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APPLICATION OF ARTIFICIAL INTELLIGENCE IN PASSENGER LOGISTICS

The development of passenger logistics in modern conditions required the use of artificial intelligence in the provision of transport services. In the passenger transportation system, it is used in the contact between the transport organization and the passenger. The article considers the sale of travel documents through the information network without the participa-tion of representatives of transport organizations. The second area of using artificial intelligence is the automatic control of vehicles without a pilot. It allows you to fulfill the commercial schedule of transport at a new qualitative level. When using artificial intelligence in passenger logistics, opportunities are created to integrate several types of transport to perform a combined passenger trip. The possibility of organizing passenger transfers at transport hubs and their high-quality servic-ing when connecting trip elements on different types of transport is considered. Passenger logistics considers the integrated use of transport of various affiliations. Additional requirements for the use of artificial intelligence in transport organiza-tions with their different affiliations are considered. In this regard, additional problems have arisen for the entire transport industry. They are associated with the intensive development of information technologies and their technical support on various types of transport, regardless of departmental affiliation.

Key words: *passenger logistics, artificial intelligence, transport system, information technology, passenger, transport services.*

Introduction

Passenger transportation is a socially significant transport activity. Given the increasing mobility of the population and the insufficient development of the passenger transportation system, the use of one type of transport to meet the demand for them is becoming difficult. In this regard, the integrated use of several types of transport was required when performing passenger transportation in almost all types of communication. Such use of types of transport for passenger transportation led to the creation and development of passenger logistics. Its use has no practical implementation without the use of elements of artificial intelligence and information technology. If we consider passenger logistics in transport as a whole, then significant changes have occurred in Belarus that determine its modern development. Such development is primarily associated with the progress of digitalization and automation of the services offered, e-commerce [1]. Taking into account the development of digital technologies, the efficiency of the organization of passenger logistics increases and brings results. Unlike freight logistics, when implementing passenger logistics, it is necessary to take into account its inherent features: the social focus of transport activities, technological compatibility of types of passenger transport, the presence of a single payment system when performing transportation in various types of communication, a unified approach to forecasting passenger transportation, dependence on the activity of the population.

Purpose of the study

When considering the use of artificial intelligence in whole or in part in passenger logistics, it is appropriate to consider its modern concept itself. In the classical concept, artificial intelligence is considered as a phenomenon demonstrated by machines, in contrast to natural intelligence demonstrated by people. The study of artificial intelligence began in the 1950s, when systems could not perform tasks as well as humans. In the modern world, artificial intelligence is considered as a general goal of building a system that demonstrates consciousness and is capable of self-learning. The most well-known types of artificial intelligence consider machine learning, which is a type of artificial intelligence, and deep learning. When creating and developing artificial intelligence in transport, a number of problems arise that require an appropriate solution [5].

In passenger logistics, artificial intelligence is used in several areas:

– intellectual development of the passenger transport system, especially in the area of high-speed train traffic (over 400 km/h);

– in the area of financial support for the transportation process: servicing passengers at the stage of initial and final operations (purchase of electronic travel documents, their initial and intermediate control); conducting private banking operations;

– information support for passengers en route – provision of information services of the global network, local and global communications;

– ensuring the safety of transportation: use of automatic train driving (driver), diagnostics of the serviceability of the track development and signaling and communication equipment for train movement;

– creating contact between passengers and representatives of other types of transport if it is necessary to use it for a combined trip.

The public uses and interacts with artificial intelligence every day, but the value of AI in education and business is often overlooked. AI has significant potential in almost all industries, such as pharmaceuticals, manufacturing, medicine, architecture, law, and finance [2].

Transport companies use artificial intelligence to improve the transport services provided to the population, improve the quality of their performance, reduce costs, improve the quality of service, and save financial resources.

The use of artificial intelligence in passenger logistics significantly reduces the number of routine operations and the use of manual labor. This allows for a significant reduction in misunderstandings between passengers and service personnel of transport organizations. The number of conflicts between passengers and representatives of transport organizations has decreased by 2–5 times over the past 10 years after the introduction of elements of artificial intelligence and information technology. The greatest distribution is reflected in the areas of business in the field of passenger transportation and tourism services.

1. Conducting an analysis of the use of digital technologies in the field of passenger logistics showed that transport organizations were able to overcome the principle of alienation between modes of transport and began to work in cooperation. The experience of the PRC has shown that with such interaction and involvement of the state, the maximum effect is achieved. A clear example is the air transportation of passengers in international traffic, carried out by Chinese airlines. Comprehensive services for tourists traveling to the PRC and their own citizens are considered as follows.

