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ANALYZING THE IMPACT OF PROCESS AUTOMATION ON PRODUCTIVITY AND ECONOMIC PERFORMANCE OF LOGISTICS COMPANIES

Summary. *Modern technologies enable automation of information processing and material flows in logistics systems. Automation strategies are used to increase productivity and economic performance of a logistics company, as well as the efficiency of internal processes of transportation, movement and storage, improve the quality of service and, consequently, increase competitiveness.*

The aim of the article is to analyze the impact of process automation on productivity and economic performance of logistics companies.

Key words: *logistics companies, productivity, economic performance, impact of automation.*

In the modern world, process automation is becoming more and more important to improve the competitiveness of logistics companies. The study of the impact of automation on productivity and economic performance of logistics companies represents a key aspect of the industry development [1, p. 151].

They have been talking about the automation of processes in logistics for a long time, and every year this issue becomes more and more relevant. Analyzing the impact of automation on the efficiency and financial results of logistics

companies gives an understanding of what changes are necessary to improve their work. Analyzing the impact of automation on productivity and economic performance is becoming an integral part of the development strategy of modern logistics companies.

The analysis of scientific literature allowed us to evaluate how automated systems affect efficiency and financial results in the field of logistics. The research included theoretical and practical study of the impact of process automation on productivity and economic performance of logistics companies.

Modern business is rapidly evolving and the logistics industry is no exception. In the era of digital transformation, traditional methods of managing warehouse and transportation operations are becoming inefficient.

Growing turnover and increasingly complex supply chains pose serious challenges for logistics companies. Manual order processing, paper-based workflow and lack of a unified control system lead to errors, delays and financial losses.

Implementation of automated warehouse management systems (WMS) and transportation management systems (TMS) becomes not just a competitive advantage, but a prerequisite for survival in the market. Modern technological solutions allow to optimize all key processes: from receiving and placement of goods to order picking and delivery organization [2, p. 307].

The use of robotic storage systems, automatic conveyors and unmanned warehouse equipment significantly increases the productivity of the warehouse. Artificial intelligence and machine learning help to forecast demand, plan routes and minimize transport downtime.

The integration of various digital tools creates a single ecosystem that provides real-time transparency of all operations. This allows us to react quickly to changes, make informed decisions and improve customer service.

In an environment of ever-increasing competition and market demands, companies that do not implement modern automation technologies risk losing

their positions and customers. Investments in the digital transformation of logistics processes are becoming a strategic necessity for sustainable business development.

The utilization of logistics management research has led to the identification of a variety of success factors that can be applied to the development and improvement of the logistics system. One of the main aspects that contribute to overall efficiency and competitiveness is the introduction of automation in logistics.

Automation in logistics has significant potential and offers great opportunities to improve the efficiency of logistics companies. The implications of implementing automated processes are presented in Figure 1.

Thus, automation of processes in logistics systems depends on the integration of information and communication technologies, hardware and software compatibility, standardized interfaces, modular systems, consistent information storage and compatible hardware and software. In addition, modern automation largely depends on advanced identification technologies and technological concepts.

