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Automation of Technological Processes when Organizing Road Cargo Transportation

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Abstract

The paper presents a project for the automation of technological processes carried out during the transportation of goods by road in international traffic. Technological processes were reviewed: Route planning and optimization, vehicle maintenance, monitoring and management of

transport processes, documentation and customs clearance, fuel consumption optimization, warehouse operations management, payment processing and financial management, quality and safety control. The problems of automation of technological processes are presented.

Keywords: Automating Technological Processes, Road Cargo Transportation

1. Introduction

Road transport plays an important role in modern logistics and transport infrastructure, ensuring the delivery of goods over long distances with minimal cost and high speed. In the context of increasing competition, improving the efficiency of logistics processes is becoming important for companies involved in cargo transportation.

One of the most significant trends in logistics is the automation of management and data processing processes.

The introduction of automated systems makes it possible to significantly reduce the time required to perform monotonous operations, increase accounting accuracy and minimize the likelihood of errors related to the human factor. This helps to improve the quality of customer service, reduce costs and increase the overall competitiveness of the company in the market.

The integration of automated systems with existing corporate systems will provide a unified information environment for managing all aspects of logistics, which is an important factor in the successful implementation of automation.

The purpose of the work is to develop a project for the automation of technological processes performed by a freight forwarding company in the provision of services for the transportation of goods by road in international traffic.

2. Automation of technological processes in the organization of cargo transportation by road

2.1 Technological processes and problems of their automation

The following technological processes can be distinguished for the organization of cargo transportation by road:

- Route planning and optimization.
- Vehicle maintenance.
- Monitoring and control of the transport process.
- Documentation and customs clearance.
- Optimization of fuel consumption.
- Warehouse operations management.
- Payment processing and financial management.
- Quality and safety control.

These technological processes play a key role in ensuring the efficiency, safety and quality of cargo transportation services, as well as in reducing costs and optimizing operational processes in this industry.

Specialized software tools, algorithms, and technologies are used to automate the described processes.

The introduction of automated technologies in the field of automotive logistics is associated with the following problems:

- **Integration of existing systems:** Many organizations already have sophisticated logistics process management systems. The integration of new technological solutions may require significant efforts and resources.
- **Data security:** Since logistics operations often involve confidential information about shipments and routes, ensuring data security is an important aspect when implementing automated systems.
- **Staff training:** The introduction of new technologies requires staff training, which can be challenging, especially in the case of complex management systems.
- **Implementation and support costs:** The implementation and support of specialized software requires the investment of additional funds. Costs may include not only the cost of purchasing and configuring software, but also hardware upgrades and technical support.

2.2 Automation of route planning

When automating route planning, the following steps are highlighted:

- **Data collection and analysis:** It is necessary to collect data on customers, cargo, vehicles, available routes, travel time, road conditions and other factors affecting route planning. This data can be obtained from various sources, such as a geographic information system, databases of transportation companies, GPS systems, etc.
- **Development of optimization algorithms:** Based on the collected data, optimization algorithms are being developed that will consider various criteria such as travel time, fuel costs, size restrictions, and delivery priorities. These algorithms can use optimization techniques such as genetic algorithms, ant algorithms, annealing simulations, etc.
- **Integration of route planning software with warehouse management,** vehicle tracking and order management systems.
- **Implementation of dynamic planning and monitoring functions** that will automatically check and optimize routes in real time based on up-to-date traffic data, schedule changes and other factors.

However, in the process of route planning automation, the following problems must be considered:

- Incomplete or inaccurate data.
- The complexity of optimization algorithms.
- Dynamic environment. The system should be able to adapt to changes and change routes in real time.
- The complexity of integration with other systems.

2.3 Automation of the vehicle maintenance process

To automate the process of vehicle maintenance, you can use:

- **Monitoring and diagnostic systems:** That automatically analyze the condition of various components and systems of the vehicle. These systems can use sensors and machine learning algorithms to identify problematic situations and warn of the need for maintenance.

- **The Internet of Things (IoT):** The introduction of IoT technologies to create "smart" vehicles capable of transmitting data about their condition in real time.
- **Automated regular checks:** This may include using robotic systems to perform physical checks and tests.
- **Maintenance management software:** Creation of software solutions for managing the maintenance process, including work planning, accounting for spare parts and materials, as well as tracking completed work.
- **Forecasting and analytics systems:** Development of forecasting systems that analyze data on the condition of vehicles and predict the need for maintenance in the future. This helps to optimize the maintenance schedule and prevent emergencies.

Automation of the vehicle maintenance process presents certain advantages. However, there are some disadvantages that should be considered:

- **Potential loss of service quality:** In the case of full automation, a decrease in the involvement of the human factor may lead to less attention to detail and the specific features of each specific service case. Automated systems may miss some aspects that a human might have noticed or considered.
- **High costs of implementing and updating systems:** The development, implementation and support of automated monitoring and diagnostic systems requires significant investments in both financial and time aspects. This may be especially true for small and medium-sized enterprises.
- **The risk of technical failures and errors:** No system is immune from failures or errors. Incorrect interpretation of data or incorrect functioning of automated monitoring and diagnostic systems can lead to false alarms or underestimation of the severity of problems.
- **The need for updating and adaptation:** Technologies are constantly evolving, and automation systems require constant updating and adaptation to new standards, requirements, and technical features of vehicles.
- **Potential data privacy issues:** The use of the Internet of Things and the collection of vehicle condition data may raise concerns about the confidentiality of this data. Improper data management and protection can lead to information leaks or abuse.

