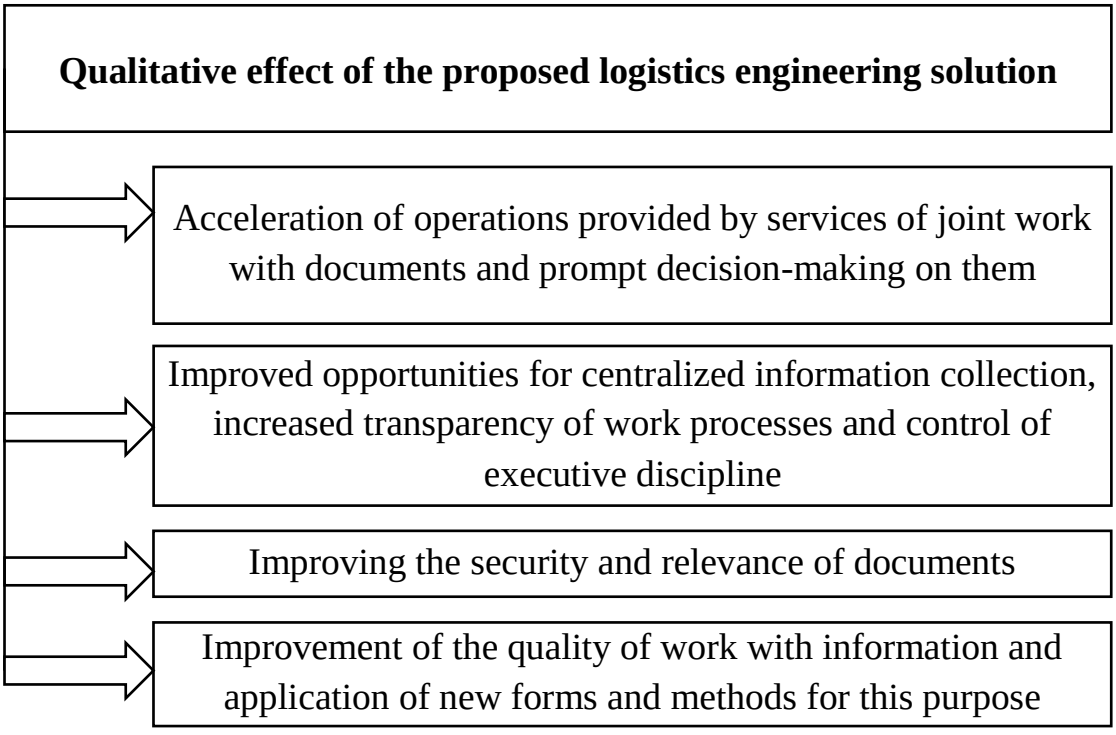

Figure 3.12 – Qualitative components of the effect of the proposed logistics engineering solution

Summarizing, we can give the key advantages of using IoT technology in the activities of the transport company (Fig. 3.13):

– improved interaction between devices or machines
– increase in efficiency;
– cost savings;
– time saving;
– increased safety of transportation.

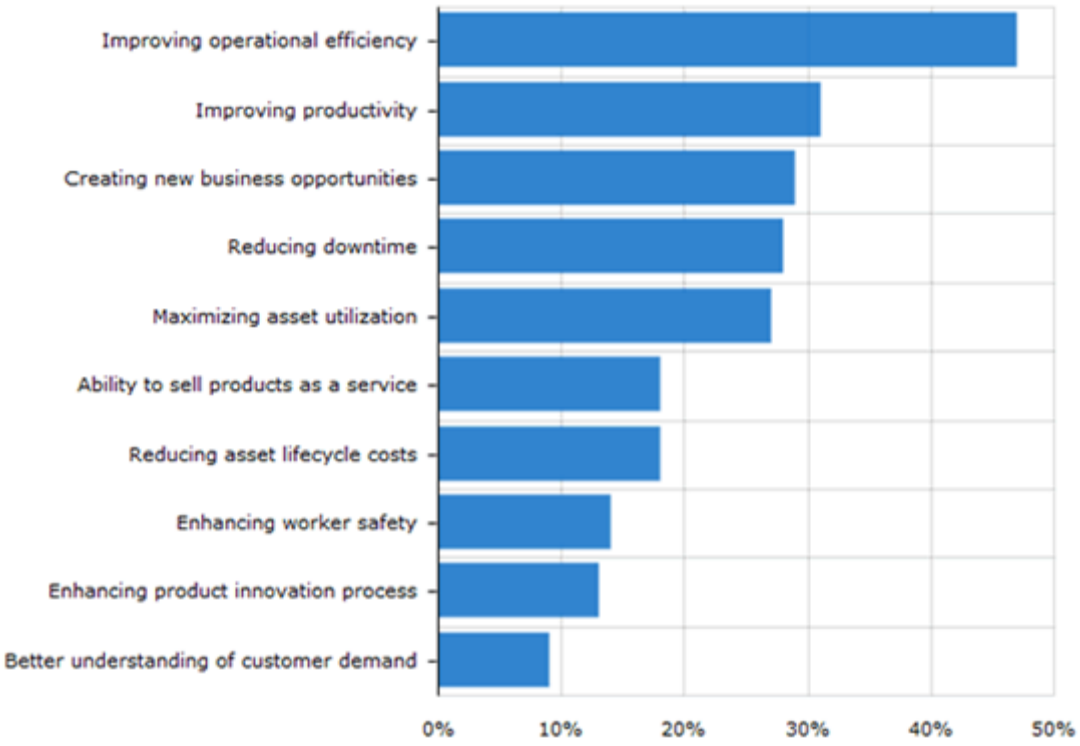

Figure 3.13 – Key benefits of using IoT technology in the transport company's activities

In addition, in the activities of a particular enterprise, these benefits may not affect the direct improvement, but at the same time be an important solution for the entire industry.

Thus, we see that the final effect of the implementation of the logistics engineering solution should be an increase in revenues and profits of the company.

To begin with, let us forecast the revenues of Ukrtrans Garant for 3 years using the time series extrapolation method.