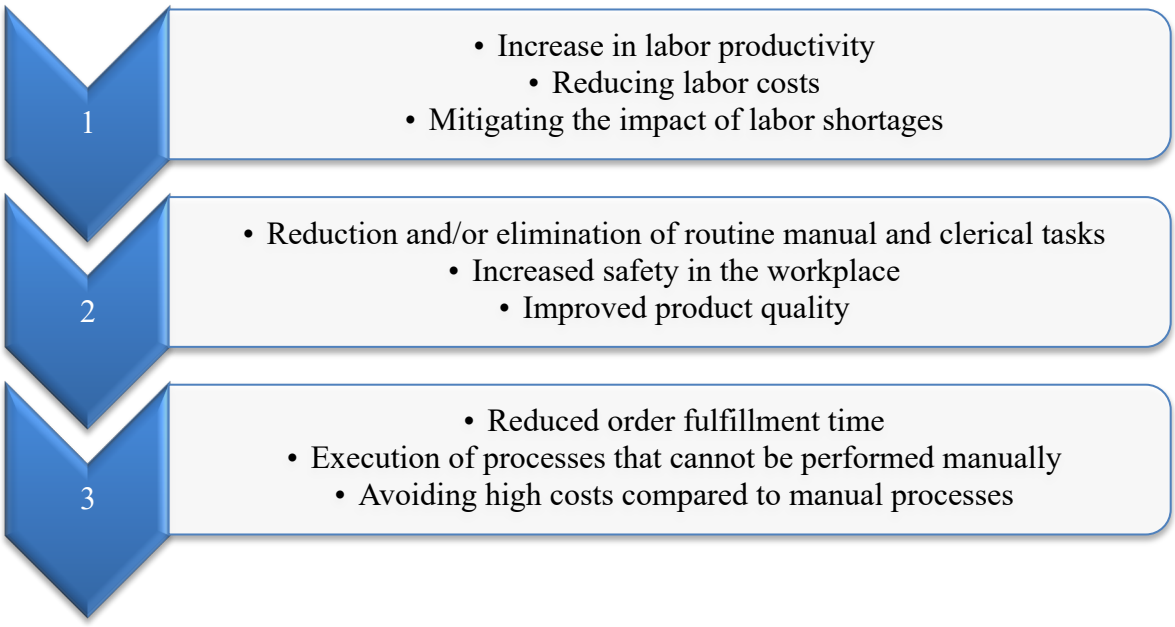

Fig. 1. Consequences of the introduction of automated processes in logistics companies [3, p. 121].

In today's environment, market leaders have identified the need for supply chain improvement and innovation following the overall industry trend toward automation. This reflects a new reality where automation is becoming a necessity rather than a luxury. However, warehouse automation requires more than that.

Today, an integral part of warehouse operations is setting up automated systems at all stages. Knowing how a warehouse handles day-to-day tasks gives logistics companies an advantage. This indicates that a holistic decision-making process that encompasses the entire system is required to maximize efficiency.

A study of automation trends in logistics companies shows that the use of robotic technology and automation in warehouse operations increases productivity by 25-70% and reduces operating costs by 20-40% [4, p. 12].

The broad category of "warehouse automation" refers to a variety of technologies that help employees perform work or complete work from start to finish. Figure 2 lists the available modern systems used to automate warehouses of logistics companies.

