Proceedings of ICFTBA 2024 Workshop: Human Capital Management in a Post-Covid World: Emerging Trends and Workplace Strategies
DOI: 10.54254/2754-1169/146/2024.LD19062

Research on the Integration Progress and Application Practice of Intelligent Transportation System and Big Data Technology

Jiaxuan Wang[1,a,*]

[1]*Institute of Smart city and Intelligent Transportation, Southwest Jiaotong University, Chengdu, 610097, China*
a. jiaxuan.wang@my.swjtu.edu.cn
**corresponding author*

Abstract: Against the backdrop of accelerated global urbanization, urban transportation issues are becoming increasingly prominent. The fusion of intelligent transportation systems (ITS) and big data technology has emerged as a crucial means to address urban transportation challenges and holds immense significance for sustainable urban development. This article employs literature review and case analysis methods to primarily investigate the integration points, research advancements, and practical applications of intelligent transportation and big data within the realm of urban transportation. The research results show that the combination of intelligent transportation and big data has achieved significant results in traffic flow management, public transportation service improvement, emergency response and safety management, as well as environmental protection, energy conservation and emission reduction. However, it also encounters obstacles such as ensuring data security, protecting privacy, and overcoming data isolation issues. In response to these challenges, this article proposes measures such as strengthening data security technology and legal regulations, promoting the construction of data sharing platforms, enhancing technological innovation, and talent cultivation. In future development, the integration of intelligent transportation and big data is anticipated to play a significant role across various sectors, offering robust support for urban transportation management.

Keywords: Intelligent transportation system, Big data technology, Urban traffic management, Data sharing and integration, Application cases of intelligent transportation.

1. Introduction

The degree of urbanization is constantly increasing globally, and urban transportation, as a key element supporting daily urban operations, is becoming increasingly important. Modern cities mainly face traffic problems such as road congestion, exhaust noise pollution, and energy consumption surges [1]. As urbanization accelerates and the number of motor vehicles skyrockets, these issues have gained increasing prominence, necessitating a transportation system that is not only more efficient and more safe but also environmentally friendly and intelligent. Besides enhancing travel efficiency, cutting down travel time, alleviating traffic congestion, and mitigating environmental pollution, it also aims to elevate residents' quality of life and bolster the transportation system.

DOI: 10.54254/2754-1169/146/2024.LD19062

Furthermore, it contributes to augmenting logistics efficiency, lowering logistics costs, and fostering diversified economic growth. The existing transportation system has undergone a gradual evolution, transitioning from a conventional system to an intelligent one that is highly integrated with information technology, communication technology, and sensor technology. The concept of intelligent transportation system was proposed by ITS America in 1990. ITS integrates advanced science and technology to comprehensively, real-time, and accurately monitor and manage transportation systems, improving traffic efficiency, ensuring safety, and reducing pollution. Among them, the massive data support and scientific decision-making basis of intelligent transportation systems benefit from the powerful data collection and processing capabilities of big data technology. The seamless integration of intelligent transportation systems (ITS) with big data technology is emerging as a crucial means to address urban transportation challenges and elevate urban management standards.

This article focuses on the intersection of intelligent transportation and big data, studies the latest progress of their combination, and explores their practical application cases in urban transportation management. After a comprehensive analysis and comparison of the INFRAMIX project in the European Union, the "City Brain" program in Hangzhou, China, and the OpenCity intelligent transportation model at the University of Hong Kong, this article aims to demonstrate the application effectiveness and achievements of intelligent transportation and big data technology in improving transportation efficiency, ensuring traffic safety, promoting energy conservation and emission reduction, and pointing out the data security challenges and data silos encountered in the current integration process of intelligent transportation systems and big data technology, and tentatively proposing targeted solutions. This article aims to deeply analyze the current situation of the integration of intelligent transportation systems and big data technology, reveal the extensive application potential of both in urban traffic management, and expect to contribute valuable references to the future development of this field.