According to the method of time series extrapolation, the projected revenues of the company can be calculated by the formulas:

$$A_n = a+b*t, \tag{3.2}$$

$$a = \frac{\sum An - b*\sum t_i}{n}, \tag{3.3}$$

$$b = \frac{n\sum An*t_i - \sum t_i * \sum A_n}{n\sum t_i^{\,2} - (\sum t_i)^{\,2}}, \tag{3.4}$$

where A_n – projected volumes of the company's income;

a, b – parameters of the equation, which are found by the method of least squares;

t – year.

The projected values of revenues are obtained by substituting the variable t, i.e. the year number, into the equation.

Data for forecast calculations are presented in Table 3.1.

Table 3.1 – Data for calculation of projected revenues of Ukrtrans Garant

№	Year	t_i	A_n, thousands UAH.	A_n*t_i	t_i^2
1	2	3	4	5	6
1	2015	1	2520,0	2520,0	1
2	2016	2	2925,0	5850,0	4
3	2017	3	3061,6	9184,9	9
4	2018	4	4119,7	16478,8	16
5	2019	5	6528,5	32642,4	25
6	2020	6	8104,3	48625,9	36
7	2021	7	8433,0	59030,9	49
8	Σ	28	35692,1	174332,9	140

As a basis we took statistical data from Table 2.2, namely the line "Revenues from services".

Substituting the data of Table 3.1. into the above formulas, we can find the values of the parameters of equation a and b:

– b = 1308,7;

– a = -317,5.

Having calculated these parameters, we can calculate the forecasted incomes for 2022-2025 (Table 3.2).

Table 3.2 – Forecasted incomes of "Ukrtrans Garant" company

№	Year	t_i	Forecasted incomes, thousands UAH
1	2	3	4
1	2022	8	10152,4
2	2023	9	11461,1
3	2024	10	12769,9
4	2025	11	14078,6

Now we can consider three possible scenarios:

1. According to the pessimistic scenario, the introduction of integrated logistics support will increase the company's profit:

– in 2023 by 5%;

– in 2024 by 10%;

– in 2025 by 15%.

2. According to the realistic option, the introduction of integrated logistics support will increase the company's profit:

– in 2023 by 7%;

– in 2024 by 12%;

– in 2025 by 18%.

3. According to the optimistic scenario, the introduction of integrated logistics support will increase the company's profit:

– in 2023 by 10%;

– in 2024 by 15%;

– in 2025 by 20%.

Thus, the projected increase in revenues of Ukrtrans Garant from the implementation of the proposed logistics engineering solution is presented in Table 3.3.

Table 3.3 – Projected revenues from the implementation of the proposed logistics engineering solution

№	Year	Increase in revenues under pessimistic scenario, UAH	Increase in revenues under the realistic option, UAH	Increase in revenues under the optimistic scenario, UAH
1	2	3	4	5
1	2023	573056	802279	1146113
2	2024	1276986	1532384	1915480
3	2025	2111790	2534148	2815720

Now consider the costs required to implement the proposed logistics engineering solution in the activities of the transit company "Ukrtrans Garant" (Table 3.4).

Table 3.4 – Cost components of the proposed logistics engineering solution

№	Costs	Year		
		2023	2024	2025
1	2	3	4	5
1	Costs for the purchase and installation of the necessary sensors, UAH	1200000	-	-
2	Costs for setting up the network system, UAH	240000	144000	144000
3	Costs for installation of control systems, UAH	264 000	-	-
4	System user training, UAH	162 000	-	-
5	Professional support of the developed solutions, UAH	66 000	66 000	66 000
6	Total expenses for the year, UAH	1 932 000	210 000	210 000

This list is approximate and may vary depending on the specific situation and the wishes of the company's managers.

We will calculate the NPV of our project for discount rates of 15% and 20% (Table 3.5).

Table 3.5 – Results of NPV calculations of the logistics engineering solution implementation project

№	Year	№	Discount coefficient. at the rate 15%	Discount coefficient. at the rate 20%	Total expenses, UAH	Total expenses at 15% rate, UAH.	Total expenses at 20% rate, UAH	Forecast. increase in income, UAH	Forecast. increase in revenues at a rate of 15%, UAH	Forecast. increase in revenues at a rate of 20%, UAH	Forecasted profit, UAH	Forecasted profit at a rate of 15%, UAH	Forecasted profit at a rate of 20%, UAH
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Pessimistic variant												
2	2023	0	1,00	1,00	1932000	1932000	1932000	573056	573056	573056	-1 358 944	-1 358 944	-1 358 944
3	2024	1	0,87	0,83	210000	182700	174300	1276986	1110978	1059899	1 066 986	928 278	885 599
4	2025	2	0,76	0,69	210000	159600	144900	2111790	1604961	1457135	1 901 790	1 445 361	1 312 235
5	–	–	–	–	2 352 000	2 274 300	2 251 200	3 961 833	3 288 995	3 090 090	1 609 833	1 014 695	838 890
6	NPV											1 014 695	838 890
7	Realistic variant												
8	2023	0	1	1,00	1 932 000	1932000	1932000	802279	802279	802279	-1 129 721	-1 129 721	-1 129 721
9	2024	1	0,87	0,83	210 000	182700	174300	1532384	1333174	1271879	1 322 384	1 150 474	1 097 579
10	2025	2	0,76	0,69	210 000	159600	144900	2534148	1925953	1748562	2 324 148	1 766 353	1 603 662
11	–	–	–	–	2 352 000	2 274 300	2 251 200	4 868 811	4 061 406	3 822 720	2 516 811	1 787 106	1 571 520
12	NPV											1 787 106	1 571 520
13	Optimistic variant												
14	2023	0	1	1,00	1 932 000	1932000	1932000	1146113	1146113	1146113	-785 887	-785 887	-785 887
15	2024	1	0,87	0,83	210 000	182700	174300	1915480	1666467	1589848	1 705 480	1 483 767	1 415 548
16	2025	2	0,76	0,69	210 000	159600	144900	2815720	2139948	1942847	2 605 720	1 980 348	1 797 947
17	–	–	–	–	2 352 000	2 274 300	2 251 200	5 877 313	4 952 528	4 678 808	3 525 313	2 678 228	2 427 608
18	NPV											2 678 228	2 427 608

The calculations showed that the NPV of our project for the implementation of the proposed logistics engineering solution in the activities of the transport company is positive for all three scenarios and for the two discount rates considered.