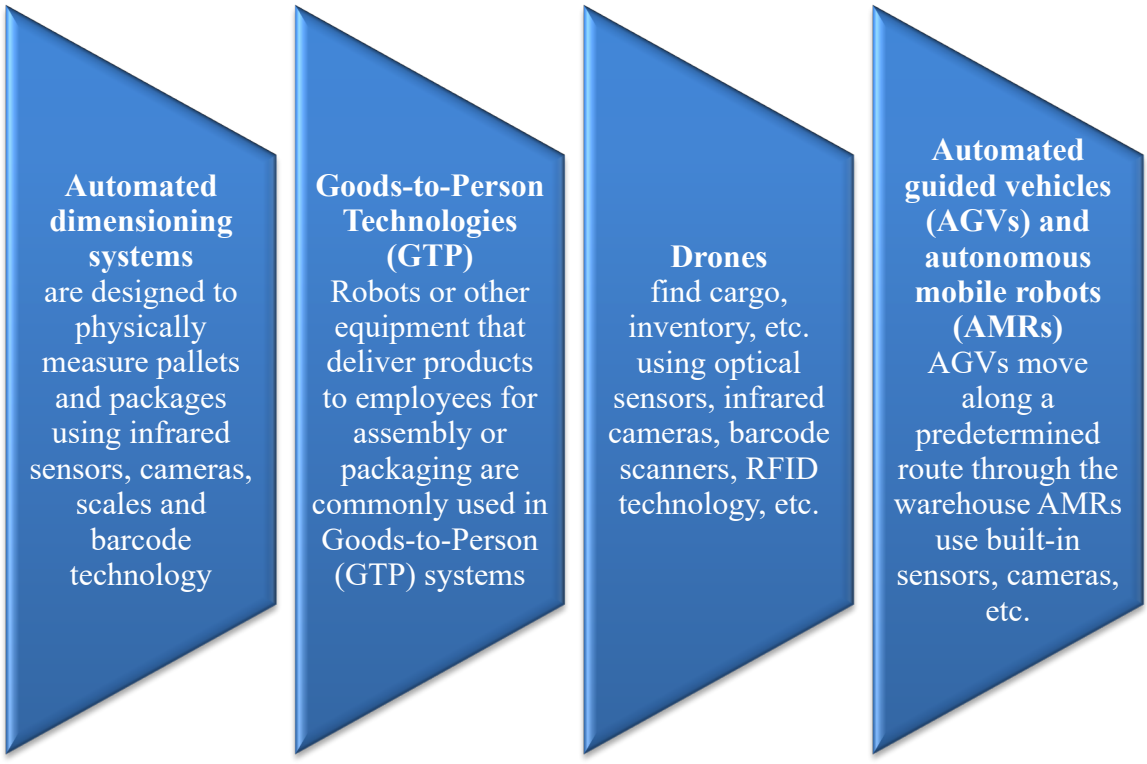

Fig. 2. Modern systems used to automate warehouses of logistics companies [4, p. 15]

Automation of warehouse operations brings significant benefits to corporations, providing them with an advantage in the competitive market. With its help, it is possible to more easily maintain an optimal level of productivity and efficiency in the warehouse, overcoming many problems. Some of them include human error, high costs, safety hazards and long lead times.

Automated dimensioning systems for warehouses come in two types:

- automated parcel dimensioning systems. With an automated parcel dimensioning system (length, width and height), weight and photographs, the dimensions of a three-dimensional or irregularly shaped parcel can be quickly recorded. The labor-intensive procedure of measuring parcel dimensions is automated, avoiding human error;

- automated pallet sizing systems. A warehouse technology called "automated pallet sizing system" automates the procedures of weighing, photographing and measuring pallet dimensions (length, width and height). It is specifically designed to quickly and accurately measure irregularly shaped and cubic pallets.

Robots or other equipment that deliver products to employees for assembly or packaging are typically used in goods-to-person (GTP) systems. These may utilize cranes or carts that move around the warehouse and pick materials. GTP offers conveyor systems as well as automated storage and dispensing options.

Modern warehouse operations are becoming more efficient with the introduction of automated sorting systems. They help remove constraints to business growth and reduce the number of orders that need manual handling. Different types of goods require different approaches to sorting - this is where RFID, barcode reading and other sensor solutions come in. Automation is affecting key warehouse processes: loading and unloading, handling returns, and picking and packing.

Experts from Grand View Research predict rapid development of the unmanned transportation industry - the average annual growth of the global market is more than 15.8% from 2019 [5, p. 89].

Robotic transportation systems successfully operate in large warehouse facilities with a well-planned navigation system and simple layout. For orientation in space, such machines use a whole complex of technologies: magnetic markings, special marking stickers on the floor, conductors, laser systems and video cameras with various sensors.

However, the introduction of such automated solutions is not feasible in cramped warehouses where a large number of employees are constantly moving and the space has a complex configuration.

Autonomous Mobile Robots (AMR) Unlike AGVs with fixed routes, autonomous mobile robots are capable of navigating their own path in real time without the use of physical signage. With advanced control systems and intelligent algorithms, they effectively identify obstacles, enabling safe interaction with staff. Designed specifically for warehouse logistics, AMRs take on large-scale, labor-intensive tasks. Their superiority over AGVs is due to the complex of built-in technologies - sensors, cameras and computing modules, which makes robots more flexible and intelligent when navigating through warehouses [6, p. 67].

Modern warehouses are actively implementing advanced technologies, among which drones occupy a special place. They are able to penetrate into any, even the most inaccessible areas of warehouses. UAVs are equipped with a whole arsenal of technological solutions, from infrared cameras to RFID readers and barcode scanners, which allows them to effectively perform various warehouse tasks. When drones detect irregularities in the placement of goods or the need for replenishment, the system instantly sends notifications. This automation of warehouse processes using drones significantly increases the productivity of the entire complex.

Figure 3 shows the benefits of warehouse automation for logistics companies.

