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

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«01» June 2024

QUALIFICATION PAPER

(EXPLANATORY NOTES)

OF GRADUATE OF ACADEMIC DEGREE

«BACHELOR»

THEME: **«Organization of the cargo transportation monitoring system»**

Speciality 073 «Management»

Educational Professional Program « Logistics »

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I certify that in this qualification paper there are no borrowings from the works of other authors without appropriate references Illia *MAMONOV*
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Kyiv 2024

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

ЗАТВЕРДЖУЮ
В.о. завідувача кафедри логістики
Світлана СМЕРІЧЕВСЬКА
(підпис, власне ім'я та прізвище)
«01» червня 2024 р.

КВАЛІФІКАЦІЙНА РОБОТА

(ПОЯСНЮВАЛЬНА ЗАПИСКА)

ЗДОБУВАЧА ОСВІТНЬОГО СТУПЕНЯ

«БАКАЛАВР»

ТЕМА: **«Організація системи моніторингу транспортування вантажів»**

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Засвідчую, що у цій кваліфікаційній роботі немає запозичень з праць інших авторів без відповідних посилань *Ілля МАМОНОВ*
(підпис) (власне ім'я та прізвище здобувача)

Київ 2024

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

Academic Degree Bachelor

Speciality 073 «Management»

Educational Professional Program « Logistics »

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«13» May 2024

TASK

FOR COMPLETION THE QUALIFICATION PAPER OF GRADUATE

Illia Mamonov
(name and surname)

1. Theme of the qualification paper: «Organization of the cargo transportation monitoring system» was approved by the Rector Directive №624/ст. of April 24, 2024.
2. Term performance of the paper: from May 13, 2024 to June 16, 2024.
3. Date of submission paper to graduation department: June 01, 2024.
4. Initial data required for writing the paper: general and statistical information about market of GPS system manufacturers, information of the company «CD-Trans» LLC, production and financial indicators of the company, literary sources on logistics and supply chain management and internal transportation, Internet source.
5. Content of the explanatory notes: introduction; Concept of organizing the monitoring of the vehicles technical condition, general analysis of «CD Trans» LLC's activities and the company's cargo transportation monitoring system analysis of vehicle traffic monitoring and identification of fuel sensor control problems; organizational and economic directions of increasing the efficiency of transport monitoring of «CD-Trans» LLC, economic substantiation of the feasibility of the proposed measures to improve the vehicle traffic monitoring system of the «CD Trans» LLC; conclusions and recommendations.
6. List of obligatory graphic matters: tables, charts, graphs, diagrams illustrating the current state of problems and methods of their solution.

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	13.05.24-16.05.24	Done
2.	Collection of statistical data, timing, detection of weaknesses, preparation of the first version of the analytical chapter	17.05.24-20.05.24	Done
3.	Development of project proposals and their organizational and economic substantiation, preparation of the first version of the project chapter and conclusions	21.05.24-26.05.24	Done
4.	Editing the first versions and preparing the final version of the qualification paper, checking by standards inspector	27.05.24-29.05.24	Done
5.	Approval for a work with supervisor, getting of the report of the supervisor, getting internal and external reviews, transcript of academic record	30.05.24-31.05.24	Done
6.	Submission paper to Logistics Department	01.06.24	Done

Graduate_____
(signature)

Supervisor of the qualification paper _____
(signature)

8. Consultants of difference chapters of paper:

Chapter	Consultant (position, surname and name)	Date, signature	
		The task was given	The task was accepted
Chapter 1	Doctor of economic sciences, professor, Reznik N.	13.05.24	13.05.24
Chapter 2	Doctor of economic sciences, professor, Reznik N.	17.05.24	17.05.24
Chapter 3	Doctor of economic sciences, professor, Reznik N.	21.05.24	21.05.24

9. Given date of the task May 13, 2024.

Supervisor of the qualification paper: _____Nadiia REZNIK_____
(signature of supervisor) (surname and name)

Task accepted for completion: _____ Illia Mamonov_____
(signature of graduate) (surname and name)

ABSTRACT

The explanatory notes to the qualification paper « Organization of the cargo transportation monitoring system» comprises of 91 pages, 43 figures, 21 tables, 56 references.

KEY WORDS: TRANSPORT SATELLITE MONITORING MARKET, GLOBAL POSITIONING SYSTEM, VEHICLE TRAFFIC MONITORING SYSTEM, FUEL SENSOR, TRANSPORT LOGISTICS

The qualification paper is devoted to improving the vehicle traffic monitoring system of a company by replacing existing fuel sensors with more efficient ones.

The theoretical part is devoted to the theoretical aspects of satellite vehicle tracking systems. The analytical part the research is devoted to the analysis of the vehicle monitoring market and the activities of the «CD Trans» company. The main characteristics of the problem with fuel sensors are described depending on the percentage of indicator values. The third part is devoted to the improvement of the vehicle traffic monitoring system of the «CD Trans» company. It was proposed to implement a project to optimize transport logistics using the modernization of fuel sensors.

The subject of the qualification paper is the company «CD Trans» LLC in the system of transportation of cargo flows with modern technologies.

The object of the research is the process of organization of the cargo monitoring system due to the use of more efficient fuel sensors in vehicles of the «CD Trans» LLC company.

Methods of research are analysis, synthesis, induction, deduction, modelling, generalization.

Materials of qualification paper are recommended to be used during scientific research, in the educational process and in the practice of specialists of logistics departments.

CONTENTS

NOTATION

ADAS – Advanced driver assistance systems

AI – Artificial Intelligence

AVL – Automatic Vehicle Location

CPM – Critical Path Method

GNSS – Global Navigation Satellite System

GPS – Global Positioning System

IoT – Internet of Things

ITS – Intelligent transport systems

MA – Mobile Applications

OBD – On-Board Diagnostics

RS – rolling stock

SBAS – Satellite -based augmentation system

INTRODUCTION

A market economy's growth leads to increased competition and the need for finding new niche markets of development. Logistics activity is an essential component of the operations of many transport companies and is necessary for sustainable growth. Transport logistics is one of the key components of the enterprise's logistics system, the key task of which is to fully satisfy the needs of consumers in the transportation of their goods, in addition, efficient transport systems provide economic and social opportunities and advantages, such as better access to markets, employment and additional investments, at the same time, transport affects such economic factors as geographic specialization, scale and scope of production, increased competition, increased land value, and all this occurs against the background of increasing requirements for the required level of logistics service and flexibility of logistics services. As a result, the incorporation of modern information and digital technologies is an essential component in modern logistics projects, which facilitates the development of customized logistics solutions tailored to the needs of each client.

Enhancing the system of tracking the movement of vehicles is one of the essential components in boosting the competitiveness of the company and is accomplished through the examination of logistics procedures, the establishment of criteria and metrics for assessing the effectiveness of logistics at the company, their assessment, and the exploration of resolutions to challenges.

This paper is dedicated to enhancing the vehicle traffic monitoring system of a transport company by substituting current fuel sensors with more effective ones.

The relevance of the research lies in the fact that fuel sensors are a crucial component of the logistics system for monitoring and managing a vehicle. Changing malfunctioning sensors can greatly enhance fuel efficiency consistent diagnostics and upkeep enable timely detection and prevention of potential breakdowns and glitches in transportation and reduce failures across the company's entire logistics network.

The purpose of qualification paper is to consider theoretical principles and substantiate practical recommendations for improving the vehicle traffic monitoring system of a transport company.

The subject of the qualification paper is the company «CD Trans» LLC in the system of transportation of cargo flows with modern technologies.

The object of the research is the process of organization of the cargo monitoring system due to the use of more efficient fuel sensors in vehicles of the «CD Trans» LLC company.

According to the purpose, the following tasks are defined:

– to define the basic principles of operation of GPS vehicle monitoring systems.

– to analyse the market for GPS vehicle monitoring systems.

– to describe the basic requirements for the vehicle monitoring system and fuel control subsystem.

– to conduct an analysis of the company's activities in the transport and logistics services market.

– to identify shortcomings in the transport monitoring process and provide requirements and recommendations for designing a monitoring system.

- to evaluate of the effectiveness of project.

The theoretical part is devoted to the theoretical aspects of satellite vehicle tracking systems. The analytical part the research is devoted to the analysis of the vehicle monitoring market and the activities of the «CD Trans» company. The main characteristics of the problem with fuel sensors are described depending on the percentage of indicator values. The third part is devoted to the improvement of the vehicle traffic monitoring system of the «CD Trans» company. It was proposed to implement a project to optimize transport logistics using the modernization of fuel sensors.

The theoretical basis of the research is the results of scientific, analytical developments of domestic and foreign experts, scientists and specialists in the field of transport logistics management, analytically processed statistical data on the market of

vehicle monitoring system developers, available reporting and forecasting data of international organizations on logistics development trends.

Open sources from manufacturers of fuel sensors were also used to carry out technical and economic calculations of the feasibility of their implementation at the enterprise. Articles, magazines and books were used as the main methodology for calculating, evaluating and assessing the effectiveness of an investment project.

Research methods: statistical analysis, comparative and graphical analysis, systematization and generalization, statistical methods for studying numerical data: vertical (structure of indicators) and horizontal (dynamics of indicators) analysis - to calculate the performance indicators of an enterprise, method of economic analysis - to study changes in the economic indicators of an enterprise; discounting method - to determine the effectiveness of the proposed project, methods of generalization, classification and typology, Critical Path Method; Gantt chart, CPM analysis.

CHAPTER 1
THEORETICAL ASPECTS OF SATELLITE VEHICLE TRACKING SYSTEMS

1.1 Concept of organizing the monitoring of the vehicles technical condition

Road transportation is a vital component of the transportation system, serving the purpose of fulfilling the needs for both cargo and passenger movement. The primary objective is to ensure the functionality of the rolling stock (RS) by maintaining it in optimal technical condition while utilizing resources efficiently. This includes adhering to regulatory standards for road and environmental safety, as well as ensuring that personnel work under conditions defined by law. Technical operation plays a crucial role in achieving these objectives.

According to reference [30], the monitoring system is highlighted as the most efficient method for managing the technical condition of vehicles. By implementing a monitoring system, operators can track the performance and maintenance needs of the rolling stock in real-time. This proactive approach allows for timely interventions and preventive measures to be taken, ultimately enhancing the overall efficiency and safety of road transport operations.

The issue of monitoring the technical condition of cars in small transport enterprises has become increasingly critical due to the limitations posed by their fleet size. Traditional methods of maintenance and repair are not suitable for these businesses, necessitating the adoption of innovative approaches to ensure the vehicles' optimal performance. By introducing new techniques and technologies for continuous monitoring, these enterprises can enhance the efficiency of their operations while keeping costs under control. It is essential to find solutions that strike a balance between providing accurate information on the vehicles' technical status and being economically feasible for small businesses.

To ensure accurate and reliable monitoring of a vehicle's technical condition, it is essential to carefully consider and choose the most optimal approaches for collecting and processing information related to the current values of its controlled parameters. This includes not only the overall condition of the vehicle but also the specific elements that make up its structure.

In the early 1990s external analog test equipment - universal measuring stands, instruments, engine analyzers, etc. - began to be used to diagnose vehicles. In the mid-1990s the electronic control system of engines, transmissions, and braking systems became widespread; sensors connected to built-in data buses, engine control modules (Engine Control Module - ECM) began to be used; portable readers of fault codes (errors) generated by ECM; technical instructions are being actively digitized.

Since the end of the 1990s ECU modules (Electronic Control Unit - electronic vehicle control systems) with a built-in electronic diagnostic system, including wireless communication channels for transmitting information from sensors, became widespread on vehicles. Operating and diagnostic data, as well as data on the location of vehicles, are transmitted via satellite or cellular communication to vehicle park management centers. Satellite communications are widely used in transport, construction and agriculture.

In the early 2000s special computing platforms for providing car service became widespread, which are a computer with USB connectors for connecting car data buses and other diagnostic devices and equipment [16]. These platforms allow you to accumulate significant volumes of data on operational parameters of vehicles and, based on them, make calculated forecasts regarding the intensity of changes in the vehicle's technical condition and the frequency of preventive maintenance.

The rapid development of computer technology and telecommunication technologies allowed to move to the creation of remote systems for monitoring the technical condition of vehicles. Well-known foreign systems allow monitoring, control and management of vehicles moving in the entire territory where there is a GPRS/GSM mobile connection. Among them are CarinPhone (Latvia, Sanatels), NaviFleet (Latvia, Geospars), Caretrack (Sweden, Volvo Construction Equipment), Dynafleet (Sweden,

Volvo Group), ruDi (Germany, Institute of transport equipment and logistics for the mining and metallurgical industry at the Technical Institute in Aachen together with the company Fritz Rensmann Maschinenfabrik (Dortmund)) and others [16, 30].

These systems exhibit a high level of complexity, primarily due to their specialized nature and close association with specific vehicle brands or production tasks like construction, agriculture, or mining. Nevertheless, the modern business environment demands enhanced mobility and efficiency from enterprises. In response to this need, scientists suggest the utilization of information technologies and the integration of intelligent transport systems (ITS) with the technical operations of vehicles. This approach presents a promising avenue to address the existing challenges [16, 30, 34].

The operation of these systems is based on data received from the on-board self-diagnosis system (OBD), which is processed on the server of the software developers. Each client is given access to a personal online account, where he has the opportunity to monitor the main parameters of the vehicle's work process and receive recommendations on the periodicity of maintenance and the need for repair actions.

In this regard, research is widely conducted on finding methods and mathematical models for monitoring the technical condition of individual components and units of the car based on parameters that can be obtained from OBD [18, 38, 40].

According to recent research and publications, a considerable amount of scientific literature focuses on the topic of monitoring the technical condition of vehicles and the methods used for its organization. However, the majority of these publications are primarily descriptive in nature, discussing either the fundamental approaches employed in various methods or their functionalities. To address the issue of monitoring the technical condition of vehicles comprehensively, a scientific approach entails developing a classification system for existing methods based on shared characteristics.

The technical condition of a truck should be understood as a set of its properties, variables in the process of production and operation, which at a certain point in time are characterized by the features established by the technical documentation [19]. In

other words, it is the degree of conformity of the parameters of systems, mechanisms, nodes and aggregates to the norms established by the rules of technical operation.

According to [17], monitoring of the technical condition of a vehicle is periodic or continuous monitoring of a pre-set set of parameters in order to monitor the deterioration of its technical condition during operation. According to this definition, the periodicity of parameter control was chosen as a key classification feature of the methods of organizing monitoring of the technical condition of vehicles, namely: periodic control or continuous control.

Today, there are a number of methods of both periodic and continuous control of the parameters of the functioning of vehicles, namely:

- using stationary devices;
- using specialized devices;
- using test systems [52].

To ensure the proper functioning of stationary equipment, it is essential to conduct regular checks on a range of parameters. This involves utilizing multifunctional devices that are specifically designed for comprehensive car diagnostics. These devices, including stands and motor testers, facilitate the direct measurement of parameter values by connecting them to the corresponding car systems, nodes, and aggregates.

Specialized devices for monitoring the technical condition of vehicles are diagnostic scanners – equipment designed for diagnosing electronic control systems by reading digital information from the car's diagnostic connector. Typically, the scanner is connected to a computer through a serial port for data transmission, or it can be made in the form of an independent multifunctional device, which is a combination of a multimeter, an oscilloscope and a microcomputer equipped with a display, with pre-installed specialized software for a particular make or model of mobile composition

The auto scanner is connected to the data exchange bus (CAN, Controller Area Network) between the car units, which allows you to get comprehensive information about its condition, measure characteristics, read data from sensors and allows you to get a comprehensive assessment of the vehicle's technical condition. However, among

the key disadvantages of this method, it should be noted that for systems and nodes that are not equipped with sensors, the technical condition is determined by indirect parameters, and in some cases it cannot be determined in this way at all.

Test systems allow to read error codes and data streams in real time and present them in the form of tables, graphs, etc. With the help of such systems, virtual tests are carried out: one of the parameters is "manually" changed and its impact on others is determined.

Test systems are additionally installed on the vehicle and include three main elements (Yi, T. H., Li, H. N., & Gu, M. 2023):

- information device – display, pocket personal computer (PC), smartphone or tablet, etc.;

- adapter – a programmable microcontroller with established communication protocols, which allows you to connect the on-board self-diagnosis system with an information device;

- communication system – the channel of information transmission from the adapter to the information device, which can be wired (COM (RS-232) or USB.) or wireless (Bluetooth or Wi-Fi) [52].

In most cases, such test systems are connected to the connector of the on-board self-diagnosis system and read information from the CAN bus, so they have all the disadvantages noted for diagnostic scanners. However, their key advantage is that all data can be obtained in real time and quickly respond to the dynamics of changes in controlled parameters.

The possibility of continuous monitoring of the parameters of the technical condition of modern vehicles during operation is provided by the self-diagnosis function of electronic systems for managing the work processes of nodes and aggregates. Such systems are equipped with a number of indicators that are displayed on the instrument panel to inform the driver about possible malfunctions and the need for technical services (TS) [49].

Having received a signal about the deviation of the values of the controlled parameters from the normative ones, the self-diagnosis system classifies the

malfunction by number (error code) and records this code in the RAM, performing corrective actions provided for this case by the control program [49].

In the global automotive industry, according to (Park Y.M., Chavez D., Sousan S., Figueroa-Bernal N., Alvarez J.R., Rocha-Peralta J. 2023), the standards of on-board systems for monitoring the technical condition of vehicles - OBD (On Board Diagnostic) have been adopted, which determine the design features of self-diagnosis systems and the protocols they perform. The standard unifies the procedure for exchanging data between the self-diagnosis system and the equipment, the system for indicating fault codes, and the procedure for the system as a whole [37]. However, a significant drawback of the OBD-II standard, despite its standardization, is the presence of a large number of different communication protocols between the system controller and information devices.

Kien N.T., Nakashima S., Shimizu N. (2020) mention that Satellite monitoring systems are another way of continuous monitoring of vehicle parameters. They make it possible to control the location, time, speed and direction of movement, the distance travelled, the fact of opening the door or hood, etc. [25].

Satellite monitoring systems consist of three main components.

1. Monitoring module – determines coordinates and time based on GPS satellite data, receives information from vehicle sensors (standard and additionally installed), forms data packets and transmits them to the server via GPRS network.

2. Monitoring server – receives information from monitoring modules, stores it in the database, transmits information to the dispatcher upon request.

3. Dispatch station – specialized software that processes and displays data received from the server, displays the location of the vehicle (monitoring module) on the map online, builds traffic routes, generates and saves reports, etc. [25].

The significant advantages of this method according to Rago V., Brito J., Figueiredo P., Costa J., Barreira D., Krustrup P., Rebelo, A. (2020) are the possibility of monitoring operating conditions (routes, speed modes, location, etc.) and obtaining information from various sensors, both standard and additionally installed (fuel

consumption sensor, accelerometer, etc.), since, according to fuel consumption is a more sensitive indicator of the technical condition of the vehicle than mileage [39].

In fig. 1.1 presents a classification scheme of methods of monitoring the technical condition of vehicles by method of organization.

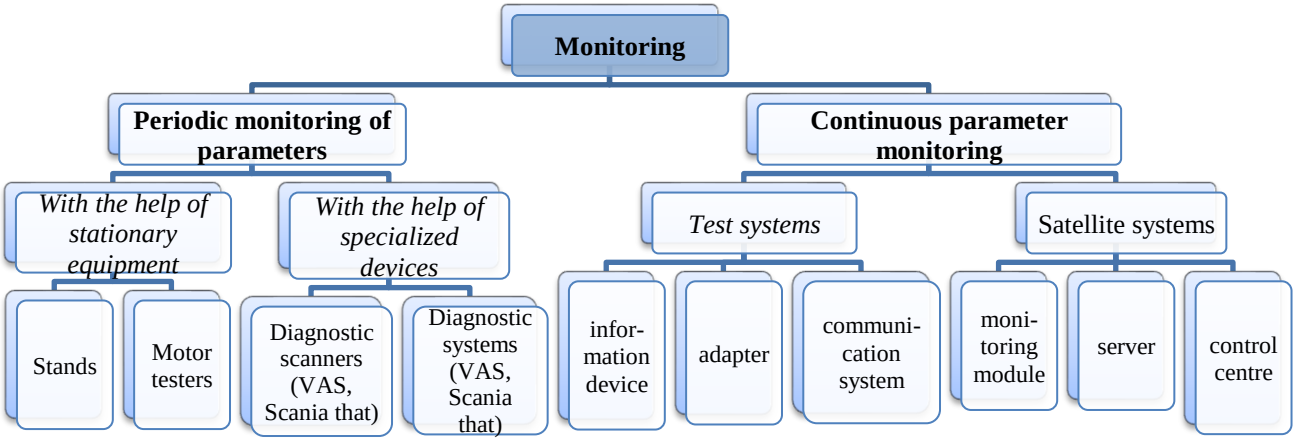

Figure 1.1 - Classification of methods of monitoring the technical condition of vehicles according to the periodicity of monitoring parameters

Source: compiled by author according to [25, 39]

The monitoring system, which will be based on continuous observation and measurement of work process parameters, is the most effective way of managing the technical condition of the car. This approach can be implemented using on-board diagnostic systems (OBD). They allow you to read a sufficiently large number of vehicle parameters in real time and, if there is a GPRS/GSM connection to the Internet, immediately transfer them to the server for processing.

However, the use of only OBD as a method of organizing monitoring has certain limitations. In particular, the fuel consumption indicators are calculated (the amount of air passing through the intake manifold is fixed and the required amount of fuel is determined at a given ratio of the excess air ratio), which significantly reduces the accuracy of the measurement and does not take into account the energy losses to overcome the resistances in the transmission, chassis, and while driving in difficult operating conditions.

To achieve the maximum possible accuracy of continuous control of the vehicle's technical condition, it is worth using satellite monitoring systems connected to OBD and supplemented with fuel consumption control sensors. Since fuel consumption is a more accurate indicator that characterizes the technical condition of the vehicle than the mileage, this approach makes it possible to promptly monitor its deterioration. Supplementing this information with data from the on-board self-diagnosis system allows, with sufficiently high accuracy, to determine potential malfunctions and make a decision on the need for preventive maintenance or repair. The feasibility of using this method is characterized by an increase in the efficiency of rolling stock operation and is determined by technical and economic calculations.

1.2 Main trends of the satellite transport monitoring market

Understanding the uneven development of satellite monitoring systems globally is crucial for stakeholders in the industry. By comprehensively evaluating the growth trends, operational principles, and essential features of these systems, we can better grasp the dynamics of the market. This analysis will not only shed light on the current state of affairs but also provide valuable information for future strategies and initiatives in the field of satellite monitoring systems.

The logistics industry has become one of the most technologically advanced sectors globally. Carriers are increasingly interested in digital technologies due to the clear benefits they offer. By embracing digital solutions, carriers can significantly optimize costs and enhance the level of service provided to clients. This shift towards digitalization has revolutionized the way logistics operations are conducted, leading to increased efficiency and improved customer satisfaction [l0]. The report titled "The Future of Transport and Logistics sector" highlights the significant role of data processing and analysis systems in the logistics field, with a staggering 90% importance rating and an average value of 83%. This underscores the crucial need for

efficient data management in the industry. However, despite the undeniable importance of digitalization in adapting to the evolving business landscape, only 28% of transport and logistics companies consider their current level of digitalization to be "advanced", as indicated in the report. Not everyone is ready to radically restructure established business processes [2, DHL: Logistics Trend Radar 2023] [16]. The study “Logistic Trend” presents main direction, among which social, economic and technological ones are highlighted (fig. 1.2).

Figure 1.2 - Logistics Trend Radar in 2023

Source: [16]

DHL has recently unveiled its latest edition of the «DHL Logistics Trend Radar», highlighting the most influential trends in the industry. The report focuses on significant factors such as decarbonization, robots, big data, supply chain diversification, and alternative energy solutions. In light of the increasing occurrence of climate-related disasters and geopolitical interferences, organizations are recognizing the importance of diversifying their supply chains to enhance resilience. This strategic move aims to make their operations more robust and adaptable, with visibility playing a crucial role in achieving this objective. Multisourcing, the

partnering with multiple competing suppliers, and multishoring, the selecting providers in more or different countries or regions. Broadening the supplier ecosystem and expanding manufacturing and distribution networks can achieve increasing resilience, agility, responsiveness, and competitiveness. 76% of businesses surveyed are planning to make significant changes to their supplier base within the next two years to ensure supply chain resilience. The key to building resilient supply chains is having visibility. In this case, big data helps to analyze large quantities of data to reveal past patterns, highlight real-time changes in the status quo, and create predictions and forecasts for the future. Organizations that are leading the way and experiencing significant improvements in their supply chains are the ones that possess the ability to analyze large volumes of rapidly accumulating, unorganized data. On the other hand, those who solely focus on fundamental transactional data are failing to capitalize on the potential for enhanced visibility. Digital twins, a rising trend in enhancing business visibility, have the capability to strengthen predictive maintenance protocols within operations. This can result in a significant decrease of up to 70% in industrial breakdowns, ensuring that supply chains continue to operate smoothly. Another technology, computer vision, serves as an example of how processes can be made more efficient and operations can be made more secure [16, P. 2].

The author Lombardi M. (2021) of the publication “An evaluation of dependencies of critical infrastructure timing systems on the global positioning system (GPS)” describes that today there are the following satellite positioning systems in the world: GPS (the USA), GLONASS (Russia), Galileo (Europe), and Beidou (China) (fig. 1.3). And also mention that today, the most widely used geopositioning system is GPS (Global Positioning System). [31, P. 47-48].

