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LOGISTICS TRENDS THAT ARE BECOMING MORE PROMINENT

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Abstract: Following logistics trends is crucial for several reasons in today's evolving business environment. Staying current with logistics trends is essential for businesses looking to remain competitive, efficient, and adaptable in a rapidly changing business landscape. It enables them to make informed decisions, reduce costs, improve customer service, and adapt to the latest technologies and regulatory requirements. While new logistics trends can bring about various benefits, they also come with potential risks and challenges. To mitigate these risks, businesses should conduct thorough risk assessments, develop contingency plans, invest in employee training, and stay updated on relevant regulations. They should also consider the long–term consequences and impacts on their supply chain and customers when embracing new logistics trends. Careful planning and evaluation are essential to successfully navigate the potential pitfalls associated with emerging logistics practices and technologies.
Keywords: internal logistics, elastic logistics, automation, digitalization, technology effects

INTRODUCTION

Logistics has always been open to the opportunities presented by new technologies, as the essence of the field lies in responding to the effects of a constantly changing environment. This process has particularly accelerated with the demand for the extensive application of the so–called "elastic logistics trend".

This approach allows companies in the supply chain to adapt to changes in the business environment and respond to fluctuations in market demand, disruptions in the procurement chain, or changes in workforce planning. Furthermore, this responsiveness enables the minimization of inventory shortages and overstocking.

Elastic logistics is the ability to be flexible in responding to the changing requirements of the supply chain by scaling warehouse resources so that they are efficient when demand peaks and bear no excessive costs in periods with fewer shipping orders. [1]

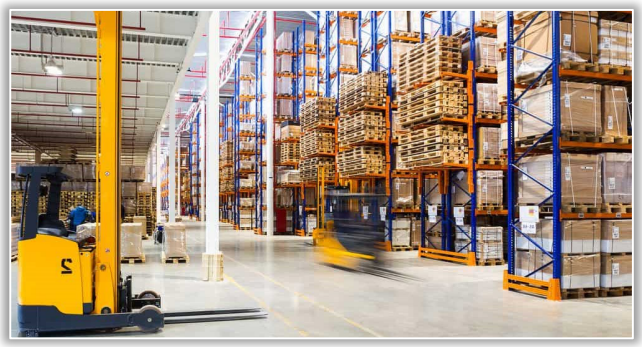

Figure 1. Logistics

Due to the significant technological advancements that have affected all areas of logistics in the past decade, technological elements play a crucial role in the further development of logistics, providing various efficiency and financial benefits.

As elastic logistics requires different tools at various points in the supply chain, it is essential to narrow down the focus in this chapter to technological elements within the company. Examples include new storage systems, material handling equipment, information processing tools, and theories that have emerged and integrated into logistics systems. In warehouses, automation in physical operations is the new direction, often linked to flexibility. The more precise, faster, and efficient the physical operations (packaging, repackaging, stacking, material handling, sorting, loading, and unloading, identification), the more effective the warehouse management.

The growth of flexible logistics raises the need for businesses to become more agile in their operations and processes. Undoubtedly, introducing technologies such as automation and the widespread application of digital technology will impact the future of logistics. While the implementation of these may initially seem daunting, with proper planning, it can become a revolutionary strategy for your business.

Therefore, the ability to quickly and efficiently respond to the continuously changing market environment can be achieved through the automation of logistics systems within the company and the combined application of digital technology tools. In the further sections of this chapter, we will focus on these (internal logistics) tools.

PHYSICAL TOOLS – AUTOMATION

Warehouses are important components of most supply chains. In terms of cost, they represent approximately 20 per cent of total logistics costs. [2]

Warehouse automation is a defining phenomenon of Industry 4.0, essentially encompassing technologies that enhance the efficiency of logistics processes. Automation tools, robots, self–driving forklifts, or various software solutions support the two functions of storage and material handling in warehouses.

Robotics is the intersection of science, engineering, and technology that produces machines called robots, designed to replicate or replace human activities. The term originates from the Czech word "robota", meaning "forced labor", and has been used for about 100 years.

Figure 2. Warehouse automation

The history of robotics spans several centuries, but its most significant developments occurred after World War II, particularly in the 1950s, when the first industrial robots appeared in the automotive industry (performing tasks such as welding and painting). With the advancement of computers and electronics, more complex, programmable robots were created.

