

TECHNOLOGY INNOVATIONS IN THE FIELD OF LOGISTICS *TEHNOLOĢIJU INOVĀCIJAS LOĢISTIKAS JOMĀ*

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Abstract. *The field of logistics has seen numerous technological innovations in recent years, driven by advancements in technology, automation, and data analytics. Some key examples of innovations in logistics include automation and robotics, predictive analytics and maintenance, internet of things and so on. Although these innovations sound advantageous to some, there may be some conflicting thoughts regarding these said advancements in the logistics field. Therefore, this article aims to analyse the beneficial and critical factors as well as the impact that innovations introduce to the logistics field.*

Keywords: *artificial intelligence, innovations, logistics, logistics business, supply chain.*

Introduction

Technological innovations in logistics have been rapidly transforming the industry, streamlining processes, increasing efficiency, and reducing costs. There are numerous technological innovations in logistics such as artificial intelligence in the supply chain, the use of automatic vehicles, databases and many more. These reasons benefit logistics tremendously but there may be disadvantages and risks factors like cybersecurity risks, data privacy concerns, technological obsolescence, workforce displacement and many more that challenge the benefits of these technological innovations.

The aim of the research is to evaluate the benefits and harms of technological innovations in logistics around the world.

Tasks of the research are:

- to present the technological innovations in logistics;
- to analyse the usage of Artificial Intelligence in the supply chain;
- to depict the implementation and advantages of databases used in businesses;
- to provide possibilities of integrating the IoT in logistics.

The focus of the research is innovations in the logistics field around the world.

Research method scientific literature analysis.

The results are provided in the conclusions section of this article.

The use of industrial automation in logistics

Automation has taken a great step ahead facilitating the companies' processes.

The aim of it is to automatically perform all those tasks that are repetitive without the need for human intervention. All the necessary information is provided so that the systems can self-manage and be accessible if external intervention is necessary. The flexibility to adapt to market innovations and pressures is required for operational and business success. Technology

provides a timely response to industry needs, including the desire for preparedness and resilience, and industrial autonomy is the next level of performance (*Atria Innovation, 2023*).

Robotics is a major field automotive processes prevail. That is a type of automation, that involves the use of robots in production lines to accomplish assembly or picking duties. Recent years have seen the rise in popularity of collaborative robots, whose diminutive size and security features allow them to operate alongside or with operators without putting themselves in danger (*Atria Innovation, 2023*). Information is extracted from images taken through the use of vision cameras. This information can be of various kinds, including detecting defects in pieces, determining the actions to be taken based on the object found, or simply reading codes. Deep Learning is used to detect or classify captured photos (*Atria Innovation, 2023*).

In logistics the use of autonomous vehicles is common today, especially for use in transporting material or maintenance. Combining it with robotic arms and computer vision is common (*Atria Innovation, 2023*). These are only a few of the possible technologies used in automation. It should be noted, that it is not enough to apply only one of them to automate a process in most cases. It is therefore necessary to use a combination of two or more of the mentioned technologies (*Atria Innovation 2023*).

Benefits of industrial automation

Automating tasks improves efficiency in the process by performing various tasks more quickly, and also production can be sustained 24 hours a day. Higher quality can be achieved by automating tasks, which allows for greater efficiency in the process by being able to perform various tasks more quickly. Production can also be maintained 24 hours a day (*Atria Innovation, 2023*). As productive work means less commuting time, it makes everything much easier. Optimized system with the use of automatic vehicles makes work easier and more efficient with much lower costs (*Alliance for automotive innovation, 2024*).

It can also involve an initial investment, but it also allows great savings. Cost savings - although automation can involve an initial investment, it also allows great savings. There are several reasons for this, such as fewer mistakes, which makes the product more economical and reduces the amount of waste generated by mistakes. An automated system allows the collection and storage of a large amount of information about the process. It is easy to perform analyses that can help improve the process and make it more efficient. Automating the toughest tasks keeps people out of perilous situations. Moreover, automated systems have great security measures that prevent accidents from occurring (*Atria Innovation, 2023*).