Four distinct global positioning systems are operated by four government organizations, yet they all employ an identical method for determining your precise location. According to Grand View Research and their publication «Market analysis Report» - the global vehicle tracking system is projected to grow steadily at a CAGR 13.7% value, during the forecast period 2022 – 2032. In the year 2022, the market cap is expected to be worth US$ 21.7 Billion [21].

Observing the skyrocketing demand in the global market, the vehicle tracking system market is expected to reach US$ 78.35 Billion by 2032. The analysis of publications on forecasts and the current situation in the market for transport monitoring systems of consulting companies (Grand View Research, Markets&Markets, Fact.MR, Research and Markets) allows us to formulate the main trends in the market and provide the following figures, which are presented in fig. 1.4 [18, 21, 34, 40].

Figure 1.3. – World Satellite navigation systems

Source: [31 P. 48]

As a result, the demand for GPS devices continues to surge as more individuals and businesses recognize the benefits they offer. The ability to accurately determine the location of objects, coupled with the cost-effectiveness of installation, has made GPS devices an indispensable tool in today's world. Small and medium-sized businesses are able to take advantage of these systems due to their affordable pricing, which in turn helps them enhance their productivity levels. As a result, the market has witnessed a growth in its customer base as more companies are able to invest in these solutions without breaking the bank.

Businesses in the transport sector greatly benefit from integrating GPS tracking systems into their vehicles, as it helps them stay competitive in a fast-paced industry. By leveraging this technology, companies can reduce operational costs, increase fleet visibility, and make data-driven decisions to improve their services. Overall, GPS

tracking systems have become indispensable tools for businesses looking to optimize their transportation operations and deliver exceptional service to their customers.

According to research of scientists Platonov S.A., Platonov A.V., Postnikov M.E., Khadonova S.V., Dymkova S.S. (2019, March), the market of satellite monitoring systems is gradually divided into 3 branches - developers of the full cycle, developers of software complexes for GPS monitoring of transport, and integrators of transport control systems (see fig. 1.5) [38].

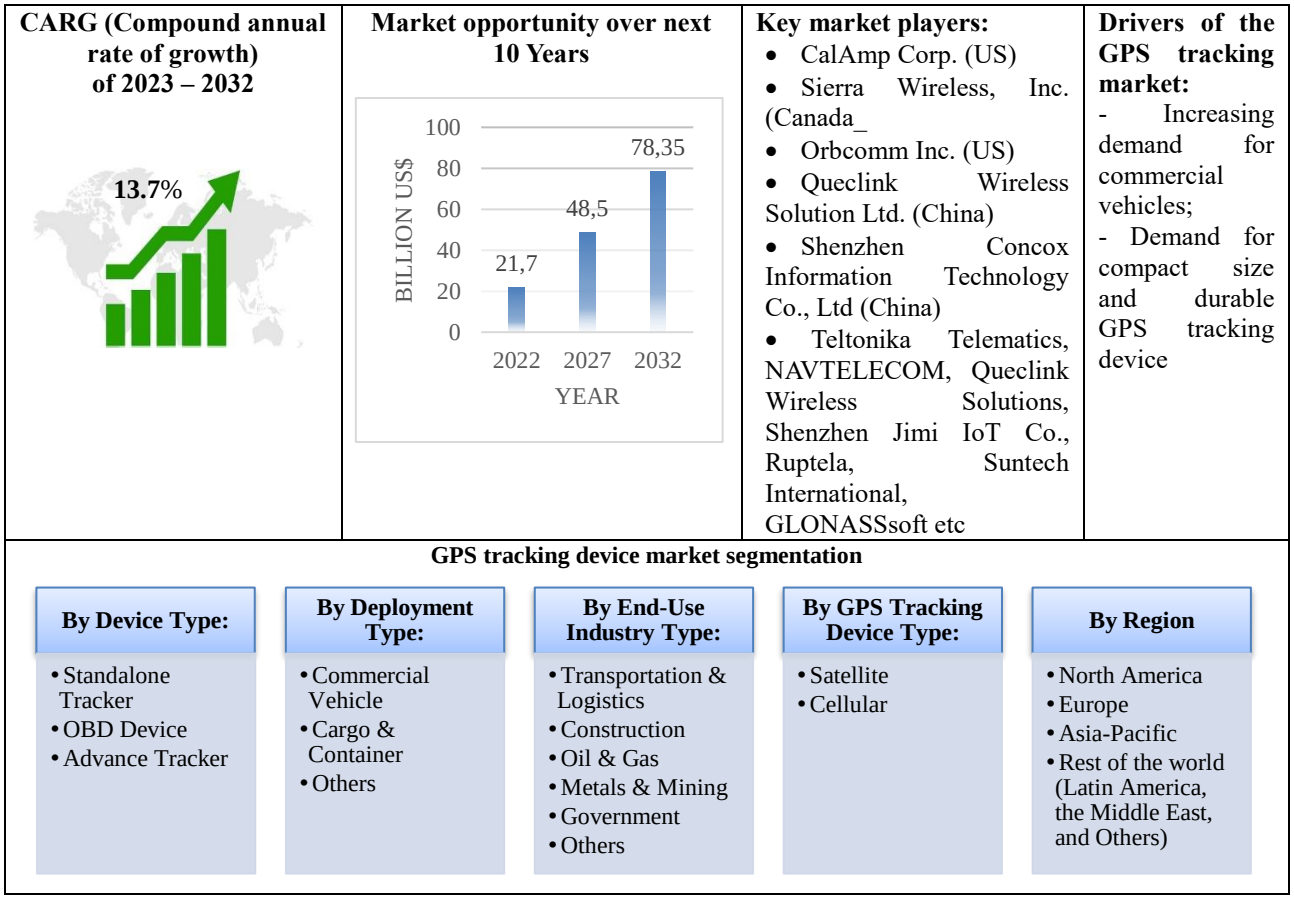

Figure 1.4. – Main figures of vehicle tracking market

Source: compiled by author according to [18, 21, 34, 40]

By understanding the different roles and contributions of developers in the satellite transport monitoring market, stakeholders can gain a deeper insight into the dynamics of the industry and identify opportunities for collaboration and growth. Each type of developer brings unique strengths and capabilities to the table, ultimately contributing to the evolution and expansion of satellite transport monitoring

technologies. The company designs and manufactures a comprehensive software and hardware system for transportation management, which is continuously enhanced to meet the evolving demands of the industry. This system includes proprietary devices for GPS tracking, such as GPS trackers, fuel level sensors, flow meters, and more. Their main objective is to ensure the stability of the transport control system. Furthermore, they provide technical support, equipment installation services, extended warranty services, and post-warranty support for users.

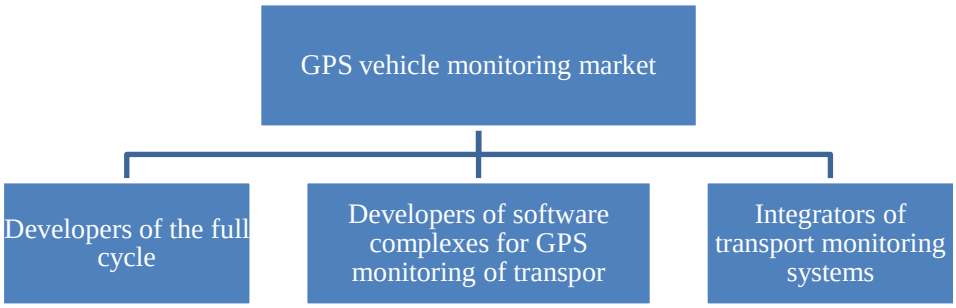

Figure 1.5 – GPS Traffic Monitoring Market Segmentation by Developer Type

Source: compiled by author according to [38]

Software developers distinguish themselves from other types of developers by focusing solely on creating and maintaining software products for GPS monitoring of transportation systems. Unlike developers who work on equipment, software developers procure their systems from full-cycle developers or overseas suppliers. However, this approach can lead to potential issues with the equipment's functionality, as it may not have been optimized for the specific software product designed for GPS monitoring. Furthermore, the absence of a well-established material base can lead to challenges in ensuring the proper functioning and longevity of the GPS trackers and fuel level sensors. Without easy access to necessary components, the maintenance and repair processes may become more complicated and time-consuming, affecting the overall efficiency of the devices.

Integrators play a crucial role as representatives and distributors of full-cycle developers and software providers. Their primary responsibility is to establish a seamless connection between you and a designated traffic monitoring system.

Subsequently, all the essential services will be delivered by representatives belonging to either the first or second type in the market. In terms of percentage, today they have divided the market among themselves approximately as follows, see fig. 1.6.

Thus, it turns out that only 20% are full-cycle developers, 30% are software complex developers, and all the rest are integrators. Such a division is obvious, because it is much easier to sell ready-made goods than to create them.

Companies operating in the transportation industry frequently encounter financial losses or a lack of profitability as a result of several factors. These include non-compliance with working schedules, exceeding speed limits, unscheduled flights, reduced mileage, unmonitored fuel consumption, and reckless driving practices. Such issues can significantly impact the overall performance and profitability of these businesses.

The available statistics indicate that implementing such measures results in a notable escalation in the company's fuel and depreciation costs, with an increase ranging between 20% and 40%. Furthermore, companies often find themselves grappling with reputational repercussions when they fail to comply with the stipulated delivery timelines for goods and cargo, or when they deviate from the declared schedule for passenger transportation.

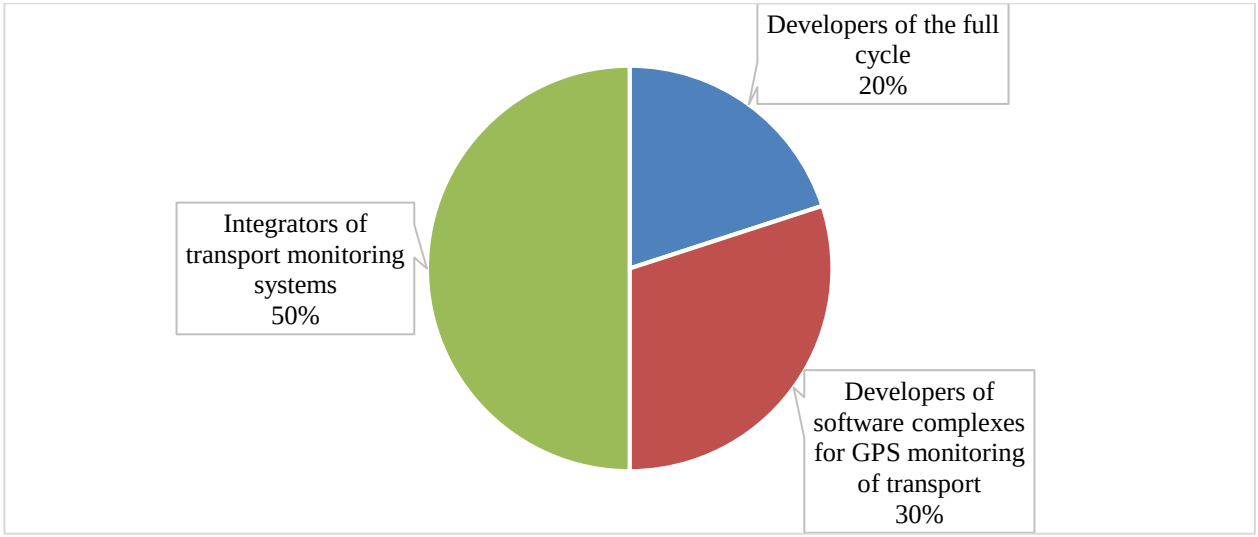

Figure 1.6 – Distribution of the main developers of the GPS monitoring market

Source: [21]

The purpose of satellite logistics monitoring is to ensure complete control over the transportation of motor vehicles. By utilizing satellite navigation systems, monitoring equipment, and digital maps, this system enables efficient tracking and management of vehicles. With the integration of GPS technology, accurate positioning and navigation are achieved, while satellite tracker terminals and cellular communication technologies facilitate real-time monitoring and communication.

The fundamental purpose of the system is to monitor and examine the precise coordinates of the motor vehicle's whereabouts. This advanced technology plays a crucial role in addressing logistical challenges within automated freight transportation and fleet management systems. Thus, vehicle monitoring systems are interrelated elements of navigation, organization and analysis of freight transportation. The set of basic requirements for vehicle monitoring systems in accordance with trends in the logistics market is shown in fig. 1.7.

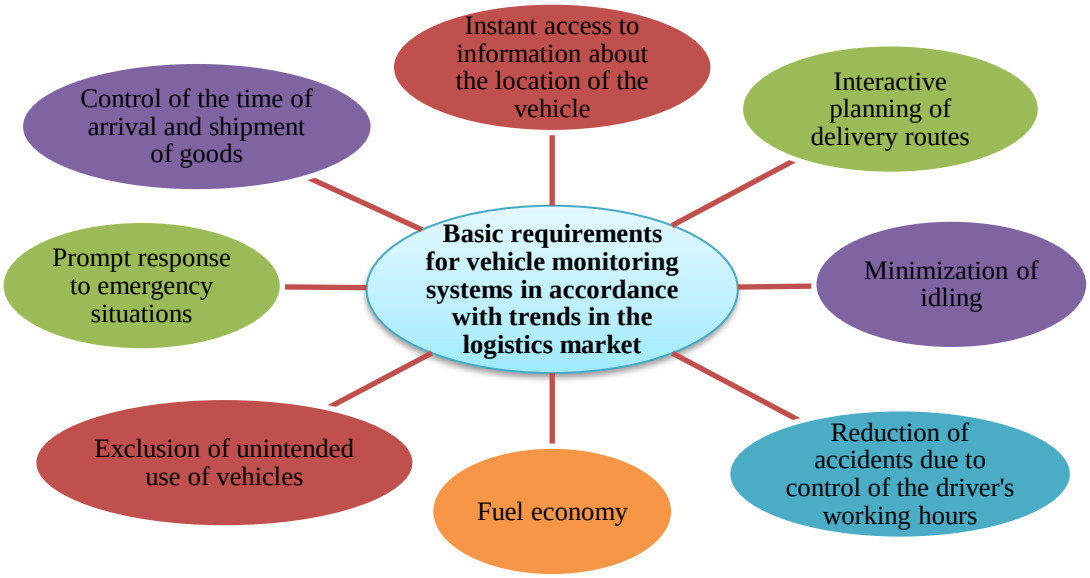

Figure 1.7 – Basic requirements for vehicle monitoring systems in accordance with trends in the logistics market

Source: complied by author

It is crucial to highlight the benefits of utilizing satellite monitoring in the transportation process, which include enhancing the efficiency of transportation and boosting the capacity of shipments by providing real-time access to information

regarding the exact whereabouts of vehicles. This enables timely arrivals of vehicles and deliveries of goods, as well as quick responses to any deviations from the planned route or schedule. Additionally, satellite monitoring aids in routing and transportation planning, leading to smoother operations.

As a result of the functioning of the system, the efficiency of the use of vehicles increases, the control over non-targeted use of the vehicle is strengthened, the “order - delivery”.

1.3 Basic principles of GPS vehicle monitoring systems

In recent years, the top logistics firms globally have been proactively integrating technology into their operations. This move represents a significant advancement in the realm of integrated logistics, also known as "supply chain management". The utilization of technology has allowed these companies to streamline their processes, enhance efficiency, and ultimately improve their overall performance. The need to set a higher level of service and reliability than that of competitors comes first. But to receive the company's expenses should remain almost unchanged. It is in this case that the monitoring system, which allows you to reliably monitor the parameters of the integrated logistics process in the supply chains of enterprises, is of almost decisive importance, therefore, the problems and tasks of implementing logistics monitoring are not only relevant, but also an urgent matter.

According to Yi T.H., Li H.N., Gu M. (2013), the main field of practical application of monitoring is management, or more precisely, management information service in various fields of activity. Monitoring is a rather complex and ambiguous phenomenon. It is used in different areas and for different purposes, but at the same time, it corresponds to general characteristics and properties [52].

Control plays a vital role in the domain of management. It is crucial to distinguish between the terms "monitoring" and "control". Control, as a management

function, serves to stabilize enterprise management. When there is a plethora of indicators that require monitoring and the analysis of their interrelationships, the utilization of computerized systems and other equipment for monitoring becomes imperative. This continuous monitoring allows for the constant observation of the connections between outcomes and enables swift responses to any emerging negative trends.

Monitoring and control serve distinct purposes in the management of a system. Monitoring involves a continuous observation of processes to detect any deviations or negative trends as they occur. This allows for immediate intervention and corrective actions to be taken in order to maintain the desired performance levels. On the other hand, control is implemented at specific time intervals to assess the overall performance and make decisions for future improvements based on the data collected during monitoring.

In the field of management nowadays, and especially in the management of an integrated supply chain, the monitoring system plays an extremely large role. The monitoring system, given the quality of the product and customer service, the regularity of production, sales and deliveries, has a great impact on the competitiveness of the enterprise.

The main advantages of introducing a monitoring system into an integrated supply chain are presented in fig. 1.8. The successful implementation of a well-structured information logistics system is crucial for businesses to effectively manage their supply chain operations. By enabling real-time monitoring of goods movement and ensuring high-quality customer service, companies can enhance their overall efficiency and competitiveness in the market. The main tasks of the supply chain monitoring system are:

- continuous information monitoring of strategic, tactical and operational logistics plan indicators;

- providing logistics system personnel with reliable and operational information about the progress of the logistics process in the supply chain in real time;

- wide implementation of electronic document flow in the organization of information exchange in the supply chain;

- provision of electronic control over the delivery of goods (movement of goods) and facilitation of customs procedures during export-import operations;

- ensuring tracking of vehicles and cargo using satellite communication and navigation systems (GPS);

- informational and analytical support for modern technologies of cargo transportation in the supply chain: intermodal, multimodal, mixed, combined, terminal, etc.;

- use of systems for automatic identification of large or aggregated cargo units and transport containers in supply chain management;

- formation of electronic messages about the approach of cargo for preliminary agreement on the cargo transshipment schedule and a certificate of delivery of goods to the carrier, forwarder, customs.

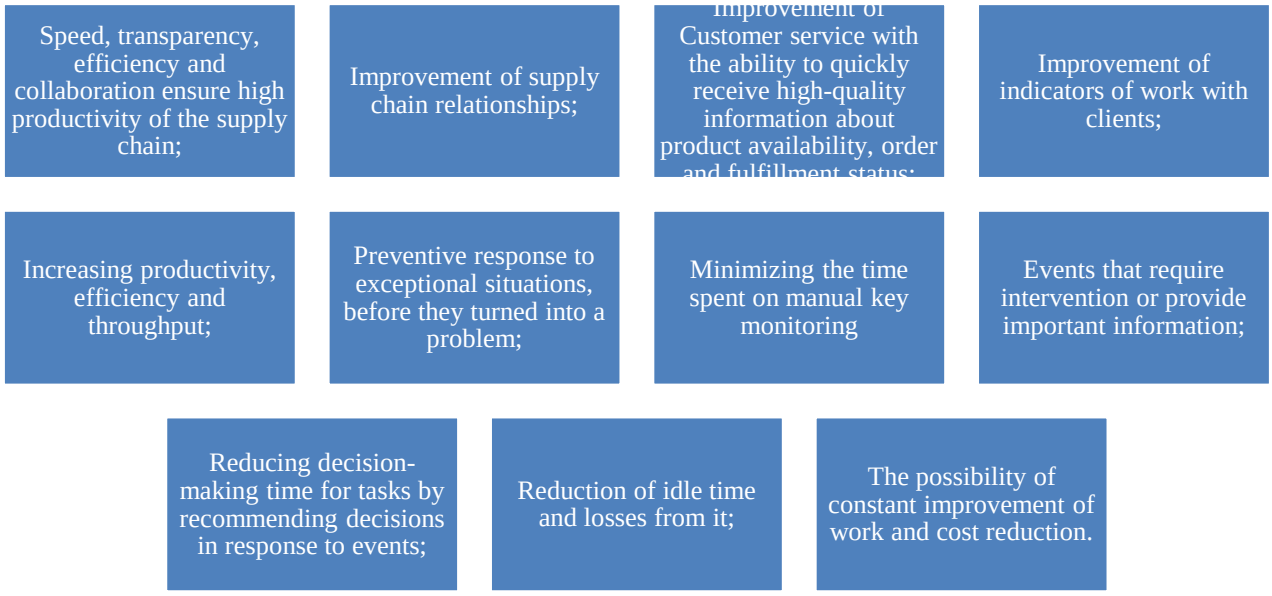

Figure 1.8 – Main advantages of introducing a monitoring system into an integrated supply chain

Source: complied by author

The distance between the satellite and the receiver antenna is determined by utilizing the known speed at which radio waves travel. In order to accurately measure the time it takes for the radio signal to reach its destination, each satellite in the navigation system emits highly accurate time signals. These time signals are generated by atomic clocks that are precisely synchronized with the system time. The coordination between the satellite receiver's clock, signal reception, and calculation of delays plays a significant role in accurately determining the antenna's coordinates. This synchronization process ensures that the navigation receiver can effectively interpret the signals received and provide accurate location information. By following these precise steps, the receiver can perform its functions efficiently and reliably. All other movement parameters (speed, course, distance traveled) are calculated based on measuring the time the object spent moving between two or more points with certain coordinates [52]. The principle of the GPS system operation is presented in fig. 1.9.

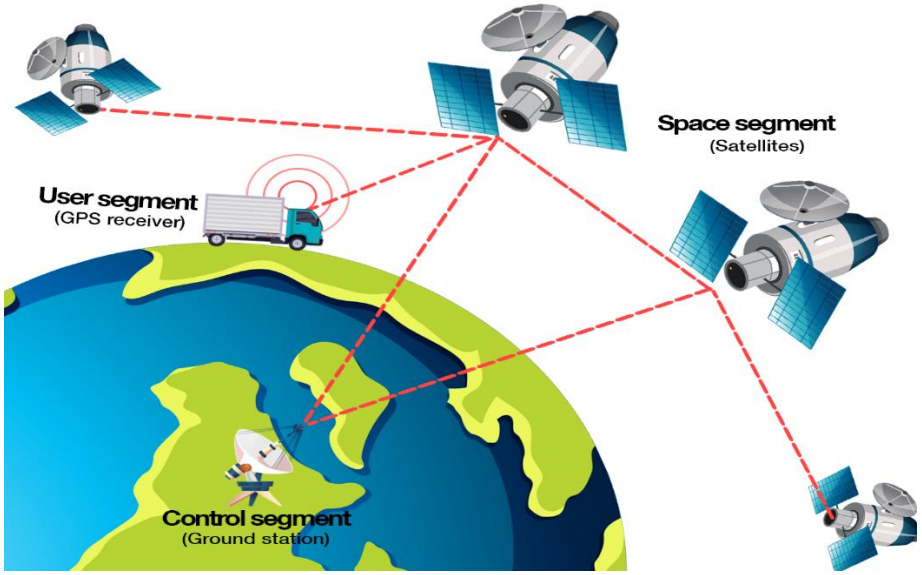

Figure 1.9 – The principle of the GPS system operation

Source: [49]

The scope of application of GPS is presented in fig. 1.10. If the object falls into the "dead zone" of GSM coverage (no cellular signal), all data is stored in the tracker's memory and immediately transmitted to the server and mobile phone when the signal appears, which allows you to implement total control over the object [49] (fig. 1.11).

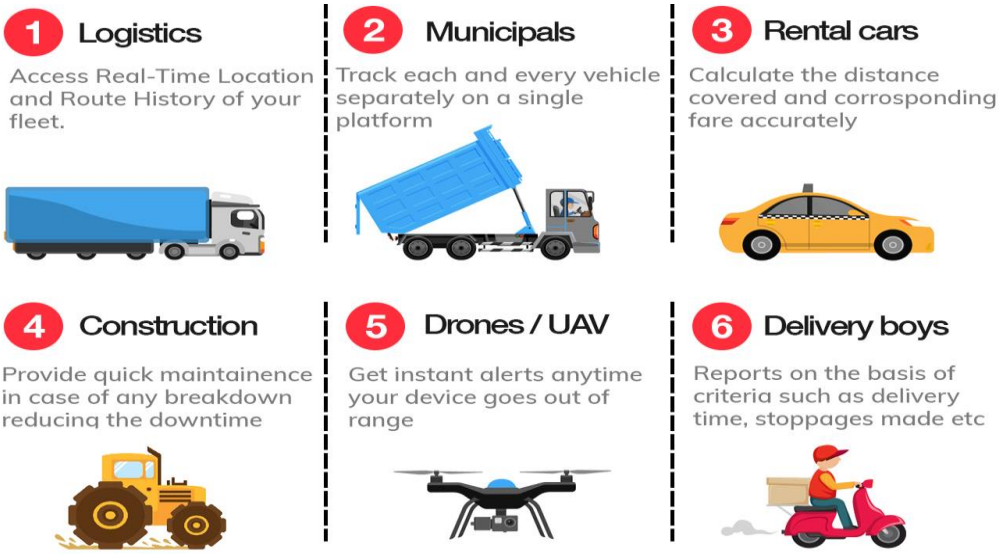

Figure 1.10 – Application of GPS tracking

Source: [49]

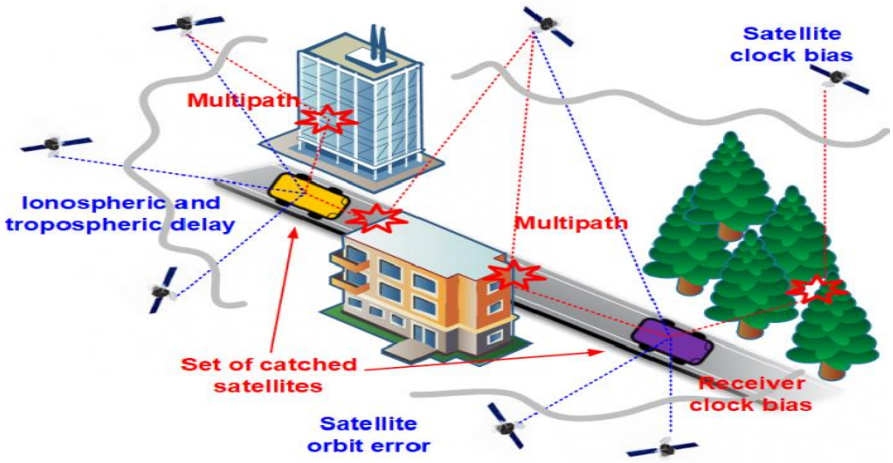

Figure 1.11 – Factors that can Affect GPS Accuracy

Source: [49]

GPS devices are frequently utilized in the commercial sector to track the location of vehicles as they travel along specific routes. There are two main types of tracking methods that are commonly employed: passive tracking and active tracking. With passive tracking, data is stored directly within the GPS tracking system. On the other hand, active tracking involves the continuous transmission of information to a centralized database through a modem integrated into the GPS system unit at regular intervals.