2. With a fare of $ 700–750, the passenger pays $ 280–420. To transport passengers, an aircraft with a higher passenger capacity of 520–580 passengers is used instead of 180–190.

3. The provision of transport services in the performance of initial and final operations is carried out using information technology and artificial intelligence (speech recognition, search for travel options by various modes of transport).

4. Search for acceptable tourist services according to budget parameters, time frames.

5. Search for options for trading goods from China and budgetary support for the transport system, trade, and tourism facilities, which allows for the greatest overall financial return with a visible low tariff.

Practical experience of inbound tourism in China shows that with relatively low tariffs at each stage of transport and tourism services, the state receives the maximum return as a whole. Artificial intelligence in transport is a set of methods for machine learning of personnel, operational data analysis, computer vision and automation of transport processes that can significantly improve the functioning of transport systems in the field of passenger transportation. These methods can be applied in various areas of passenger transport and logistics.

When studying the use of artificial intelligence and digital technologies in passenger logistics in various countries, the following results were obtained:

– allow to speed up document flow when providing transport services to passengers;

– a high level of competition between national carriers is maintained when they participate in the international passenger services market;

– an opportunity is created for effective investment in passenger logistics of various types of transport when integrating their services;

– the use of artificial intelligence, blockchain and large amounts of information technologies by logistics organizations and companies when performing passenger transportation, which can significantly increase the efficiency of employees;

– digital technologies allow to optimize passenger transportation, speed up business processes, especially in tourism, reduce cash costs and passenger delivery time.

The use of technologies in passenger logistics allows:

1) to consider artificial intelligence by functionality: optimization of transportation routes; scoring of counterparties and tour operators, transportation organizers; automation of business processes when working with passengers with the involvement of technological and financial resources;

2) to use blockchain in the sectors of passenger transportation logistics: inventory and tracking of current passenger routes; improving the quality of passenger transportation according to established parameters; payment for travel documents and invoicing by participants in the performance of passenger transportation; resolution of industrial and economic disputes between participants in the transportation process; improvement of the transparency of technological, technical and financial actions of transport organizations when interacting in a single transport process; the emergence and expansion of the private freight market (the presence of private owners of vehicles and infrastructure);

3) to master a large amount of information of various levels in the shortest possible time, which allows you to:

– forecasting and planning passenger transportation in total volume and by types of transport;

– monitoring the state of the passenger transportation market and the conditions for its development;

– monitoring the state of transport vehicles, infrastructure, financial position of organizations, prospects for their participation in the implementation of passenger transportation logistics;

– minimization of risks in passenger transportation by various types of communications and by time periods of the year (seasonality);

– development of a strategy for the development of passenger transportation logistics by one or more types of transport.

The use of new passenger logistics technologies in the context of the expansion of the passenger transportation market and the use of an intermodal transportation system by types of communications made it possible to achieve the following indicators [8]:

– technological – an increase in the volume of passenger transportation carried out according to integrated transport schemes in China by 2,8 times over five years, for the conditions of Belarus – 1,8 times;

– economic – to reduce the unprofitability of socially significant passenger transportation by 10–15% (intra-republican communication);

– to more actively implement technologies using artificial intelligence.

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– economic – to reduce the unprofitability of socially significant passenger transportation by 10–15 % (intra-republican communication);

– more actively implement technologies using artificial intelligence. Artificial intelligence in passenger transportation makes it possible to regulate and control the state of ecosystems in transport during passenger transportation.

The use of information technologies together with artificial intelligence in rail transport makes it possible to perform the following functionality [6].

1. An intelligent system for dispatching management of the operational situation on railway sections, directions and especially in large railway junctions has been created for train traffic management. Using artificial intelligence, a train operation plan is developed and the safe passage of trains is ensured [4]. This is especially important when they are moving at high speed, when a person (dispatcher) in the control system cannot control a rapidly changing train situation.

2. For the implementation of passenger services: receiving an order for booking seats in vehicles, purchasing travel documents, paying for travel and carrying out the necessary banking operations using information technology.

3. Direct control of the movement of passenger trains in an automated schedule (a driver is used when driving passenger trains).

It is advisable to note the importance of the information basis for managing all passenger logistics sys-

tems when using elements of artificial intelligence [3]. It should be noted that when implementing it, the decisive task is to select the optimal route for a passenger's trip using the most suitable vehicle, logistics intermediaries, and mode of transport. Artificial intelligence in passenger logistics creates opportunities for supporting complex business processes and a large volume of information used. The volume of information used in passenger logistics, compared to cargo logistics, exceeds 4,5 times.