Fig. 3. Advantages of warehouse automation of logistics companies [7, p. 3812]

Instant error detection and correction is one of the key advantages of automation. Automated systems achieve particularly impressive results in sorting processes, where the level of accuracy is close to perfect. While it is impossible to achieve 100 percent error-free performance, automation significantly outperforms human capabilities in terms of accuracy.

During holiday periods and times of high demand, warehouse automation is at its most efficient. Warehouse employees are able to focus on important strategic tasks when routine operations are taken over by automated systems. This not only speeds up work processes, but also makes the staff's labor better and more enjoyable.

Monotonous and energy-consuming processes prevail in warehouse operations, which are significantly optimized when automatic systems are implemented. Robotic complexes demonstrate superiority over human labor in the speed and accuracy of tasks. Efficiency is especially noticeable in mass cargo

handling - automation captures the parameters of thousands of packages, including their dimensions, weight and visual characteristics, at lightning speed. Significant reduction of processing time and minimization of contact points in warehouse logistics are achieved by implementing modern automation technologies.

Artificial intelligence greatly simplifies warehouse logistics management by providing managers with up-to-date data on the placement of goods in real time. Thanks to constant access to accurate information, managers can quickly make optimal decisions based on analytics.

The introduction of automation fundamentally changes the approach to organizing warehouse space. Traditional requirements to the width of aisles between racks become irrelevant, as robotic systems are able to work effectively in narrower corridors than humans. This allows to significantly increase the usable storage area without violating safety standards, maximizing the use of available warehouse space [8, p.2730].

Automation of warehouse processes requires substantial initial investments, but demonstrates an impressive rate of return on investment. The economic effect is achieved due to many factors: reducing administrative costs, minimizing the cost of employee training, optimizing the storage and handling of goods, and eliminating the risks associated with the human factor in inventory and product handling. Although companies may initially avoid large automation costs, failure to modernize warehouse infrastructure in the long term can lead to critical consequences: shortages of goods, lower quality of service and, as a result, loss of customers and reputation of the logistics business.

Transportation operations in logistics have improved through the use of several advanced technologies, reflected in Figure 4.