2. Fundamentals of Intelligent Transportation Systems and Big Data Technology

2.1. Overview of Intelligent Transportation System

As a comprehensive transportation management system, Intelligent Transportation Systems (ITS) can effectively integrate advanced information technology, data transmission technology, electronic sensing technology, and computer decision-making technology into the entire road transportation system, and provide comprehensive, real-time, and accurate monitoring and management of the transportation system. Improving the management level of the transportation system is the basic goal of intelligent transportation systems. In addition, improving the traffic capacity of the transportation network and reducing the negative impact of the transportation system on the environment, creating a more real-time, accurate, and efficient road traffic environment, are also the standards that ITS has been committed to achieving [2].

As one of the inevitable choices for cross century economic growth and transportation system construction, the importance of ITS has been highly recognized worldwide. At present, countries with high levels of ITS development worldwide include the United States, Japan, and the European Union, followed closely by South Korea, Singapore, and the Hong Kong Special Administrative Region of China in Asia, which also demonstrate a high level of ITS development. However, in China, the research and promotion of ITS is still in its early stages [3].

2.2. Fundamentals of Big Data Technology

Big data technology refers to a technological system that extracts valuable information from massive, high-speed, and diverse data, including multiple stages such as data collection, storage, processing,

DOI: 10.54254/2754-1169/146/2024.LD19062

analysis, and visualization. To accommodate vast, rapidly expanding, and diversified information assets, it necessitates novel processing models that possess enhanced capabilities for decision-making, insight discovery, and process optimization.

With the advent of the "cloud era", the strategic significance of big data technology is becoming increasingly prominent. Its strategic significance lies not only in mastering Banda's data information, but also in using its powerful data processing capabilities to uncover deep patterns and patterns behind the data, providing strong support for decision-making. In the field of intelligent transportation, big data technology can process massive traffic data from various sensors, cameras, GPS devices, providing real-time and accurate information support for traffic management.

2.3. Integration Point of Intelligent Transportation and Big Data

2.3.1. Sharing and integration of data resources

In the integration of intelligent transportation and big data, the sharing and integration of data resources are key links. Intelligent transportation systems collect massive traffic data in real-time through various sensors, onboard devices, and road facilities. The diversity, dispersion, and scale of this data require efficient sharing and integration mechanisms. The incorporation of big data technology has facilitated the storage, processing, and analysis of such data. By building a unified data platform and standard system, traffic data from different sources and types can be shared across levels, regions, and systems, greatly improving the efficiency of data utilization. Simultaneously, by leveraging data mining, machine learning, and other technologies to conduct thorough analysis on shared data, hidden values can be uncovered, providing robust support for traffic management, planning, and decision-making processes, among others. Hence, the sharing and integration of data resources serve as a fundamental pillar for the integration of intelligent transportation and big data, and are pivotal in driving the intelligent, efficient, and eco-friendly development of transportation systems.

2.3.2. Intelligent analysis and decision support

Intelligent transportation utilizes the mining and analysis capabilities of big data to conduct in-depth analysis of traffic data, providing accurate decision support for traffic management, predicting traffic flow and managing road congestion, predicting user travel needs and recommending driving routes, preventing traffic accidents, and ultimately improving the efficiency and safety of road driving. By optimizing the timing scheme of traffic signals, coordinating the traffic sequence and vehicle driving strategies on the road, road traffic flow can be maximized and traffic congestion can be alleviated [4].