Using a large amount of information allows you to flexibly develop a business strategy in the field of passenger transportation, preferred passenger routes, and attract new transport customers. This approach allows you to increase the cash income of transport companies.

Analysis of business processes in passenger transportation logistics showed that the cost of transportation has a strong impact on demand and competitiveness. At the same time, it is necessary to take into account several options for organizing business processes in passenger logistics. They cannot be developed without the use of elements of artificial intelligence in the field of organizing and ensuring high-quality passenger transportation. In the transport industry, solutions using artificial intelligence have currently been developed. They allow you to evaluate factors in combination and offer the best option for transporting a passenger according to several criteria: travel time, its cost, quality and passenger satisfaction.

China's experience shows that the use of artificial intelligence for passenger logistics has allowed the expansion of the high-speed rail network to over 80 000 km and the largest network of such transportation in the world to be created. This makes high-speed passenger service highly profitable with large volumes of passenger transportation by train (4,5 billion on holidays).

The use of artificial intelligence in passenger logistics allows for a high-quality forecast of supply and demand for passenger transportation by type of communication, transportation volumes and problems in their organization. This allows for the adoption of well-founded strategies in the implementation of passenger logistics [7].

Artificial intelligence of passenger logistics has a positive effect on passenger transportation on all types of communications. It improves business processes in transport activities, guarantees the safety of the transportation process and ensures passenger satisfaction. It is used for auto-management of passenger fleet vehicles, analysis of transportation data in real time and forecasting of income and profit of transport enterprises.

The world's largest railway companies use artificial intelligence in passenger logistics to better inform the population about the provision of transport services.

The main advantage of using artificial intelligence in passenger logistics in rail transport is the ability to automate processes that were previously performed manually. For example, machine vision systems allow you to automatically determine the position and technical condition of the railway infrastructure, communication devices and automation of train traffic control. Algorithms for analyzing the received data allow you to predict possible emergency situations, diagnose them and prevent them at early stages.

The main application of artificial intelligence in passenger logistics in rail transport is also the optimization of the expected flow of passengers on different types of communication. Using machine learning algorithms and analysis of large amounts of data, an intelligent system is able to predict and adapt the train schedule taking into account negative technological factors - weather conditions, uneven departure of passengers. This solution allows you to reduce train delays, and improve the implementation of the train schedule, increase the punctuality of rail transport.

Considering that the motorization of the population is proceeding at a rapid pace, a decrease in the volume of passenger transportation is predicted. To maintain it at the required level, passenger logistics uses information for representatives of the private sector of motorists to improve their understanding of the situation on the road transport infrastructure. Using elements of artificial intelligence, users are provided with the identification of transport objects and tracking of their condition. This is important for potential passengers acting as drivers. They are warned about weather conditions, road accidents and the state of the environment. In this case, drivers become potential passengers. The introduction of artificial intelligence into the railway infrastructure system and passenger logistics can improve the safety of passenger transportation. The use of artificial intelligence elements in passenger logistics can detect and prevent possible emergency situations, especially those threatening the safety of passengers, provide information on the analysis of data coming from various sensors and cameras installed at stations, crossings and in cars. Artificial intelligence in passenger logistics provides automatic control and provides information on regulating the speed of trains of various categories. This helps prevent dangerous situations on railway sections and stations, with passengers during transportation.

Thus, the use of artificial intelligence in the railway infrastructure system is an important step in the development of the transport industry. Optimization of traffic flow and increased safety allow for more efficient and safe operation of rail transport, which has a positive effect on the comfort and convenience of passengers, as well as on the economic efficiency of transportation.

In order to assess the effectiveness of using artificial intelligence, an analysis of performance indices is carried out according to several parameters. These include:

– creation of a new data block confirming the effectiveness of using artificial intelligence in passenger logistics;

– analysis of the main performance indicators of the logistics industry in the implementation of passenger transportation. This is due to the rapidly developing digital technologies in the implementation of transport logistics;

– digitalization of the studied area of passenger logistics, which makes it possible to predict and track the route and type of transport, plan for passengers and the transport organization of transportation, predict the cost of expenses and expected implementation dates;

– assessment of performance indicators that allow assessing the quality of logistics services.

The development of artificial intelligence and its use in passenger logistics in rail transport is a controversial area. There is concern that with the increased attention to it when used in passenger logistics, it will be difficult to make it accessible to people from all socio-economic backgrounds. Therefore, developers of passenger logistics argue that the best way to promote artificial intelligence is through education and training of employees of transport organizations to prevent its biased attitude towards passengers.