Disadvantages of industrial automation

Industries using machines and robots to boost their efficiency will lead to job displacement and joblessness. With regard to those changes, the society would face economic and social challenges. Still, the over reliance on automation can lead to a potential loss of skills and proficiency of employees. Their skills may be lost if they become too dependent on automated systems (*Atria Innovation, 2023*). Thus, creativity and innovation can be limited by the presence of automation in the manufacturing process, as machines are designed to follow specific instructions or designs, depending on the industry (*Macrometa, 2024*).

To sum up, according to Atria Innovation (2023), automating industrial processes can have numerous advantages. Due to their complexity, tasks will continue to be performed by people. But, even in the most routine tasks, the application of automation in any of its versions can offer great benefits and advantages for everyone.

Artificial intelligence in the supply chain

In the competitive global market, companies must operate efficiently to maintain growth. Artificial intelligence (AI) predicts demand, optimizing inventory and supply chain processes to prevent stock issues (*Patel, 2023*). The 2020 Covid-19 pandemic has shown supply

chain vulnerabilities, prompting companies to invest in digital solutions for enhanced efficiency and competitiveness (Javiad, 2024).

When the supply chain is fully optimized with successful supply chain management (SCM), companies are likely to experience these benefits (Patel, 2023):

- *Decreased operating costs*, example, a grocery store proprietor purchases fresh vegetables directly from the farmer, bypassing the need for intermediaries, it can result in cost savings and expedite the availability of produce in the store (Patel, 2023).
- *Inventory management optimization*. AI systems monitor inventory, track usage patterns, and reorder items as necessary, cutting shipping costs, preventing stock-outs, improving capital turnover, and avoiding inventory backlogs (Industry news, 2024).
- *Shorter delivery times and on-time delivery*. Walmart employs AI to examine sales trends and fine-tune inventory management, diminishing instances of product shortages and expediting the delivery of fresh groceries to customers (Patel, 2023).
- *Enhanced supplier relationship management*. AI-powered supplier relationship management (SRM) software helps in selecting suppliers based on pricing, past purchases, and sustainability. Robotic process automation (RPA) automates routine supplier tasks like invoice sharing and payment reminders (Javiad, 2024).

Although AI offers numerous advantages for supply chain management, it comes with its own set of challenges. Therefore, it is crucial to acknowledge some of the drawbacks linked to its application in supply chains (Patel, 2023):

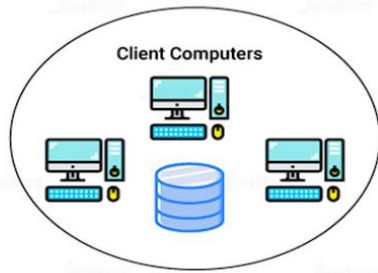
- *Biased algorithms*. Design flaws or erroneous data sorted into algorithms can lead to limited software and technical artefacts. AI duplicates societal biases for race, gender, and age, which increases social and economic inequalities. If data is not representative of the entire supply chain, it can lead to skewed results and poor decision-making (Patel, 2023).
- *System Limitations*. Typically hosted on the cloud, AI systems require substantial bandwidth, leading to significant initial costs for many supply chain partners. Accessing these AI capabilities may also necessitate specialized hardware at times (Gulati, 2023).
- *Loss of human expertise*. Automation may result in employment reductions, particularly in roles focused on repetitive tasks (Sander, 2023).

All in all, the significance of AI in supply chain management is projected to increase in the forthcoming years, empowering businesses to be effective in the global market and streamline their operations (Gulati, 2023). As explained, AI represents a significant transformative force, tackling both the advantages and obstacles across business functions by offering insights into operations and the ability to analyse vast amounts of data (Patel, 2023).