Now let's calculate the payback period of the project. To do this, it is necessary to summarize the discounted projected profits of our project for the entire period under consideration at different discount rates.

Graphical finding of the project payback points for different forecasts at a discount rate of 15% is shown in Fig. 3.14.

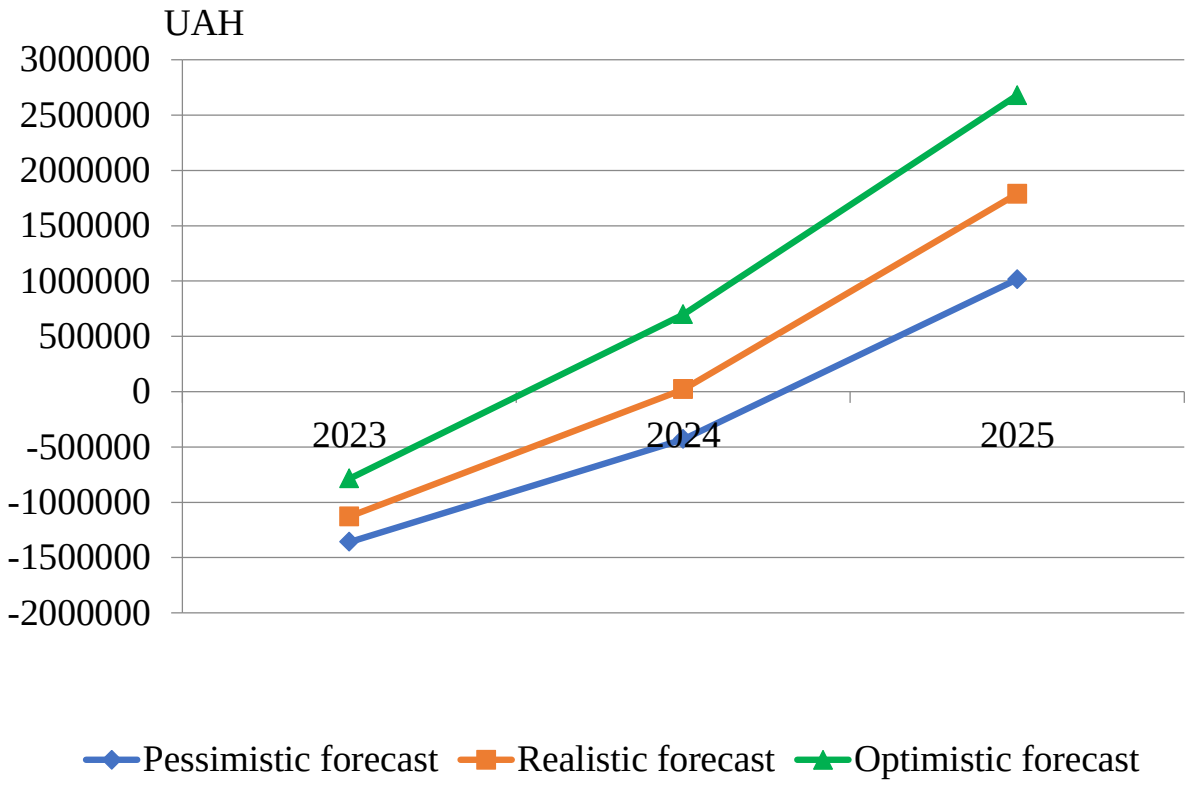

Figure 3.14 – Project payback points at 15% interest rate

Graphical finding of the project payback points for different forecasts at a discount rate of 20% is presented in Fig. 3.15.

According to the above figures, we see that:

– according to the pessimistic variant, our project proposals will pay off in 2.3 years;

– according to the realistic variant, our project proposals will pay off in 2 years;

– according to the optimistic variant, our project proposals will pay off in 1.6 years.