The use of artificial intelligence in passenger logistics has significantly increased not only the efficiency of logistics, but also the quality of passenger service.

The technology of using artificial intelligence elements in passenger logistics can lead to optimization of the transportation route and increased efficiency of its implementation. At the same time, the use of information technology can make the entire transport operation traceable, and the process itself controllable and predictable. This allows you to exclude many uncontrollable factors in passenger logistics and ensure high quality of transportation.

Conclusion

The use of artificial intelligence in passenger logistics provides the following advantages.

Users of passenger logistics services of transport organizations can track the status of their orders for passenger transportation in real time from their mobile phones.

High efficiency is achieved in the field of distribution passenger logistics in large transport hubs using intelligent transport.

The problem of planning a passenger transportation route is solved with its integrated organization using several types of transport, provided that they are carried out safely with all the ensuing consequences [9].

The prospect of effective use of artificial intelligence and its combination with passenger logistics is considered, taking into account the following aspects: intelligent equipment reorganizes production factors of logistics (use of an express service system); intelligent computing changes the form of execution of logistics processes.

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ПРИМЕНЕНИЕ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА В ПАССАЖИРСКОЙ ЛОГИСТИКЕ

Развитие пассажирской логистики в современных условиях потребовало использования искусственного интеллекта при предоставлении транспортных услуг. В системе пассажирских перевозок он применяется при контакте транспортной организации и пассажира. Рассматривается продажа проездных документов через информационную сеть без участия представителей транспортных организаций. Вторым направлением использования искусственного интеллекта является автоматическое ведение транспортных средств без пилота. Оно позволяет на новом качественном уровне выполнять коммерческое расписание движения транспортных средств. При использовании искусственного интеллекта в пассажирской логистике создаются возможности интегрировать несколько видов транспорта для выполнения комбинированной поездки пассажира. Рассматривается возможность организации пересадок пассажиров в транспортных узлах и качественном их обслуживании при стыковании элементов поездки на различных видах транспорта. Пассажирская логистика рассматривает комплексное использование транспорта различной принадлежности. Рассматриваются дополнительные требования по использованию искусственного интеллекта в организациях транспорта при их различной принадлежности. В связи с этим возникли дополнительные проблемы для всей транспортной отрасли. Они связаны с интенсивным развитием информационных технологий и их техническим обеспечением на различных видах транспорта независимо от ведомственной принадлежности.

Ключевые слова: пассажирская логистика, искусственный интеллект, транспортная система, информационные технологии, пассажир, транспортное обслуживание.

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АНАЛИЗ ОТКАЗОВ И ИСПЫТАНИЯ ПЕРЕДАЧ СО СЛОЖНЫМ ДВИЖЕНИЕМ ЗВЕНЬЕВ

Рассмотрены вопросы исследования отказов в гидромеханических передачах, у которых звенья совершают сложные движения. Отмечено, что коробки передач в составе гидромеханических трансмиссий (ГМТ), являясь самыми дорогостоящими механизмами автотранспортных средств и других мобильных машин, имеют наименьший срок службы среди остальных агрегатов, причем многие элементы и сопряжения ГМТ, в частности, фрикционы переключения передач, в большой мере ограничивают надежность и долговечность. Проведен анализ причин возникновения опасных дефектов в передачах со сложным движением звеньев. Предложена конструкция мехатронной системы управления гидромеханической трансмиссии как эффективное средство диагностики и мониторинга отказов. Отмечено, что повышение надежности эксплуатации и увеличение ресурса мобильных машин, оснащенных ГМТ, а также безотказная работа фрикционов коробок передач обеспечивается путем комплексной активной диагностики их технического состояния на основе использования микропроцессорных бортовых систем. В процессе проведения ходовых испытаний были исследованы режимы трогания с места и разгона порожнего и груженого самосвала БелАЗ-7555 при автоматическом и командном режимах управления ГМТ. Приведены результаты стендовых и полевых испытаний гидромеханических передач со сложным движением звеньев.

Ключевые слова*: сложное движение звеньев, гидромеханическая передача, диагностика, дефект, техническое состояние, фрикционные муфты.*

Введение

Для карьерных самосвалов, строительно-дорожной и другой мобильной техники важно обеспечить высокую производительность выполнения транспортной работы, надежность эксплуатации, улучшить условия труда водителя или оператора, обеспечить безаварийное функционирование всех механизмов и подсистем. Использование коробок передач (КП) с микропроцессорным управлением совместно с бортовыми системами и комплексами, в принципе, позволяет обеспечить эти требования [1].