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Big Data and Artificial Intelligence in the Transportation Economy

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Abstract: With the rapid development of the global economy and the increasing demand for transportation, the traditional mode of transportation management has gradually shown its limitations in dealing with the complex and changing transportation environment. The rise of big data and artificial intelligence technology has brought new opportunities to the field of transportation economy. This paper discusses the application of big data and artificial intelligence in transportation economy, focusing on its application in traffic flow prediction, transportation demand analysis, cost management, intelligent monitoring, automated warehousing and customer experience optimization, etc., with a view to improving transportation efficiency, reducing operation costs, and providing strong support for the intelligent development of modern transportation system.

Keywords: big data; artificial intelligence; transportation economics; intelligent transportation; logistics management

1. Introduction

Against the backdrop of globalization and technological innovation, transport has become increasingly important as a key link to regional economies. However, the traditional traffic organization model has shown its limitations in coping with traffic surges and optimal resource allocation in unexpected situations. With the development of big data and artificial intelligence technologies, traffic management and transportation scheduling have ushered in opportunities for innovation [1]. Big data technology can provide accurate prediction support, while AI improves transportation efficiency and safety through intelligent learning and decision optimization.

2. Overview of the Transport Economy

Transportation economy plays an important role in regional economic development and directly affects industrial structural adjustment and optimization and upgrading. Against the backdrop of the rapid development of the global economy, the domestic transportation industry is facing the dual challenges of both continuous demand growth and increasing operational complexity. The traditional traffic organization model has shown its limitations in coping with unexpected traffic surges and the optimal allocation of resources in unexpected situations. With the rapid development of big data and artificial intelligence technology, traffic management and transportation scheduling have ushered in new opportunities. The powerful analysis capability of big data can provide accurate

prediction support for traffic management, while AI technology can improve transportation efficiency, reduce operating costs, and further enhance transportation safety through autonomous learning and decision-making optimization, providing a more intelligent solution for the modern transportation system [2].

3. Big Data in the Transportation Economy

3.1. Traffic Flow Prediction and Scheduling Optimization

With the help of big data technology, traffic flow prediction can more accurately reflect the future traffic state and provide scientific basis for relevant decision-making. Multi-source data collection means, such as sensors, cameras, GPS devices and mobile Internet technology, make it possible to obtain massive traffic information in real time, including the number of vehicles, driving speed, signal operation status, weather conditions, etc. The fusion and analysis of these data can realize a comprehensive description of the traffic status, providing reliable data support for traffic flow prediction. Fusion analysis of these data can realize a comprehensive description of the traffic state and provide reliable data support for traffic flow prediction.

In the construction of prediction models, the application of data mining and machine learning techniques makes deep learning of historical data possible. Regression analysis, time series analysis and deep learning models can be used to build traffic flow prediction models. Among them, methods such as Autoregressive Integral Sliding Mean Model (ARIMA) and Long Short-Term Memory Network (LSTM) can more accurately capture the dynamic change pattern of traffic flow and reveal the relationship between it and factors such as weather and holidays, so as to improve the accuracy of prediction [3].

In terms of scheduling optimization, big data-driven dynamic signal control technology enables real-time adjustment of signal light hours to ease traffic congestion. During peak hours, bus route configuration is optimized based on data forecasts to ensure that public transportation capacity matches residents' travel demand and reduce road traffic pressure. In addition, big data analysis of the frequent areas and causes of road accidents can build a database of high-risk areas to achieve accurate monitoring of traffic accidents and risk warning. Through in-depth mining of accident data, high-risk hours and road sections can be identified, and traffic warnings can be issued in advance to effectively prevent accidents. Traffic flow prediction and scheduling optimization with the help of big data technology not only helps to improve the operational efficiency of the transportation system, but also improves the overall economic efficiency and safety level, providing support for the construction of intelligent transportation system.

3.2. Transportation Demand Analysis and Route Planning Optimization

In the field of transportation economics, big data technology enables the precise collection and analysis of transportation demand, including such key elements as the type and quantity of goods, time-sensitive requirements and distribution goals. This precise data processing capability enables enterprises to more effectively predict market demand and optimize transportation routes to improve logistics and distribution efficiency.