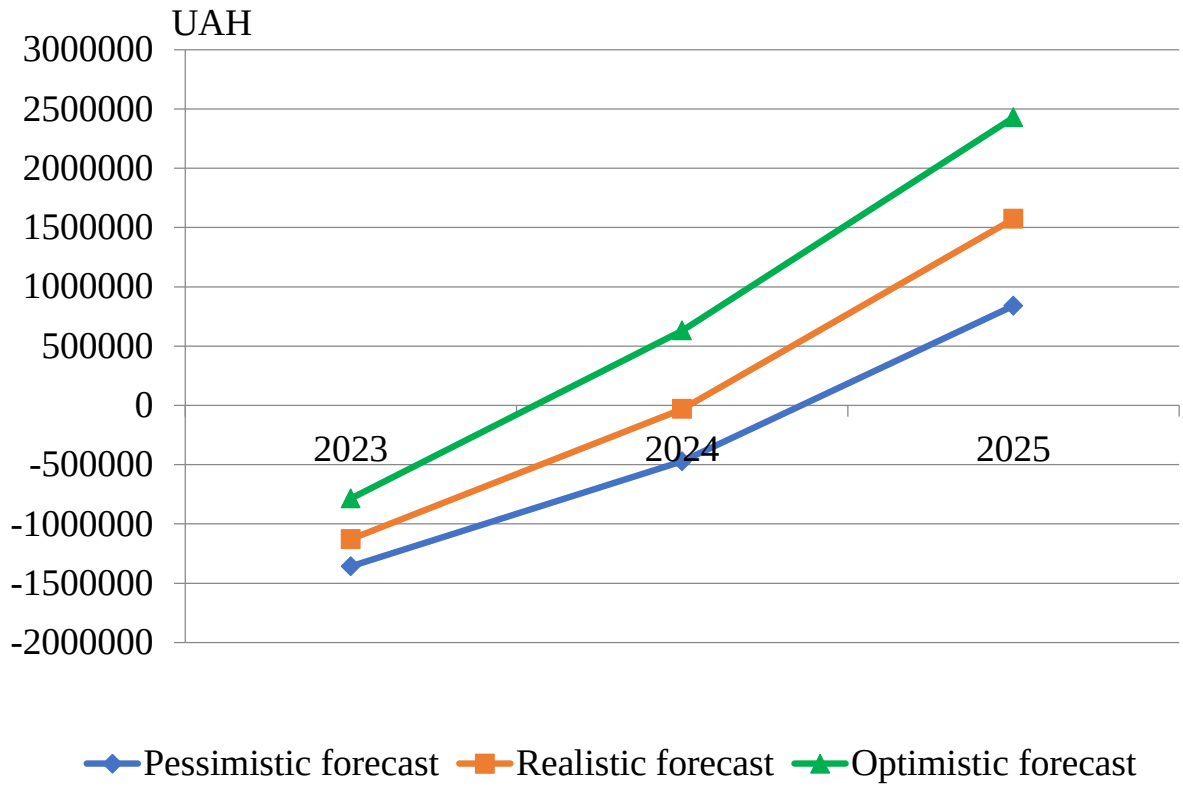

Figure 3.15 – Project payback points at 20% interest rate

So, in any case, our project proposal is cost-effective and can be recommended for implementation in the activities of the transport company "Ukrtrans Garant" for its improvement.

3.4 Chapter 3 summary

The third chapter dealt with the recommendation for the implementation of logistics engineering solutions in the activities of the transport company.

We developed of a strategy for improving the activities of a transport company based on logistic engineering solutions. The choice of the model of strategy for

managing the activities of the transport company was determined by the content of its stages. Developing a strategy to improve the management of a transport company's operations is very important to increase its efficiency. With the tips discussed above, it is possible to make the existing supply chain ready for the future.

We made recommendations for the implementation of logistic engineering solutions in the activity of the transport company.

The latest technology is mostly about speed, accuracy, security and continuous supply. They include 3D printing, drone delivery, and the Internet of Things. Driverless vehicles add to this promising reality. For the possibility of developing proposals for the implementation of a logistics engineering solution in the activities of a transport company, investigate these technologies in more detail.

Taking into account all the above, the project recommendation was the implementation of a logistics engineering solution based on the combination of several latest technologies, which will make it possible to ensure the greatest efficiency in the management of the transport company.

The basis of the proposed logistics engineering solution should be IoT technology, which in a broad sense means technology that provides communication between various objects without human intervention, with the subsequent provision of recommendations or services. IoT functions are widely used for data collection and processing, planning and decision-making, as well as development of recommendations and services.

We determined the influence of logistic engineering solutions on the activity of the transport company "Ukrtrans Garant". The calculations showed that the NPV of our project for the implementation of the proposed logistics engineering solution in the activities of the transport company is positive for all three scenarios and for the two discount rates considered. So, in any case, our project proposal is cost-effective and can be recommended for implementation in the activities of the transport company "Ukrtrans Garant" for its improvement.

CONCLUSIONS AND RECOMMENDATIONS

In the first chapter, the theoretical foundations of logistics engineering in the activities of a transport company are considered.

First of all we made research of the essence of the logistic engineering. Logistics engineering generally deals with the effective use of engineering methods to resolve logistics problems. Logistics Engineers are utilized throughout the entire system life cycle, from concept to disposal for the system life cycle stages.

Then we considered the RFID system as one of the logistics engineering solutionsю RFID (Radio Frequency Identification) is a way to store and transmit information from a convenient label carrier to the desired location, using special devices. Such identification marks make it easier to identify various objects: goods in the store, movable vehicles during transportation, help to determine their location, can identify people and animals, not to mention the wide range of identification of documents and property.

The label itself usually contains an antenna, receiver, transmitter, and storage memory. The label receives energy from the radio signal of the reader antenna or from its own power supply, after receiving an external signal, the label responds with its own signal, which contains certain identification information. So RFID tags are a kind of label, only smarter.

The passive RFID tag is able to work without its own power source, it receives power for power only from the scanner signal (Fig. 1.6). Such labels are smaller in size than active ones, lighter in weight, cheaper to manufacture, and have an unlimited service life – this is their main advantage.

Currently, the field of application of information systems based on RFID technology is quite wide, especially in the field of business process automation, where there is a process of sequential replacement of bar coding technology. This is due to the fact that RFID systems have much more advantages than traditional bar coding systems.

In the second chapter, the situation on the market of transport services in Ukraine was analyzed. Our analysis showed that in recent years, the volume of transported goods by all modes of transport ranged from 600 to almost 812 million tons. During the considered period, the maximum volume of transported goods was observed in 2011, and the minimum was observed in 2020. According to the results of 2021, the volume of transported goods by all modes of transport amounted to 619.9 million tons.

In addition, it was concluded that in the last ten years road transport has been showing a fairly successful expansion in the cargo transportation market of Ukraine, while other competitors are weakening their positions.

An analysis of the activities of the logistics company "Ukrtrans Garant", which has been engaged in the organization of cargo transportation in Ukraine and abroad for more than 15 years, was also conducted.

The company "Ukrtrans Garant" cooperates with Ukrainian and foreign manufacturers and offers its clients: an individual approach to each client; fast and high-quality transportation; selection of the optimal route; delivery security guarantee; a large fleet of vehicles with different load capacities and body types; ideal ratio of quality and cost; a wide range of services and coverage of countries.

Advantages of the "Ukrtrans Garant" company: own fleet; 100% machine supply; transportation of all types of cargo; transportation of collective cargo and reloading with one-way payment.

Analysis of the production and financial indicators of the company "Ukrtrans Garant" showed that the company effectively overcame crisis situations on the Ukrainian market and continues to function at a fairly profitable level.

In addition, innovative solutions in the activities of transport companies were investigated. It has been pointed out that technological innovation is playing an increasing role in all sectors of the economy, and logistics and supply chain management cannot remain aloof from this process either.