2.3.3. Service innovation and application expansion

Intelligent transportation systems based on big data can provide more personalized and intelligent transportation services, enhancing user experience. Firstly, an intelligent transportation system based on big data can fully guarantee the convenience and efficiency of public transportation. Through front-end data collection and in-depth analysis, the driving routes and stopping points of intelligent buses can be improved, and an intelligent public transportation service system can be constructed. Build a three-dimensional album and a comprehensive interconnected smart hub security system. Secondly, intelligent transportation systems based on big data can be used to develop front-end and back-end services for travel. Assist users in understanding the road conditions and approximate pedestrian and vehicular traffic around their destination in the front-end of travel, and recommend suitable destinations based on their needs. Developing intelligent switching and smart parking in the backend of travel, helping users solve the last mile problem of public travel and the parking problem

DOI: 10.54254/2754-1169/146/2024.LD19062

of personal travel. Finally, intelligent transportation systems based on big data can also save labor and material costs for road maintenance. By installing a road intelligent maintenance system on the road, real-time monitoring of road conditions can be achieved to prevent road problems, eliminate hidden dangers in advance, and achieve efficient and rapid maintenance of fault points [5].

3. Research Progress on the Combination of Intelligent Transportation and Big Data

3.1. Key Technological Breakthroughs

In the context of the new era, big data technology has brought new ideas and approaches to solving transportation problems. Firstly, in terms of facility framework construction, the framework of smart transportation facilities needs to be improved with the goal of fully meeting people's travel needs. The services in the first, middle, and last stages of travel need to be improved, among which services such as intelligent transfer, intelligent parking, and intelligent transportation hubs should be optimized to achieve intelligent, visual, and integrated modes of traffic management and control. Secondly, in terms of data collection, the development of IoT technology has made the collection of traffic data more comprehensive and real-time, providing rich data samples and patterns for intelligent transportation systems to continuously learn and improve themselves. At the same time, in addition to traditional transportation data sources, there is an increasing consideration for integrating diverse data sources such as natural data, economic and social data, ecological data. By integrating and crossing multiple data sources, it is possible to simulate the real traffic environment more comprehensively, understand the actual traffic conditions and users' travel needs, and provide more practical and personalized traffic strategy recommendations [4]. Finally, in terms of data processing and analysis, the application of technologies such as cloud computing and distributed computing has greatly improved the efficiency and accuracy of big data processing. But it still has a certain lag. In the current era of big data, mobile signal information can be selected as a means of location monitoring, and cutting-edge artificial intelligence technologies such as machine learning and deep learning can be integrated to deeply explore the organizational characteristics of various transportation modes. Through these means, traffic flow can be predicted more accurately, traffic events can be identified, and the correlation between traffic characteristics, travel density, and urban functions can be revealed [6].

3.2. Typical Application Cases

With the increasing importance of intelligent transportation for urban development and construction, research projects combining intelligent transportation systems with big data are underway around the world. Among them, the INFRAMIX project of the European Union, the City Brain project of Hangzhou, China, and the OpenCity intelligent transportation model of the University of Hong Kong are research projects with significant achievements in the past five years, but they inevitably still have certain limitations. However, as technology continues to advance and application scenarios broaden in the future, these projects are anticipated to offer even greater support for the comprehensive development of intelligent transportation systems and the extensive utilization of big data.

3.2.1. INFRAMIX project in the European Union

The INFRAMIX project of the European Union was launched in June 2017 and concluded in May 2020. The project underwent field testing on highways in Austria and Spain, evaluating the new infrastructure upgrade plan through collaborative simulation and hybrid testing. The project was jointly initiated by Austrian AustriaTech, BMW, Siemens and other units, which successfully developed digital road infrastructure and conducted relevant tests, providing strong support for mixed

DOI: 10.54254/2754-1169/146/2024.LD19062

flow driving of autonomous vehicle and traditional vehicles [7]. This project upgrades and transforms traditional road infrastructure through big data analysis and collaborative simulation technology, develops a vehicle infrastructure collaborative simulation environment, and successfully evaluates the support capability of digital infrastructure for future networked autonomous driving vehicles, providing valuable data support for the further development of intelligent transportation systems [8]. However, given the long project cycle and the current focus on infrastructure support for autonomous driving technology, there is still room for further exploration in the comprehensive construction of intelligent transportation systems and the deep application of big data.