The global demand for locating cars, vehicles, and valuable cargo is significant. This service enables efficient management of motor vehicle routes, ensures vehicle safety, and facilitates their retrieval in the event of theft or other incidents. According to the definition recommended by the International Radio Consultative Committee (ICRC), in systems of automatic (automated) determination of the location of the vehicle (hereinafter, following the English abbreviation, - AVL - Automatic Vehicle Location systems), the location of a moving vehicle in a group of its kind is determined automatically as a result of its movement within the given geographical area [49].

The demand for locating cars, other vehicles, valuable cargo, and more is high worldwide. This service enables the management of motor vehicle routes, ensures vehicle safety, and facilitates their recovery in the event of theft or other incidents.

According to the definition recommended by the International Radio Consultative Committee (ICRC), in systems of automatic (automated) determination of the location of the vehicle (hereinafter, following the English abbreviation, - AVL - Automatic Vehicle Location systems), the location of a moving vehicle in a group of its kind is determined automatically as a result of its movement within the given geographical area [49].

In addition to the positioning subsystem, an AVL system also incorporates a data transmission subsystem. This subsystem enables the seamless transfer of location information from the vehicles to a central server or control center. This ensures that the data is readily available for analysis and decision-making processes. Furthermore, specific implementations of AVL systems may offer multiple options for determining location, providing flexibility and adaptability to different operational requirements.

Depending on the size of the geographical area in which the AVL system operates, it can be:

- local, that is, calculated for a small radius of action, which is characteristic mainly for remote support systems;

- zonal, limited, as a rule, to the boundaries of the settlement, region, region;

- global, for which the area of influence is the territory of several states, continents, the territory of the entire globe.

The implementation of location determination functions in AVL systems is marked by technical parameters such as the precision of location determination and the frequency of data verification. It is evident that these parameters are contingent upon the operational area of the AVL system. The smaller the size of the area of operation, the higher the accuracy of determining the location should be. For example, for zonal systems operating on the territory of the city, the accuracy of determining the location from 100 to 200 m is considered sufficient. Some special systems require the accuracy of units of meters, for global systems, the accuracy of units of kilometers is sufficient. For zonal dispatching systems, obtaining data on the location of a moving object up to once per minute can be considered ideal. Remote support systems require a higher frequency of information updates.

The relevance of the task of fuel control lies in the fact that transport and logistics enterprises with their own fleet face the problem of high costs for their maintenance. Approximately half of all costs are incurred by fuel costs, and considering that the prices of PMM are increasing every day, there is a serious question of controlling fuel consumption rates and whether all the fuel is used as intended.

The integration of GPS systems in fuel consumption monitoring and control enables a comprehensive tracking of every liter of fuel utilized. The implementation of this system ensures that the expenses associated with it are fully recovered within the initial month, thanks to the substantial fuel savings achieved. Consequently, fuel consumption is promptly reduced and maintained within the prescribed limit [44].

In essence, GPS navigation systems play a crucial role in ensuring a smooth and efficient driving experience. By providing real-time information on traffic conditions, road closures, and alternative routes, these systems help drivers make informed decisions while on the road. Additionally, the ability to monitor fuel levels allows for better planning and management of refueling stops [40].

Furthermore, it is achievable to analyze in detail the consumption patterns of fuel, the rates at which it is used under different loads and distances covered. The exact spots where refueling occurs, any stops made, as well as periods of idle time are all

carefully logged. The fuel is employed as per its designated function: for prescribed travel routes.

In fig. 1.12 presents 3 main components of GPS monitoring of cost and fuel level control.

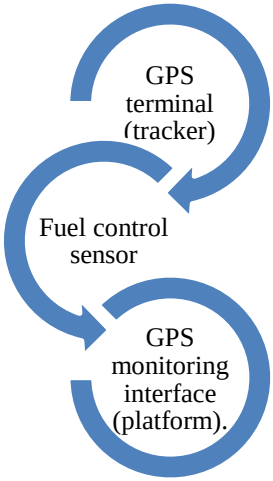

Figure 1.12 – Components of GPS monitoring of cost and fuel level control

Source: complied by author according to [45, 46]

The GPS system for monitoring of cost and fuel level control consists of three main parts that are interconnected:

1) GPS terminal (tracker) – navigation device.

2) Fuel control sensor – a digital gauge of the actual fuel level in the tank.

The price of such a sensor is much higher than a capacitive one. Both of them transmit the real amount of fuel in the tank every 10-20 seconds. In the form of a graph, the rate of change of the fuel level over time is constructed. You can estimate the amount of filling and draining according to the schedule. The standard float sensor cannot be used as a control device for the fuel level in the tank, since its measurement error is greater than 20%. 3) The GPS monitoring interface (platform) is a computer program or WEB site through which real-time vehicle tracking is carried out. History is also saved, reports can be generated for any period of time.

The program enables: display data on fuel consumption, determine places, time and volumes of refueling or ebbing; estimate mileage statistics and fuel consumption

on certain routes, trips, sections; there is also a mobile application for the phone, with similar functionality as on the computer.

It is worth noting that there are also flow meters for monitoring the volume of fuel that has passed from the tank to the car engine. They are installed in the fuel line for forward and reverse flow. The disadvantage of such control systems (flow meters) is their high cost and the inability to see the fuel level.

The effective control and management of fuel play a vital role in the transportation sector. It is an essential task for enterprises engaged in freight transportation as it directly affects their ability to compete in the market. Furthermore, the efficient management of a company's fleet contributes to improved operational efficiency, ensuring smooth and cost-effective transportation services.

The GPS monitoring system uses several methods of fuel control; various types of fuel sensors help solve this problem (fig. 1.14).

Sensors of the fuel metering flow equipment system

Sensors for capacitive control of fuel

Sensors for the ultrasonic method of fuel level control

Sensors of the CAN fuel control system

Figure 1.14 – Types of fuel sensors in the GPS monitoring system

Source: complied by author according to [49]

To begin with, it is essential to provide a concise summary of the benefits and drawbacks associated with various types and alterations of fuel sensors. This knowledge will enable you to gain a better understanding and effectively articulate your requirements when seeking assistance from GPS fuel consumption control service providers.

Having analyzed from the main manufacturers and reports on the types of installation of fuel sensors on the fleet of transport enterprises, in the table 1.2 group the main advantages and disadvantages of each type of fuel sensor.

Table 1.2 – Advantages and disadvantages of types of fuel sensors

Types of fuel sensors	Advantages	Disadvantages
Sensors of the fuel metering flow equipment system.	– Accuracy of readings (probable measurement error is no more than 1%); – Control of fuel consumption, not its amount in the tank; – The possibility of using it locally without online data control; – Does not require taring.	- Impact on the operation of the fuel quality flow meter; – The need for frequent maintenance; – Installation and regular replacement of additional filters; – Difficult installation process (incorrect installation can affect the operation of the unit); – The meter does not give any information about refueling / emptying and remaining fuel in the tanks.
Sensors for capacitive control of fuel	– Simple installation, without interfering with the operation of the fuel system; – The most common type of tracking; – Displays the volume of real fillings / drains and estimated consumption; – Data is obtained in real time, making it impossible for unauthorized persons to influence the performance of the equipment; – Practically makes it impossible to drain fuel with a volume of more than 2-5 liters.	– Relatively long installation and taring process (3 hours); – Fluctuations in fuel in the tank (especially for agricultural and construction machinery) lead to complications in cost analysis; – In case of a change in the properties of the fuel or serious changes in meteorological conditions, the data of the calibration tables should be adjusted using special correction coefficients.
Sensors for the ultrasonic method of fuel level control	– Ease of installation; – Consistently high measurement accuracy; – The probability of data deviation is close to 0.	– High cost; – The need to keep the sensor clean (which obliges to systematically clean the device).
Sensors of the CAN fuel control system	– Relative ease of installation; – In addition to data on the level and consumption of gasoline, additional data can be obtained (engine speed, engine load, brake pedal operation, interior temperature, coolant temperature, etc.).	– Not all automakers make fuel information publicly available via CAN. - In the case of new cars, the readings are quite accurate, but over time they may differ significantly from the actual ones; – Reprogramming the on-board computer may affect the displays.

Source: complied by author according to [45, 46]

The conducted analysis allows to draw conclusions that, in our opinion, in today's realities, a combination of options 2 and 4 is ideal - installation of monitoring equipment in combination with a fuel level sensor and a CAN reader. The stages of implementation of fuel control due to the GPS monitoring system are presented in fig. 1.15.

Finally, after the successful completion of the installation and testing phases, the GPS tracker is fully operational and ready to provide real-time tracking information to the client. The client can now monitor the vehicle's location, speed, and other relevant data through the server interface. This meticulous process ensures that the GPS tracker is installed correctly, functions properly, and meets the client's requirements for effective tracking and monitoring.

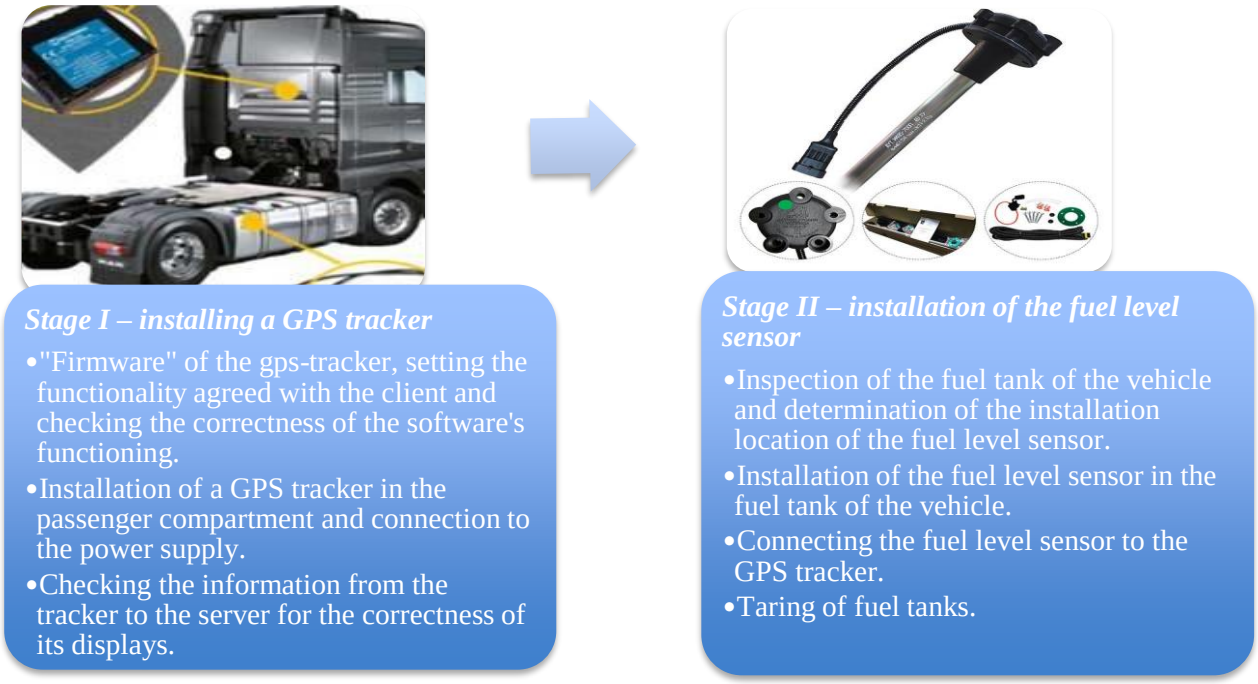

Figure 1.15 – Stages of implementation of fuel control through the GPS monitoring system

Source: complied by author according to [27]

In the second phase, the process begins with the installation of fuel level sensors. This entails thoroughly examining the vehicle's fuel tank and identifying the optimal position for installing the sensor. Once the ideal location is determined, the sensor is securely installed within the fuel tank. Following this, the fuel level sensor is connected to the GPS tracker, ensuring accurate monitoring and tracking. Lastly, the fuel tanks are calibrated to establish a baseline measurement, known as taring, which enables precise fuel level readings.

So, today, in terms of expenses for the maintenance of transport, the main share falls on the article of fuel and lubricants, given their high cost. At the same time, without a control system, it is extremely difficult to monitor the operation of the transport, the efficiency of its use and the correctness of operation, non-target use, and as a result - costs for fuel and lubricants.

Summing up the results of the analysis, we can say that the implementation of a GPS monitoring system significantly increases the efficiency of using a vehicle fleet and reduces the costs of its operation. Controlling fuel consumption is an important task in the management process, since fuel costs make up a large part of the daily costs of providing a vehicle fleet for any enterprise.

The fuel level control method stands out as the most precise and informative approach in today's context. This method not only allows us to access information regarding fuel consumption and level but also provides data on refueling time, volume, and location. The margin of error in this method is merely 1-2% of the fuel tank's volume, making it considerably more accurate than the readings obtained from a conventional automotive sensor system. The latter tends to have an error rate of at least 10%, which further amplifies as the vehicle ages.

The analysis of the issue of the satellite vehicle monitoring system allows us to draw the following conclusions. Modern technology offers many safety and security systems of the vehicle. One of the most advanced is the Global Positioning System or GPS. Based on this system, it is possible to monitor any vehicle. Satellite monitoring systems allow both to determine the location of the controlled object and to receive various information about the condition of the monitored object itself. To obtain information about the state of the object, it is necessary to install a number of sensors. GPS monitoring also allows, in addition to real time determination, to view the entire route traveled.

A thorough analysis of the most recent research and publications has indicated that a significant proportion of scientific literature is dedicated to exploring the monitoring of vehicles' technical condition and the methodologies employed for this purpose. However, the majority of these publications adopt a descriptive approach,

either outlining the fundamental approaches utilized in a specific method or elucidating the functionalities associated with them. The complex problem of monitoring the technical condition of vehicles can be effectively addressed through a scientific approach. This approach entails the development of a classification system that categorizes the various methods used in research. By identifying common features among these methods, researchers can gain a deeper understanding of the subject and devise more efficient solutions.

The study of the analyzed topic made it possible to determine key classification features and to present a classification scheme developed on its basis for methods of monitoring the technical condition of vehicles.

It was found that in order to achieve the maximum possible accuracy of continuous monitoring of the vehicle's technical condition, it is worth using satellite monitoring systems connected to OBD and supplemented with fuel consumption control sensors. Since fuel consumption is a more accurate indicator that characterizes the technical condition of the vehicle than the mileage, this approach makes it possible to promptly monitor its deterioration. Supplementing this information with data from the on-board self-diagnosis system allows, with sufficiently high accuracy, to determine potential malfunctions and make a decision on the need for preventive maintenance or repair.

The emergence of satellite monitoring systems has opened up new avenues for enhancing efficiency and compliance in the transport industry. With the increasing focus on environmental sustainability and regulatory compliance, there is a growing need for advanced monitoring solutions. The integration of monitoring technologies in the insurance sector has further boosted the demand for telematics systems, driving innovation and growth in the market.

The described integrated approaches to implementing a monitoring system in transport companies allows to highlight the following advantages:

- Speed, transparency, efficiency and collaboration ensure high supply chain productivity;

- Improving relationships in the supply chain;

- Improving customer service with the ability to quickly obtain high-quality information about product availability, order status and fulfilment;

- Improving customer service performance;

- Increased productivity, efficiency and throughput of the chain;

- Preventive response to exceptional situations before they develop into a problem;

- Minimizing the time spent on manual monitoring of keys;

- Monitoring events that require intervention or provide important information;

- Reducing the time it takes to make decisions on tasks by recommending decisions in response to events;

- Reducing downtime and losses from it;

- Possibility of continuous improvement of work and cost reduction.

In the logistics market, transport enterprises face a significant challenge in managing their expenses, particularly when it comes to fuel costs. As fuel and lubricant prices continue to escalate each day, these companies prioritize the implementation of strategies to effectively control and monitor fuel consumption as a crucial aspect of their operations.

GPS systems for fuel consumption monitoring and control were analyzed in detail, which allow full tracking of every liter of fuel consumed. It has been determined that GPS navigation systems increase the safety of drivers, contribute to maintaining the speed regime, choosing the best driving route, and also no longer need to report to the management, because all information about how the car was used is displayed in real time or in history. With the use of fuel level control, you can see the exact volume of refueling and the level of fuel in the fuel tank.

The types of fuel sensors are analysed in detail, their main advantages and disadvantages are presented. The stages of their implementation on motor vehicles are described.

Chapter 1 summary

In the theoretical part of the qualification paper devoted to theoretical aspects of satellite vehicle tracking systems. The analysis of the issue of the satellite vehicle monitoring system allows us to draw the following conclusions.

Modern technology offers many safety and security systems of the vehicle. One of the most advanced is the Global Positioning System or GPS. Based on this system, it is possible to monitor any vehicle. Satellite monitoring systems allow both to determine the location of the controlled object and to receive various information about the condition of the monitored object itself. To obtain information about the state of the object, it is necessary to install a number of sensors. GPS monitoring also allows, in addition to real time determination, to view the entire route traveled.

Analysis of the latest research and publications showed that a significant number of scientific publications are devoted to the issue of monitoring the technical condition of vehicles and methods of its organization. However, most of them are descriptive in nature and reveal either the principle approaches used in one or another method, or their functionality. A scientific approach to the complex solution of the problem of monitoring researches of the technical condition of vehicles involves the creation of a classification of existing methods based on certain common features.

The study of the analyzed topic made it possible to determine key classification features and to present a classification scheme developed on its basis for methods of monitoring the technical condition of vehicles.

It was found that in order to achieve the maximum possible accuracy of continuous monitoring of the vehicle's technical condition, it is worth using satellite monitoring systems connected to OBD and supplemented with fuel consumption control sensors. Since fuel consumption is a more accurate indicator that characterizes the technical condition of the vehicle than the mileage, this approach makes it possible to promptly monitor its deterioration. Supplementing this information with data from the on-board self-diagnosis system allows, with sufficiently high accuracy, to

determine potential malfunctions and make a decision on the need for preventive maintenance or repair.

An analysis of global trends in the field of transport monitoring has shown that the potential for using satellite monitoring systems is great. In addition to the traditional tasks of cost optimization, tightening legislation in the field of transport and environmental regulation, as well as the use of systems monitoring technologies in the insurance sector of the economy, have led to a significant increase in demand for monitoring systems and given new impetus to the development of the global telematics market.

The activity of transport enterprises in the logistics market shows that approximately half of all costs are incurred by fuel costs, and given the fact that the prices of fuel and lubricants are increasing every day, the first part of the work deals with the issue of fuel rationing control.

GPS systems for fuel consumption monitoring and control were analyzed in detail, which allow full tracking of every Liter of fuel consumed. It has been determined that GPS navigation systems increase the safety of drivers, contribute to maintaining the speed regime, choosing the best driving route, and also no longer need to report to the management, because all information about how the car was used is displayed in real time or in history. With the use of fuel level control, you can see the exact volume of refueling and the level of fuel in the fuel tank.

The types of fuel sensors are analyzed in detail, their main advantages and disadvantages are presented. The stages of their implementation on motor vehicles are described.

CHAPTER 2
GENERAL ANALYSIS OF «CD TRANS» LLC'S ACTIVITIES AND THE COMPANY'S CARGO TRANSPORTATION MONITORING SYSTEM

2.1 Market analysis of GPS system manufacturers

It is important to note that the market for transport monitoring systems is constantly evolving, and new technologies and innovative solutions are emerging. In addition, there are many small and medium-sized companies that specialize in specific market segments or regions. When choosing a vehicle monitoring system provider, it is important to consider your unique requirements and business needs, as well as evaluate the reputation, reliability and quality of the products and services offered.

Several new technologies and innovations have emerged in the vehicle monitoring market that are bringing significant changes to the way vehicles are monitored and controlled. Here are some of them [18]:

1. Internet of Things (IoT): IoT technology plays an important role in the development of transport monitoring systems. Using various sensors and devices installed on vehicles, real-time data on location, speed, engine condition, fuel level and other parameters can be obtained. This data is transmitted via the Internet and is used for monitoring and making management decisions.

2. Big Data and Analytics: With the advent of big data and the development of analytical tools, deeper research and analysis of data collected through transport monitoring systems has become possible. Analytics allows you to identify trends, patterns, predict behaviour and optimize operational processes in the transport sector.

3. Artificial Intelligence (AI) and Machine Learning: AI and machine learning technologies are used to automatically analyse data and make decisions in real time. For example, transport monitoring systems can use AI to determine optimal routes, predict arrival times, identify anomalies in driver behaviour, and other tasks.

4. Internet of Things (IoT) sensors and devices: The advent of compact and energy-efficient IoT sensors and devices allows for more accurate collection of vehicle health data. For example, sensors can monitor fuel consumption, cargo compartment temperature, wear levels and other parameters to help manage fleets and ensure safety.

5. Mobile Applications: Mobile applications have become a popular tool for monitoring and managing vehicles. They allow drivers and fleet operators to access information about location, vehicle condition, delivery schedules and other useful information directly on their smartphones.

6. Real-time data analytics: With the increasing availability of real-time data from vehicles and IoT sensors, advanced data analytics techniques are being employed to derive valuable insights. Real-time data analytics enables instant monitoring of vehicle performance, driver behaviour, fuel consumption, and other key parameters. By analysing this data in real-time, fleet managers can make informed decisions, identify potential issues, and optimize operations on the go.

7. Predictive maintenance: Predictive maintenance uses data collected from vehicles and applies machine learning algorithms to predict when maintenance or repairs are likely to be needed. By monitoring various parameters such as engine performance, tire wear, and battery health, predictive maintenance systems can detect patterns and anomalies that indicate potential failures. This proactive approach helps prevent unexpected breakdowns, reduces downtime, and optimizes maintenance schedules.

8. Video telematics: Video telematics combines video cameras with telematics systems to provide a comprehensive view of vehicle operations. Video feeds from in-vehicle cameras can be analysed to monitor driver behaviour, identify safety risks such as distracted driving or harsh braking, and provide evidence in case of accidents or disputes. Video telematics enhances fleet safety, driver training, and overall operational efficiency.

9. Advanced driver assistance systems (ADAS): ADAS technologies, such as collision avoidance systems, lane departure warning, and adaptive cruise control, are becoming more prevalent in transportation monitoring systems. These systems use

sensors, cameras, and radar to monitor the vehicle's surroundings and provide alerts or automated actions to enhance driver safety. ADAS can help prevent accidents, reduce insurance costs, and improve overall fleet performance.

10. Integration with smart city infrastructure: The emergence of smart city initiatives has opened up opportunities for integration between transportation monitoring systems and urban infrastructure. For example, systems can be integrated with traffic management systems, parking guidance systems, and public transportation networks to optimize routes, reduce congestion, and improve overall transportation efficiency within cities.

It's important to note that the field of transportation monitoring systems is evolving rapidly, and new technologies and innovations continue to emerge. These advancements aim to enhance safety, efficiency, and sustainability in transportation operations while providing valuable insights for fleet managers and operators.

At the moment, the market for manufacturers of transport monitoring systems in the world is represented by a wide range of companies that offer various solutions and services. Below is an overview of several major players in this market. Let’s have a closer look at the top GPS hardware manufacturers based on our client’s preference (table 2.1).

South Korean manufacturer Suntech shows significant growth in GPS device sales of more than 70% in 2023. The company's products are in demand especially in North and South America, as they have proven themselves in the field of not only monitoring but also technology for IoT [18].

The 9th and 8th places in the ranking are occupied by Chinese manufacturers of GPS devices, Sinotrack and Topflytech, respectively. These companies have a total number of connected devices of about 6 thousand, and both companies enjoy worldwide demand for quality products at an affordable price. Let us note that the growth of 2 companies in sold products over the analysed period shows more than 170%, which is an intensive conquest of the telematics goods market [21].

The company representative of Taiwan – «Atrack» for 2023 took 7th place. At the same time, the annual increase was more than 200%. This shows the interest and

need of customers to purchase trackers in more than 100 countries around the world. Atrack has a variety of telematics devices for different purposes.