Innovations in the field of logistics are connected not only with the desire of logistics companies to introduce new technologies in order to keep up with the

development of the industry – to a large extent this is demanded by the clients of logistics – representatives of trade businesses and large industrial enterprises that require that their goods or services came to the customer faster and with lower costs.

Thus, we can claim that the introduction of cloud technologies into business processes has contributed to the accelerated digitization of supply chains. This allows you to take into account the amplitude of instability and quickly react to possible deviations or disruptions in supply chains. Transportation companies are modernizing their supply chains as a digital supply chain that integrates the physical flows of products and services and provides affordable, efficient, safer, infinitely scalable solutions that can be easily integrated with existing systems.

The third chapter dealt with the recommendation for the implementation of logistics engineering solutions in the activities of the transport company.

We developed of a strategy for improving the activities of a transport company based on logistic engineering solutions. The choice of the model of strategy for managing the activities of the transport company was determined by the content of its stages, which can be divided as follows:

- determination of the mission (goals, priorities) of strategy development;
- assessment of conditions and factors of the external market environment;
- determination of the target, functional, organizational and resource potential of the company for the formation and implementation of the strategy;
- formation of the strategy, as well as mechanisms for its implementation;
- evaluation of results with simultaneous monitoring of strategy implementation;
- assessment of the new positioning of the company in the market of goods and services, achieved due to the strategy.

Developing a strategy to improve the management of a transport company's operations is very important to increase its efficiency. With the tips discussed above, it is possible to make the existing supply chain ready for the future.

We made recommendations for the implementation of logistic engineering solutions in the activity of the transport company.

We noticed that logistics, manufacturing, transportation and supply chains are experiencing rapid and unprecedented transformations today. The future of these industries is tied to innovation and technology.

Technology has always been the driving force behind logistics. Today, logistics and transport companies offer a fairly wide range of technological and engineering solutions.

Until recently, people were looking for ways to transport goods faster, in larger volumes and more economically. These problems were solved in the first place with the help of the invention of the railway, cars (including trucks), modern ships and airplanes. The invention of the computer, the Internet and related technologies became a real revolution in logistics. Web technologies, programs and transport management systems appeared. But currently, the logistics industry is experiencing another revolution.

The latest technology is mostly about speed, accuracy, security and continuous supply. They include 3D printing, drone delivery, and the Internet of Things. Driverless vehicles add to this promising reality.

For the possibility of developing proposals for the implementation of a logistics engineering solution in the activities of a transport company, investigate these technologies in more detail:

1. 3D printing or Additive Manufacturing (AM).
2. Internet of Things (IoT) and Industrial Internet of Things (IIoT).
3. Use of drones.
4. Cars without a driver.
5. Artificial intelligence and augmented reality.

Based on the conducted research, we can draw several conclusions. For decades, the field of transportation, warehouse and order fulfillment management remained at the level of "prehistoric" technologies in the form of isolated warehouses, inefficient processes and limited information availability. However, technology has changed as the business processes performed in the supply chain have changed. Modern technologies provide small and medium-sized enterprises with the opportunity to use

innovative tools to provide end-to-end tracking, visualization and processing of cargo.

At the moment, many factors suggest that the technologies used in the supply chain need to be expanded and changed. The reasons for this are problems with the end users of goods and the capacity of supply chains.

Thus, today's technologies in supply chains are not efficient enough. The use of modern technologies will significantly change the situation.

Taking into account all the above, the project recommendation was the implementation of a logistics engineering solution based on the combination of several latest technologies, which will make it possible to ensure the greatest efficiency in the management of the transport company.

After all, as studies have shown, technological tools provide a viable and long-term basis for reducing human intervention and errors. Rethinking supply chain design and operations with a logistics engineering solution will help overcome barriers and close gaps in product supply chains.

The basis of the proposed logistics engineering solution should be IoT technology, which in a broad sense means technology that provides communication between various objects without human intervention, with the subsequent provision of recommendations or services. IoT functions are widely used for data collection and processing, planning and decision-making, as well as development of recommendations and services.

The architecture of the proposed logistics engineering solution based on IoT can be divided into the following levels:

– sensory layer, that is, the level of perception of information for its recognition;

– network layer for data transmission and reception;

– application layer for direct supply chain management.

We determined the influence of logistic engineering solutions on the activity of the transport company "Ukrtrans Garant".

The costs associated with the implementation of the proposed logistics engineering solution in the transport company's operations, such as capital investment in technology, its operability, energy, fuel, labor, etc. should be minimized to make our project proposal profitable for the transport company Ukrtrans Garant.

IoT-enabled Big Data can help in this aspect by creating cost patterns in the data warehouse and showing predictive and prescriptive solutions for better decision-making using machine learning algorithms. In addition, the high level of quality and safety of goods for end users at any time, anywhere increases visibility and interaction in the supply chain, which will also contribute to significant benefits.

The calculations showed that the NPV of our project for the implementation of the proposed logistics engineering solution in the activities of the transport company is positive for all three scenarios and for the two discount rates considered.

According to the above figures, we see that:

– according to the pessimistic variant, our project proposals will pay off in 2.3 years;

– according to the realistic variant, our project proposals will pay off in 2 years;

– according to the optimistic variant, our project proposals will pay off in 1.6 years.

So, in any case, our project proposal is cost-effective and can be recommended for implementation in the activities of the transport company "Ukrtrans Garant" for its improvement.

