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Intelligent warehouse systems

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Abstract: Artificial intelligence can change the overall operation of a business and make work activities more efficient not only in terms of time but also economically. Individual enterprises are increasingly trying to incorporate artificial intelligence into production processes and the need to summarize knowledge about this trend is the main pillar of this paper.

Keywords: artificial intelligence, warehouse, intelligent warehouse.

INTRODUCTION

The *European Logistics Association* characterizes logistics as 'the organization, management and management and implementation of the flow of goods, from development and purchasing to production and distribution according to the final customer's order, so that all market requirements at minimum cost and minimum capital expenditure.

According to the *Council of Logistics Management*, logistics is "the process of planning, executing and managing the efficient, effective flow and storage of of goods, services and related information from the point of origin to the point of consumption, the to satisfy customer requirements."

Kortschak defines logistics as "the science of coordinating active and passive elements of an enterprise at a favorable time cost to improve its flexibility and adaptability to changing market conditions."

According to a survey by the *German Ifo Institute*, conducted in *August* 2023, uses only 13.3 % of the companies surveyed actively use *AI*. These are companies of different sectors and focuses, which shows that compared the logistics sector has a dominant and pioneering position. According to a 2024 analysis of research by *HERE Technologies*, the use of artificial intelligence in their companies, approximately 34 % of *U.S.* transportation and logistics companies. The study also revealed that *U. S.* companies are resistant to implementing artificial intelligence due to high costs (23 %), concerns about disrupting existing processes (12 %),

and problems associated with identifying suitable suppliers (11 %).

According to a 2020 survey on artificial intelligence in *Slovakia* conducted by *Slovak Centre for Artificial Intelligence Research*, the application of artificial of artificial intelligence in the transport and logistics sector up to 23 %.

1 TECHNOLOGIES OF INTELLIGENT WAREHOUSE SYSTEMS

Intelligent warehouse systems include several technologies using artificial intelligence for warehouse logistics. One of these is *NIMMSTA's* innovative industrial smart clock, which enables highly efficient picking, thanks to two-way interaction between the worker and the warehouse management system.

The watch allows product numbers to be entered directly via the display, for example during warehouse inventory, or to make corrections to inventory data during the picking process. The smartwatch also allows, with the help of built-in *QR* code readers, quickly scan and read information about a given product or package. Figure 1 shows *NIMMSTA's* industrial smartwatch [1, 2].

Fig. 1. Industrial smart watch [1]

Fig. 2. *Amazon Robotics' GTP* warehouse robots [4]

Warehouse robots are another *AI* technology that is a significant investment in improving the supply chain management of businesses. For example, retail giant *Amazon* owns its own brand of warehouse robots, *Amazon Robotics*. Today, *Amazon* has close to 200,000 robots in its warehouses across 26 distribution centers, where they assist workers in picking, sorting, shipping, and storing packages [3]. Figure 2 shows a warehouse robot from *Amazon Robotics*.

There are several types of warehouse robots:

- *Warehouse Drone* - warehouse drones are usually used for inventory management. They are equipped with barcode sensors that help in inventory management and inform warehouse workers when replenishment is needed,
- *Collaborative Robot* (*Co-bot*) - an industrial robot that can work safely alongside humans in a shared workspace. Helps reduce picking walking time and increase productivity,
- *Robotic Arm* - arms can be used for picking, loading empty boxes onto conveyor belts, or placing items into the sorting automated machine for outbound conveyor belts,
- *Autonomous Mobile Robots for Cargo Transportation* - these are used to put away goods, transporting pallets over long routes, placing empty pallets in their correct location,
- *Goods-to-Person Mobile Rack Transport Robot Delivers* products via mobile racking systems to workers' workstations.

2 EVALUATION OF THE POSSIBILITIES OF USING ARTIFICIAL INTELLIGENCE IN LOGISTICS

The benefit of intelligent warehouse systems, mainly warehouse robots, is their high productivity and performing routine tasks at a consistent quality and speed. The use of intelligent warehouse systems increases safety in handling and the risk of damage to goods is also reduced. Also, these systems help in optimising warehouse space. They also have the advantage of being relatively quick to implement.

The disadvantages of smart warehouse systems include their high acquisition cost and difficult maintenance [6-8], for which personnel need to be trained. Specialised staff is also needed to operate the equipment. Another disadvantage is the fact that intelligent warehouse systems, but especially warehouse robots, cannot be used for other activity other than that for which they are programmed.

Shipping company *DHL*, in conjunction with *DRONAMICS*, the leading developers and operators of medium-haul cargo drones, are creating a network of short- and medium-haul transport drones. Figure 3 shows a delivery drone developed by *EHang* in cooperation with *DHL-Sinotrans*.

DHL-Sinotrans and *EHang* have launched their own network of transport drones in China, which is now fully operational. The *EHang* Falcon intelligent

drone, with eight propellers on four arms, is designed with multiple systems for full backup and intelligent and safe flight control modules. Among its high-performance features include vertical takeoff and landing, high-precision *GPS* and visual identification, intelligent flight path planning, fully automated flight, network connectivity and real-time planning time.

Fig. 3. *DHL's EHang Falcon* delivery drone [5]

As a fully automated and intelligent solution, the drones, which can carry up to 5 kg of cargo per flight, take off and land atop smart enclosures that have been specially developed for fully autonomous loading and unloading shipments. The smart cabinets can seamlessly interface with automated processes including sorting scanning and storage of express mail, they also contain more advanced features such as facial recognition and *ID* scanning [12-15].

CONCLUSIONS

Leading experts in the field of artificial intelligence are making predictions and it is expected that there will be wider implementation of *AI* in businesses of all sizes in the coming periods. These predictions are related to changing workforce dynamics, with greater automation impacting job creation and job destruction in equal measure. Increased use of robotics, autonomous vehicles and other *AI*-driven technologies is also expected.

The goal of artificial intelligence is to create programs and systems that can analyse data, learn from experience, solve problems, interact with people and even perform autonomous actions. Examples of AI applications include voice assistants, self-driving cars, disease diagnosis in medicine, product recommendations in e-commerce, data analysis in business processes and many others. Artificial intelligence [9-11] has a wide reach and has the potential to fundamentally impact many aspects of of everyday life and a variety of industries, from technology and healthcare to transportation and manufacturing. It is an area of active research and innovation that is constantly evolving and pushing the boundaries of what can be achieved in the field of computational intelligence.

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