Table 2.1 – Top 10 World GPS hardware manufacturers in 2023

Name of company	Country	Annual Sales Volume 2023	Growth compared to the previous year, %	Total number of connected devices, units
Teltonika	Lithuania	95500	230	137000
Coban	China	28000	46	89000
Queclink	The USA	20000	100	40000
Concox	China	15600	31	65500
Ruptela	Lithuania	13400	57	36500
Sensata Insights	Lithuania	9800	155	16000
Atrack	Taiwan	9000	230	13000
Topflytech	China	5800	172	6000
Sinotrack	China	4000	231	6000
Suntech	South Korean	3500	71	8000

Source: complied by author according to [17, 19]

Lithuania is represented in the top 10 manufacturers of monitoring and telematics devices by three manufacturers. 5th and 6th places are Sensata Insights and Ruptela. These companies have 16 thousand and 36.5 thousand connected devices, respectively. Moreover, Ruptela for 2023 has an increase of 13.4 thousand, which is why it has overtaken its competitor Sensata Insights. In any case, companies offer their clients both the simplest telematics solutions and specialize in the implementation of complex systems, with the possibility of their integration into clients' global supply chains [17].

Total number of connected devices by GPS hardware manufacturers according to market results in 2023 is presented in fig. 2.1. On the pie chart below (fig. 2.2), presented the share of each of the top 10 brands constitutes in the overall devices' growth [19].

Another Chinese company Concox is a top manufacturer in the ranking and takes 4th place with the number of connected devices 65.5 thousand devices. The Concox

company is known not only in the market for tracker products themselves, but also for information software, thus offering its customers a full range of services - from tracker installation to an information system.

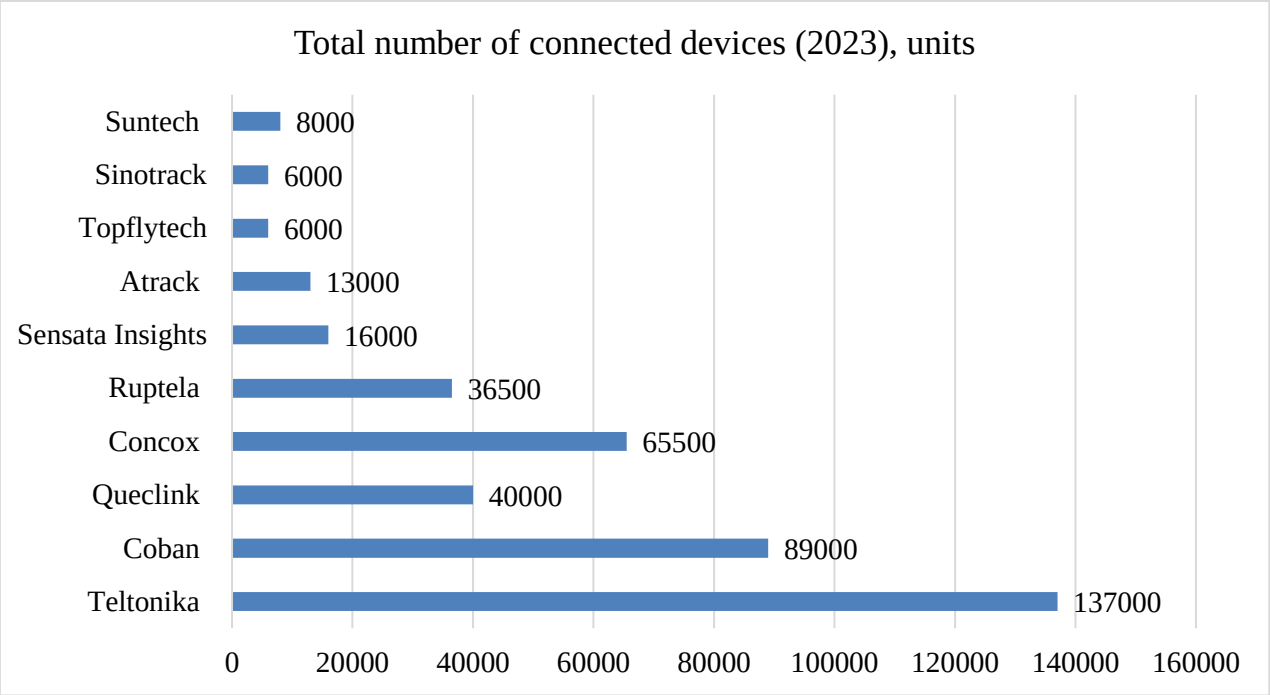

Figure 2.1 – Total number of connected devices by GPS hardware manufacturers (2022) , units

Source: complied by author according to [19]

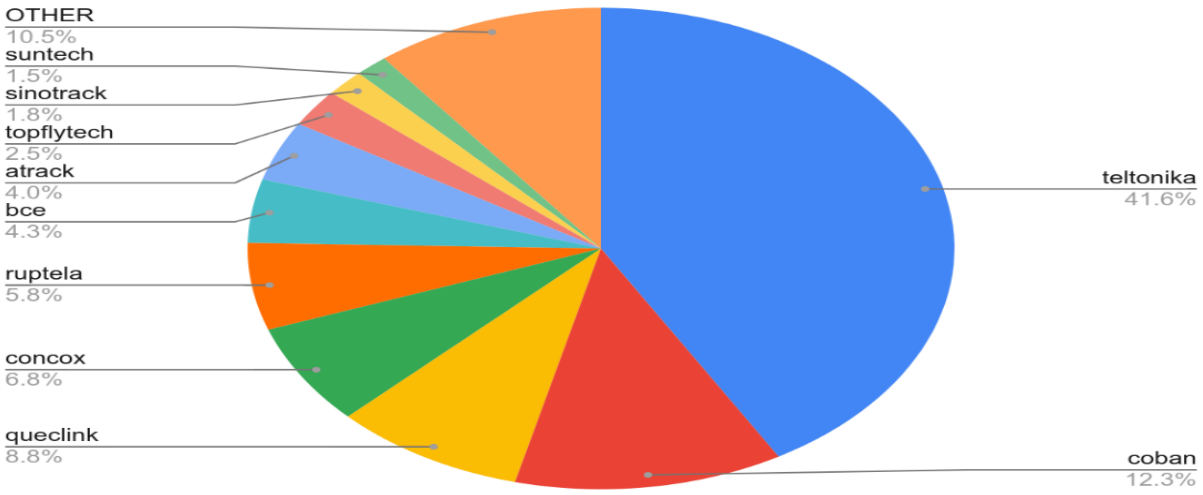

Figure 2.2 – The share of each of the top 10 brands in the overall devices' growth

Source: complied by author according to [17, 19]

The US market in third place is represented by the manufacturer Queclink with the number of connected devices in the field of telematics equal to 40 thousand. The company offers both the devices themselves and information support for various sectors of the economy, thus covering a wide range of clients around the world. Queclink is well established in the IoT space and holds a leading position among its competitors there.

The Chinese company “Coban” ranks 2nd among competitors in its own country thanks to the connection of new devices over the past year in the amount of 28 thousand and a total number of more than 89 thousand. The main products are GPS trackers at an affordable price, which has made this brand very popular.

The market leader in 2022 was Teltonika, with a total number of connected telematics devices of more than 137 thousand. The company specializes in a wide range of trackers and information support, offering its customers European quality at a reasonable price [34].

Even though basic GPS tracking is still prevalent in developing countries, which contributes to the popularity and high sales of mass devices, more complex IoT and telematics projects, especially in developed countries, require advanced functionality and higher reliability, which is best delivered by higher-class hardware.

2.2 General characteristics of «CD Trans» LLC in the market of fuel and lubricant imports

«CD Trans» LLC is a leading Ukrainian company, the main activity of which is the retail sale of fuel and related goods through a network of gas stations. The company is one of the leaders in the oil products market. «CD Trans» LLC operates in most regions of Ukraine. Another important area of activity of «CD Trans» LLC is the sale of consumer and related goods in stores at gas stations. «CD Trans» LLC also sells oil

products in large and small groups and provides services for the storage and transportation of oil products for third-party legal entities.

The company's head office is located in Kyiv. The key indicators characterizing the company are given in the table 2.2.

Table 2.2 - Key indicators of «CD Trans» LLC

№	Indicator	Quantitative characteristic
1	The number of fuel tankers	32
2	Number of gas tankers	5
3	Number of accredited laboratories	4
4	including number of mobile laboratories	2
5	The number of active own oil depots	3
6	Total number of employees	111

The history of «CD Trans» LLC began in 2012. Today, Ukraine has two types of national fuel quality standards. The old State standard of Ukraine regulate the fuel of those refineries that produce gasoline close to the EURO 3 standard. The new State standard of Ukraine comply with EURO 4 and EURO 5 European standards and meet the need for high-quality fuel for new cars. The gas station network in Ukraine offers fuel that meets the new State standard of Ukraine and the requirements of the environmental standards EURO 5 (Pulls 95, Pulls Diesel, A-95 EURO) and EURO 4 (Diesel fuel EURO). The EURO standard is, in fact, an environmental standard that strictly regulates the content of toxins in fuel. Their small amount, as a result, significantly improves the quality of fuel, which is determined by the level of content of various toxic substances: lead, sulphur, benzene and other fuel components. It is these substances in fuel that are the biggest polluters of the environment.

«CD Trans» LLC consistently supports and develops the reputation of a company that, in addition to its active position on the market, implements the best global standards and practices into Ukrainian business and the business environment, lives an active public life, actively supports the public sector, cultural and sports life of society. The types of fuel offered by the company and their properties are listed in table 2.3.

Table 2.3 – Offered types of fuel by «CD Trans» LLC

№ п/п	Fuel	Standard	Octane / cetane	Imports
1	Pulls 95	EN 228:2008 (EURO 5)	95	+
2	Pulls Diesel	EN 590:2009 (EURO 5)	till 55	+
3	A-95 EURO	EN 228:2008 (EURO 5)	95	+
4	A-92 EURO	EN 228:2008 (EURO 5)	92	+
5	Diesel fuel EURO	EN 590:2004 (EURO 5, EURO 4)	51	+
6	A-80	State standard of Ukraine 4063-2001	80	-

So, according to the data in the table, you can see that most of the fuel is imported by the company. Countries that export fuel are presented in fig. 2.3.

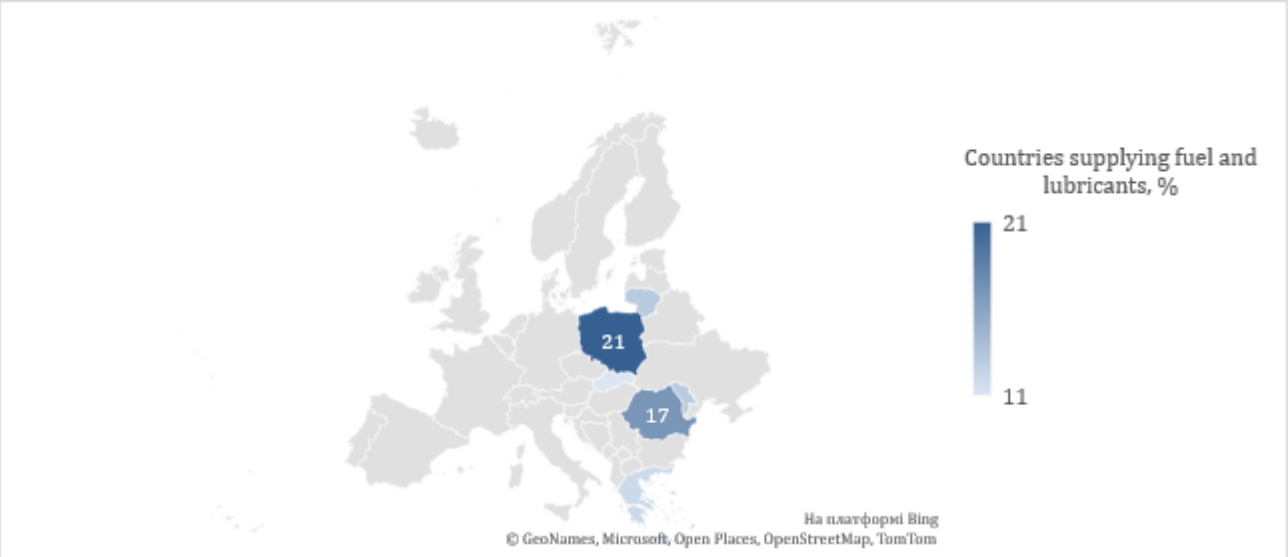

Figure 2.3 – Geography of fuel and lubricant imports by «CD Trans» LLC in Ukraine in 2023

The largest number of fuel names is supplied from the Baltic countries, Poland, Greece, Romania, Moldova, and Slovakia. Distribution by share of supply is shown in fig. 2.3. A large list of fuel types is also imported from Lithuania. Fuel undergoes strict quality control. In order to carry out more effective control over the quality of fuel in

the network of «CD Trans» LLC, a separate division was created - the Testing Centre for Fuel and Lubricant Materials, consisting of eight stationary, three district and two mobile laboratories. The laboratories of the Testing Centre are equipped with modern high-precision equipment manufactured in the USA, Japan, Austria, Germany, and Great Britain.

The efficiency of information exchange regarding the quality of oil products is provided by a specially created information and analytical system.

In the laboratories, the quality of gasoline and diesel fuel is checked according to more than fifteen different indicators, such as detonation resistance (octane number indicators), sulphur content in fuel, the presence of various impurities, water, resins, etc. in gasoline, diesel fuel or oils.

Control over the quality of oil products is carried out according to a three-stage system.

1. Input control.

Incoming control involves checking the quality of petroleum products in each tank car arriving at the company's oil terminals. These tests and analyses give us the opportunity to monitor the quality of petroleum products of various refineries and provide recommendations to the commercial direction of the Company regarding the rating of refineries by the quality of the petroleum products they offer «CD Trans» LLC.

2. Storage in tanks.

Samples from the tank for quality control are taken after draining each batch of fuel. As a result of the analysis of this sample, «CD Trans» LLC receives a passport of the quality of the oil product, which the next day, together with the waybill, accompanies the oil product in the fuel truck from the oil terminal to the customers.

3. Quality control at gas stations.

Quality control of petroleum products is regularly carried out by both stationary laboratories and a specially created mobile laboratory. Samples of petroleum products taken at gas stations are analysed in the laboratory according to the field of accreditation of the laboratory. According to the results of the analysis of each type of

fuel, a quality passport is filled out, which is stored at the gas station in a place accessible to the consumer.

The construction of the organizational structure of the enterprise plays a very important role. The organizational structure significantly affects the content and justification of management decisions, the speed of their delivery to direct executors, the clarity, reliability and efficiency of information, the content of the work of various managers and functionaries.

The total number of employees of «CD Trans» LLC is presented in the table 2.4 and show the dynamics of the increase in fig. 2.4. At the beginning of 2024, the total number of employees of «CD Trans» LLC was 47 people (in addition, there are 64 drivers).

Table 2.4 – Staff structure of employees of «CD Trans» LLC during 2021 - 2024

№	Staff structure	Number of persons at the beginning of the year			
		2021	2022	2023	2024
1.	General Director of «CD Trans» LLC	1	1	1	1
2.	Chief lawyer	1	1	1	1
3.	Lawyers	1	3	4	5
4.	Financial director	1	1	1	1
5.	Accountants	1	2	3	3
6.	Director of logistics	1	1	1	1
7.	International transportation managers	1	2	3	8
8.	Domestic transportation managers	1	1	3	5
9.	Forwarders	2	2	3	4
10.	Drivers	8	9	10	12
11.	Chief Engineer	1	1	1	1
12.	Mechanics	2	2	3	5
13.	A total of persons	21	26	34	47

Next, the detailed information about the main tasks and responsibilities of the company's employees will present. Therefore, the main tasks of the legal department are legal support for the conclusion of transportation contracts, as well as interaction with various state and private structures, both domestic and foreign.

The director of logistics is responsible for the operation of «CD Trans» LLC, namely, control over the organization of the provided transport services of the enterprise. Competence of international and domestic transportation managers includes registration and coordination of order fulfilment, organization of related services. Accordingly, managers operate on transport exchanges and online platforms of carriers. Freight forwarders are responsible for shipment/delivery, loading, unloading, marking, packing, etc.

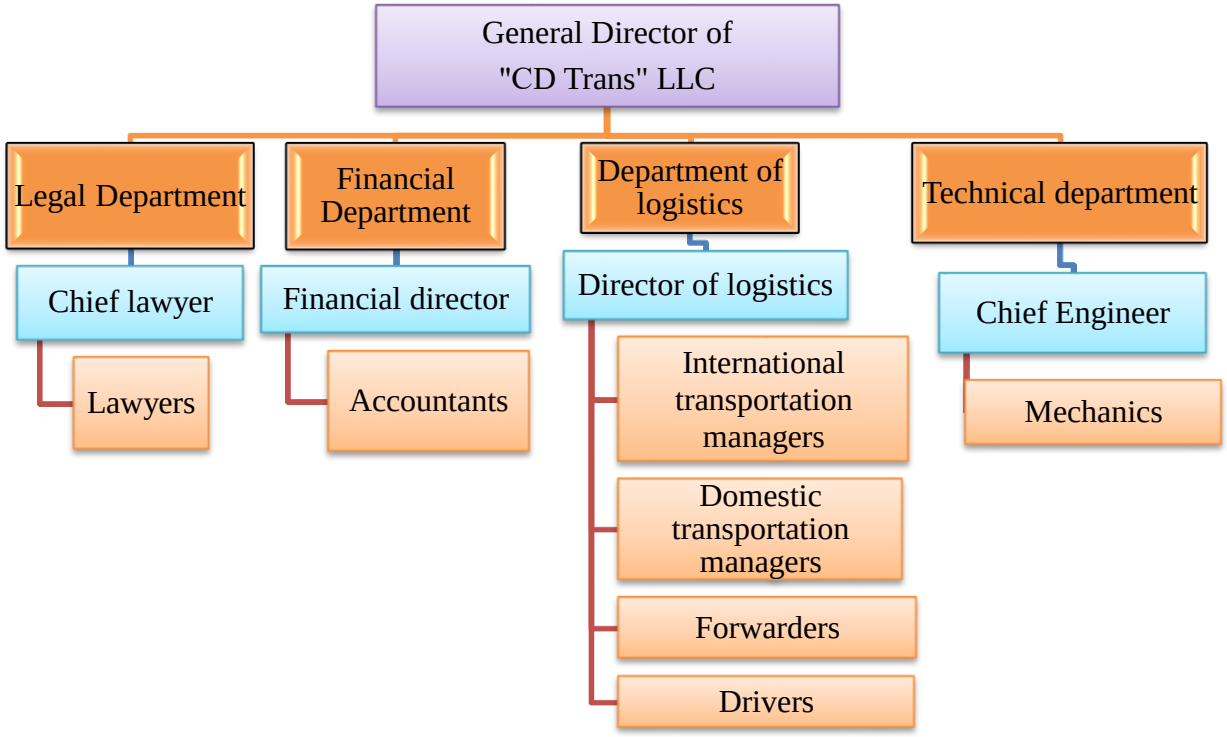

Figure 2.4 – Organizational structure of «CD Trans» LLC management

Dynamics of the number of full-time employees of «CD Trans» LLC during for 2021 – 2024 is presented in fig. 2.5.

Accountants report to the financial director, who is responsible for the financial state of the enterprise and mutual settlements with clients and partners.

The technical department, in particular, the chief engineer is responsible for the technical condition of the company's vehicles. Vehicles of the enterprise that are not in flight are located either in the repair area or on the territory of the enterprise.

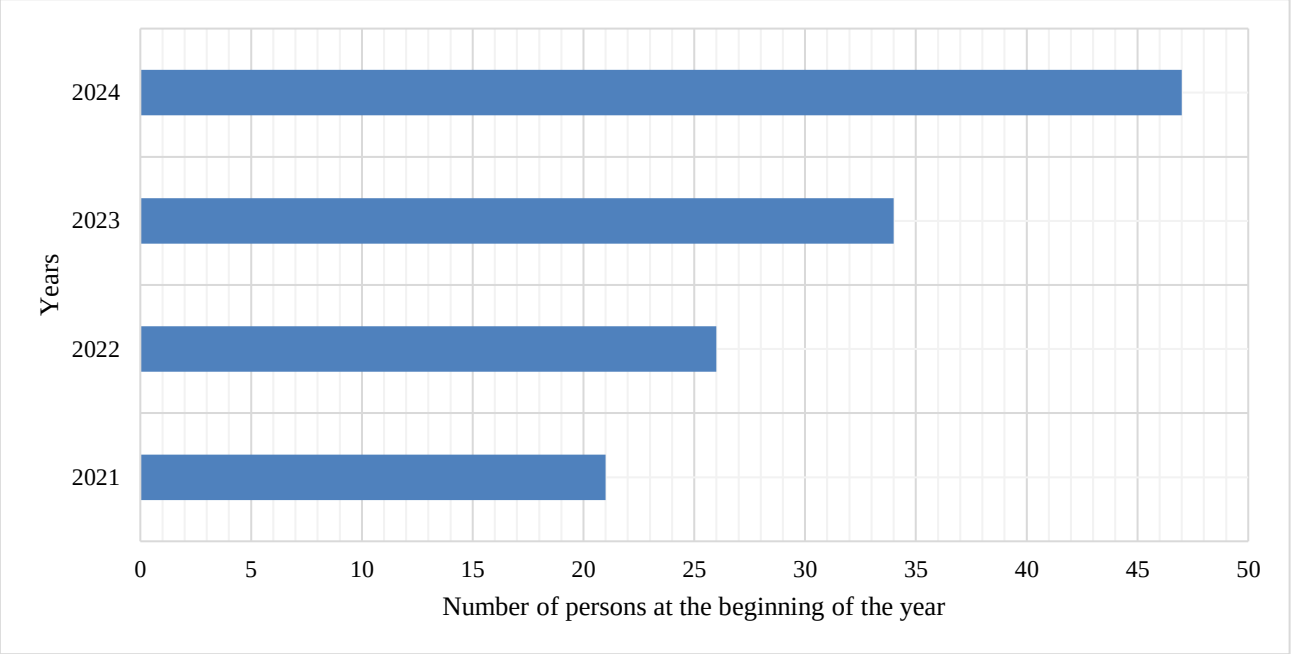

Figure 2.5 - Dynamics of the number of full-time employees of «CD Trans» LLC during 2021 - 2024 (data at the beginning of the year)

In general, it is worth noting that the organization of work at enterprises is carried out through the coordinated work of all departments and clear coordination of actions by their managers.

The main aspects of the motivation of the personnel of «CD Trans» LLC are: material incentive; non-material stimulation; microclimate; self-motivation; Feedback. Employee motivation is carried out through a consistent process of building an optimal motivation system. Thus, the management has chosen the main general directions of motivation that can be applied by the enterprise. Within the framework of these selected areas, employees are divided into groups based on motivation. For selected groups, based on qualification, gender and age composition, work experience, nature of performed duties and other factors, optimal directions of motivation are chosen. For example, material incentives are used for employees with extensive work experience, and non-material and self-motivation for new personnel.

For employees of the logistics department, where there is a significant number of employees, important importance is attached to the microclimate, and for the legal department, the head of the enterprise provides constant feedback.

After a certain time, the management checks the motivation results and evaluates the effectiveness of the selected motivation directions. In case of motivation inefficiency, selection of other parameters of the motivation system is carried out.

«CD Trans» LLC provides constant motivation, not one-time. Planned or general motivation includes encouraging and developmental. Incentive aims to encourage the employee to work if he loses interest in work. The developmental one consists in revealing certain skills and talents that can positively affect the quality of work and the employee's well-being.

In the company, according to the form of monetary reward, they use:

- premium motivation - a reward for high-quality and consistently timely performance,

- bonus - an additional award for the best employees for individual achievements,

- supporting - keeping employees at work, preventing staff turnover, maintaining the already achieved level of work.

Thus, at «CD Trans» LLC, the organization of functional-hierarchical management is determined by the type of activity and organizational structure, complemented by a system of motivation of personnel, which effectively affects work results.

«CD Trans» LLC focuses on European service standards and offers a full range of services related to the transportation of goods according to the system "from the sender's door to the recipient's door" without unnecessary worries for the Clients. Door-to-door delivery includes: customs clearance and freight forwarding. The general scheme of the robot is presented in fig. 2.6.

«CD Trans» LLC offers the most rational routes, the shortest terms and optimal tariffs. Depending on the nature of the cargo, conditions and route of transportation, «CD Trans» LLC uses all types of vehicles. Having at its disposal many contracts with carriers, the company has the opportunity to provide transport to the cargo owner almost anywhere in the world. In addition to everything, «CD Trans» LLC can offer its clients cargo insurance services.