In the process of demand analysis, multiple data sources such as order data from e-commerce platforms, real-time freight data from logistics companies, road traffic conditions and weather changes can be synthesized to comprehensively capture the fluctuating trends of market demand and make future demand forecasts accordingly. The big data-based demand forecasting model combines machine learning and data mining technologies to accurately identify fluctuations in transportation demand. The application of algorithms such as support vector machines and neural networks allows regression analysis and trend prediction of historical data, providing data support for enterprises to formulate traffic planning and optimize transportation solutions.

Under the big data environment, the comprehensive collection of road traffic information can provide efficient path planning support for logistics and distribution. Traditional path optimization algorithms, such as Dijkstra's algorithm, genetic algorithm, etc., can dynamically adjust the transportation routes in combination with real-time traffic data to avoid adverse factors such as congestion and construction. On this basis, the path optimization method based on big data can find the optimal balance between cost and efficiency, and improve the overall efficiency of logistics transportation by taking into account factors such as transportation mode, vehicle type and energy consumption.

3.3. Early Warning and Management of Transportation Costs

Accurate prediction and management of transportation costs are of great significance to the operational efficiency and cost control of enterprises. Big data technology can monitor and analyze logistics costs in real time, including vehicle fuel consumption, delay costs due to traffic congestion, personnel costs and maintenance costs. To realize effective transportation cost management, it is necessary to establish a comprehensive information collection system covering transportation vehicles, goods, roads, and drivers, and build a comprehensive logistics cost database with the help of the Internet of Things and sensing technology to record detailed logistics process information.

Multidimensional analysis of transportation cost data using big data technology can identify key factors affecting costs and provide early warning of potential cost risks. Based on this, a transportation cost prediction model can be constructed, and when the transportation cost in a region exceeds the expected value, the system can automatically provide an early warning to remind managers to adjust the transportation plan in order to reduce unnecessary expenditures. In addition, the big data-driven cost analysis system can be combined with real-time monitoring information to achieve accurate management of transportation costs. Through real-time tracking of vehicle locations, travel speeds and transportation paths, it identifies unreasonable detours, congestion and inefficient parking, provides an optimized basis for transportation scheduling, and reduces the time spent on empty running and inefficient driving, thus effectively controlling operating costs.

4. Application of Artificial Intelligence in Transportation Economics

4.1. Intelligent Monitoring and Real-Time Risk Warning

In the modern transportation system, artificial intelligence technology, especially the application of machine vision and deep learning, makes it possible to monitor the real-time road traffic conditions, road surface status and various potential risk factors. Traffic accidents, violations and unexpected weather and other factors pose a threat to the stability of the transportation system, through intelligent means, accurate monitoring and dynamic early warning can be realized, providing efficient decision-making support for the relevant management departments.

Risk warning not only relies on basic data such as traffic flow and vehicle speed, but also needs to be analyzed comprehensively in combination with multidimensional information such as meteorological conditions and road maintenance. Based on machine learning and deep learning methods, possible traffic accidents or high-risk conditions that may occur in a specific time period in the future can be predicted through mining and modeling of historical and real-time data [4]. Under severe weather conditions, such as heavy rainfall and snowstorms, the traffic flow on a specific roadway can be accurately predicted, and corresponding warnings can be issued to provide necessary precautionary guidelines for drivers and traffic managers.

In addition, the system can identify abnormal behaviors such as fatigue driving and speeding during driving and provide real-time warnings on driving behaviors based on artificial intelligence technology, and automatically perform braking or adjust driving routes when necessary to reduce the probability of major traffic accidents. At the same

time, AI technology can provide technical support for accident investigation and responsibility determination, combining intelligent cameras, sensors and other equipment to comprehensively analyze factors such as weather, vehicle failures, and driving operations, and establish an accident responsibility assessment model based on historical data to improve the accuracy and efficiency of accident handling.