Properly planned and systematically carried out maintenance of the company's rolling stock plays an essential role in ensuring the safety and reliability of cargo transportation services, as well as in optimizing costs by preventing the occurrence of serious defects and expensive restoration work. The organization and performance of vehicle maintenance in accordance with established standards and recommendations helps to increase the efficiency of the fleet and extend its service life.

2.4 Automation of monitoring and control of the transport process

Automation of monitoring and control of the transport process includes the following steps:

- **Development and use of a sensor network:** Installation of motion sensors, video surveillance cameras and other devices to collect data on the

condition and movement of vehicles and road infrastructure.

- **Using GPS systems and software platforms:** Integration of GPS systems into all cargo vehicles for continuous tracking of their location. Creation of software platforms for analyzing this data and making managerial decisions.
- **Development of algorithms and artificial intelligence systems:** Creation of machine learning algorithms for data analysis and forecasting of changes in traffic flow. The use of artificial intelligence for automatic decision-making and optimization of traffic flow management.
- **Automatic control:** Development of automatic control systems that can make decisions based on data on the current state of traffic flow and traffic conditions. For example, changing traffic lights at intersections in real time depending on the density of traffic flow.
- **Feedback and adaptation:** Creating a feedback system that can analyze the results of decisions made and adapt traffic management strategies based on the experience gained.
- **Staff training:** Staff training in the use of automated monitoring and management systems, as well as adapting their work to new conditions that may arise as a result of automation implementation.

The analysis of practical examples allows us to conclude that it is necessary to automate the technological process of monitoring and managing the company's fleet.

Automation will reduce the likelihood of human error, increase the speed and accuracy of data analysis, and provide a more rapid response to changes in the transport environment. This approach will make the monitoring and management system more efficient and resilient to possible negative impacts.

2.5 Automation of the process of documentary and customs clearance

For successful documentation and customs clearance, it is necessary to strictly comply with the requirements of the legislation of both the country of export and import. This includes the correct completion of declarations, accounting of goods according to customs codes, as well as compliance with restrictions and prohibitions on the import / export of certain goods.

During the clearance process, technical difficulties often arise related to the use of specialized software, processing large amounts of data, and interacting with customs authorities. Incorrect filling out of documents or errors in data can lead to delays and fines.

Successful customs clearance requires effective communication with various parties to the process, such as carriers, brokers, customs authorities, and customers. Continuous information exchange between the participants in the process helps to avoid misunderstandings and speeds up the passage of customs procedures.

To automate the process of documentary and customs clearance, it is necessary to develop a comprehensive information system that includes the following components and functions:

- **Electronic filling of declarations:** Development of a software module for automatically filling out declarations based on the provided data on goods and

senders. This may include document templates pre-filled with information from the database.

- **Integration with customs databases:** The system should have access to databases of customs codes, restrictions and prohibitions on the import / export of goods to automatically verify the compliance of completed declarations.
- **Electronic interaction with customs authorities:** Development of an interface for electronic document exchange with customs authorities. This will automate the process of sending and receiving documents, including declarations, invoices, and other necessary documents.
- **Monitoring and tracking:** Implementation of a monitoring system that allows tracking the status of each stage of customs clearance. This will help quickly respond to possible delays and problems in the process.
- **Notifications and automatic alerts:** A built-in notification system for all participants in the process, which will inform about changes in the status of declarations, the need for additional documents or payment.
- **Analytics and reporting:** Integration of the system with the analytics module, which will allow analyzing data on the customs clearance process and generating reports on its effectiveness, time delays and problems.
- **Security:** Implementation of data protection and access control mechanisms to prevent possible attacks or unauthorized access to confidential information.
- **Integration with other systems:** Providing the ability to integrate with warehouse accounting and management systems to automatically update information about goods being moved and their condition.

Despite the complexity and variety of tasks related to documentation and customs clearance, automation of this process is becoming increasingly necessary.

Automated systems make it possible to speed up the passage of customs procedures, reduce the likelihood of errors and simplify communication between the participants in the process. In addition, they provide more effective control over the movement of goods and reduce the risks associated with unfair behavior of participants.

Thus, automation of documentary and customs clearance not only increases the efficiency and transparency of the process but also contributes to ensuring security and compliance with legislation.

2.6 Optimization of fuel costs

Automating the process of optimizing fuel costs in road freight transportation can provide significant advantages and solve some problems.