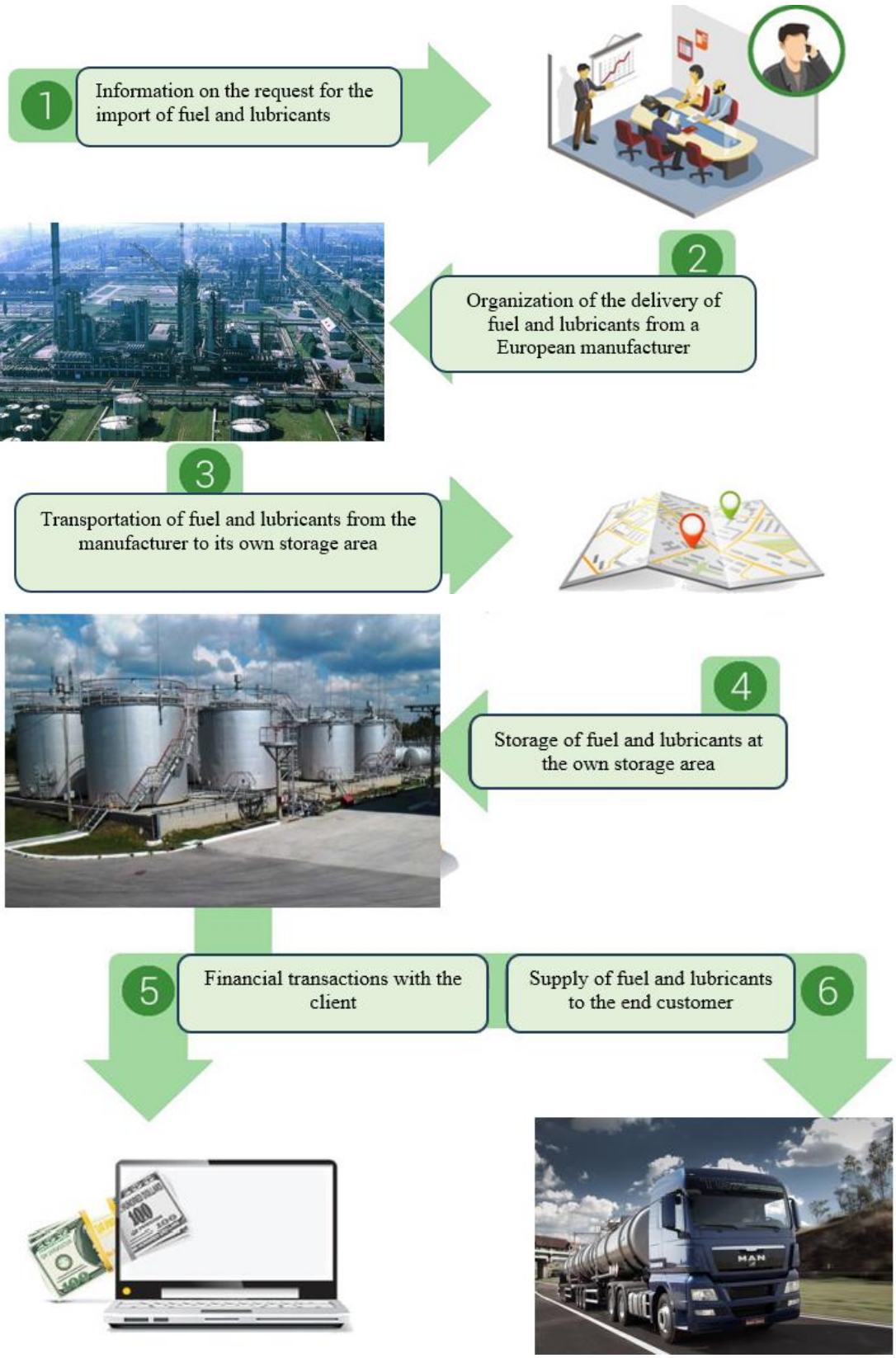

Figure 2.6 – Scheme of work of «CD Trans» LLC with clients

In general, the list of services provided by the company can be grouped by the field of transport and logistics activities, that are showed in fig. 2.7.

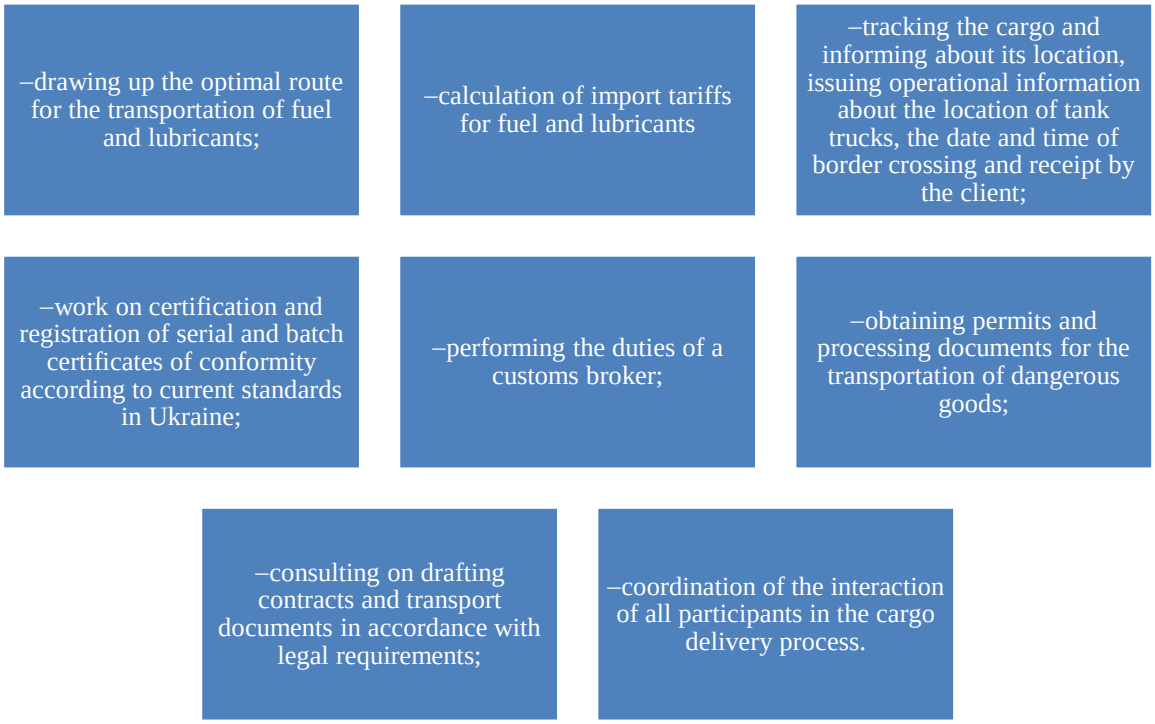

Figure 2.7 - List of services of «CD Trans» LLC

Freight forwarding allows you to reduce total transportation costs, reduce risks, and improve the quality of transportation. That is, it is the delivery of the cargo under the conditions when the freight forwarder is responsible for the cargo from the moment of loading by the sender until the delivery of the cargo to the recipient.

Specialists of «CD Trans» LLC undertake the entire range of delivery tasks, taking into account the specifics of the cargo and customer requirements. Moreover, when delivering cargo according to the "door-to-door" scheme, the company can provide outsourcer services.

2.3 Analysis of production and financial indicators of «CD Trans» LLC

A comprehensive assessment of the financial condition of «CD Trans» LLC is carried out on the basis of an analysis of the company's performance, in particular, a calculation of the system of financial ratios.

So, let's analyse the financial indicators according to the main aspects of the functioning of «CD Trans» LLC and group them into the following blocks, which are presented in fig. 2.8.

Figure 2.8 – Groups of financial indicators of the analysis of the activity of «CD Trans» LLC

Next, let's analyse the activities of «CD Trans» LLC over the last 3 years of its operation. We will use the data from the company's balance sheet, which we will present in the table 2.5, and the general indicators of income, expenses and profit are presented in fig. 2.9.

Table 2.5 – Initial data of the balance sheet of the company «CD Trans» LLC during 2021 - 2023, Uah

№	Indicators	Line code	2021	2022	2023
1	2	3	4	5	6
1	Balance data				
2	Initial cost of fixed assets	031	360520	378099	395423
3	Wear and tear	032	86782	85365	17304
4	Inventories	100	41300	42000	45050
5	Unfinished production	120	-	-	-
6	Final product	130	-	-	-
7	Goods	140	20385	20073	21536

Continuation of table 2.5

1	2	3	4	5	6
8	Promissory notes received	150	57810	55340	50230
9	Other current receivables	210	31800	32600	34520
10	Current financial investments	220	-	-	-
11	Cash in national currency	230	134285	143170	152330
12	Cash in foreign currency	240	886720	891520	913513
13	The amount of current assets	260	1984568	1995486	1985736
14	Total assets	280	1853299	1872289	1933567
15	Total equity	380	938600	937500	1818750
16	Total provision of the following costs and payments	430	126000	136000	156000
17	Total long-term liabilities	480	35720	34500	30363
18	Promissory notes issued	520	41500	42000	47500
19	Current liabilities from internal settlements	600	60000	58000	52500
20	Total current liabilities	620	678030	640439	520589
21	Deferred income	630	24900	23850	21300
22	Total liabilities	640	1851779	1872289	1933567
23	Data from the financial results report				
24	Net income (revenue) from product sales	035	3452330	3593430	3891362
25	Cost of goods sold	040	602123	607176	612398
26	Other operating income	060	986580	997780	999139
27	Administrative expenses	070	272330	293110	321412
28	Selling expenses	080	178990	152403	150236
29	Other operating expenses	090	886557	867306	839233
30	Financial result from operating activities (profit)	100	2513582	2671215	2967222
31	Net profit	220	2160736,5	2270532,75	2522138,7

First, let's analyse the indicators of the company's property status, which are grouped into tabular (table 2.6) and graphical form (fig. 2.10).

Thus, according to the data presented, the following conclusions can be drawn that the degree of depreciation of the fixed assets of «CD Trans» LLC has decreased, and by a significant amount in three years. This positive trend is evidenced by the wear rate indicator, which decreased from 0.42 in 2022 to 0.14 in 2023.

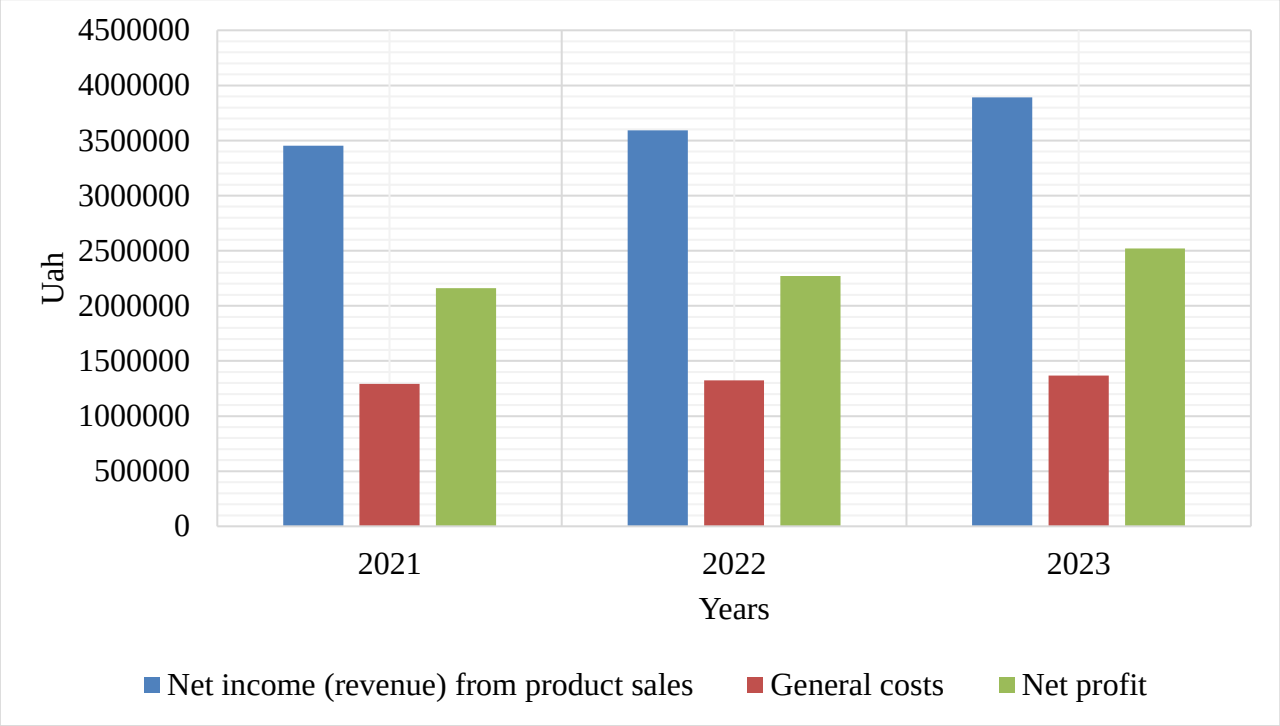

Figure 2.9 – Dynamics of financial indicators of «CD Trans» LLC

Table 2.6 – Indicators of property status assessment of «CD Trans» LLC

№	Indexes	Normative value	Years		
			2021	2022	2023
1	Depreciation rate of fixed assets	Reduction	0,43	0,42	0,14
2	The rate of renewal of fixed assets	Increase	0,19	0,26	0,51
3	The coefficient of disposal of fixed assets	Must be less than the rate of renewal of fixed assets	0,15	0,19	0,31

The fixed assets renewal ratio increased from 0.19 in 2021 to 0.26 in 2022, and to 0.51 in 2023, which indicates an increase in the share of new fixed assets from those available at the end of the reporting period.

The ratio of disposal of fixed assets increased from 0.15 in 2021 to 0.19 in 2022, and in 2023 it increased by another 0.12 points. Such an increase in the coefficient indicates an increase in the part of the fixed assets that were eliminated during the reporting period.

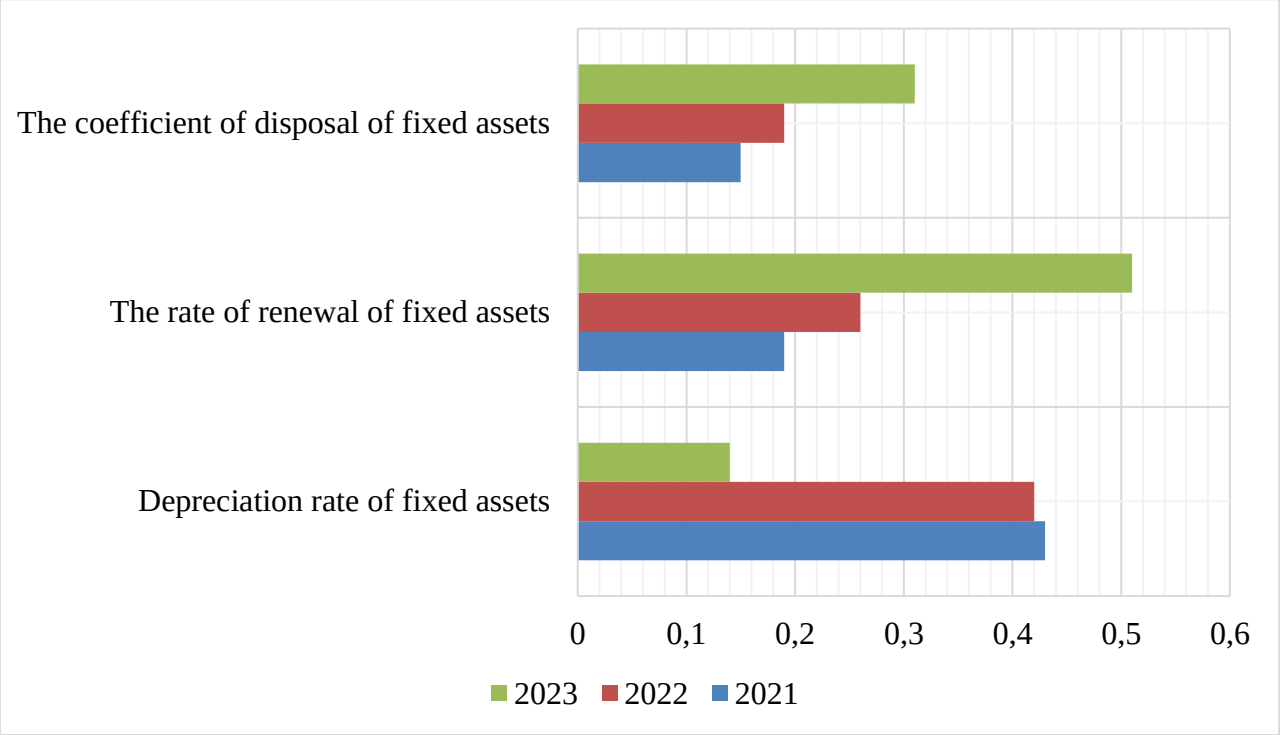

Figure 2.10 – Dynamics of property status ratios of «CD Trans» LLC for the analysed period

So, taking into account that «CD Trans» LLC provides transport and forwarding services, the decrease in the rate of depreciation of fixed assets with a simultaneous increase in the rate of renewal indicates the constant renewal of transport assets.

Regarding the liquidity indicators of «CD Trans» LLC, it can be noted that the company's condition is generally quite acceptable (table 2.7 and fig. 2.11). The coverage ratio is greater than one and increased from 1.03 in 2021 to 1.07 in 2022 and further increased to 1.2 in 2023. The obtained data mean that the company not only has enough resources to repay its current liabilities, but also increases their number.

Table 2.7 – Liquidity indicators of «CD Trans» LLC

№	Indicator	Normative value	Years		
			2021	2022	2023
1	Coverage ratio	More than 1	1,03	1,07	1,2
2	Quick liquidity ratio	0.6-0.8	0,7	0,8	0,8
3	Absolute liquidity ratio	Greater than 0, increase	0,3	0,56	0,2

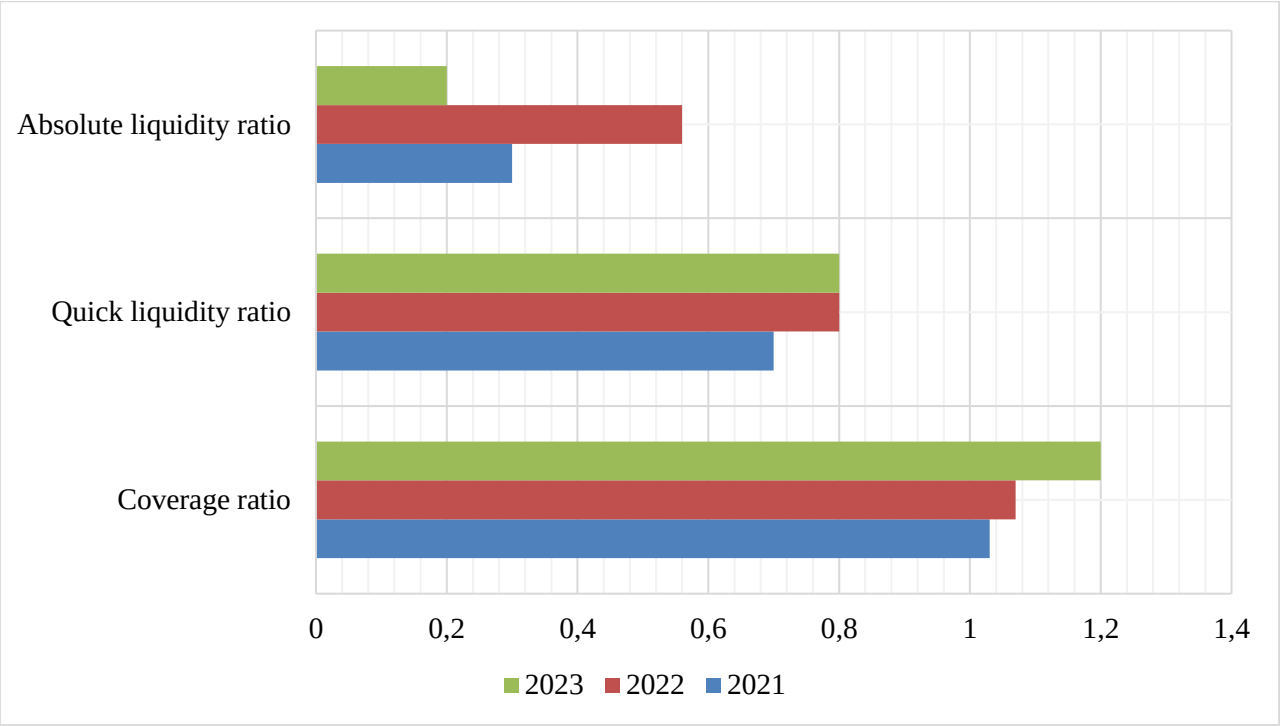

Figure 2.11 – Dynamics of liquidity ratios of SD Trans LLC for the analysed period

Analysing the ratio of quick liquidity, it is worth noting that in 2021 it was 0.7, during the next two years it almost did not change: in 2022 and in 2023 «CD Trans» LLC had almost the same ability to pay current liabilities, provided timely settlement with debtors.

In turn, the ratio of absolute liquidity revealed that in 2022 the share of debts increased slightly compared to 2021, from 0.3 to 0.56, and in 2023 the share of debts that could be immediately paid decreased, and the ratio was 0 ,2.

Next, analyse the indicators of financial stability of «CD Trans» LLC, which are presented in the table 2.8 and shown in fig. 2.12.

It is worth noting that the presented indicators of the financial stability of «CD Trans» LLC demonstrate positive trends throughout the analysed period. For example, an indicator of autonomy or financial independence is greater than 0.5 and indicates insignificant growth. This trend indicates that the specific weight of «CD Trans» LLC's equity capital in the total amount of funds advanced to its activities is growing.

Table 2.8 – Indicators of financial stability of «CD Trans» LLC

№	Indicator	Normative value	Years		
			2021	2022	2023
1	Coefficient of autonomy	More than 0.5	0,5	0,62	0,64
2	Funding ratio	Less than 1	0,7	0,7	0,8
3	Coefficient of provision of own working capital	More than 0.1	0,5	0,6	0,7
4	Equity manoeuvrability ratio	More than 0.1	0,6	0,74	0,8

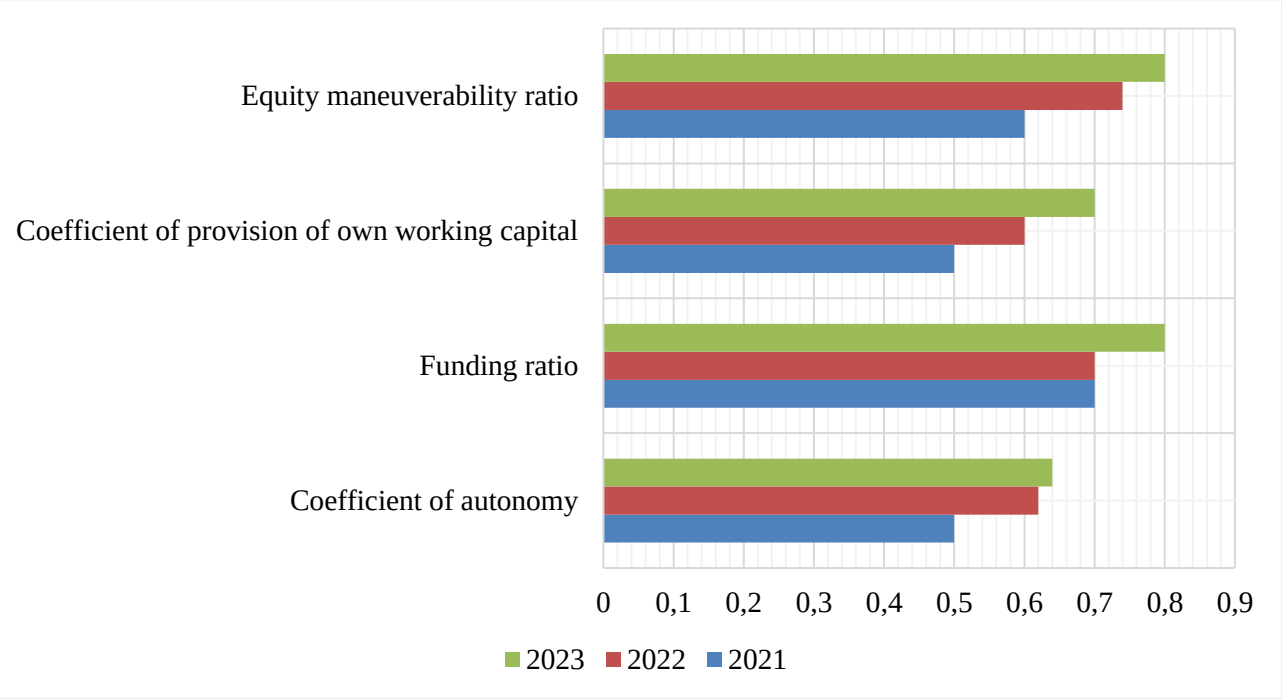

Figure 2.12 – Dynamics of financial stability coefficients of «CD Trans» LLC for the during 2021 - 2023

The second indicator was the financing ratio, the value of which is less than 1. This characterizes the low dependence of «CD Trans» LLC on the funds involved. According to the results of the calculations of the ratio of provision of own current assets, the part of current assets financed by own funds is significant and slightly increased in 2023.

And the last indicator of financial stability is the coefficient of manoeuvrability of «CD Trans» LLC's own capital. It shows a significant part of equity capital and a share of capitalized equity capital that is gradually increasing.

Then analyse the indicators of business activity of «CD Trans» LLC, which we will present in the table 2.9 and show their dynamics in fig. 2.13. Thus, the turnover ratio of assets, which characterizes the efficiency of all available resources, regardless of the sources of their involvement, gradually increased over the course of three years.