REFERENCES

1. Abdallah S. Systems Engineering Used for Logistics Integration in Product Design. URL: jtle.net/uploadfile/2015/0826/20150826022750821.pdf.
2. Additive Manufacturing – How Will It Impact Traditional Supply Chains? URL: https://manufactur3dmag.com/additive-manufacturing-will-impact-traditional-supply-chains/.
3. Arlbjørn J. Exploring supply chain innovation / J. Arlbjørn, H. Haas, K. Munksgaard // Logistics Research. – 2011. – №3 (1). – P. 3-18.
4. Artificial intelligence. URL: https://builtin.com/artificial-intelligence.
5. Artificial intelligence. URL: https://www.britannica.com/technology/artificial-intelligence.
6. Bhargava A. Industrial IoT and AI implementation in vehicular logistics and supply chain management for vehicle mediated transportation systems. URL: https://link.springer.com/article/10.1007/s13198-021-01581-2.
7. Blockchain in Logistics Will It Change the Industry? (Part 1). URL: http://transmetrics.eu/blog/blockchain-in-logistics-will-itchange-the-industry-part-1/
8. Business guide to Industrial IoT (Industrial Internet of Things). URL: https://www.i-scoop.eu/internet-of-things-iot/industrial-internet-things-iiot-saving-costs-innovation/.
9. Campbell, T. A. and Ivanova, O.S. (2013). "Additive Nabufacturing as Disruptive Technology: Implications of Three-Dimensional Printing," Technol. Innov., vol. 15, no. 1, pp. 67-79.
10. Campbell, T., et al. (2011). "Could 3D Printing Change the World?" URL: http://www.atlanticcouncil.org/publications/reports/could-3d-printing-change-the-world.
11. Carter C. A framework of sustainable supply chain management: moving toward new theory / C. Carter, D. Rogers // International Journal of Physical Distribution & Logistics Management. – 2008. – Vol. 38 Issue: 5. – P. 360-387.

12. Carter C. Sustainable supply chain management: evolution and future directions/ C. Carter, P. Easton // International Journal of Physical Distribution & Logistics Management. –2011. – Vol. 41 No. 1. – P. 46-67.

13. Complete guide on RFID and its applications in supply chain management and logistics. URL: https://www.peerbits.com/blog/rfid-applications-in-supply-chain-management-and-logistics.html.

14. Dickson, B. (2016). Blockchain has the potential to revolutionize the supply chain. URL: https://techcrunch.com/2016/11/24/blockchain-has-the-potentialto-revolutionize-the-supply-chain/.

15. Doan B. Radio Frequency Identification (RFID) and its impacts on logistics activities. URL: https://www.theseus.fi/bitstream/handle/10024/149991/Doan_Binh.pdf?sequence=1&isAllowed=y.

16. Ernst & Young. (2016). How will 3D printing make your company the strongest link in the value chain?. Ernst & Young's Global 3D Printing Report, 2016. URL: http://www.ey.com/Publication/vwLUAssets/ey-global-3d-printing-report-2016-full-report/$FILE/ey-global-3d-printing-report-2016-full-report.pdf.

17. Flint D. Exploring processes for customer value insights, supply chain learning and innovation: an international study / D. Flint, E. Larsson, B. Gammelgaard // Journal of Business Logistics. – 2008. –№ 29(1). – P. 257-281.

18. Grawe S. Logistics innovation: a literature-based conceptual framework // International Journal of Logistics Management. – 2009. – № 20(3). – P. 360-377.

19. Hancock, M. and Vaizey, E. (2016). Distributed ledger technology: beyond block chain. 1st ed. [ebook] London: Government Office for Science. URL: https://www.gov.uk/government/.

20. Ho-Hyung, L. (2013). How a 3-D supply chain process system could revolutionize business. Supplychainquarterly. URL: http://www.supplychainquarterly.com/topics/Strategy/

21. How AI and IoT can transform the logistics and transportation management ecosystem? URL: https://www.leewayhertz.com/develop-logistics-management-software/.

22. IoT In Logistics. URL: https://www.sketchbubble.com/en/presentation-iot-in-logistics.html.

23. IoT In Transportation And Logistics– Major Trends Of 2020. URL: https://www.allrideapps.com/iot-in-transportation-and-logistics/.

24. Internet of Things: Science Fiction or Business Fact? A Harvard Business Review Analytic Services Report. URL: https://hbr.org/resources/pdfs/comm/verizon/18980_HBR_Verizon_IoT_Nov_14.pdf.

25. Internet of Things in Logistics. A Collaborative Report by DHL and Cisco on Implications and Use Cases for the Logistics Industry. URL: http://www.dhl.com/content/dam/Local_Images/g0/New_aboutus/innovation/DHLTrendReport_Internet_of_things.pdf.

26. Kovacs G., Kot S. New logistics and production trends as the effect of global economy changes. Polish Journal of Management Studies. 2016. URL: http://yadda.icm.edu.pl/baztech/element/bwmeta1.element.baztech28f37b29-531e-4313-adb7-3533c9d50462/c/Kovacs_PJMS_2016_14_2.pdf.

27. Lambert D. Supply Chain Management Processes, Partnerships, Performance, 2nd ed. / D. Lambert, K. Croxton, S. Garcı´a-Dastugue, M. Knemeyer, D. Rogers // Hartley Press Inc., Jacksonville, FL – 2006. – 344 p.

28. Larson P. Logistics Versus Supply Chain Management: An International Survey / P. Larson, A. Halldorsson // International Journal of Logistics Research and Applications. – 2004. – № 7(1). – P. 17-31.

29. Logistics. URL: https://www.sebokwiki.org/wiki/Logistics.

30. Logistics Engineering. URL: http://www.msrblog.com/business/strategic-management-business/logistics-engineering.html.

31. Madakam S. Internet of Things (IoT): A Literature Review / S. Madakam, R. Ramaswamy, S. Tripathi // Journal of Computer and Communications. – 2015. – № 3. – P. 164-173. DOI: http://dx.doi.org/10.4236/jcc.2015.35021.

32. Mashhadi, A. R., et al. (2015). Impact of Additive Manufacturing adoption on future of Supply chains, MSEC2015-9392, Proceedings of the ASME 2015 International Manufacturing Science and Engineering Conference. URL:

http://proceedings.asmedigitalcollection.asme.org/proceeding.aspx?articleid=2445765.

33. Matičević G. RFID and Supply Chain Management for Manufacturing Digital Enterprise. URL: https://www.intechopen.com/books/supply-chain-management-new-perspectives/rfid-and-supply-chain-management-for-manufacturing-digital-enterprise.

34. Meaning, benefits and value of IIoT (Industrial Internet of Things). URL: https://www.i-scoop.eu/internet-of-things-iot/industrial-internet-things-iiot-saving-costs-innovation/industrial-internet-things-iiot/.