Potential benefits of automation:

- **Real time and accuracy:** Automated systems can use real-time data on road conditions, traffic, weather, and other factors to make optimal decisions. This allows you to quickly respond to changing conditions and maximize the use of resources.
- **Route optimization:** Machine learning systems and optimization algorithms can analyze many parameters to select the most cost-effective routes, taking into account road conditions, traffic jams and other factors.

- **Speed and load control:** Automated systems can control the speed of movement and the distribution of cargo across the vehicle to minimize fuel consumption.
- **Prevention of breakdowns and failures:** By monitoring the condition of vehicles in real time and warning of malfunctions, automated systems can help prevent possible problems that could lead to increased fuel consumption.

Disadvantages of automation:

- **Dependence on technology:** Automated systems require reliable infrastructure and technological support. System failures can lead to downtime and unexpected costs.
- **Unaccounted parameters:** Some factors, such as individual driving style or terrain features, may be difficult to account for in automation algorithms.
- **Investments and training:** The implementation of automated systems requires significant investments in equipment and staff training.

In general, automating the process of optimizing fuel costs in road freight transportation is a powerful tool that can significantly improve the efficiency and competitiveness of a company, but requires careful handling and consideration of certain limitations.

2.7 Automation of warehouse operations

Automation of warehouse operations is a significant advantage for companies involved in the storage and movement of goods.

Automation capabilities:

- **Automatic barcode reading systems:** Barcode reading allows you to automatically consider the acceptance and dispatch of goods, reducing the likelihood of errors and speeding up the scanning process. It also helps to update data in real time, which ensures more accurate accounting of goods.
- **Robotic systems for moving goods:** Robots can automatically move goods around the warehouse, reducing delivery time and increasing the efficiency of warehouse space use. They can also help with physically demanding or monotonous tasks, freeing up human resources to perform more complex tasks.
- **Artificial intelligence-based inventory management algorithms:** The use of artificial intelligence algorithms makes it possible to predict the demand for goods, optimize inventory levels, and optimize the distribution of goods in a warehouse. This helps to reduce storage costs and avoid surpluses or shortages of goods.

Disadvantages of automation:

- **High initial costs:** The implementation of automated systems may require significant financial investments for the purchase and installation of equipment, as well as staff training.
- **Difficulty in setup and maintenance:** Automated systems require complex configuration and periodic maintenance, which can be difficult for companies without sufficient experience or resources.
- **Unforeseen failures:** Like any technology, automated systems are prone to failures that can lead to downtime and loss of productivity.

- **Limitations of flexibility:** Some automated systems may be less flexible than manual processes, which may make it difficult to adapt to changing business needs.

The introduction of modern warehouse management systems, such as automatic barcode reading systems, robotic systems for moving goods, and artificial intelligence-based inventory management algorithms, is becoming a necessity for organizations seeking to optimize their warehouse processes and increase market competitiveness.

2.8 Payment processing and financial management

Automation will reduce the risk of errors, speed up payment processing and financial management, and improve the overall efficiency of business processes.

Automation methods:

- **Implementation of specialized software solutions,** such as transport logistics management systems and electronic payment systems. Transport logistics management systems allow to automate the processes of billing, financial flow control and data analysis, providing centralized financial management and reducing time for routine operations.
- **The use of electronic payment systems** that allow customers to pay for cargo transportation services online. This simplifies the payment process for both customers and the company, minimizing the risk of errors and delays. Such systems also ensure the security of financial transactions and the ability to monitor the status of payments in real time.

Effective use of automated systems requires not only technical training, but also strategic planning to minimize risks and maximize business benefits.

2.9 Quality and safety control

Despite technological and engineering achievements in the field of road transport, regular quality monitoring and strict process control are essential components of ensuring the reliability and safety of road transport.

Various control methods are used to ensure a high level of quality of road transport. One of the main methods is careful selection and training of drivers. This includes checking their qualifications, knowledge of the rules of the road, as well as safe driving skills. Additionally, technical inspections and maintenance of vehicles, regular updating of the fleet of vehicles, as well as monitoring of the condition of the road infrastructure are applied.

An effective quality and safety control system for road transport requires clear organization and coordination between the various participants in the process. This system includes both government agencies responsible for the development and regulation of legislation in the field of transport, as well as private companies engaged in road transport. Organizational measures include setting safety standards, conducting audits and inspections, as well as developing training and professional development programs for staff.

Modern technological innovations play a significant role in improving the efficiency of control and safety of road transport. This includes the use of GPS systems to monitor the location and speed of vehicles, the introduction of driver health monitoring systems, as well as the development of

automated warning and emergency prevention systems on the roads.

Quality and safety control of road transport is a key aspect of modern transport infrastructure. An effective control system requires an integrated approach, including careful selection and training of personnel, regular maintenance of vehicles, as well as the introduction of modern technological solutions. All this is aimed at ensuring the safety of road users and the efficient functioning of road transport.

3. Conclusions

The problem of automation of technological processes in the organization of cargo transportation by road is of key importance for modern logistics. Increasing automation in this area will reduce costs, improve customer service, and provide a competitive advantage in the market. However, to successfully solve this problem, it is necessary to consider the complexities of integrating new technologies, ensuring data security and training staff.

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