4.2. Automated Warehousing and Logistics Scheduling

In the transportation economic system, artificial intelligence technology plays an important role in logistics management and warehouse optimization. The rapid development of e-commerce and the demand for efficient management mode in the logistics industry has promoted the application of automation technology in the warehousing system, which makes it possible to improve the efficiency of warehousing, reduce the operating costs, and at the same time optimize the logistics scheduling process.

The automatic storage system relies on RFID tags, barcode technology, and other means to enable digital management of goods. With the help of artificial intelligence and robotics, it integrates automated shelves, unmanned transport vehicles, and conveyor belts to form a highly efficient and collaborative warehouse management mode (see Figure 1). From goods receiving, storage to picking and distribution, the whole process of automated operation can be realized through the intelligent system. The system not only improves the operational efficiency of the warehousing process, but also effectively reduces human errors and improves the overall operational reliability.

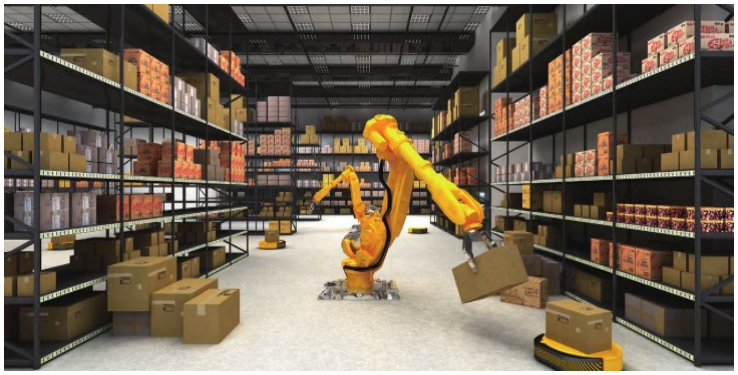

Figure 1. Automated Warehousing.

Traditional logistics scheduling relies on manual experience and a single optimization algorithm, while AI-driven systems leverage real-time data analysis and dynamic decision-making. AI-driven logistics scheduling systems can integrate orders, warehouses, vehicles, traffic, and other multi-dimensional information, continuously optimize the scheduling algorithm, intelligently select the optimal distribution path, and adjust the driving route according to real-time traffic conditions. Under the influence of unexpected traffic congestion or accidents, AI can adjust the scheduling plan based on real-time road conditions to ensure maximum logistics efficiency and reduce transportation costs. In addition, the combination with Intelligent Transportation System (ITS) enables the optimization of the urban logistics system, intelligently adjusting the distribution plan through real-time monitoring of traffic flow, cargo type, distribution time and other information, avoiding traffic congestion during peak hours and ensuring the on-time delivery of goods.

4.3. Intelligent Customer Service System and Customer Experience Optimization

In the field of transportation economy, the improvement of customer experience and the construction of intelligent customer service system has become an important development direction. Artificial intelligence technology combined with speech recognition, nat-

ural language processing, machine learning and other methods, enabling automatic identification of customer needs and intelligent service, improving customer satisfaction and optimizing service quality [5].

The intelligent customer service system relies on an AI-powered auto-response platform, covering multiple channels such as telephone, websites, and mobile applications, to provide efficient customer consultation services. The application of natural language processing technology enables the system to comprehend customer needs with high accuracy and quickly provide targeted answers. For complex logistics problems, the intelligent system can categorize and organize user information and automatically assign it to the corresponding professional customer service personnel to improve the efficiency and accuracy of problem handling.

Personalized service has become an important direction to enhance customer experience. Based on data such as historical orders, user preferences, complaint records, etc., the intelligent customer service system can provide customers with customized transportation solutions or real-time traffic condition inquiries, enhancing user engagement and satisfaction. At the same time, artificial intelligence technology can analyze customer emotions, identify fluctuations in emotions such as anxiety and anger during conversations, and adjust the service accordingly to create a more personalized customer experience. Through the data analysis platform, customer feedback is mined in depth to provide a basis for companies to optimize their service processes, thereby enhancing the overall customer experience.