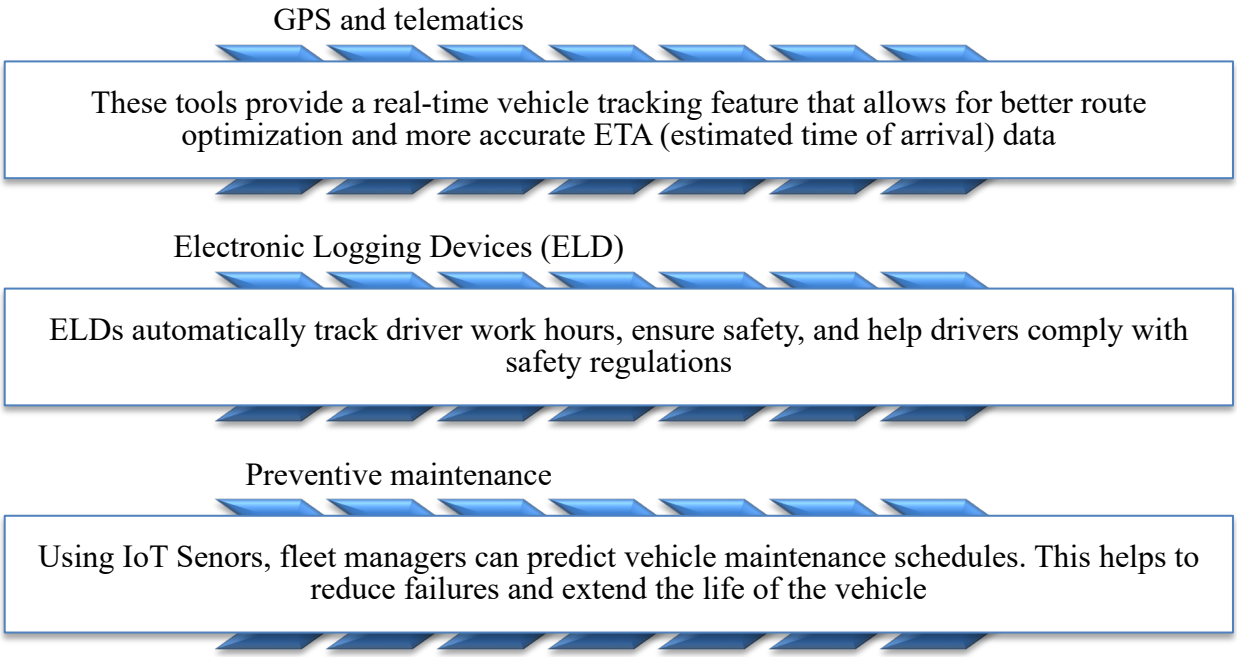

Fig. 4. Used advanced technologies in the organization of transport operations of logistics companies [9, p. 136]

Telematics solutions that combine GPS navigation, sensors and software allow companies to optimize delivery routes and monitor the status of cargo in real time. This significantly reduces fuel and vehicle maintenance costs.

Thanks to satellite positioning, dispatchers can track the location of each unit of transport with an accuracy of a few meters. Modern telematics devices also collect data on speed, fuel consumption and driving style of drivers.

Artificial intelligence analyzes large amounts of telematics data, which helps to predict optimal routes, taking into account traffic conditions, weather conditions and other factors. This significantly improves the accuracy of delivery planning.

Integration of GPS systems with corporate IT solutions ensures transparency of logistics processes at all stages. Customers are able to track the movement of their cargoes online, which improves the quality of service.

Modern electronic recorders are complex systems that include GPS trackers, temperature, humidity and motion sensors, as well as real-time data

transmission modules. Thanks to this, dispatchers can track the location of vehicles, control compliance with the route and delivery time intervals [10, p.143].

Electronic recorders become especially important in the transportation of perishable products and especially valuable cargo. Constant monitoring of transportation conditions allows to prevent spoilage of goods and promptly respond to abnormal situations.

The introduction of electronic recorders contributes to a significant reduction of operational costs. Automation of accounting and control processes minimizes the influence of the human factor and reduces the time required to process documentation. Companies get an opportunity to optimize routes, save fuel and increase the efficiency of transport fleet use.

Thus, modern technologies allow to optimize delivery routes, which leads to a significant reduction in idle mileage, which allows to increase productivity, as well as reducing fuel consumption leads to cost reductions improving the economic performance of the logistics organization. Artificial intelligence analyzes large data sets, helping to plan transport load and forecast demand for transportation services.

As an example, DHL Global Forwarding, a freight transportation company, has implemented robotic process automation to automate (and even eliminate) labor-intensive tasks and free up employees to perform more important tasks and improve customer service [11].

To transport goods around the world - by land, air or sea - a company needs a large number of employees. The logistics business is a multifaceted business that involves mediating between customers and carriers, handling complex customs procedures, managing multimodal transportation solutions and much more. That's why DHL Global Forwarding, Freight (DGFF), the world's leading provider of air, ocean and land freight transportation services, employs more than 40,000 people. To ensure the most efficient routing and transportation services

possible, 4,500 of them work in the company's five Global Service Centers (GSCs). These shared service centers support DGFF's global logistics operations and perform support functions such as finance.

Despite advances in digital technology, the freight forwarding and cargo business is still dominated by manual processes. The question was whether DGFF could change this.

The company had robotic process automation (RPA). This technology allows users to customize computer software - in other words, a bot - so that it mimics the actions of a human in executing a process in a digital system.

Improved customer service was made possible by enhancing the functionality of shared services and giving staff additional tools to work with. This has achieved the primary goal of improving the efficiency of customer interactions.

DGFF partnered with UiPath, a leading global RPA software company, to create a global process automation center. The plan was to leverage innovative technologies like RPA to optimize vital internal processes and improve the performance of DGFF's shared services model.

The project began by scrutinizing virtually every part of the GSC model to identify processes that required manual intervention. Initial efforts focused on identifying processes that involved tedious subtasks for a large number of transactions using business rules or structures. These would be the best candidates for automation and could possibly deliver results quickly.

