
Possibilities of using artificial intelligence in logistics

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Abstract: The paper focuses on the topic of the possibilities of using artificial intelligence in logistics. It provides basic information about the given topic, which is presented in the theoretical basis. It describes the definition, history and development and objectives of logistics. It also deals with aspects of *Logistics 4.0* and the definition and history of artificial intelligence. The core of the work divides individual options between logistics platforms using artificial intelligence and logistics technologies using artificial intelligence, the principle of operation of which is subsequently described. The conclusion is devoted to the evaluation of the current state of use of artificial intelligence in the logistics industry. It also contains an overview of the advantages and disadvantages of the mentioned possibilities of use.

Keywords: artificial intelligence, logistics, development.

INTRODUCTION

Logistics 4.0 can be defined as a modern approach to the management and optimization of supply chains that uses digital technologies and innovations. This concept is based on the idea of *Industrial revolution 4.0* and applies it to the field of logistics. The goal of *Logistics 4.0* is to achieve greater efficiency, speed and flexibility within the supply chain, reduce costs, minimize losses and increase quality and customer satisfaction. This modern approach can be

implemented in all industries, from manufacturing and distribution to retail and e-commerce, and brings a number of benefits in the form of better planning, optimization and control over logistics processes.

The basic task of digitizing activities in the company connected with logistics is to reduce the number of errors, increase productivity, track location and time and cost efficiency. Digitization in logistics helps, among other things, to solve problems such as tracking products, packages and vehicles, checking

delivery times, filling out web forms and invoices, optimizing routes or reducing costs. Most logistics companies use cloud databases that allow them to access customer and order data very quickly. Digital logistics companies have the ability to effectively manage their day-to-day operations, including availability, costs, flow and resource monitoring, transportation processes, personnel and suppliers to ensure flawless processes and improve customer service [1, 2].

One of the basic elements of digitization is the blockchain. Its main idea is to store transactions and data in computer networks, organized in a decentralized, transparent and secure manner for all parties involved. Blockchain works on the basis of a decentralized database. A network consists of computers and devices with the same authorizations that are connected to each other. All network participants have unrestricted access to all information, but cannot change the content of the data set itself. Blockchain can only be updated by expanding it. Each set of data forms a separate block, which is generated according to a predefined procedure and is connected to the existing chain of data blocks in a cryptographically secure manner. The link between individual data blocks is called a hash. Each block has a cryptographic seal, called a hash value. The new block takes the hash value from the previous block and is assigned a new one. During this process, the chain is continuously monitored. Every time a participant enters new data, it is transmitted to the entire network in an encrypted form, which prevents the manipulation of information. For this reason, the blockchain is transparent and at the same time practically resistant to counterfeiting.

1 THE USE OF INTERACTIVE TECHNOLOGY IN THE LABORATORY

Under logistics platforms using artificial intelligence, we can include platforms designed for demand forecasting and delivery planning, dynamic pricing and route optimization, or platforms for scoring potential customers and sales analysis.

There are several different qualitative and quantitative forecasting demand forecasting methods that can be used:

Collective opinion - uses the knowledge and experience of the company's sales team to gather historical data about customer demand. However, this method is not powered by artificial intelligence.

Customer survey method - provides key information about customer expectations and needs. Despite its usefulness in forecasting sales, forecasting actual demand can be more challenging.

Barometric method - uses economic indicators to predict trends and measure activity in the past, present and future.

Expert opinion method - involves seeking expert opinions from external suppliers to identify future activities.

Market experiment method - uses market experiments conducted under controlled conditions to inform retailers about consumer behavior.

Statistical method - allows companies to identify and analyze relationships between various variables, track performance history over time, identify trends and extrapolate potential future trends. Figure 1 shows some of the demand forecasting platforms.



Fig. 1. Demand forecasting platforms

2 ROUTE OPTIMIZATION

Route optimization is the process of finding the most efficient, often the fastest and most cost-effective route for transporting goods. It includes analysis of fixed factors such as distance, road condition, route restrictions (weight and height limits), bridges and expressways and vehicle capacity, but also dynamic issues such as road closures and construction works, traffic accidents, customs and border controls, weather conditions or vehicle breakdowns. Route optimization can also involve the integration of different modes of transport, such as combining road and rail transport, to achieve optimal efficiency. The goal is to determine the optimal route that minimizes travel time, fuel consumption, and total transportation costs while maximizing the number of deliveries and cargo capacity. State-of-the-art route optimization systems use complex artificial intelligence algorithms to analyze multiple variables and constraints to provide the best possible routes. This process is highly efficient due to some key features. Route optimization uses several types of *artificial intelligence (AI)*, with the most common being:

Machine learning - represents a way of improving future forecasts and decision-making using algorithms that learn from historical data and experience. In the context of route planning and optimization, machine learning techniques can

predict traffic behavior patterns, optimal delivery times, and best routes based on past route data.

Genetic algorithms - simulate the processes of natural selection and genetics to identify the optimal vehicle route. In route planning, genetic algorithms can generate and evaluate various alternative routes, taking into account factors such as distance, traffic and expected delivery time.

Swarm intelligence - involves coordinating the behavior of several individuals in order to achieve a common goal. The method is inspired by the way companion animals such as ants, bees and birds behave. Swarm intelligence can be applied in route optimization by simulating the behavior of a swarm of vans in order to identify ideal routes for trucks.