35. Nowak G., Maluck M., Stürmer C. The era of digitized trucking: Transforming the logistics value chain. Strategy. 2016. URL: https://www.strategyand.pwc.com/reports/era-of-digitized-trucking.

36. Pervez H. Blockchain and IoT Based Disruption in Logistics. URL: https://www.researchgate.net/publication/332228542_Blockchain_and_IoT_Based_Disruption_in_Logistics.

37. Pfohl H.-C. The Impact of Industry 4.0 on the Supply Chain / H.-C. Pfohl, B. Yahsi, T, Kurnaz // Innovations and Strategies for Logistics and Supply Chains. Technologies, Business Models and Risk Management ; [Kersten, W., Blecker, T., Ringle, C.M.], Hamburg International Conference of Logistics (2015). – 31–58. URL: https://hicl.org/publications/2015/20/1.pdf.

38. Rauh C. Use of Technology Innovation in Logistics. Otto-Friedrich-Universität Bamberg. URL: http://www.morethanshipping.com/use-of-technology-innovation-inlogistics-2.

39. Research and Markets. The Words Largest Market Reseach Store. URL: https://bit.ly/3wUqaJn.

40. RFID (radio frequency identification). URL: https://www.techtarget.com/iotagenda/definition/RFID-radio-frequency-identification.

41. Sadouskaya, Krystsina. Adoption of Blockchain Technologyin Supply Chain and Logistics. (2017). URL: https://www.theseus.fi/bitstream/handle/

10024/126096/Adoption%20of%20Blockchain%20Technology%20in%20Supply%20Chain%20and%20Logistics.pdf?sequence=1.

42. Semenova S., Fomina O., Moshkovska O. (2021). Accounting for innovations in value management of companies in the context of globalization (Облік інновацій в управлінні вартістю компаній в умовах глобалізації). Globalization and its SocioEconomic Consequences. SHS Web of Conferences, EDP Sciences, Zilina, Slovak Republic, vol. 92; 02057. DOI: https://doi.org/10.1051/shsconf/20219202057

43. Sun C. Application of RFID Technology for Logistics on Internet of Things. URL: https://www.researchgate.net/publication/276117373_Application_of_RFID_Technology_for_Logistics_on_Internet_of_Things.

44. Top 10 Supply Chain and Logistics Technology Trends. URL: https://www.transmetrics.ai/blog/supply-chain-logistics-technology-trends/.

45. The role of artificial intelligence in logistics. URL: https://www.ilscompany.com/the-role-of-artificial-intelligence-in-logistics/.

46. Wagner S. Innovation management in the German transportation industry / S. Wagner // Journal of Business Logistics. – 2008. – № 29(2). – P. 215-231.

47. Warehousing Strategies to Make Your Supply Chain Future-Ready. URL: https://fulfillment.shiprocket.in/blog/warehousing-strategies-to-make-supply-chain-future-ready/.

48. What can IoT based transportation offer you? URL: https://www.techtipsnapps.com/2019/02/iot-based-transportation.html.

49. What is logistics engineering? URL: https://napessolutions.com/logistics-engineering.

50. Wikipedia, the free encyclopedia. URL: https://en.wikipedia.org/wiki/Main_Page.

51. Witman D. Logistics Challenges and Opportunities In the Post Covid-19 World. Global Trade. January 22nd, 2021. URL: https://www.globaltrademag.com/logistics-challenges-and-opportunities-inthe-post-covid-19-world/.

52. Zhang X. Applications of RFID in Logistics and Supply Chains: An Overview. URL: https://www.researchgate.net/publication/268465962_Applications_of_RFID_in_Logistics_and_Supply_Chains_An_Overview.

53. 3D Printing and the Future of Supply Chains. A DHL perspective on the state of 3D printing and implications for logistics. URL: http://www.dhl.com/content/dam/downloads/g0/about_us/logistics_insights/dhl_trend report_3dprinting.pdf.

54. Авраменко О. В. Міжнародна логістика: місце України на світовому ринку транспортно-логістичних послуг. URL: http://www.economy.nayka.com.ua/?op=1&z=9256.

55. Амельницька О.В. Система логістичного сервісу транспортно-експедиційного підприємства. URL: http://ea.donntu.edu.ua/bitstream/123456789/18345/1.doc.

56. Аналіз логістичного ринку та складських послуг в Україні. URL: https://www.impulse-consulting.com.ua/analiz-lohistychnoho-rynku-ta-skladskykh-posluh-v-ukraini/.

57. Аналіз ринку вантажоперевезень автомобільним транспортом в Україні. 2020 рік. URL: https://pro-consulting.ua/ua/issledovanie-rynka/analiz-rynka-gruzoperevozok-avtomobilnym-transportom-v-ukraine-2020-god.

58. Аналіз ринку логістики України. 2018 рік. URL: https://pro-consulting.ua/ua/issledovanie-rynka/analiz-rynka-logistiki-ukrainy-2018-god.

59. Балобанов А. Транспортная логистика и интермодальные перевозки. URL: http://greencar.at.ua/load/logistika/transportnaja_logistika/transportnaja_logistika_i_intermodalnye_perevozki/4-1-0-2.

60. Белянська Ю.В. Інновації у сфері інтелектуалізації ланцюгів постачання. URL: https://impeer.org.ua/wp-content/uploads/2022/02/Proceedings_SmaLog.pdf.

61. Більовський К.Е. Стан та перспективи розвитку ринку логістичних послуг в Україні / К.Е. Більовський // Вісник Хмельницького національного університету. 2016. № 4. Т. 2. С. 25-29.

62. Буковський А. “Європейський зелений курс” та залізниця: як зробити ринок вантажних перевезень України більш “зеленим”. URL: https://urm.media/yevropejskij-zelenij-kurs-ta-zalizniczya-yak-zrobiti-rinok-vantazhnih-perevezen-ukrayini-bilsh-zelenim/.

63. Гайдабрус, Н.В. Аналіз стану логістичного обслуговування та інноваційної діяльності підприємств України / Н. В. Гайдабрус // Бізнесінформ. 2015. №4. С. 123-129.