Table 2.9 – Indicators of business activity of «CD Trans» LLC

№	Indicator	Normative value	Years		
			2021	2022	2023
1	Asset turnover ratio	Magnification	0,123	0,388	0,425
2	Accounts Payable Turnover Ratio	Magnification	0,639	0,788	0,863
3	Accounts receivable turnover ratio	Magnification	0,865	0,869	0,892

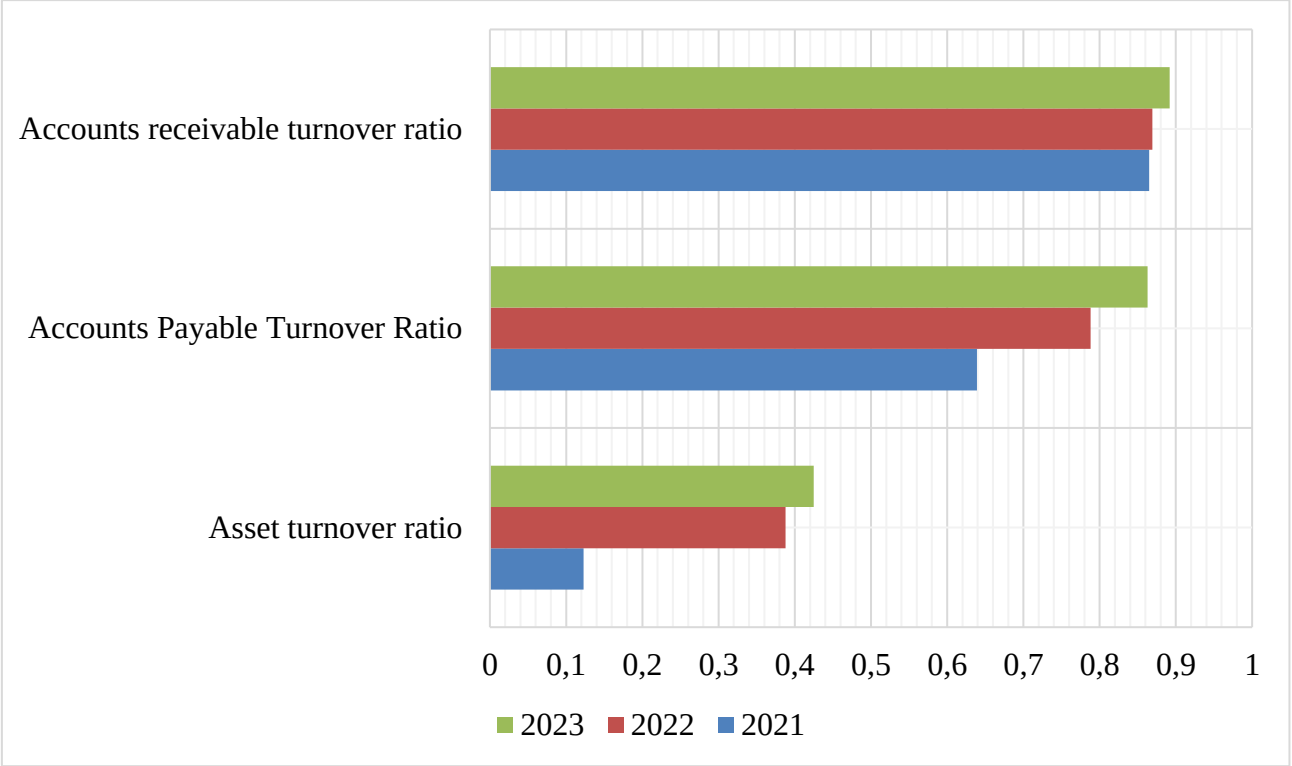

Figure 2.13 – Dynamics of business activity ratios of «CD Trans» LLC for the analysed period

In turn, the turnover ratios of payables and receivables showed that the speed of their rotation has increased, although the pace of the second ratio is somewhat lower.

One of the important indicators of the analysis of the activity of any enterprise is the calculation of profitability indicators. So, in the table 2.10 and fig. 2.14 present the values of profitability indicators of «CD Trans» LLC. The value of profitability indicators showed the efficiency of the use of «CD Trans» LLC assets and invested funds, which is evidenced by the high and growing value of the coefficients of profitability of assets and equity.

Table 2.10 – Profitability indicators of «CD Trans» LLC

№	Indicator	Normative value	Years		
			2021	2022	2023
1	Rate of return on assets	More than 0, an increase	0,6	0,7	0,8
2	Return on equity ratio	More than 0, an increase	0,7	0,7	0,8
3	The coefficient of profitability of the activity	More than 0, an increase	0,62	0,63	0,65
4	Product profitability ratio	More than 0, an increase	1,9	1,9	1,9

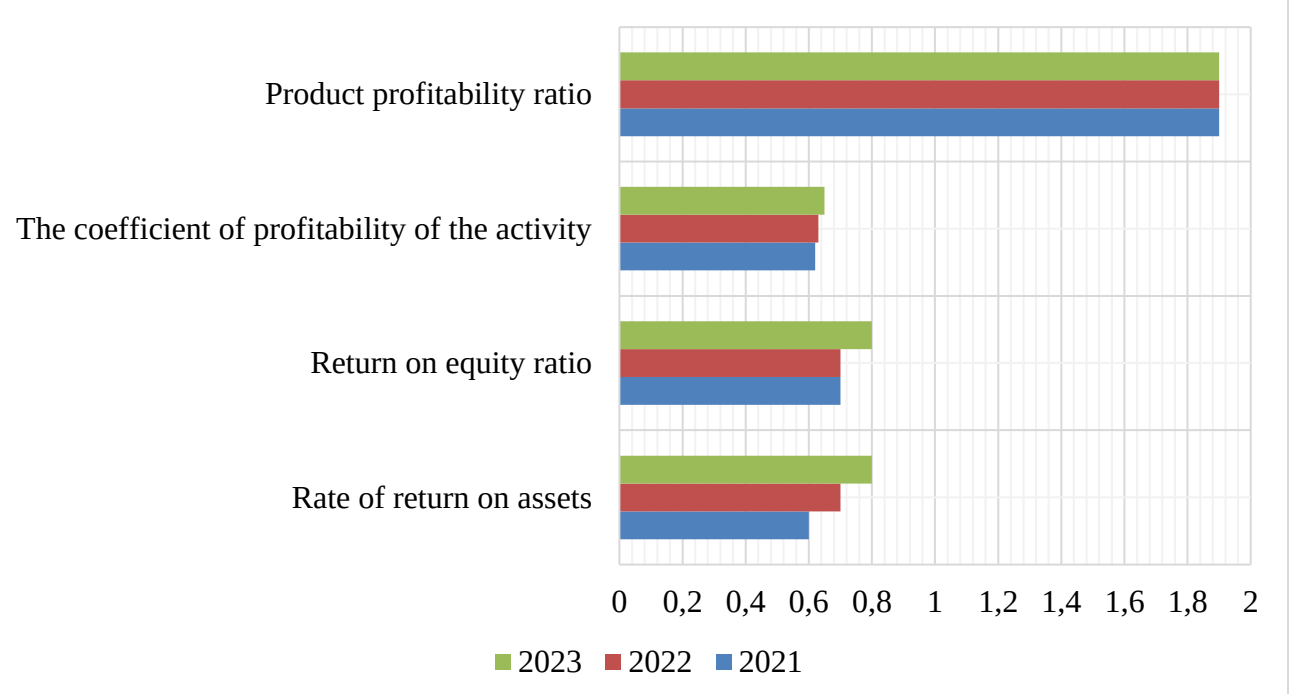

Figure 2.14 – Dynamics of profitability ratios of «CD Trans» LLC

Then it’s necessary to define the main profitability ratios that were calculated for SD Trans LLC. Return on assets (ROA) is a financial ratio that characterizes the efficiency of the use of all company assets.

Return on equity (ROE) is a financial ratio that characterizes the efficiency of the use of equity capital. Shows the return (rate of return) on invested equity. Maximization of this indicator is an important task that must be performed by the managers of the enterprise.

The profitability ratio is calculated as the ratio of the net profit of the enterprise to the net revenue from the sale of products (works, services). An increase in this indicator indicates an increase in the efficiency of the enterprise's economic activity, while a decrease is the opposite.

Product profitability is an economic category that characterizes the effectiveness of the sale of products (goods, works and services). It is defined as the ratio of net profit from sales to the cost of production.

The profitability ratio of «CD Trans» LLC, which characterizes the efficiency of economic activity, also showed a slight increase - from 0.62 to 0.65. The coefficient of profitability of products turned out to be stable, which indicates the stability of economic activity and profit from the main activity.

As a result of the analysis of financial indicators, we note that profitability is one of the main value indicators of efficiency, which characterizes the level of return on assets and the degree of use of capital in the process of production or provision of services.

The next step of the analysis will be the state of production indicators of «CD Trans» LLC. Therefore, at the beginning, it should be analysed the market of transportation of the enterprise. When carrying out international transportation, «CD Trans» LLC adheres to the rules of the basic terms of «Incoterms», which determine its obligations as a carrier depending on the selected conditions of transportation.

In general, the company's client base includes domestic enterprises in the metallurgical, petrochemical, energy and other industries, as well as international companies.

As part of its international activities, «CD Trans» LLC imports fuel and lubricants to Ukraine. The main international transportation destinations of «CD Trans» LLC is Europe.

The main networks of the customer industry are divided into two conditional groups, which differ in the format of gas stations:

- full-size gas stations with a store, services and additional services;

- narrow-format gas stations that do not have a store, additional services and services. The first group includes the following companies: Concern Galnaftogaz, Lukoil, Continuum, Hefest/Parallel, Shell. The companies of the second group include the following operators: Avias, Alfa-nafta, Ukrnafta and most small chains.

In general, the number of completed contracts is growing every year, as evidenced by the data in fig. 2.15.

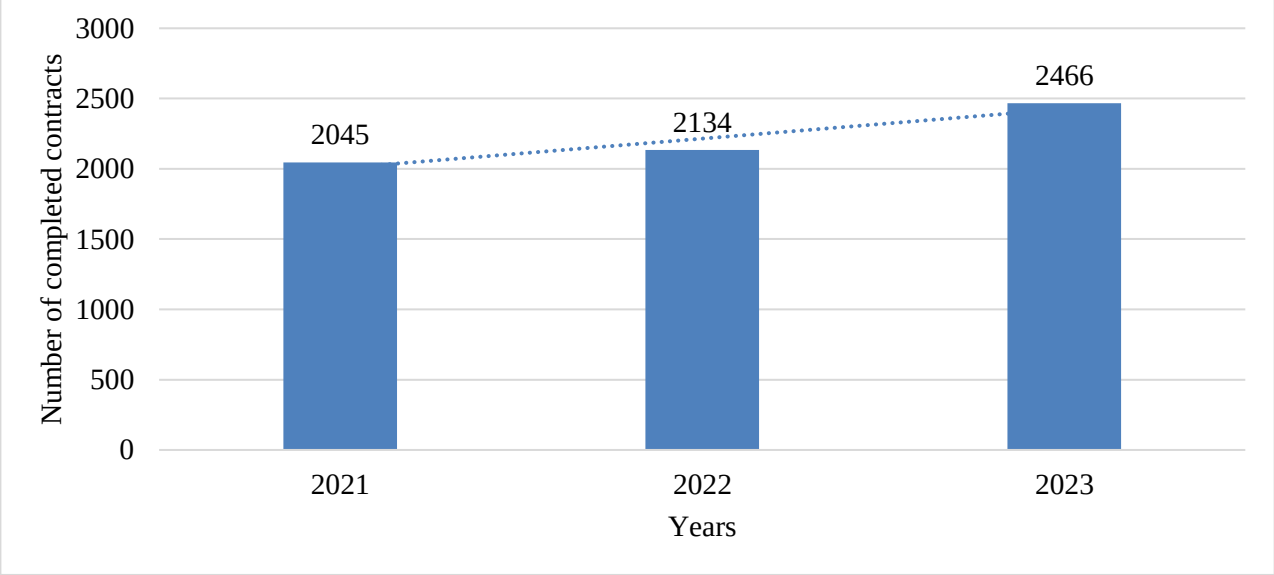

Figure 2.15 – The number of completed contracts (transportations) of the «CD Trans» LLC company during 2021 - 2023

«CD Trans» LLC uses its own transport, which is available in the company in the amount of 32 units: MAN TGS 26.400 – 8 units, Renault Premium 2011 – 6 units, Mercedes-Benz Actros 2017 – 7 units, DAF XF 105 – 7 units, DAF XF 2015 – units.

The number of flights in 2023 is presented graphically in fig. 2.16.

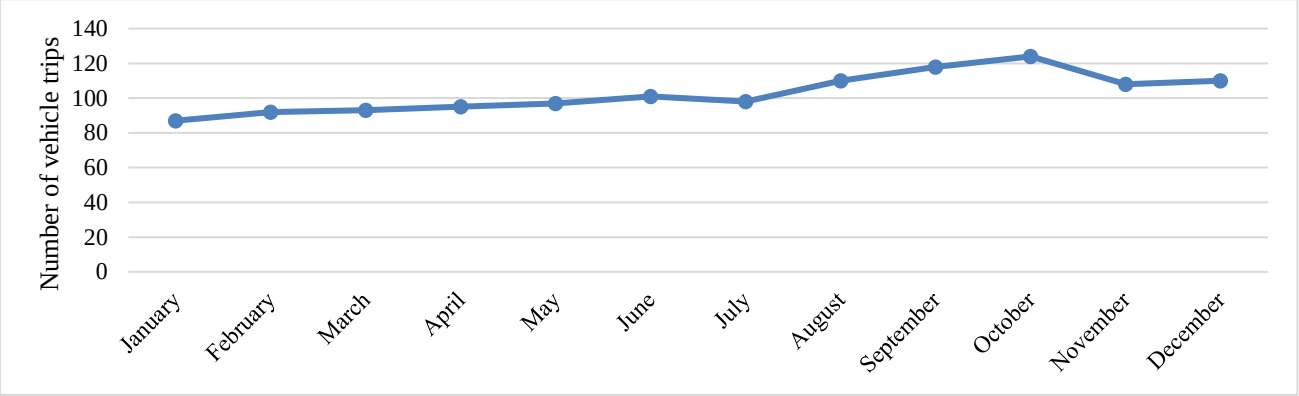

Figure 2.16 – Number of flights of «CD Trans» LLC in 2023

So, summarizing the general analysis of the activity of SD Trans LLC, we note that it has been operating in the Ukrainian market for the import of fuel and lubricants since 2012 and provides the following services: import and sale of petroleum products (optimization and expansion of the geography of supplies of petroleum products of European production); provision of a full range of transport and forwarding services for the transportation of fuel and lubricants by road transport.

For the sake of consumers, the company focuses on the client's needs, strives to be flexible and active professionals who develop and quickly implement world-leading practices.

2.4 Analysis of vehicle traffic monitoring and identification of fuel sensor control problems

Today, «CD Trans» LLC manages its transport activities using the Mapon system [33]. The company fleet management platform is an effective and simple way to remotely track vehicles and assets, managing your company's fleet using professional, user-friendly solutions.

It should be noted that the Mapon company, since its establishment in 2006, began to create its platform for fleet management, improving its services and improving their quality every year. Mapon is part of the Draugiem Group - an

international association of IT companies created in Latvia and widely represented both in Europe and in other parts of the world. The number of connected clients of the company is growing every year, which indicates the confidence of logistics companies in the quality of services provided (fig. 2.17).

In collaboration with partners, Mapon has created a network of services in many European countries, thus providing customers with immediate assistance in cases where technical problems arise with the tracking equipment while abroad.

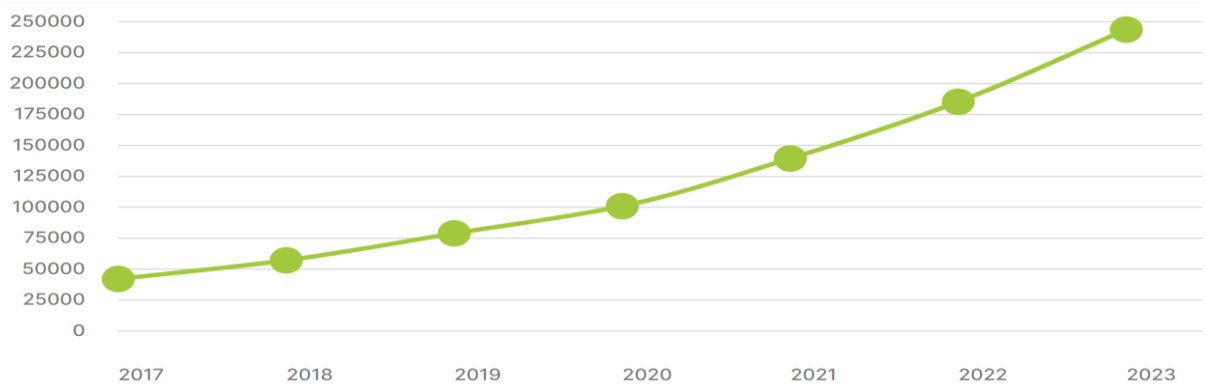

Figure 2.17 – Number of connected Mapon clients

Source: [33]

In fig. 2.18 presents the main large clients of Mapon, who already use the Mapon monitoring and control system in their activities.

Figure 2.18 – Mapon's main major clients

Source: [33]

Mapon transport monitoring system has a wider scope of use than just route tracking. Using such systems, you can always find out the most accurate position of an object, calculate vehicle mileage, downtime, and also calculate the most optimal,

rational route for vehicles (fig. 2.19). The GPS vehicle monitoring system allows you to significantly reduce fuel costs, calculate optimal routes between the starting and ending points of vehicle movement, and improve driver discipline, which will undoubtedly affect business development. With the help of Mapon transport monitoring systems, it is possible to document the movement of transport at any time.

The Mapon transport monitoring system for the «CD Trans» LLC company allows:

- optimize enterprise costs thanks to the efficient operation of the company's vehicle fleet;

- maximize the efficiency of the fleet;

- complete control over transported cargo, which means the ability to provide guarantees to customers, which in today's market conditions is a significant advantage over competitors;

- the ability to control actual fuel consumption, which means, in most cases, minimizing the cost of maintaining a vehicle fleet;

- the ability to ensure the safety of each vehicle in the company's fleet, and of personnel whose work is related to transportation and relocation.

Figure 2.19 - Mapon system interface and online vehicle positioning

Source: [33]

Vehicle monitoring systems from Mapon are:

– control of transport routes, parking locations, parking time, fuel consumption, distance travelled and other parameters (fig. 2.20);

– online monitoring of all employees and vehicles of your company;

– the ability to record vehicle operating parameters - engine hours, mileage, speed, and so on;

– control of fuel consumption, minimizing the risk of drains and theft of fuel and lubricants;

– protection of vehicles from theft and theft;

– control over vehicle downtime;

– timely receipt of information about various alarming events;

– generation of detailed reports. Moreover, reports can be generated both for the company's vehicle fleet in general and for an individual vehicle;

– the ability to promptly and promptly respond to various force majeure circumstances and emergency situations; GPS monitoring of vehicles allows you to control vehicles transporting construction and special equipment, various cargoes, including oversized and heavy cargo.

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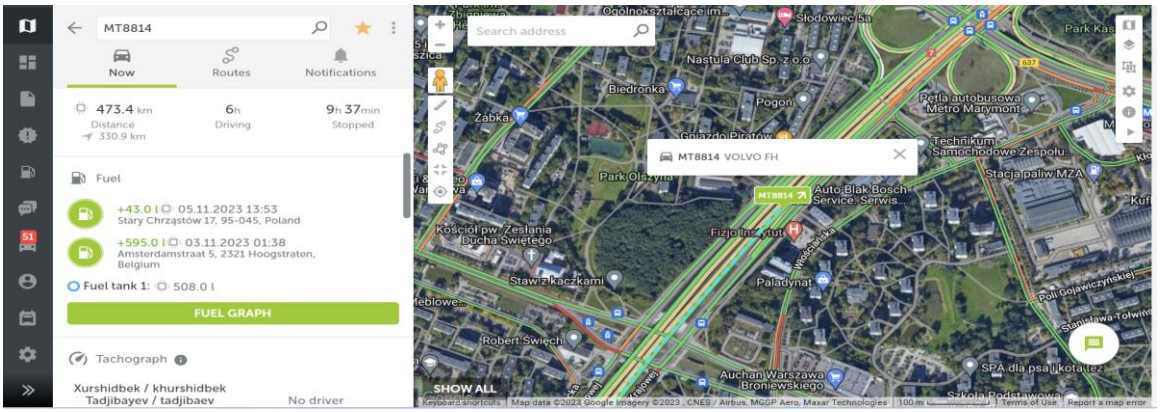

Figure 1.20- Interface of the general information tab about the "Fuel Control" of the «CD Trans» LLC company for the selected vehicle online

Source: [33]

A professional fuel management solution that helps to monitor fuel consumption, improve fleet fuel economy and reduce operational expenses. With features like data visualization, trip logs, reports and analytics, optimize your vehicle performance and make informed decisions for enhanced productivity.

Figure 2.21 – Monitoring fuel consumption of the «CD Trans» LLC company for a selected vehicle online

Source: [33]

The fuel flow meter installed on «CD Trans» LLC vehicles shows data on the actual fuel consumption of the vehicle engine. To ensure the correct operation of the fuel sensors, we will carry out calculations; in this case, the removal of fuel residues in the fuel tanks can be carried out mathematically:

Fuel balance at the end of the reporting period is calculated as fuel balance at the beginning of the reporting period plus the volume of fuel filling minus actual fuel consumption according to the flow meter [10].

$$Fb_{ERP} = Fb_{BRP} + V_{FF} - F_c, \quad (2.1)$$

where Fb_{ERP} - fuel balance at the end of the reporting period;

Fb_{BRP} - fuel balance at the beginning of the reporting period;

V_{FF} – volume of fuel filling;

$F_{c,}$ - fuel consumption according to the flow meter

To confirm the reliability of the data obtained using a fuel flow meter, it is necessary to carry out control spills.

The easiest way is to compare actual data and data obtained using the Mapon satellite monitoring system. The period of control spillage should be as long as possible; a work shift of the vehicle is desirable. Also, when carrying out a control

spill, it is necessary to monitor the operation of the vehicle in order to avoid intervention by the driver (driver, machine operator).

Let's calculate the error of the sensors installed on «CD Trans» LLC vehicles. In the sample we will take 14 vehicles, the calculation period is 29.04.2024 – 04.05.2024. The results are presented in table 2.11.

Table 2.11 – Results of calculations of the error in fuel consumption calculated from the actual value of fuel control sensors, litters (calculation period 29/04/2024 to 04/05/2024).

Vehicle number in the Mapon system	Fuel balance at the beginning of the reporting period	Fuel filling volume, liters	Actual fuel consumption according to flow meter data	Fuel balance at the end of the reporting period (calculated)	Fuel balance at the end of the reporting period (according to sensor data)	Fuel consumption error calculated from fuel control sensors, liters	Indication error in %
1	123	1060	1020	163	215	52	31,9
2	459	3180	3330	309	342	33	10,7
3	526	4240	4525	241	268	27	11,2
4	226	3180	3200	206	223	17	8,3
5	60	2650	2430	280	322	42	15,0
6	417	4240	4300	357	389	32	9,0
7	143	2120	1980	283	295	12	4,2
8	80	4770	4630	220	245	25	11,4
9	258	5830	5750	338	354	16	4,7
10	160	6890	6660	390	432	42	10,8
11	30	6360	6100	290	333	43	14,8
12	247	4770	4890	127	148	21	16,5
13	430	5830	5910	350	393	43	12,3
14	96	5300	5380	16	25	9	56,3

Source: compiled by the author based on his own analysis and company data

In fig. 2.22 present graphically the results obtained from the operation of fuel sensors. Based on the measures taken, it can be seen that the operating error of fuel sensors varies in the range of 4-57%, depending on the volume of fuel in the tank. It should be noted that the smaller the actual volume of fuel in the tank, the greater the percentage of error.