5. Application Strategies of Big Data and Artificial Intelligence in Transportation Economic Management

5.1. Construct Cross-Platform Data Sharing Mechanism

The establishment of a cross-platform data-sharing mechanism is an important initiative to promote technological advancement in the transportation economy. The core of data sharing lies in the development of unified data standards and interface protocols to solve the problems of incompatible data formats and inconsistent interface specifications between different systems. Industry associations or government agencies can take the lead in formulating unified data standards covering such key elements as logistics nodes, cargo flow trajectories, ship scheduling, equipment operation status and so on, in order to realize cross-system data interconnection and interoperability.

The introduction of cloud computing technology can accelerate real-time data processing and improve system reliability in data sharing. Due to the huge volume and wide distribution of data involved in the transportation economy, it is difficult for the traditional data management model to meet the demand for efficient processing, while the sharing mechanism based on cloud computing can realize centralized storage, real-time calling and processing of data, and improve the efficiency of data utilization. Through collaboration and information sharing among cross-industry enterprises, it promotes the optimal allocation of resources and improves the overall operational efficiency.

5.2. Promote the Application of Automation and Intelligent Equipment

The automation upgrade of the warehousing system is a crucial step in advancing the logistics economy. The introduction of intelligent facilities such as intelligent cranes, unmanned transportation vehicles, and intelligent yard equipment has improved the accuracy and operational efficiency of warehousing operations. Enterprises can build an intelligent warehouse management system (TOS), combining big data and artificial intelligence technology, automatic scheduling of warehousing facilities, optimization of operational processes, and efficient collaboration between equipment.

The optimization of storage management also depends on the application of intelligent equipment. In the transportation economic system, short-term storage needs are more common, and warehousing efficiency directly affects the operation of the overall

logistics chain. Automated facilities such as intelligent shelves, unmanned forklifts, and automatic sorting systems can improve storage utilization and optimize access and scheduling of goods. Unmanned forklifts based on intelligent navigation systems can realize automatic loading and unloading, reduce manual intervention and improve safety. The automated sorting system optimizes goods classification and distribution paths through intelligent algorithms, shortening logistics turnaround time and improving overall operational efficiency.

5.3. Deepen the Application of Artificial Intelligence and Big Data Technology

The construction of data collection and management system provides a solid foundation for the application of big data and artificial intelligence technology. Transportation economic enterprises can carry out real-time monitoring of cargo status, equipment operation, traveling routes and other information through sensors, IoT equipment, GPS and other technologies. In the loading and unloading link, sensors can collect information on cargo weight, storage location, loading and unloading process, etc., and carry out data processing through cloud computing to realize intelligent logistics management. In the transportation link, GPS and weather monitoring devices can obtain vehicle location information and combine with AI technology to optimize the route and improve driving efficiency.

The in-depth application of AI technology relies on an intelligent decision support system (DSS) to assist enterprises in optimizing transportation decision-making. DSS integrates big data analysis and AI algorithms to dynamically formulate the most cost-effective and time-efficient logistics plans. For example, in the process of transportation planning, DSS can combine real-time weather, warehouse operation, market demand and other factors to intelligently optimize the distribution path and reduce operating costs. In warehouse management, the system can automatically adjust replenishment and shipping strategies according to changes in inventory levels and market demand to ensure efficient supply chain operations. At the same time, it strengthens the collaboration between enterprises and technology suppliers and research institutions, promotes the in-depth application of artificial intelligence and big data technology in the transportation economy, and provides continuous technical support for the development of the industry.

6. Conclusion

In summary, the application of big data and artificial intelligence in the transportation economy has greatly improved the intelligence level of the transportation system. Through accurate prediction of traffic flow and dynamic scheduling optimization, it not only improves the operational efficiency of the transportation system, but also reduces operational costs and enhances safety. At the same time, with the help of big data analysis of transportation demand, combined with artificial intelligence technology for path planning, the logistics and distribution process can be further optimized. In addition, the application of intelligent monitoring systems and automated warehousing facilities makes transportation management and logistics operations more efficient and reliable. The comprehensive application of these technologies not only promotes the modernization and transformation of the transportation economy but also enhances economic efficiency and contributes to sustainable urban development and improved public transportation services.

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