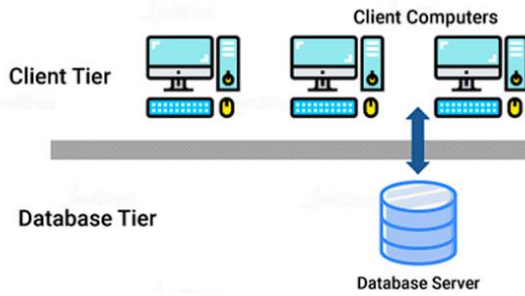
Databases and their implementation in business

Communication between the different teams and being able to store and access information is another important point of automation. Databases are used to keep track of the elements and how they relate to each other (Atria Innovation, 2023). According to TechTarget (2024), it is also commonly used in businesses to store all the information to make informed business decisions. Some of the ways the organizations use it are to improve all the processes, keep eye on buyers, etc. It can be set up for easier access management and updating. The information is organized and related information is stored in way that it can be easily accessed, retrieved, managed, and updated. It is where all data is stored, very much like a library that houses a wide range of books from different genres (TechTarget, 2024).

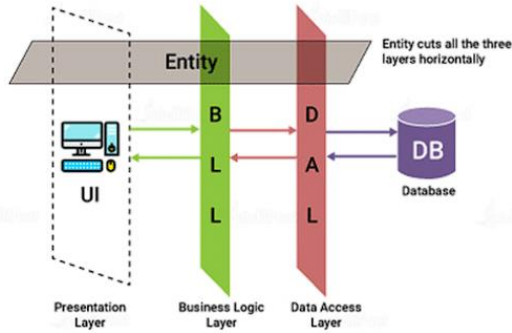
Database architecture in businesses and organizations involves the application of programming languages to design software (see Figure 1).



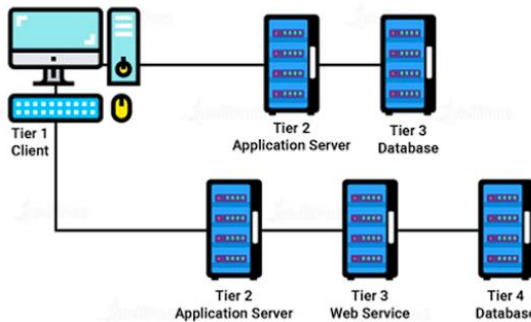
1-tier Architecture



2-tier Architecture



3-tier Architecture



n-tier Architecture

Figure 1. IntelliPaat scheme, Database architecture tiers (IntelliPaat, 2024)

The architecture can be either single-tier or multi-tier like 1-tier architecture, 2-tier architecture, 3-tier architecture, n-tier architecture, etc. (IntelliPaat, 2024)

Databases have the following components:

- *Hardware:* Physical electronic devices such as storage devices, input/output (I/O) devices, and many more. It can act as an interface between computers and real-world systems.
- *Software:* Programs for managing and controlling the overall database. Database Management System (DBMS) itself is software. The operating systems (OS), the database application programs that allow data access in DBMS, the network software that shares data, etc. are all examples.
- *Data:* It is the information that is gathered, stored, accessed, and processed by a DBMS, e.g., actual data, operational data, and metadata.

- *Procedure*: It is the specific set of instructions and rules to use a database for designing and running the DBMS, as well as to instruct users on how to operate and manage it.
- *Database access language*: This helps export data to and access the same from the database. To enter new data or update or retrieve the data from the database, you can write commands in the database access language. DBMS then displays the results in a *user-readable form* (IntelliPaat, 2024).

The databases serve as big facilitators of business by minimising data redundancy, improving data security, increasing consistency, lowering updating errors and reducing costs of data entry, data storage, and data retrieval (Intellipaat 2024).

Nevertheless, the Database Management System has its disadvantages too:

- Maintaining the software and hardware required for a DBMS is usually expensive.
- Using DBMS could seem very difficult for someone from a non-technical background.
- Since all the data is stored in one DBMS, if the software fails, all the data of the organization could be lost (IntelliPaat, 2024).

To sum up, with the help of databases, professionals in organizations are able to make use of the organized data to facilitate improved and effective decision-making, agility, and scalability. The different types of databases, along with the changes in the approaches of technology, advancements in automation, and the cloud are driving databases in new directions (IntelliPaat, 2024).

The IoT technologies for logistics

There are numerous benefits of technology. Not only facilitating the daily life, it can also be beneficial in logistics. One of the greatest technological inventions for logistics is IoT technology. This innovation helps to keep in touch with your cargos, be aware of their temperature location and conditions, whilst also being free from extra duties (TechTarget, 2023).