During this process, big data technology has mainly contributed to the project from three aspects. Firstly, big data technology provides powerful data processing and analysis capabilities for the INFRAMIX project. During the same period, the combination of big data technology and vehicle road cloud integration system provides new impetus for the development of intelligent connected vehicle industry. Finally, big data technology helps the automotive industry better understand market demand, optimize supply chain relationships, promote business model innovation, accelerate the transformation and upgrading of the intelligent automotive industry, and promote healthy development.

3.2.2. City brain project in Hangzhou, China

The City Brain project in Hangzhou, China was launched in October 2016 and is still in operation. The project employs technologies like big data, cloud computing, and artificial intelligence to advance the modernization of urban governance. It has established an intelligent platform encompassing 11 key systems and 48 application scenarios, spanning policing, transportation, cultural tourism, and healthcare. The urban brain provides scientific decision-making basis for urban managers and convenient services for citizens by comprehensively connecting various data, integrating various business systems, and implementing integrated computing [9]. The application of Hangzhou City Brain in the field of transportation is particularly prominent, and significant results have been achieved in improving urban traffic conditions through large-scale data. However, the implementation of the Urban Brain project necessitates substantial investments in manpower, material resources, and finances. Additionally, data sharing and interoperability across different cities continue to encounter numerous challenges. How to further promote the popularization and application of the Urban Brain project still requires continuous exploration and efforts.

During this process, big data technology has mainly contributed to the project from three aspects. Firstly, big data technology enables the city brain to collect and process data from various fields in real-time. Through deep mining and analysis of this data, the city brain can identify problems, predict future trends, and ultimately achieve self optimization of the city brain. Secondly, big data technology enables the urban brain to aggregate, monitor, govern, and analyze real-time operational data of the entire city, achieving cross domain collaborative work and improving the efficiency and effectiveness of urban governance. Finally, big data technology improves data processing and analysis capabilities, helping city managers better understand the data of urban operations, make more scientific decisions, and promote the modernization of urban governance systems and governance capabilities.

3.2.3. The OpenCity Intelligent Transportation Model of the University of Hong Kong

The OpenCity intelligent transportation model of the University of Hong Kong is an innovative achievement released by the University on September 19, 2024. This model combines Transformer and graph neural network techniques to capture complex spatiotemporal correlations in traffic data. The OpenCity model is capable of recognizing and integrating spatiotemporal patterns from multiple data sources, and is suitable for various traffic prediction scenarios, demonstrating strong scalability

DOI: 10.54254/2754-1169/146/2024.LD19062

and adaptability [10]. This model has achieved significant results in zero sample learning, providing strong support for the widespread application of intelligent transportation systems. However, the OpenCity model still needs to face the complexity and diversity of different urban environments and transportation modes in practical applications. How to further optimize the model to adapt to a wider range of scenarios is still an important direction for its future development [11].

In this process, big data technology has mainly contributed to the model from three aspects. Firstly, the OpenCity model breaks through the spatial limitations of existing models and achieves adaptive cross regional spatial generalization, enabling effective prediction in different geographical regions [12]. Secondly, compared to traditional models that are only good at short-term forecasting, the OpenCity model achieves temporal generalization and significantly improves long-term forecasting capabilities, providing more forward-looking strategic support for urban planners [12]. Finally, by learning powerful traffic dynamic representations, the OpenCity model successfully addresses the spatiotemporal heterogeneity of urban traffic patterns, maintaining a high degree of adaptability and accuracy.

3.3. Challenges and Countermeasures

Although the combination of intelligent transportation and big data has achieved significant results, it still faces many problems and challenges. On the one hand, the issues of data security and privacy protection are increasingly becoming a focus. How to ensure the security of transportation data during transmission and storage, prevent its leakage and abuse, has become an important issue that urgently needs to be addressed. On the other hand, the phenomenon of data silos is severe, and it is difficult to effectively share data between different departments and systems, which restricts the overall efficiency of intelligent transportation systems.