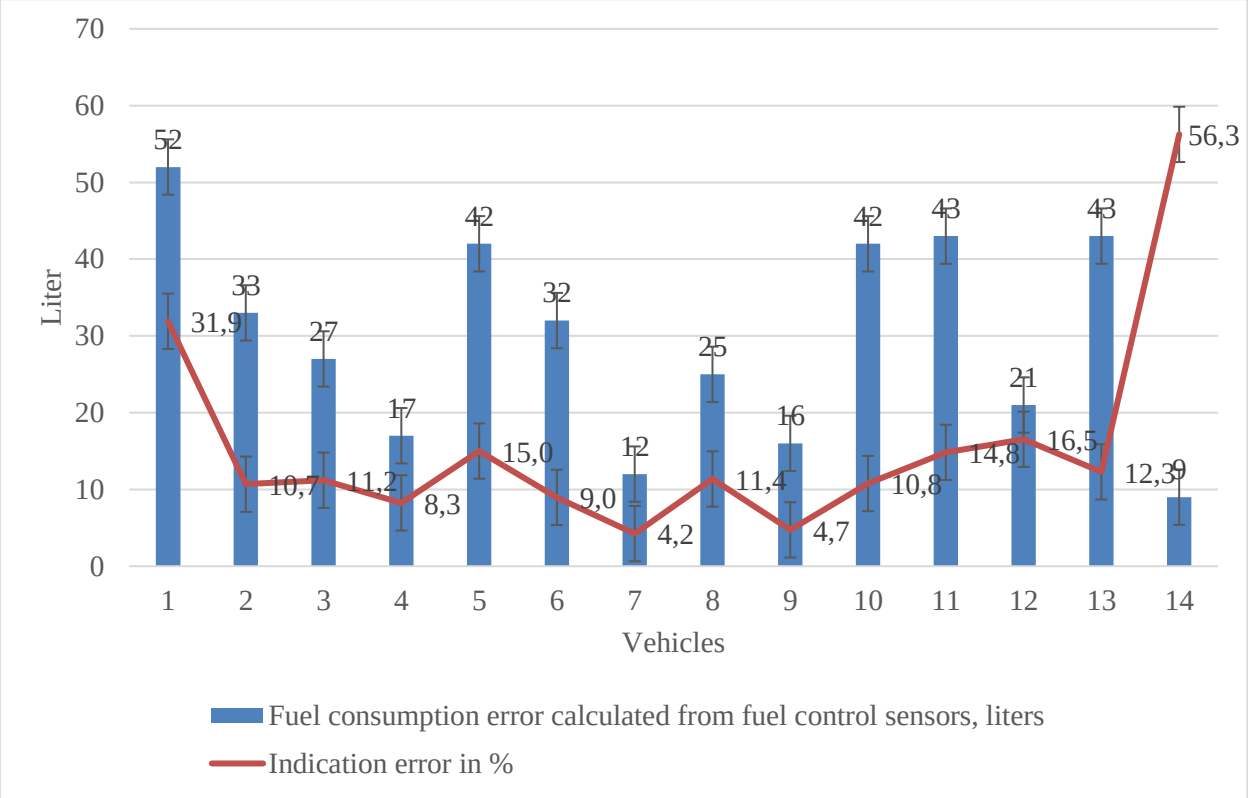

Figure 2.23 – Results of monitoring errors in the operation of fuel sensors with a random sample of 14 «CD Trans» LLC vehicles

Source: compiled by the author

Do not also forget the error of the refuelling nozzle at gas stations; sometimes this error can range from 0.5% to 1.0%.

An average error of 5% is the average maximum value. Under ideal conditions the error is 1-3%. It is also worth considering that the Mapon system is not an accounting system, but only a means of obtaining data on the basis of which accounting is carried out.

Thus, the «CD Trans» LLC company was faced with the fact that after installing a fuel control sensor and configuring the software, the reports over time began to produce something completely different: high reading errors, incorrect display of gas stations, etc.

In table 2.12 present the main causes and explanation of errors in readings from «CD Trans» LLC fuel level sensors.

Table 2.12 - Causes and explanation of errors in readings from «CD Trans» LLC fuel level sensors

Error	Cause	Explanation
1-4%	Laws of physics	Any liquid expands when heated and contracts when cooled. Fuel is no exception. Our company's engineers conducted an experiment: Fuel in a calibration container with a volume of 10 litters (10,000 ml) was exposed to direct sunlight, the fuel was heated by 10 degrees Celsius, the volume of fuel increased by 170 ml. Result: when the Fuel temperature changes by 10 C, the volume changes by approximately 1.7%. The performance is also affected by the density of the fuel and its composition. How is it in life: the vehicle stands still, the fuel temperature = ambient temperature. environment. The vehicle moves, the fuel tank is cooled by air flows, the fuel is cooled (on average by 3-4 degrees Celsius), and the volume of fuel changes accordingly.
4-8%	Fuel level sensor error	Lack of fuel level sensor supply voltage. Failure of the fuel level sensor power supply system.
8-15%	Fuel level sensor fluctuating error	It is worth noting that the manufacturer's 1% error was obtained by conducting experiments in ideal laboratory conditions, on a stand where the surface is flat, the sensor is positioned strictly vertically, and perpendicular to the free surface area of the fuel. In practice, it was found that the error of the sensor itself may increase, because Operating conditions for the equipment are far from ideal. So, this can include the tilting of the vehicle, when the car is not on a level road and, accordingly, the tank is also tilted, the sensor inside the tank is also tilted, but the fuel levels up without tilting. There are many factors influencing the accuracy of the readings, and an error can occur even if the tank is filled with a different type of fuel.
15-30%	Error in processing data from the fuel level sensor by the monitoring terminal	The fuel level readings in the terminal from the Mapon fuel level sensor come at a frequency in the range from 600 to 2000 Hz. The frequency reading processor also has an error. Failure of the RS-232 interface of the fuel level sensor. Inoperability of the EIA-485, RS-485 interfaces of the LLS fuel level sensor. Deviation of internal and external resistances of the fuel level sensor. No sensor readings at the top or bottom of the tank (dead zone).
More 30%	Approximation of readings by fuel level	The program algorithm filters out various fuel fluctuations and produces a number based on the average fuel level. Fluctuations in fuel in the tank are usually caused by road unevenness: various bumps, holes, etc. Also, fuel can fluctuate in the fuel tank when vehicles turn, accelerate, or decelerate. All these factors affect the accuracy of the fuel level readings in the fuel tank. Lack of contact in the fuel level sensor wiring. No contact with the central rod. Connecting the sensor to a switchable power supply. Then the level drop will occur at the same moments as, for example, the vehicle is turned off or the terminal switches to backup power. To eliminate this, you must either connect the sensor to a non-switchable power supply or, if this is not possible, install ignition filtering in the software. Connection to the vehicle's Can-bus. In this case, when the vehicle is de-energized, the on-board computer also stops transmitting correct values. To resolve this, you need to install ignition data filtering in the software. Submit the fuel level sensor for specialized diagnostics.

Source: complied by author

The cause-and-effect relationship revealed that:

Firstly, the correct operation of the fuel control sensor depends on the quality of the fuel: winter and summer diesel fuel have different dielectric constants.

Secondly, the fuel level sensor is sensitive to the emulsion of water in the fuel, as well as metal debris (sawdust, shavings). This leads to short-circuiting the sensor and, as a result, erroneous readings.

The measurement error of fuel level sensors in the tank also depends on the following factors

1) Factory error in measuring the fuel level by the sensor itself.

The error depends on the length of the sensor and is usually on the order of 1.5-3% depending on the manufacturer and quality of the sensor. At «CD Trans» LLC this figure ranges from 30-50%.

2) Poor calibration of the fuel tank. Sometimes, due to poor calibration, even an expensive fuel control sensor can behave much worse than a cheaper, but well calibrated analogue.

Calibration is still the key and most important process, on which the quality of the fuel control sensor readings, the magnitude of the error and inconsistencies in fuel level data will mainly depend.

Chapter 2 summary

Making conclusion, the analytical part of the research is devoted to the analysis of the vehicle monitoring market and the activities of the «CD Trans» LLC company. It is important to note that the market for transport monitoring systems is constantly evolving, and new technologies and innovative solutions are emerging. In addition, there are many small and medium-sized companies that specialize in specific market segments or regions. When choosing a vehicle monitoring system provider, it is important to consider your unique requirements and business needs, as well as evaluate

the reputation, reliability and quality of the products and services offered. Top 10 World GPS hardware manufacturers in 2023 were analysed.

In the analytical part, the activities of «CD Trans» LLC - a leading Ukrainian company whose main activity is the retail sale of fuel and lubricants and related goods - were analyzed. «CD Trans» LLC also sells oil products in large and small groups and provides services for the storage and transportation of oil products for the military and agricultural sectors. The management structure of the company was analyzed in detail, and the staff of the company, which at the beginning of 2024 amounted to 111 people, was analyzed.

The analysis of the geography of the main importing countries made it possible to determine that «CD Trans» LLC imports fuel and lubricants from the Baltic countries, Poland, Greece, Romania, Moldova, and Slovakia. The specialists of «CD Trans» LLC undertake a full range of delivery tasks according to the criteria of the cargo specification and the client's requirements. Moreover, when delivering cargo according to the «door-to-door» scheme, the company can provide outsourcer services.

A comprehensive assessment of the financial condition of «CD Trans» LLC was provided in detail, created on the basis of an analysis of the company's performance, in particular, a system for calculating financial ratios. In general, it can be said that the company is profitable, which is indicated by the rate of profit growth according to the analysis of 2021-2023.

The analysis of production indicators revealed that the number of orders is increasing every year, the needs of which are met by the performance of transportation by the company's own fleet of gasoline and gas trucks, which the company has in the amount of 32 units. The company also has its own storage base for fuel and lubricants located in the Lviv region.

Currently, the company «CD Trans» LLC implements a logistics strategy to minimize the total logistics costs. The goal of the business can reasonably be formulated as follows: to minimize the total logistics costs, guaranteeing an acceptable level of customer service in its activities. In addition, customers are not always ready to overpay for a high level of logistics service (high logistics costs as a result), due to

which «CD Trans» LLC may not receive important orders. Thus, the implementation of this strategy is the most optimal.

Today, «CD Trans» LLC manages its transport activities using the Mapon system. The company fleet management platform is an effective and simple way to remotely track vehicles and assets, managing your company's fleet using professional, user-friendly solutions. Managing the fuel resources of the «CD Trans» LLC fleet was a challenging task before implementing the system. Mapon makes it easy to enter, view and analyse all fuel consumption data in a single, easy-to-use platform. Knowing the average fuel consumption of each vehicle and its approximate load, you can make effective forecasts on the total fuel consumption in your fleet.

Looking at the problems that «CD Trans» LLC faced in the monitoring area after implementing the Mapon system, it was identified that the fuel sensors were not functioning properly. The work analysed the actual fuel value with the data in the system, and identified significant differences. Based on the measures taken, it can be seen that the operating error of fuel sensors varies in the range of 4-57%, depending on the volume of fuel in the tank. It should be noted that the smaller the actual volume of fuel in the tank, the greater the percentage of error. Thus, the «CD Trans» LLC company was faced with the fact that after installing a fuel control sensor and configuring the software, the reports over time began to produce something completely different: high reading errors, incorrect display of gas stations, etc.

In conclusion, the main characteristics of the problem with fuel sensors are described depending on the percentage of indicator values.

In the next part, present the rationale and economic calculations for replacing fuel sensors of older models with new ones and the effectiveness of such a project for the management of the «CD Trans» LLC company.

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CHAPTER 3
PROJECT PROPOSALS TO IMPROVEMENT OF THE VEHICLE TRAFFIC MONITORING SYSTEM OF THE «CD TRANS»

3.1 Organizational and economic directions of increasing the efficiency of transport monitoring of «CD-Trans» LLC

An important condition for improving the management and optimization of freight transportation is to increase the scientific validity of decision-making methods at all levels of planning management. In order to successfully solve this problem, it is necessary to make a correct socio-economic justification of the effectiveness of the implementation of each progressive technical solution.

At this stage of development, the transport logistics system at the «CD Trans» LLC enterprise functions effectively, but needs some optimization and improvement to improve its functioning in the future.

As a result of the monitoring of the transport logistics system, the analysis of the practice of making management decisions in this area, and the study of the efficiency of its functioning, the following problems of the «CD Trans» LLC transport company's vehicle traffic monitoring system were identified:

1. Signal Loss: The fuel sensor may temporarily lose communication with the monitoring system due to various reasons such as electromagnetic interference, faulty cables or wireless communication problems. This may result in the fuel level being displayed incorrectly or not being present in the system.

2. Inaccurate Measurements: The fuel sensor may be worn out or mis calibrated, resulting in inaccurate fuel level measurements. This can lead to incorrect fuel consumption data, making it difficult to accurately track and control inventory.

3. Clogged: Fuel sensors can become clogged with dirt, sediment or other impurities in the fuel. This may result in incorrect measurements or blocking of the sensor. Regular cleaning or maintenance of the sensors can help prevent this problem.

4. Technical faults: The fuel sensor may be subject to various technical faults such as contact corrosion, electronic component failure or power supply problems. This can lead to complete inoperability of the sensor or distortion of its measurements.

5. Incorrect installation: Incorrect installation of the fuel sensor may result in improper operation or complete failure. For example, incorrect positioning of the sensor in the fuel tank may result in incorrect fuel level measurement.

To overcome these problems, it is important to regularly maintain and calibrate fuel sensors, as well as use reliable monitoring systems that can detect and prevent data manipulation.

An integrated approach to improving the transport monitoring system requires is presented in fig. 3.1.

Improving the transport monitoring system requires an integrated approach, including both technical innovation and optimization of business processes and interaction with drivers.

When monitoring vehicles, various problems can arise. Here are some common problems:

Loss of Communication. One of the main problems is the loss of communication between the vehicle and the monitoring system. This may be caused by poor network coverage, signal interference, hardware problems, or other technical problems. Loss of communication results in unavailability of data on the location, status and other parameters of transport, which makes effective management and monitoring difficult.

Incorrect or inaccurate data. Sometimes the monitoring system may provide incorrect or inaccurate data. This may be caused by faulty sensors, software errors, or incorrect system configuration. Incorrect data can lead to incorrect conclusions and poor decisions.

Figure 3.1 - An integrated approach to improving the transport monitoring system requires

Source: complied by author

Incompatibility and diversity of systems. In case of using different types of vehicles with different monitoring systems, incompatibility problem may arise. Different manufacturers may use different communication protocols, data formats and interfaces, making it difficult to integrate and collect data from all vehicles into a single system.

Human Factors Errors. Human factors can also become a problem in a vehicle monitoring system. This may include improper installation of equipment, improper training of personnel, incorrect use of the system, or misinterpretation of data. Human

errors can lead to inaccurate or incomplete data and reduce the effectiveness of monitoring.

Data security. Transport monitoring is associated with the collection and transmission of a large amount of data, which may contain confidential information about routes, cargo, clients, etc. Data security issues such as unauthorized access, hacking or data leaks can cause serious harm to a business and compromise the confidentiality and reliability of the monitoring system.

Addressing problems associated with vehicle monitoring may include careful inspection and maintenance of equipment, improved communications and network infrastructure, training of personnel, use of standardized protocols and interfaces, and implementation of data security measures such as encryption and access control.

To solve these problems, the company proposed replacing the existing fuel sensors with new ones that can avoid the problems mentioned above.

The process for replacing the fuel sensor may vary slightly depending on the specific vehicle and its design. However, in general terms, the following steps can understand the process of replacing the fuel sensor: prepare the necessary tools, disconnecting the power supply, finding the location of the fuel sensor, enabling access to the sensor, disconnecting the wire and tube, removing the old fuel sensor, installing a new fuel sensor, connecting the wire and tube, check operation.

It is important to note that the process of replacing a fuel sensor can be complex and require a certain level of skill and knowledge. It is recommended to entrust the replacement of the fuel sensor to a professional auto mechanic or service centre specializing in car repair and maintenance. These professionals have the necessary knowledge, experience and tools to perform the task. You can contact an authorized service canter associated with the vehicle manufacturer. They will have access to original parts and expertise appropriate to the make and model of the vehicle. If independent service canters are preferred, you need to make sure that the chosen centre has a good reputation, experience working with the brand of car and qualified mechanics. It is important to note that fuel sensor replacement may vary depending on the specific model and design of the vehicle.

The frequency of fuel sensor replacement can vary depending on several factors, including vehicle operating conditions and the quality of the sensor itself. In general, the fuel sensor rarely needs to be replaced, and it can last for a long time without problems.

However, in some cases, the fuel sensor may fail or begin to give inaccurate readings. This can be caused by a variety of reasons, such as dirt or sediment building up in the tank, damage to the wiring or the sensor itself, or a manufacturing defect.

In general, if the fuel sensor is working properly and not causing problems, replacement is not necessary. However, if there are problems with its functioning, it is recommended to replace the fuel sensor as soon as possible to ensure reliable and accurate fuel level readings in the vehicle.

To optimize transportation routes, it is necessary to develop measures to improve the freight transportation system taking into account logistical principles.

Let's identify the problem, namely: due to the fact that the object of management is a motor vehicle enterprise, management functions are closely related to its direct type of activity, that is, the provision of transport services. The enterprise must implement the following management functions: perspective and current planning of the transport process; economic analysis in all areas of its activity; clear and correct organization of work in compliance with safety techniques, timely repair and technical inspection of the fleet of motor vehicles; rationalization of the transport process, technical inspection and ongoing repair of rolling stock; coordination of work both within the enterprise and between consignors and consignees; control over the transport process, identification of deficiencies in its organization and their timely elimination.

Cameras mounted on several parts of the vehicles provide a 360 ° view of the journey, and LTE signals in the vehicles improve GPS tracking. The quality and amount of detailed data that these smart devices can collect and organize is unprecedented. With this new level of information, global companies are beginning to see their supply chains become leaner and more efficient.

Today, the market for digital devices, including GPS sensors, is quite diverse. Let's review the concept of the development of this project on table 3.1.

Table 3.1 - Project development concept

Date of creation:	July 2024
Reasons for project initialization The «CD Trans» LLC company needs to optimize business processes, in particular, this applies to the optimization of transport logistics in order to increase competitiveness, improve reliability indicators and increase the number of "on-time orders". For this purpose, the company's vehicle dispatching digitization project is being launched.	
The essence of the proposed innovative idea and how to use it to solve a specific problem. The essence of the proposed idea is to reinstall the fuel sensors, which are included with the device for checking the transport and control of combustible materials in the car, the controller measures the level of fuel and sends the consumption indicators to the instrument panel. The fuel level sensor captures and outputs information to an analog or digital unit. Thus, the dispatcher or the driver receives a notification about the violation in time.	
The goal of the project is to increase the company's competitiveness on the market. It should be noted that the direction of IoT as a direction of digitization is one of the most promising directions in terms of transport logistics and enjoys the greatest demand.	
Assumptions/Risks Establishing correct communication with the external and internal environment Correct software setting of each of the sensors Determining the correctness of the transmitted device indicators	

Source: complied by author

The main operations of the project cycle are presented in the table 3.2.

The network schedule of the project is shown in fig. 3.2.

For a graphic representation of the connections between works, it is suggested to consider the Gantt chart (fig. 3.3). Each segment corresponds to a separate task or subtask.

A network graph will help determine the project's critical path, which is the minimum duration during which the project can be completed.

Table 3.2 – List of the main operations of the project cycle

WBS	Title of work	Duration of work, days	Previous work
1	2	3	4
A	Formation of the team, distribution of responsibilities and powers, justification of the project goal	5	-
B	Calculation of the number and cost of the necessary sensors, purchase of software	14	A
C	Analysis and systematization of the data necessary to put them in the program's operating base	7	A
D	Conclusion of contracts for the supply of necessary sensors	1	A

Continuation of table 3.2

1	2	3	4
E	Conducting a briefing of specialists of the transport department and the software implementation department to discuss key points regarding the operation of the software, discussion of visions of the project's functionality, feedback	1	B, C, D
F	Installation of sensors on a small number of cars for test work	14	E
G	Allocation of a working area at the enterprise for the installation of a tracking PC	3	F
H	Synchronization of car and sensor data	10	F
I	Setting up the interaction system of sensors and the PC of the transport logistics department	25	H, G,
J	Evaluation of results, correction of malfunctions	14	I
K	Staff training, providing algorithms for working with the system, receiving feedback	12	I
L	Implementation of the project and all vehicles of the enterprise	30	J, K

Source: complied by author

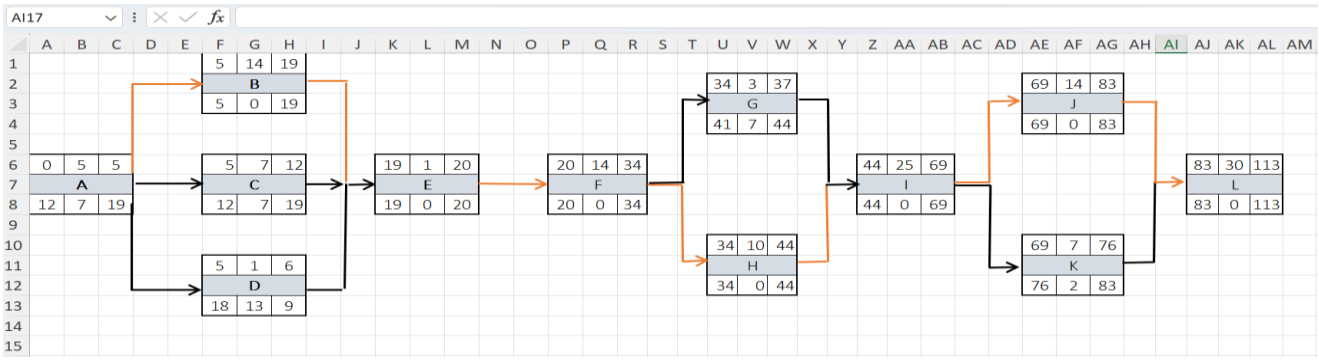

Figure 3.2 – Grid diagram of the project

Source: complied by author

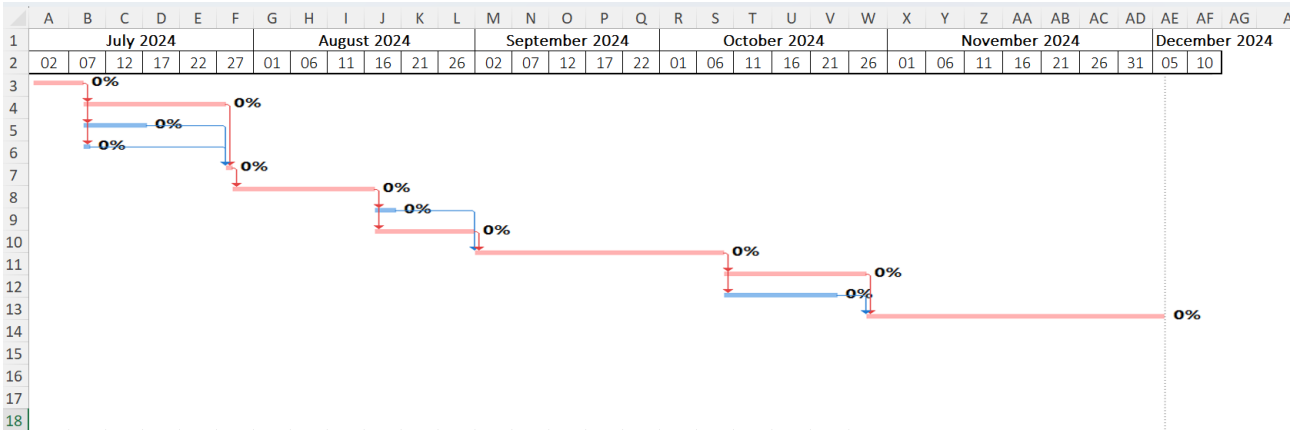

Figure 3.3 – Gantt chart with tracking of project implementation

Source: complied by author

So, we define the critical path of the project: T = 5+14+1+14+10+25+14+30=113 days.

Now let's calculate the intensity of the grid graph. To calculate the tension of the network schedule, first of all, the work intensity coefficients are calculated. After that, the specific weight of the work of each zone (Table 3.3) is found - critical C(%), reserve R(%).

Table 3.3 – Areas of design works

Zone	Number of works	Specific weight
Critical zone (C)	8	67%
Reserve zone (R)	4	33%

Source: complied by author

Thus, the intensity factor of the entire grid graph is 67%. The intensity factor of the schedule should be within 15-25%. It is worth concluding that this grid schedule is tense, since most jobs fall into the critical zone and only 4 jobs have a time reserve.

However, considering the fact that the execution time of each of the operations is predicted with a surplus of time, as well as the fact that only experts in their field will work on the project, no delays in the implementation of the project are predicted.

3.2 Economic substantiation of the feasibility of the proposed measures to improve the vehicle traffic monitoring system of the «CD Trans» LLC

To track and obtain information about each transport vehicle, the operator platform AOS using the Internet of Things can be implemented. The platform uses IBM Blockchain, Watson IoT and IBM Cloud technologies.

In practice, the AOS car is equipped with special IoT sensors for assigning RFID tags. Each label contains information about the carrier, the cargo, the location at a

specific time, as well as the availability of space in the truck - this is how IoT improves transportation.

Information is recorded on the blockchain, which allows the company to quickly obtain the necessary information, while providing reliable protection against unauthorized access. Also, according to IBM experts, this solution makes it possible to reduce the impact of the human factor and significantly speed up the information processing process.

Among the advantages of implementing IoT at the «CD Trans» LLC enterprise, it is worth identifying:

- optimization of the use of the company's resources: personnel, machines and equipment will be used more efficiently and economically, costs will be reduced;

- reducing the importance of human error - unfortunately, people cause most accidents. Losses, thefts, counterfeits and replacement of products during delivery - all these problems concern not only income, but also reputation. IoT will improve delivery security and create a new job market;

- transport control - thanks to IoT transport services, companies will not only know where a specific cargo is and set the delivery time, but will also be able to monitor the condition of the cargo and change parameters depending on the current situation.

The main indicators of the effective implementation of the project to implement the IoT system at the enterprise are shown in fig. 3.4.

Installation costs and the cost of the fuel sensor, Euro – 184.95 euros. Costs for service personnel, EUR/month – 1500. Variable costs are associated with the need to pay salaries to employees who service cars and the system. In general, the system should not cause failures, at the same time, it is recommended to assign 2 specialists to 32 vehicles, who will check the correctness of data transmission.

Total costs in the 1st month of the project, euros - calculated as the sum of costs for service personnel and installation costs and the cost of the fuel sensor. Expenses in other months of the project (month 2-N), euros - we accept as payment for service personnel. Possible average income from transport activity, euro/month - was

calculated as the average number of completed orders, wages for drivers, fuel, depreciation costs.