Reinforcement learning - uses the trial-and-error method so that the algorithm learns to make decisions in such a way as to achieve the best possible result in a particular case. Reinforcement learning can be applied to train AI algorithms that improve their decision-making abilities in route planning and vehicle routing, responding to feedback from their actions.

Unlike conventional methods that rely on predefined routes, *AI-driven systems* can adapt in real time. They take current traffic information into account and adjust routes on the fly to avoid congestion, accidents or unexpected road closures. Artificial intelligence uses historical data to predict potential traffic patterns, weather conditions and other factors that may affect the shipping process.

The most advanced systems can also use augmented reality to provide directions for different modes of transportation. The *Polish* company *NeuroSYS* has created a real-time navigation system with an innovative routing algorithm used at sea, which can be used in all modes of transport.

AI route planning and optimization software can help businesses create more efficient delivery routes by leveraging geocoding and mapping technology. The software's ability to accurately map delivery areas and identify specific customer addresses can help reduce delivery times and increase customer satisfaction [3].

3 SCORING OF POTENTIAL CUSTOMERS

Lead scoring is a process that allows sales reps to target the right leads. AI-powered tools can automatically score potential customers based on their behavioral and interest profiles. Lead scoring systems that use machine learning algorithms quickly process data and determine exactly which leads are most likely to become paying customers. These strategies are beneficial for sales and marketing teams to attract and acquire quality leads.

The main goal is to generate leads from websites, social media or emails and then convert them into paying customers. [4]

Marketers collect information about potential customers, such as demographics, purchase history, interests and website behavior. Based on this data, potential customers are assigned a score. If a potential customer has visited a given website more than once and shown interest in certain products, their score will increase.

Figure 2 shows some of the software used to score leads.



Fig. 2. Lead scoring software

LeadPages - offers a tool for creating landing pages and conversion tools. Additionally, it provides AI recommendations and built-in *SEO* to optimize page content and style. Pop-up forms and notification panels can be used to attract and convert visitors into leads [5].

Cognism - refines customer insights for *B2B* marketers by providing up-to-date lead data, enabling more effective targeting of advertising to the right audience [6].

Pardot - is a marketing automation tool that helps drive sales. Its features include lead tracking and marketing campaign automation.

Ahrefs - is an *SEO* tool that can be useful for *B2B* marketers. It helps to track website performance and analyze keywords.

Phrase - is a content optimization software that helps generate relevant content based on keywords and user questions.

4 LOGISTICS TECHNOLOGIES USING ARTIFICIAL INTELLIGENCE

It is possible to perceive self-driving vehicles, delivery drones, or intelligent storage robots as logistics technologies working on the basis of artificial intelligence.

Self-driving cars have the potential to change logistics by reducing the dependence on human resources in the form of drivers. *Tesla*, *Google* and *Mercedes-Benz* are investing massively in the concept of autonomous vehicles. However, according to expert estimates, only about 10 % of light trucks will drive autonomously by 2030.

At launch, autonomous cars reliably use sensors, actuators, sophisticated algorithms, machine learning

systems and powerful processors. Their main goal is to create and maintain an accurate map of the surroundings based on various sensors located on different parts of the vehicle. These sensors include radar sensors to monitor the position of surrounding vehicles, video cameras to detect traffic lights, read road signs and track other vehicles and pedestrians. Lidar sensors use reflected light pulses to measure distances, identify road edges and lane markings. Ultrasonic sensors in the wheels detect curbs and other vehicles when parking. Powerful software then processes these sensory inputs, plots the optimal path and provides instructions to the car's drivers, controlling acceleration, braking and steering. Hard-coded rules, obstacle avoidance algorithms, predictive modeling and object recognition help the software follow traffic rules and safely navigate through obstacles.

Delivery drones are among the autonomous devices that facilitate the logistics of products in various industries, not only in transport. These industries may include healthcare or the military industry. In the healthcare sector, it is mainly the transport of medicines in various countries where land transport is not possible or safe. Transportation using drones is not only more sustainable, but also speeds up the transport of medical materials, which is especially important, as medicines often have a short shelf life. The *Swoop Aero* platform is the only drone logistics platform in the world, whose task is to create a network of delivery drones that provide the transportation of medicines in different countries. Autonomous military drones can gather real-time information and support decision-making. Drones are also capable of carrying weapons and are now remotely controlled. *DJI Innovations* is the market leader, owning approximately 70% of the global enterprise drone market. Figure 3 shows *Zipline's* delivery drone releasing a package using a parachute system.



Fig. 3. Zipline P2 delivery drone

It is possible to include several technologies using artificial intelligence for the needs of warehouse logistics among intelligent warehouse systems. One of them is the innovative industrial smart watch from *NIMMSTA*, which enables highly efficient picking, thanks to two-way interaction between the worker and the warehouse management system.

CONCLUSIONS

Disadvantages of intelligent warehouse systems include their high purchase price and demanding maintenance, for which it is necessary to train personnel. Specialized personnel are also needed when operating the given equipment. Another disadvantage is the fact that intelligent warehouse systems, but especially warehouse robots, cannot be used for any activity other than the one for which they are programmed.

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