According to a K. Yasar and A.S. Gillis (2023), the internet of things, or IoT, is a system of interrelated devices connected to the internet to transfer and receive data from one to the other. IoT devices can be classified in to two groups:

1. Sensing devices, that include sensors and actuators.
2. General devises, that are connected by a wired or a wireless interface.

Both general devises and sensing devises transfer information to the cloud (TechTarget, 2023), (see Figure 2).

Working of IoT

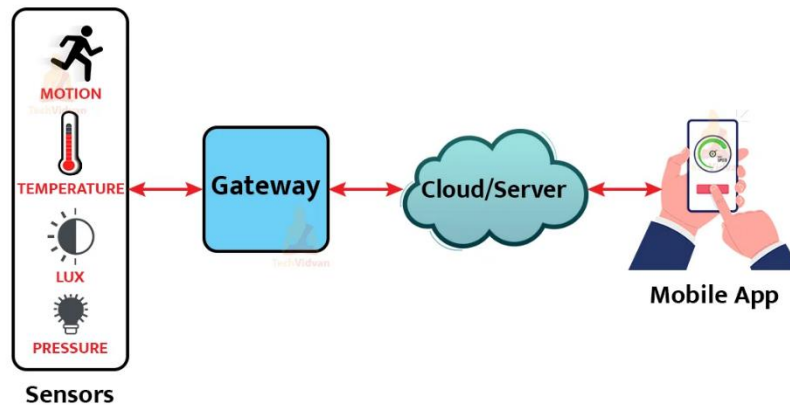


Figure 2. Working scheme of IoT (TechVidvan, 2021)

IoT in logistics is already in high use. As stated by A. Samsukha (2023), IoT technology is frequently used in wireless devices such as GPS, for package tracking, so that not only the carrier is aware of the cargos' state. It can also be tracked by the provider and purchaser as well. In addition to that, IoT technology can also be used to track inventory. By the help of sensing devices, a current inventory and number of products or components can be not only known by an amount, but it can also be interacted with, by sensing a shortage of it and optimizing stock levels. Another great usage of IoT technology is fleet management. Besides it being able to provide the location of the vehicle, it can also track its speed, estimate delivery timing, condition, optimize routes and scheduling. This way improving fleet performance. And finally, this previously mentioned technology can identify patterns, automatically predict the failures in equipment and schedule maintenance.

While being a great invention, IoT has a few resolutions that should be improved in the future to fulfil its capability. Firstly, as more sensors and devices are used in a system, there is more data to handle. Without scalable infrastructure, managing its data would be too difficult. Secondly, it is no secret that the internet is often attacked by cyberattacks, which can lead to loss in data, package, and funds burglary and many more. By increasing security businesses should be able to protect their data and prevent unauthorized access. Finally, the possibility of maintaining inaccurate data can lead businesses to huge losses, such as financial, reputational damage, legal risks, and missed opportunities for growth (Samsukha, 2023).

Overall, IoT technology is a great investment for logistics companies, due to its significant advantages in Shipments tracking, monitoring, inventory management, fleet management and predictive maintenance. However, its scalability, security, data quality, and integration should also be considered and improved to ensure its capability (Samsukha, 2023).

Conclusions

1. As the world is in a permanent change and needs of improving, in the most routine tasks, the application of automation in any of its versions can offer great benefits and advantages to everyone, but also there will continue to be tasks that can only be performed by people due to their complexity. The need of human interaction shouldn't be also neglected especially when it comes to customer experience, since the costumers are the source of income for survival and expansion.
2. Communication with AI and machines has become daily and common. It takes place through various man-machine interfaces that use menus, dialog boxes, or form elements. Sometimes,

there are used more advanced interfaces that involve voice recognition, synthesis, or natural language analysis.

3. Databases work as the system helping store and access the information of the company. It helps to increase data security and consistency. Still Database Management Systems may be pricy and need extra qualifications to manage by the company staff. Still with the help of it, companies may speed up decision-making, scalability and agility processes.
4. IoT is a greatly advance technology, helping monitor, track, manage the shipments, fleet and other fields in logistics. Still the scale of usage, security and integration in to the system of the business and the client should be taken into account.

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