64. Глушенко Т.М. Аналіз розвитку логістичних послуг на сучасному світовому ринку / Т.М. Глушенко // Науковий вісник Херсонського державного університету. 2014. Вип. 6. Ч. 1. С. 169-171.

65. Горошко К. О., Аляб’єва О. М. Світовий досвід розвитку логістичних підприємств. Економічний вісник Запорізької державної інженерної академії. 2016. Вип. 3. С. 72-74.

66. Григорак М. Ю. Анализ рынка логистических услуг в Украине/ М. Ю. Григорак, В. В. Коцюба // Логистика: проблемы и решения. 2006. №2(3). С. 21-29.

67. Державна служба статистики України. URL: http://www.ukrstat.gov.ua/.

68. Дмитриев, А. Логистика транспортно-экспедиторских услуг. URL: http://greencar.at.ua/load/logistika/transportnaja_logistika/dmitriev_a_v_logistika_transportno_ehkspeditorskikh_uslug/4-1-0-198.

69. Дякова Д. Інноваційна логістика: перспективи та реалії. Товарознавчі та маркетингові дослідження товарних ринків: збірник наукових праць за матеріалами студентської науково-практичної інтернет-конференції (20 лютого 2014 року) / голова ред. кол. С. Гирич. Вінниця, 2014. С. 50–52.

70. Ібрагімхалілова Т.В. Потенціал розвитку ринку транспортно-логістичних послуг в Україні. URL: http://irbis-nbuv.gov.ua/cgi-bin/irbis_nbuv/cgiirbis_64.exe?C21COM=2&I21DBN=UJRN&P21DBN=UJRN&IMAGE_FILE_DOWNLOAD=1&Image_file_name=PDF/efek_2011_5_48.pdf.

71. Іванець І.О., Капрпнь О.В. Дослідження специфіки використання RFID-систем в логістичній діяльності // Проблеми підготовки професійних

кадрів з логістики в умовах глобального конкурентного середовища: 20 міжнародна науково-практична конференція, 28-29 жовтня 2022 р.: тези доп. – К.: НАУ, 2022. – С. 73-78.

72. Закон України «Про транспортно-експедиційну діяльність» від 01.07. 2004 № 1955– IV. URL: http://zakon2.rada.gov.ua/laws/show/1955-15.

73. Капітонець М.В. Аналіз ринку логістики України: статистичний аспект. URL: https://jeou.donnu.edu.ua/article/view/9706/9630.

74. Карпенко О.О. Аналіз досвіду використання інформаційнокомунікаційних технологій у портах світу. Економіка та суспільство. 2018. №15. URL: http://www.economyandsociety.in.ua.

75. Кузик К. Перспективи використання дронів для оптимізації логістичного процесу. International Scientific Journal. 2015. С. 3.

76. Лобовко В. Анализ рынка логистических услуг Украины. Тренды, сложности и возможности. URL: https://trademaster.ua/articles/312595.

77. Малащук Д.В. Сучасний стан та особливості розвитку світового ринку логістичних послуг. URL: http://www.economy.nayka.com.ua/pdf/6_2018/34.pdf.

78. Мурадян Л.А. Автоматична ідентифікація окремих частин транспортного засобу при впровадженні нових концепцій системи технічного обслуговування та ремонту. URL: http://eadnurt.diit.edu.ua/bitstream/123456789/10334/1/Muradian.pdf.

79. Основні тенденції в розвиткові логістики 2017 року. Logist.fm. URL: http://logist.fm/publications/osnovnyetendencii-v-razvitii-logistiki-2017-goda.

80. Особливості ринку логістичних послуг в Україні. URL: https://proconsulting.ua/ua/pressroom/osobennosti-rynka-logisticheskih-uslug-v-ukraine.

81. Офіційний сайт компанії «Укртранс Гарант». URL: http://ukrtransgarant.com/ua.

82. Петруня Ю.Є. Вплив новітніх технологій на логістику та управління ланцюгами поставок. URL: https://armgpublishing.com/wp-content/uploads/mmi/volume-9-issue-1/mmi2018_1_130_139.pdf.

83. П’ять новітніх технологій, які змінять логістику раз і назавжди. URL: https://www.imena.ua/blog/5-tech-logistic/.

84. Савочкін Д. Розвиток методів просторової локалізації об’єктів на базі технології радіочастотної ідентифікації. URL: https://nure.ua/wp-content/uploads/2018/Dissertation/aref_Savochkin.pdf.

85. Середницька Л.П. Інноваційні технології в логістичній системі. URL: https://economyandsociety.in.ua/journals/19_ukr/96.pdf.

86. Склад будущего от AMAZON: как устроена работа гигантского онлайн-ритейлера. Логистика: проблемы и решения. 2014. № 4–5. С. 20–28.

87. Слідами Amazon: «Нова пошта» тестує доставку дронами. URL: http://vkurse.ua/ua/business/novayapochta-testiruetdostavku-dronami.html.

88. Статистичний аналіз структури та тенденцій розвитку логістичного ринку України / Р. В. Ціщик, Н. В. Котис // Проблеми системного підходу в економіці. 2018. Вип. 3(1). С. 54-59. URL: http://nbuv.gov.ua/UJRN/PSPE_print_2018_3%281%29__11.

89. Стратегічний менеджмент. URL: https://pidru4niki.com/89724/ menedzhment/ strategichniy_menedzhment.

90. ТОП-3 технології майбутнього, які змінюють логістику. URL: https://www.trans.eu/ua/blog/lohistyka-4-0/technologii-majbutniogo/.

91. ТОП-10 інновацій, які змінять логістику в 2020 році. URL: https://elnews.com.ua/uk/top-10-innovaczij-yaki-zminyat-logistyku-v-2020-roczi/.

92. Тараненко Ю. Економічна сутність та значення логістики для діяльності підприємства. Економіка & держава. 2015. № 5. С. 131–135.

93. Трушкіна Н. В., Кітріш К. Ю. Управління ланцюгами постачань у контексті концепції індустрія 4.0. Ефективна економіка. 2020. № 12. DOI: 10.32702/2307-2105-2020.12.74