Automation is quite common in large warehouses, especially in transportation/sorting and automated storage and retrieval systems, as each of these types of equipment can be found in more than two–thirds of large warehouses. [3]

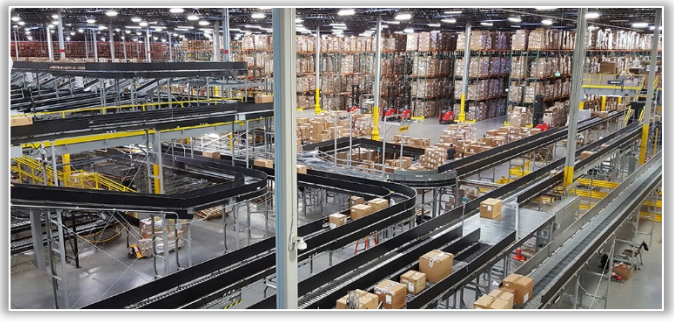

Figure 3. Automation

The simplest and most common form of automation is the use of conveyor belts. Besides making the warehouse area more efficient with conveyor systems, it's essential to note that it provides a much safer material handling option for goods. Nowadays, the use of robots is an integral part of modern logistics. They can handle picking and packing processes within warehouses. In both cases, they operate with the assistance of various cameras, sensors, and algorithms.

Packaging is typically a monotonous task, and using robots is advisable, especially when uniform packaging is required, as they can be programmed for the entire packaging process. Automation is a long–term investment, primarily suitable for economic environments where labor is more expensive. When establishing an automated environment, consideration must be given to providing proper training in transforming workplaces and employing skilled individuals to perform maintenance and repair processes. [4]

Today, we witness continuous development as artificial intelligence and machine learning are integrated. Advanced autonomous vehicles (not only for roads but also for industrial use) are becoming a part of our everyday lives.

Automated Guided Vehicles (AGV)

Automated Guided Vehicles (AGV), or automated guided vehicles, are material handling devices designed to assist in material flow and order fulfillment within manufacturing facilities and warehouses.

AGVs are automated vehicles capable of moving and navigating autonomously along predetermined routes or maps. These intelligent vehicles find applications in various industrial settings.

Figure 4. Automated Guided Vehicles (AGV)

AGVs are often employed in material handling tasks, such as warehouses and logistics centers. These devices can efficiently transport pallets, boxes, or other loads from one point to another, seamlessly integrating into manufacturing processes.

Equipped with sensors and cameras, these devices help determine their routes and avoid obstacles. Their use contributes to reducing

reliance on human labor, optimizing processes, and increasing productivity.

Autonomous Mobile Robot (AMR)

The abbreviation "AMR" comes from the expression "Autonomous Mobile Robot", which in Hungarian means "Autonóm Mobil Robot." AMRs are autonomous vehicles capable of navigating their environment independently, without the need for external guidance or control. Autonomous robots can navigate around obstacles and efficiently optimize routes. These devices adapt flexibly to changing environments and can be easily integrated into production lines.

Figure 5. Autonomous Mobile Robot (AMR)

AMRs are typically equipped with sensors, cameras, and other detectors to perceive their surroundings and adapt to their habitat. Autonomous operation allows them to dynamically adjust their routes according to current conditions, thereby increasing efficiency and adaptability.

Automated Storage and Retrieval System (AS/RS)

The "Automated Storage and Retrieval System" (AS/RS) is an automated storage and retrieval system that employs robots and machinery to efficiently and automatically manage warehouses. The goal of AS/RS systems is to maximize warehouse space utilization, minimize stocking time, and accurately pick goods during the retrieval process.

Figure 6. Automated Storage and Retrieval System" (AS/RS)

These systems typically consist of high shelves or storage units served by robots or stacker cranes. AS/RS systems can be single–deep, where goods are stored in a single row, or multi–deep, where goods are stored in multiple rows or levels. AS/RS systems significantly contribute to the more efficient and automated operation of warehouses. They reduce the need for human labor, increase accuracy, and expedite warehouse processes.