To address these challenges, the following measures can be taken. Firstly, it is very important to strengthen data security technology and the construction of laws and regulations, which can build a comprehensive data security protection system. Secondly, the development of the times requires promoting the construction of data sharing platforms, breaking down data barriers, and achieving cross departmental and cross system data sharing and integration. Furthermore, it is urgently necessary to bolster technological innovation and foster talent development in order to elevate the intelligence quotient and practical application abilities of intelligent transportation systems.

4. The Combined Application of Intelligent Transportation System and Big Data Technology in Urban Transportation

4.1. Traffic Management and Optimization

The application method combining intelligent transportation and big data has been instrumental in urban traffic flow management. Big data analysis technology collects real-time traffic flow, vehicle speed, and vehicle type data and conducts in-depth analysis to accurately predict the trend of traffic flow changes. Meanwhile, combined with the intelligent traffic signal control system, this method can achieve intelligent scheduling and optimized control of traffic signals, providing scientific decision-making suggestions for traffic management departments and effectively alleviating traffic congestion problems [13].

4.2. Improving Public Transportation Services

The application method combining intelligent transportation and big data can significantly enhance the standard of public transit offerings. Due to the real-time monitoring and analysis of public transportation vehicle operation data by big data technology, the status of vehicle operation and

DOI: 10.54254/2754-1169/146/2024.LD19062

passenger travel needs are accurately grasped, the layout of bus routes and station settings are optimized, and the coverage and convenience of public transportation are improved [13, 14]. Furthermore, the adoption of technologies like mobile payments and electronic ticketing can elevate the level of intelligence in public transportation services, thereby offering passengers a more seamless and efficient journey experience.

4.3. Emergency Response and Safety Management

Emergency response and safety management are major challenges in the development of intelligent transportation combined with big data. Under normal circumstances, by collecting real-time information on emergency events such as traffic accidents and road construction, and utilizing big data analysis technology, the impact range and degree of the event can be quickly evaluated, furnishing scientific guidance for decision-making in emergency management departments [15]. Concurrently, by combining the monitoring and scheduling functions of intelligent transportation systems, emergency events can be quickly responded to and effectively handled. In addition, by utilizing big data analysis technology, traffic violations can be intelligently identified and alerted, and the level of traffic safety management can also be improved [16].

4.4. Environmental Protection, Energy Conservation and Emission Reduction

The combination of intelligent transportation and big data applications can also promote environmental protection, energy conservation, and emission reduction in urban transportation. By analyzing data such as traffic flow and vehicle types, high emission vehicles and road sections can be accurately identified, providing targeted governance measures for environmental protection departments [17]. Concurrently, combined with the intelligent scheduling function of the intelligent transportation system, it is possible to optimize the vehicle's driving route and speed control strategy, reduce the number of vehicle idle and acceleration times, and thus reduce fuel consumption and exhaust emissions [18]. In addition, due to leveraging big data analysis technology, the energy consumption of public transportation systems can be finely managed, and the public transportation system can be promoted towards a green and low-carbon direction [19].

5. Conclusion

In summary, the combination of intelligent transportation systems and big data technology not only improves the management level of transportation systems, but also significantly enhances the traffic capacity of transportation networks and reduces the negative impact of transportation systems on the environment. It has played an important role in traffic management and optimization, improvement of public transportation services, emergency response and safety management, as well as environmental protection, energy conservation and emission reduction. Nonetheless, the current integration of these two entities encounters hurdles like data security, privacy protection, and isolated data silos. To address these issues, it is imperative to bolster data security technology and legal frameworks, foster the development of data sharing platforms, and accelerate technological innovation along with nurturing talent.