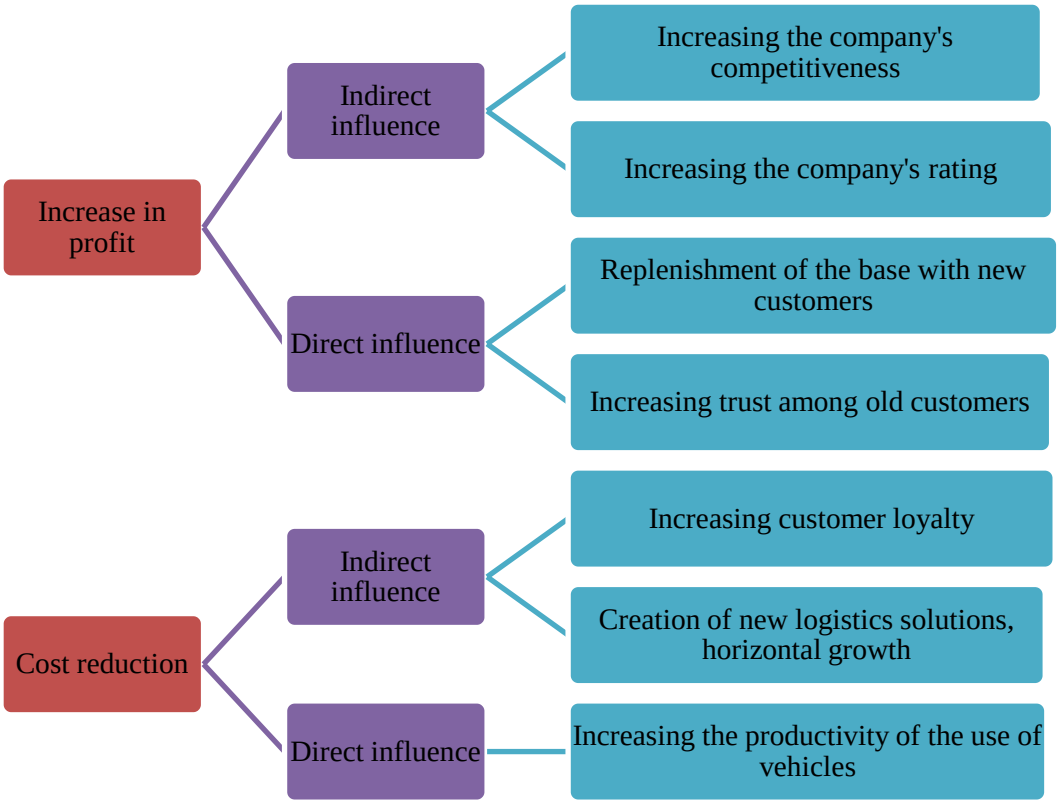

Figure 3.4 – Main indicators of effective project implementation

Source: compiled by the author

In the table 3.4 - 3.5, the calculations of the financial values of the project in the first month are presented, as well as the calculations of the break-even point of the project are given. Thus, according to the received calculations, it was determined that the project will pay off in the 5th month, which can be seen from the calculations of the accumulated profit.

Let's show the value of the calculation of the cumulative profit for 1-12 months of implementation in fig. 3.5. In this diagram schematically presents the project payback results for the entire fleet of the «CD Trans» LLC.

Table 3.4 – Calculation of financial values of the project in the first month

Number of vehicles	Installation costs and cost of the fuel sensor, Euro	Expenses for service personnel, euro/month	Total expenses in the 1st month of the project, euros	Costs in other months of the project (2-N month)	Possible average income from transport activities, EUR/month	General expenses for the maintenance of the vehicle, euros	Profit/loss in the 1st month, EUR/month
2	369,9	60	429,9	60	8000	10600	-3029,9
4	739,8	120	859,8	120	16000	18200	-3059,8
6	1109,7	180	1289,7	180	24000	25800	-3089,7
8	1479,6	240	1719,6	240	32000	33400	-3119,6
10	1849,5	300	2149,5	300	40000	41000	-3149,5
12	2219,4	360	2579,4	360	48000	48600	-3179,4
14	2589,3	420	3009,3	420	56000	56200	-3209,3
16	2959,2	480	3439,2	480	64000	63800	-3239,2
18	3329,1	540	3869,1	540	72000	71400	-3269,1
20	3699	600	4299	600	80000	79000	-3299
22	4068,9	660	4728,9	660	88000	86600	-3328,9
24	4438,8	720	5158,8	720	96000	94200	-3358,8
26	4808,7	780	5588,7	780	104000	101800	-3388,7
28	5178,6	840	6018,6	840	112000	109400	-3418,6
30	5548,5	900	6448,5	900	120000	117000	-3448,5
32	5918,4	960	6878,4	960	128000	124600	-3478,4

Source: compiled by the author

To evaluate the economic efficiency of projects, a system of indicators is used, which reflect the ratio of costs and the results obtained from the implementation of innovations. The main criteria for the effectiveness of the introduction of innovations today are: the impact of innovations on the growth of incomes, satisfaction of service consumers, the growth of incomes from the implementation of new services, the improvement of labour productivity and the dynamics of profits. However, not only economic results should testify to the effectiveness of project implementation.

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Table 3.5 – Calculation of financial values of the project for 2024

Number of vehicles	Profit/ loss in the 1st month, EUR/month	Value of accumulated profit by month, euros										
		2	3	4	5	6	7	8	9	10	11	12
2	-3030	-5690	-8350	-11010	-13670	-16330	-18990	-21650	-24310	-26970	-29630	-32290
4	-3060	-5380	-7700	-10020	-12340	-14660	-16980	-19300	-21620	-23940	-26260	-28580
6	-3090	-5070	-7050	-9030	-11010	-12990	-14970	-16950	-18930	-20910	-22890	-24870
8	-3120	-4760	-6400	-8040	-9680	-11320	-12960	-14600	-16240	-17880	-19520	-21160
10	-3150	-4450	-5750	-7050	-8350	-9650	-10950	-12250	-13550	-14850	-16150	-17450
12	-3179	-4139	-5099	-6059	-7019	-7979	-8939	-9899	-10859	-11819	-12779	-13739
14	-3209	-3829	-4449	-5069	-5689	-6309	-6929	-7549	-8169	-8789	-9409	-10029
16	-3239	-3519	-3799	-4079	-4359	-4639	-4919	-5199	-5479	-5759	-6039	-6319
18	-3269	-3209	-3149	-3089	-3029	-2969	-2909	-2849	-2789	-2729	-2669	-2609
20	-3299	-2899	-2499	-2099	-1699	-1299	-899	-499	-99	301	701	1101
22	-3329	-2589	-1849	-1109	-369	371	1111	1851	2591	3331	4071	4811
24	-3359	-2279	-1199	-119	961	2041	3121	4201	5281	6361	7441	8521
26	-3389	-1969	-549	871	2291	3711	5131	6551	7971	9391	10811	12231
28	-3419	-1659	101	1861	3621	5381	7141	8901	10661	12421	14181	15941
30	-3449	-1349	752	2852	4952	7052	9152	11252	13352	15452	17552	19652
32	-3478	-1038	1402	3842	6282	8722	11162	13602	16042	18482	20922	23362

Source: compiled by the author

Forecasted revenues are associated with the growth of the company's competitiveness, increase in reputation, increase in trust in the company by clients, and, as a result, - receipt of larger volumes of orders, increase in the number of corporate clients, interest in the company's services, and conclusion of partnership agreements.

Let's evaluate the effectiveness of this project, because it is one of the key points when making investment decisions on financing the development of the enterprise system. The basis of such an assessment is the calculation and comparison of the amount of estimated investments and future income (cash inflows), as well as a comparison of the effectiveness of investments in various logistics projects. At the same time, as an alternative to investments in the creation of a logistics system, there are financial investments in other production facilities, placing financial funds in a bank at interest or converting them into securities.

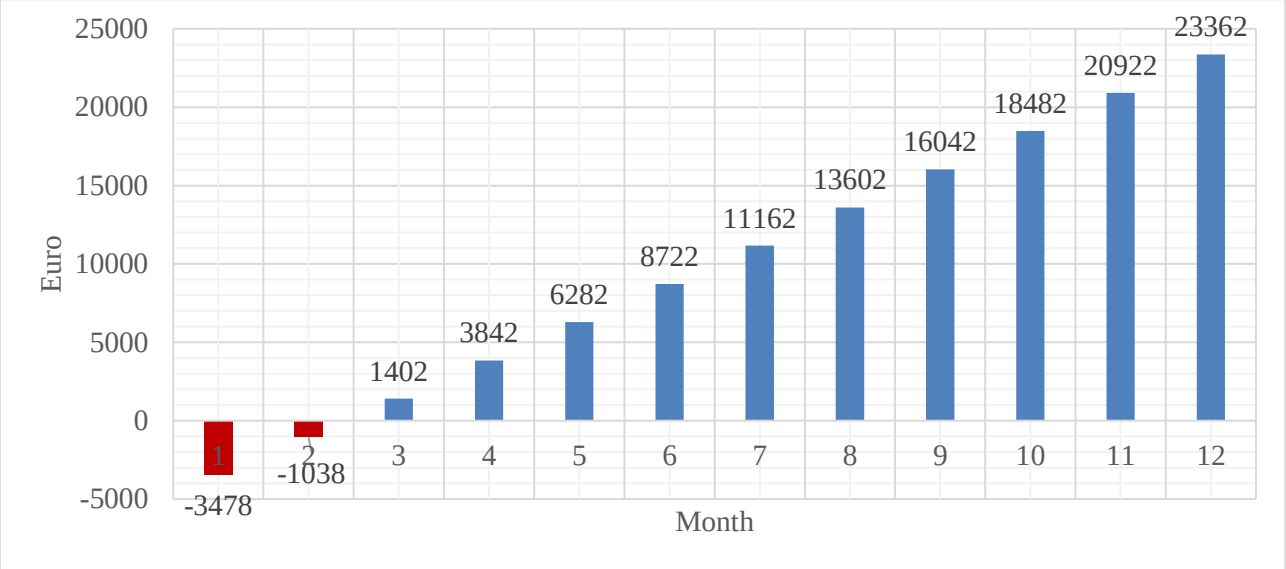

Figure 3.5 – Payback of the project to improve the vehicle monitoring system by digitizing activities and replacing fuel sensors

Source: compiled by the author

Dynamic methods are often called discounting, since they are based on determining the current value (ie, discounting) of cash flows associated with the implementation of an investment project. The main idea of the net present value method is to find the difference between investment costs for the design of a logistics system and future revenues from the operation of this system, expressed in a time-adjusted (usually before the start of implementation) monetary amount.

To calculate the net present value (NPV - Net Present Value) using the AVAC method (AVAC - analysis of the value of alternative capital investments), the following steps should be taken into account: 1. Determination of the analysis period. 2. Determination of costs and revenues. 3. Determination of the discount rate. 4. Calculation of net present value. 5. Estimate NPV: Compare the amount of net present values with the cost of the initial investment. If the NPV is greater than zero, then the project is profitable, and if the NPV is less than zero, then the project is not profitable. The higher the NPV, the more profitable the project.

The general formula for calculating NPV using the AVAC method:

Substituting the formula for calculating PV into the first formula, we get:

$$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t} - I_0. \quad (3.1)$$

where *CF* – Cash flow;

n - the period allotted for the implementation of the planned plans (can be expressed in months or years);

r – discount rate;

IC – Initial funds that were invested to start the project.

I_0 - the amount of initial costs (investment).

If the net discounted value of the flow of payments calculated in this way has a positive sign (NPV>0), it means that during its economic life the logistics project will recover the initial costs I_0, will ensure the receipt of profit according to the given standard r, as well as some of its reserve, equal to NPV.

A negative value of NPV shows that the given rate of profit is not ensured and the project is unprofitable.

At NPV=0, the project only pays for costs, but does not generate income. The general rule of NPV: if NPV>0, then the project is accepted, otherwise it should be rejected.

With a given discount rate, it is possible to determine the current value of all outflows and inflows of funds during the economic life of the logistics project, as well as to compare them with each other. The result of such a comparison will be a positive or negative value (net inflow or net outflow of funds), which shows whether or not the project meets the accepted discount rate.

Let I_0 (English investment) be the amount of initial costs, that is, the amount of investment at the beginning of the logistics project; PV (present value) is the current value of the cash flow during the economic life of the project. Then the net present value (NPV) is equal to:

$$NPV=PV-I_0. \quad (3.2)$$

The accumulated amount of discount income can be determined by the formula:

$$PV = \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t}, \quad (3.3)$$

where CFt - the net flow of payments (CF cashflow) for period t.

Table 3.6 presents the assessment of the NPV of the investment project.

As the calculations have shown, if the cash flow is correctly assessed, the project will ensure reimbursement of the incurred expenses:

- a discount rate of 10% was taken for the project, and this will allow approximately until the end of the second month of profit. In general, the value of the NPV indicator is positive, which means that the project is profitable. In addition, this project will provide a return on investment.

Table 3.6 - Calculations for estimating the net discounted income of an investment project

Indicators	Start of project	Year 2024		
Investments, Euros	6878,4	with discount rate r= 10%	with discount rate r= 15%	with discount rate r= 20%
Income, Euros		1536000	1536000	1536000
Costs, Euros		1495200	1495200	1495200
EBITDA, Euros		40800	40800	40800
Depreciation, 35%		14280	14280	14280
EBIT, Euros		26520	26520	26520
Income tax, 15%		4773,6	4773,6	4773,6
NOPAT, Euros		21746,4	21746,4	21746,4
Discount rate, %		10	15	20
Discount factor		0,909	0,870	0,833
Net Present Value, NPV		19769,45455	18909,91304	18122

Source: compiled by the author

Then calculate the profitability index of the project. Profitability Index (PI) is one of the main parameters that allows you to assess the prospects of an investment project (business plan) in terms of future profitability. The profitability index is

rightfully considered one of the main and accurate criteria when choosing and comparing investment projects.

The profitability index is calculated according to the following formula:

$$PI = \frac{NPV}{IC} = \frac{\sum_{i=1}^{n} \frac{CF_t}{(1+r)^t}}{IC}, \quad (3.4)$$

where PI –estimated profitability index of the future project;

IC – Initial funds that were invested to start the project.

PI= 19769,45/6878,4 = 2,87 (with discount rate r= 10%).

PI= 18909,13/6878,4 = 2,75 (with discount rate r= 15%).

PI= 18122/6878,4 = 2,63 (with discount rate r= 20%).

There is also a calculation of the value of the discounted ROI, which calculated as:

DROI= 19769,45/6878,4-1 = 1,87 (with discount rate r= 10%).

DROI= 18909,13/6878,4 -1 = 1,75 (with discount rate r= 15%).

DROI= 18122/6878,4- 1 = 1,63 (with discount rate r= 20%).

Evaluation of the performance indicators of the investment project is presented in table 3.7.

Table 3.7 – Evaluation of investment Project performance indicators

Indicator	Results (with discount rate r= 10%)	Results (with discount rate r= 15%)	Results (with discount rate r= 20%)	Decision-making
Net Present Value (NPV), EUR	19769,45455	18909,91304	18122	NPV > 0 – the project can be accepted
Profitability index (PI)	2,87	2,75	2,63	The project is accepted because PI > 1.
Discounted return on investment (DROI)	1,87	1,75	1,63	DROI is more than 0 – the project is accepted.
Discounted payback period (DPP), months	3	3	3	The project is accepted

Source: compiled by the author

Thus, already starting from the 3rd month of 2024, the cumulative flow, that is, the sum of cash flows for the past months, acquires a positive value, and already at the end of 2024, the cash receipts exceed the amount of initial investments and amount to 18909,91 euros (with discount rate r= 15%). According to the NPV calculation, the project can be accepted and it will pay off in 5 months.

Control of vehicles will help reduce the time to eliminate problematic situations, improve interaction between drivers and the transport department.

With traditional supply chain management solutions, logistics managers often find out about delays or misused assets after they arrive hours late - or not at all - at their destinations. Those hours ultimately translate into lost productivity, delayed production, and broken customer relationships.

Chapter 3 summary

The project chapter is devoted to the improvement of the vehicle traffic monitoring system of the «CD Trans» LLC transport company. It was proposed to implement a project to optimize transport logistics using the modernization of fuel sensors to improve the control function, minimize losses, to provide more specific information to drivers when searching for a particular loading/unloading point, help in unforeseen situations, and increase the level of the company's competitiveness.

The concept of the project was determined, the network schedule of the project was designed. The NPV of the investment project was predicted, it was determined that the project would pay off in 3rd months, the profitability index was also determined, which was 2.75 (with discount rate r= 15%), as well as the discounted return on investment, which was 1.75, according to which the project should be implemented at the enterprise. It was determined that the implementation of this project will lead to an increase in quality indicators of logistics operations, in particular, an increase in extremely important indicators for the client - reliability of supplies.

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Thus, the goal of the work is achieved and the tasks are completed.

These recommendations, developed by the author, are addressed to the managers of the «CD Trans» LLC transport company and logisticians of the transport division. These recommendations can be used in other logistics companies, but taking into account additional analysis of the malfunction of fuel sensors and their impact on the efficiency of the vehicle monitoring system.

Based on the findings, the author makes the following recommendations and suggestions:

- during analysing the efficiency of the vehicle monitoring system, errors were identified in the operation of fuel sensors of «CD Trans» LLC vehicles, which indicates

a malfunction of existing fuel sensors. Analysed the market data, the most effective was Sensors of the CAN fuel control system - Sensor, fuel supply (Volvo), original product from the vehicle manufacturer

- use of a methodology for calculating the efficiency indicator of introducing fuel sensors to the entire company’s vehicle fleet

- use of design analysis methodology to calculate the effectiveness of investments in the purchase of fuel sensors.

CONCLUSIONS AND RECOMMENDATIONS

The qualification paper is devoted to the organization of the cargo transportation monitoring system in company «CD Trans».

The aim of this research is to consider theoretical principles and substantiate practical recommendations for improving the vehicle traffic monitoring system of a transport company to increase its activities in the international market.

The analysis of the issue of the satellite vehicle monitoring system allows us to draw the following conclusions.

Modern technology offers many safety and security systems of the vehicle. One of the most advanced is the Global Positioning System or GPS. Based on this system, it is possible to monitor any vehicle. Satellite monitoring systems allow both to determine the location of the controlled object and to receive various information about the condition of the monitored object itself. To obtain information about the state of the object, it is necessary to install a number of sensors. GPS monitoring also allows, in addition to real time determination, to view the entire route traveled.

Analysis of the latest research and publications showed that a significant number of scientific publications are devoted to the issue of monitoring the technical condition of vehicles and methods of its organization. However, most of them are descriptive in nature and reveal either the principle approaches used in one or another method, or their functionality. A scientific approach to the complex solution of the problem of monitoring researches of the technical condition of vehicles involves the creation of a classification of existing methods based on certain common features.

The study of the analyzed topic made it possible to determine key classification features and to present a classification scheme developed on its basis for methods of monitoring the technical condition of vehicles.

It was found that in order to achieve the maximum possible accuracy of continuous monitoring of the vehicle's technical condition, it is worth using satellite monitoring systems connected to OBD and supplemented with fuel consumption

control sensors. Since fuel consumption is a more accurate indicator that characterizes the technical condition of the vehicle than the mileage, this approach makes it possible to promptly monitor its deterioration. Supplementing this information with data from the on-board self-diagnosis system allows, with sufficiently high accuracy, to determine potential malfunctions and make a decision on the need for preventive maintenance or repair.

An analysis of global trends in the field of transport monitoring has shown that the potential for using satellite monitoring systems is great. In addition to the traditional tasks of cost optimization, tightening legislation in the field of transport and environmental regulation, as well as the use of systems monitoring technologies in the insurance sector of the economy, have led to a significant increase in demand for monitoring systems and given new impetus to the development of the global telematics market.

The described integrated approaches to implementing a monitoring system in transport companies allows to highlight the following advantages:

- Speed, transparency, efficiency and collaboration ensure high supply chain productivity;
- Improving relationships in the supply chain;
- Improving customer service with the ability to quickly obtain high-quality information about product availability, order status and fulfilment;
- Improving customer service performance;
- Increased productivity, efficiency and throughput of the chain;
- Preventive response to exceptional situations before they develop into a problem;
- Minimizing the time spent on manual monitoring of keys;
- Monitoring events that require intervention or provide important information;
- Reducing the time it takes to make decisions on tasks by recommending decisions in response to events;
- Reducing downtime and losses from it;
- Possibility of continuous improvement of work and cost reduction.

The activity of transport enterprises in the logistics market shows that approximately half of all costs are incurred by fuel costs, and given the fact that the prices of fuel and lubricants are increasing every day, the first part of the work deals with the issue of fuel rationing control.

GPS systems for fuel consumption monitoring and control were analysed in detail, which allow full tracking of every Liter of fuel consumed. It has been determined that GPS navigation systems increase the safety of drivers, contribute to maintaining the speed regime, choosing the best driving route, and also no longer need to report to the management, because all information about how the car was used is displayed in real time or in history. With the use of fuel level control, you can see the exact volume of refuelling and the level of fuel in the fuel tank.

The types of fuel sensors are analysed in detail, their main advantages and disadvantages are presented. The stages of their implementation on motor vehicles are described.

Making conclusion, the analytical part of the research is devoted to the analysis of the vehicle monitoring market and the activities of the «CD Trans» LLC company. It is important to note that the market for transport monitoring systems is constantly evolving, and new technologies and innovative solutions are emerging. In addition, there are many small and medium-sized companies that specialize in specific market segments or regions. When choosing a vehicle monitoring system provider, it is important to consider your unique requirements and business needs, as well as evaluate the reputation, reliability and quality of the products and services offered. Top 10 World GPS hardware manufacturers in 2023 were analysed.

In the analytical part, the activities of «CD Trans» LLC - a leading Ukrainian company whose main activity is the retail sale of fuel and lubricants and related goods - were analyzed. «CD Trans» LLC also sells oil products in large and small groups and provides services for the storage and transportation of oil products for the military and agricultural sectors. The management structure of the company was analyzed in detail, and the staff of the company, which at the beginning of 2024 amounted to 111 people, was analyzed.

The analysis of the geography of the main importing countries made it possible to determine that «CD Trans» LLC imports fuel and lubricants from the Baltic countries, Poland, Greece, Romania, Moldova, and Slovakia. The specialists of «CD Trans» LLC undertake a full range of delivery tasks according to the criteria of the cargo specification and the client's requirements. Moreover, when delivering cargo according to the «door-to-door» scheme, the company can provide outsourcer services.

A comprehensive assessment of the financial condition of «CD Trans» LLC was provided in detail, created on the basis of an analysis of the company's performance, in particular, a system for calculating financial ratios. In general, it can be said that the company is profitable, which is indicated by the rate of profit growth according to the analysis of 2021-2023.

The analysis of production indicators revealed that the number of orders is increasing every year, the needs of which are met by the performance of transportation by the company's own fleet of gasoline and gas trucks, which the company has in the amount of 32 units. The company also has its own storage base for fuel and lubricants located in the Lviv region.

Currently, the company «CD Trans» LLC implements a logistics strategy to minimize the total logistics costs. The goal of the business can reasonably be formulated as follows: to minimize the total logistics costs, guaranteeing an acceptable level of customer service in its activities. In addition, customers are not always ready to overpay for a high level of logistics service (high logistics costs as a result), due to which «CD Trans» LLC may not receive important orders. Thus, the implementation of this strategy is the most optimal.

Today, «CD Trans» LLC manages its transport activities using the Mapon system. The company fleet management platform is an effective and simple way to remotely track vehicles and assets, managing your company's fleet using professional, user-friendly solutions. Managing the fuel resources of the «CD Trans» LLC fleet was a challenging task before implementing the system. Mapon makes it easy to enter, view and analyse all fuel consumption data in a single, easy-to-use platform. Knowing the

average fuel consumption of each vehicle and its approximate load, you can make effective forecasts on the total fuel consumption in your fleet.

Looking at the problems that «CD Trans» LLC faced in the monitoring area after implementing the Mapon system, it was identified that the fuel sensors were not functioning properly. The work analysed the actual fuel value with the data in the system, and identified significant differences. Based on the measures taken, it can be seen that the operating error of fuel sensors varies in the range of 4-57%, depending on the volume of fuel in the tank. It should be noted that the smaller the actual volume of fuel in the tank, the greater the percentage of error. Thus, the «CD Trans» LLC company was faced with the fact that after installing a fuel control sensor and configuring the software, the reports over time began to produce something completely different: high reading errors, incorrect display of gas stations, etc.

In conclusion, the main characteristics of the problem with fuel sensors are described depending on the percentage of indicator values.

In the next part, present the rationale and economic calculations for replacing fuel sensors of older models with new ones and the effectiveness of such a project for the management of the «CD Trans» LLC company.

The project chapter is devoted to the improvement of the vehicle traffic monitoring system of the «CD Trans» LLC transport company. It was proposed to implement a project to optimize transport logistics using the modernization of fuel sensors to improve the control function, minimize losses, to provide more specific information to drivers when searching for a particular loading/unloading point, help in unforeseen situations, and increase the level of the company's competitiveness.

The concept of the project was determined, the network schedule of the project was designed. The NPV of the investment project was predicted, it was determined that the project would pay off in 3rd months, the profitability index was also determined, which was 2.75 (with discount rate r= 15%), as well as the discounted return on investment, which was 1.75, according to which the project should be implemented at the enterprise. It was determined that the implementation of this project will lead to an

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