Drones

Although the use of drones initially promised many advantages in all areas of logistics, it has become certain that the limitations of the technology and the lack of regulations restrict the widespread adoption of drones. However, in logistics, they are increasingly being used, for example, for various tasks in warehouses. Drones can help optimize logistics and storage processes, such as inventory checks and counting. Drones can traverse the warehouse, capturing images or videos of the inventory with their cameras.

Another application is the surveying of warehouse layouts, where drones create maps of the warehouse area, aiding in layout optimization and the development of more efficient storage strategies. The use of drones can be beneficial in increasing the efficiency and accuracy of warehouses, serving as complementary tools to assist human labor.

Figure 7. Drones

Aerial drones can optimize the inventory processes in warehouses. They can scan through the inventory much faster than a human, providing accurate data instantly to the warehouse inventory management software. Drones do not occupy valuable space, and there is no need for markers or fixed paths that could impede traffic in the warehouse.

Summary of advantages and disadvantages

It is important to understand that automation itself is not a bad thing, but its excessive extent or improper application can cause problems. Although the introduction of robotics and advanced technologies is extremely costly, the investment can pay off within a few years.

The use of robots comes with many advantages:

— reduction of human errors and warehouse costs,
— good adaptability,

— guaranteed availability,
— dangerous tasks no longer need to be performed by humans,
— potential for significant long–term profit,
— faster and more accurate execution of processes.

However, excessive warehouse automation can carry some challenges and potential dangers. Some potential risks and challenges include:

— job losses,
— investment costs,
— system errors and cybersecurity risks,
— unilateral dependence on technology.

While automation can make warehouse operations more efficient, it may also mean less need for a different type of human workforce. This underscores the importance of skills and retraining needs, as the rise of automation may require new skills from workers. Optimized and well–planned automation, however, can contribute to the efficiency, competitiveness, and innovation of companies. The key is to apply automation in an appropriate and balanced manner, taking into account the importance of human labor and potential societal impacts.

DIGITAL TOOLS – DIGITIZATION

The purpose of digitization is to transform key business activities, business processes, existing organizational structures, existing management concepts, and ultimately the products produced by the company. [5] In reality, the digital transformation of a business is a broader phenomenon than the digitization of a single product, service, or any activity of the company. This also relates to various business processes of the company. [6]. For this digital transformation, it is essential to have IT advancements that facilitate the flow and management of data.

Internet of Things

Az Internet of Things refers to a technology that enables the interconnection of various smart devices or machines over the Internet, creating a network. The essence of this is that these objects can collect and share data with each other through this network. [7] This technology can be applied in many areas of life, including healthcare, industry, or even smart homes and smart cities.

IoT devices can be extremely useful in logistics as well, providing numerous advantages to companies that employ them. It can enhance storage efficiency with the help of various smart shelves and autonomous vehicles, enabling the tracking of goods and more efficient arrangements in the warehouse. However, traceability is not only achieved within the warehouse but also in transportation, thanks to GPS–based devices or, for example, RFID (Radio–Frequency Identification) tags that allow precise location tracking.

Sensitive goods, such as various food items or medicines, often occur in storage or transportation, requiring continuous attention. IoT sensors can alert if environmental conditions are not suitable for sensitive goods, allowing for quick and immediate resolution of emerging issues.

Logistics companies also commonly use IoT devices for the maintenance of machinery and vehicles. These devices can continuously monitor the condition of machines and vehicles. Based on the data collected during monitoring, predictive maintenance is performed, enabling the prediction of potential faults.

With the help of IoT technology, security has also been elevated to the next level, thanks to small sensors placed in the warehouse. These devices monitor the entrances of warehouses and can send notifications about potential security incidents.

Big Data

The term Big Data lacks a formal definition, but it could best be summarized as a vast amount of information that cannot be understood in small quantities. [8]

Processing current datasets is increasingly challenging; traditional database management is no longer capable of handling the complexity of information at such a scale and pace. Big Data Analytics encompasses a complex technological environment, including all software, hardware tools, and models that facilitate the management of digitally detectable data. [9]

The analysis gathers data, which can be structured, partially structured, or unstructured, and prepares them for processing. After processing, the data are cleaned of invalid or incomplete fields, and formatting errors are corrected or deleted. The analysis is carried out using modern tools and techniques such as artificial intelligence, data mining, or machine learning. Thanks to this, patterns and relationships can be identified that human labor cannot deduce or perceive.