The findings of this article not only offer theoretical backing for the integration of intelligent transportation and big data, but also serve as valuable references for the future progression of this domain. As technology continues to evolve and application scenarios broaden, the fusion of intelligent transportation systems with big data technology will persist in playing a pivotal role in urban transportation management, further bolstering the intelligent, efficient, and eco-friendly development of urban transportation.

DOI: 10.54254/2754-1169/146/2024.LD19062

References

[1] *Zhao, J.L. (2024). The Role and Mitigation Strategies of Intelligent Transportation Systems Based On Big Data Algorithm Analysis In Traffic Congestion. Electronic Components and Information Technology, 8 (5), 86-88.*

[2] *Zhou, Y.J. (2003). Overview of Intelligent Transportation Systems (ITS). Automobiles and Accessories, (37), 26-28.*

[3] *Yang, Y.K. (1999). Overview of Intelligent Transportation Systems (ITS) and Development Strategy Selection in China. Advances in Geographic Sciences, 18 (3), 274-278.*

[4] *Xia, Y.W.(2017). In the Era of Big Data, We Need to Have Big Data Thinking.*

[5] *Wu. C.Q., Liang, N., &Xu, K. (2021). Application of Smart Transportation Scenarios Based on Big Data Technology. China Automatic Identification Technology, (6), 48-50.*

[6] *Cui, J.K. (2024). Research on Intelligent Traffic Flow Prediction Model Based on Deep Learning and Big Data Analysis. Information Technology Research, 50 (3), 16-22.*

[7] *Zhao, P.M. (2021). Interpretation and Reflection on the Research of New Transportation Infrastructure under Mixed Driving Traffic Conditions: Taking Europe as an Example. SUTPC News. 2024.10.13, http://www.sutpc.com/news/jishufenxiang/697.html*

[8] *Sohu News. (2020). Analysis of Typical Cases of Connected Autonomous Driving in Europe and America. 2024.10.13, https://www.sohu.com/a/441508995_505819*

[9] *IUD China Leadership Decision Case Study Center (2016). Hangzhou: "City Brain" Battles Traffic Congestion. Leadership Decision Information, (45), 18-19.*

[10] *Tencent News. (2024). HKU Releases OpenCity Intelligent Transportation Model! Breaking the Barrier of Zero Sample Prediction in Time and Space, Training Speed Can Be Increased by Up to 50 Times. 2024.10.13, https://new.qq.com/rain/a/20240919A06U2R00*

[11] *Baidu. (2024). Applications of OpenCity Large Model in Traffic Prediction. 2024.10.13, https://baijiahao.baidu.com/s?id=1808875721962314725*

[12] *Li, Z.H., Xia, L., Shi, L., Xu, Y., Yin, D.W., & Huang, C. (2024). OpenCity: Open Spatio-Temporal Foundation Models for Traffic Prediction. arXiv. 2024.10.13, https://arxiv.org/abs/2408.10269*

[13] *Ren, K. (2017). Reflections on Building Intelligent Transportation Management Based on Big Data. Road Traffic Management, (3), 35-36.*

[14] *Zhao, H.T. (2024). Analysis of Smart Transportation Planning and Construction under the Background of Big Data. Northern Transportation, (9), 92-94.*

[15] *Chen, X. (2024). Exploration of the Application of Big Data Technology in Intelligent Transportation. Communication World, 31 (3), 157-159.*

[16] *Wang, H.G. (2024). Application of Artificial Intelligence in Intelligent Transportation under the Background of Big Data. Science and Information Technology, (6), 160-162*

[17] *Jing, G. (2019). Discussion on the Application of Big Data in Smart City Research and Planning. Building Materials and Decoration, (9), 127-128.*

[18] *Li, W. (2017). Exploration of the Application of Transportation Big Data in Intelligent Highways. Theoretical Research on Urban Construction (Electronic Version), (6), 206-207.*

[19] *Ding, H.F. (2022). Exploring the Planning and Construction of Intelligent Transportation in the Context of Big Data Era. Engineering Construction and Design, (15), 104-106.*