To test the potential of robotic process automation, a pilot project called "Post Flight" was launched. In order to optimize the operations team's performance, a special report was created based on a comprehensive analysis. Using the DGFF system, the automated assistant collected key information including the timeliness of partner flights. By identifying problem areas in the post-flight report, the team was able to allocate resources efficiently, eliminating the need to check on well-functioning elements.

The pilot program proved so successful that the company was able to fully recoup its investment in just one month.

The implementation of the RPA platform allowed halving the staff - from 30 to 15 employees. The freed specialists were redirected to more profitable areas of activity. Although the system provided valuable analytical tools, the greatest effect was the immediate optimization of internal processes. The reduced staff now focuses on processing automatically detected exceptions, which has significantly improved both the transparency of logistics operations and the level of customer service.

Due to the complex effect of the implemented changes, we have achieved the key goal of significantly improving the level of service, while reducing costs and providing an excellent return on investment.

In today's world of digital technologies, it is possible to automate routine operations with the help of special simulation programs. These virtual assistants, working through a user interface, are able to perform the same actions with data and applications as regular employees. Such technology is called RPA (robotic process automation) and is based on the use of artificial intelligence and software bots. It is important to note that although some call it software robotics, this technology has nothing to do with controlling physical robots - it is designed solely for automating digital business processes.

Unlike standard IT solutions, RPA technology acts more delicately, preserving the integrity of the underlying systems and effectively utilizing the existing infrastructure. This significantly reduces development costs and time. Automated systems demonstrate impeccable accuracy and are able to function without interruption, far surpassing human capabilities in speed and efficiency. Their functionality covers a multitude of routine operations, from file system management and IP address management to application interaction and information processing.

After the pilot project exceeded expectations, the full potential of RPA technology became apparent. The project team quickly set about implementing the initial idea: to provide process automation as a new service for the entire DGFF organization.

To do this, the company created a Center of Excellence (CoE) and a Virtual Delivery Center (VDC). The CoE Center was created to define standards for robotic process automation at DGFF to help business partners and employees understand how it works and the added value it provides. The center helps all stakeholders explore and promote opportunities based on RPA technology and share lessons learned and best practices.

The Virtual Delivery Center is a new unit within the Global Service Center. The VDC, which consists of a team of nearly 30 people, provides process automation as a service within DGFF. Their job is to scrutinize a particular process, use RPA technology to automate it, and then take that new robot and share it with other DGFF service centers and facilities around the world. This means that services that used to be delivered manually can now be automated and delivered virtually - a perfect example of man and machine working together.

Within DGFF, an innovative division, the VDC, has emerged as part of the Global Service Center. A team of 30 specialists is dedicated to the implementation of robotic process automation (RPA), turning manual labor into automated operations. Their work demonstrates an effective symbiosis between human intelligence and machine technology. The team not only develops robotic solutions for specific tasks but also distributes them across DGFF's various service centers and business units around the world, making automation an affordable service for the entire organization.

DGFF now envisions a future in which the overall service center and the organization as a whole can integrate robotic process automation with other advanced technologies such as intelligent optical character recognition (OCR),

machine learning and artificial intelligence (AI) to further automate the collection and analysis of structured and unstructured data.

Thus, in today's world, technological innovations are fundamentally changing the face of the logistics industry. The introduction of automated management systems is becoming not just a competitive advantage, but a prerequisite for the survival of companies in the market. The digital transformation of logistics processes opens up new horizons for optimizing operational activities.

Comprehensive automation of logistics operations allows to significantly reduce time and financial costs, minimize the impact of the human factor and increase the accuracy of planning. The use of modern IT-solutions makes it possible to track the movement of cargoes in real time, to control the state of stocks and to respond promptly to changes in market conditions [12, p.11].

The economic effect from the introduction of automated systems is manifested in the reduction of operating costs, optimization of resource utilization and improvement of customer service quality. Modern artificial intelligence and machine learning technologies allow creating predictive models for demand forecasting and supply chain management.

In an increasingly competitive and globalized marketplace, the level of process automation is becoming a key factor determining the success of a logistics business. Companies investing in digital technologies are realizing significant benefits in the form of increased operational efficiency and improved financial performance.

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