What can be particularly helpful is error analysis or supply chain optimization, whether in route planning or warehousing. It can optimize inventory turnover, facilitating storage and retrieval, and in route planning, it can search for and plan optimal routes based on available

traffic and route information. It can also assist in maintaining positive relationships with customers, helping us understand how to be chosen and how to improve the quality of our service. Market mapping is a complex and lengthy process, which Big Data Analytics simplifies, assisting in the search for new markets and the expansion of existing ones

Cloud Computing

Cloud computing provides high–performance servers and infrastructure that ensure the accessibility, storage, and processing of data over the Internet. [10] Among cloud–based services, Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) systems can be distinguished. In the first case, infrastructure is provided for storage and computing capacity. PaaS provides an environment for various applications, and in the case of SaaS, the software itself is offered as a service. [11]

The main advantage of cloud–based services is the location– and time–independent access to data. However, a disadvantage is that access to the cloud is only possible through (private or public) networks. It is crucial, though, that clouds are adequately secured, as technology evolves alongside hacking techniques.

Security systems are capable of monitoring the state of the cloud, and detecting and mitigating attacks. The adoption of cloud computing also maintains the competitiveness of companies, as it can provide environments for, for example, Big Data analysis, which is now an element of many company strategies.

ChatGPT

"Artificial intelligence," refers to machines that can perform tasks entrusted to them that require human intelligence. The goal of artificial intelligence is to create machines and systems capable of thinking, learning, making decisions, and solving problems, much like the human brain operates. [12]

One such AI system is ChatGPT, which has become extremely popular as a chatbot in recent times.

The operating principle of GPT models, including ChatGPT, is based on machine learning and involves several steps:

1. data collection
2. preprocessing
3. learning
4. interpretation
5. refinement

In short, a large amount of textual data, such as books, articles, or social media posts (in logistics, this could be emails, inventory levels, arrival times, etc.), is collected. The input data is then tokenized, breaking the text into smaller characters and words. After cleaning and preparing, the data becomes more understandable and easier for the machine to process. The model learns from this input data. When a user poses a question, the machine breaks it down into input tokens and provides a meaningful response, thereby streamlining office work by eliminating constant data searches and filtering by employees.

The model is continually developed based on user feedback and responses to further enhance its capabilities.

CONCLUSIONS

The excessive application of digital technology in logistics can pose numerous risks. While digital technology offers many opportunities to increase efficiency and optimize processes, inadequate planning, system errors, or other issues raise some risks, such as cybersecurity.

The use of IoT devices emphasizes the critical role of data security. Therefore, it is essential to establish a proper security system to protect our data. As these devices are connected to the internet, they are exposed to significant risks, including cyber–attacks. If the devices or networks are inadequately protected, attackers can easily access data and potentially take control of the devices. However, preparation for such attacks is possible.

It is recommended to integrate security mechanisms into the devices, such as encryption or authentication mechanisms. Additionally, firewalls or access controls are worth implementing to prevent unauthorized access. Regular security updates for devices and software are crucial. Finally, it is advisable to choose reliable IoT devices and service providers who prioritize cybersecurity.

However, the application of digital systems increases the quantity and complexity of data, leading to additional data integrity issues. In cases of incorrect or poorly managed data, inaccuracies in information can cause serious problems in logistics decision–making.

Many studies suggest that excessive digitization makes logistics systems excessively dependent on technology. This means that if a system fails or shuts down, the entire logistics chain may be affected, making it challenging to transition to manual processes. This is an ongoing issue, as

even today's logistics systems struggle to function with manual control. Any failure or shutdown of an automated warehouse system, for example, can cause significant delays and issues in the supply chain.

Unfortunately, there is no optimal solution; technology must be used, and those who resist new system directions will fall behind. Thus, risk mitigation is the only viable path for logistics players, considering factors such as cybersecurity and the importance of human labor. Thorough planning and continuous monitoring can help minimize these risks.

In conclusion, cautiously applying modern technologies can improve current systems and aid in joining and remaining competitive within the industry.

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