

Current Status and Future Development of Intelligent Transportation Systems in the Logistics Industry

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Abstract:

With the rapid development of the global logistics industry and the deepening of digital transformation, Intelligent Transportation Systems (ITS) has become the core driving force for the optimization of modern logistics supply chain. In this study, we systematically review the current status of ITS application, technical architecture and challenges in the logistics industry, and look forward to its future development trend. The study finds that ITS significantly improves the efficiency, safety and sustainability of logistics and transportation through the integration of cutting-edge technologies such as Internet of Things (IoT), Artificial Intelligence (AI), Big Data Analytics (BDA) and Blockchain. The global ITS market is expected to grow from USD 30.64 billion in 2024 to USD 60.92 billion by 2033, at a CAGR of 7.94%. However, the deployment of the system still faces multiple challenges such as complex technology integration, high infrastructure investment, data security risks, and lagging regulatory policies. In the future, self-driving vehicles, Telematics, digital twins and smart distribution will become the main direction of the development of intelligent transportation systems. This paper provides a theoretical basis and practical guidance for the digital transformation of logistics enterprises and the formulation of government industrial policies.

Keywords: Intelligent Transportation System; Logistics Industry; Internet of Things; Artificial Intelligence; Autonomous Driving; Digital Twins

1. Introduction

Driven by both globalization and digitalization, the logistics industry is experiencing unprecedented changes. As the key hub connecting production, dis-

tribution and consumption, intelligent upgrading of logistics and transportation systems has become an inevitable choice to improve supply chain efficiency, reduce operation costs and realize sustainable development. Intelligent transportation system as the

advanced information and communication technology, sensor technology, artificial intelligence and automation control technology fusion applied to the transportation management of the integrated system, is profoundly changing the traditional logistics and transportation mode of operation [1].

In recent years, the global logistics market continues to expand. According to market research data, the global freight transportation and logistics market size is expected to grow to \$1,869 billion by 2026, with a compound annual growth rate of 4.4% [2]. Behind this growth, the booming development of e-commerce, consumers on the delivery of time-sensitive requirements for the enhancement of the supply chain complexity of the increase in the level of intelligence of the logistics and transportation system has put forward a higher level of requirements. Traditional logistics transportation is facing many challenges: delays in distribution due to traffic congestion, rising labor costs, fluctuating fuel prices, environmental pollution pressure, and inefficiency in the last mile of distribution are becoming more and more prominent. Intelligent Transportation System (ITS) provides technical support to solve these challenges through real-time data collection, intelligent analysis and decision-making, and automated execution.

The application of ITS in the field of logistics covers multiple levels. At the macro level, ITS significantly reduces urban traffic congestion by monitoring traffic flow in real time, optimizing signal timing and providing dynamic route planning [3]. At the meso level, intelligent fleet management systems use GPS positioning, on-board sensors and big data analysis to achieve real-time tracking, fuel consumption optimization and predictive maintenance of transportation vehicles [4]. At the micro level, automated warehouse management systems, intelligent sorting equipment and unmanned delivery vehicles and other technologies are reshaping every aspect of logistics operations. The synergistic effect of these technologies builds an efficient, safe and sustainable smart logistics ecosystem.

Currently, major economies around the world have incorporated the development of intelligent transportation systems into their national strategies. The United States through the Infrastructure Investment and Jobs Act, for the deployment of intelligent transportation technology to provide financial support of 110 billion U.S. dollars [5]. The European Union has launched the European Green Deal to promote the digital and low-carbon transformation of the transportation sector, with the goal of reducing greenhouse gas emissions by 55% by 2030 [6]. The Chinese government has explicitly proposed to promote the wide application of ITS in logistics in the Outline for the Construction of a Strong Transportation State [7]. These

policy supports create a favorable external environment for the innovative development of ITS in the logistics industry.

Based on the above background, the purpose of this paper is to comprehensively analyze the current status, technical architecture, challenges and future development trends of ITS application in the logistics industry. The research adopts the method of literature review and case study to systematically sort out the latest research results and practical experience of ITS at home and abroad. The theoretical significance of the study is to enrich the academic knowledge system in the field of intelligent logistics and provide a reference framework for subsequent research; the practical significance is to provide decision-making support for the technology selection, system deployment and operation optimization of logistics enterprises, as well as to provide empirical evidence for the government to formulate relevant industrial policies and regulatory rules.

2. Theoretical background and sustainable analysis of intelligent transportation system (ITS)

The theoretical foundation of ITS originates from the cross-fertilization of multiple disciplines, involving traffic engineering, information science, control theory, operations research and systems engineering. From the perspective of conceptual evolution, the prototype of ITS can be traced back to the traffic control system in the 1960s, but it really appeared as an independent research field in the early 1990s, and the first World Conference on Intelligent Transportation Systems (WCITS), held in Paris in 1994, marked the formal establishment of the concept in the international transportation community, industry and science and technology community [8]. After more than 30 years of development, ITS has evolved from the initial traffic signal control and monitoring camera functions to a complex network system integrating predictive analytics, Telematics communication and autonomous driving technologies.

In the field of logistics, the technical architecture of ITS can be divided into four layers: perception layer, network layer, platform layer and application layer. The perception layer realizes real-time collection of transportation environment, vehicle status and cargo information through hardware devices such as IoT sensors, RFID tags, GPS positioning devices and on-board cameras. The network layer utilizes 5G communication, Vehicle to Vehicle (V2X) and cloud computing technologies to ensure high-speed transmission and reliable storage of massive data [9]. The platform layer processes, analyzes and verifies the collect-

ed data based on big data analysis, artificial intelligence algorithms and blockchain technology to generate decision support information. The application layer transforms

the intelligent capabilities into specific business functions, including path optimization, fleet scheduling, cargo tracking, predictive maintenance and intelligent distribution.

Table 1: ITS technical architecture levels and key technologies.

Architecture Layer	Core Technologies	Key Functions
Perception Layer	IoT Sensors, RFID Tags, GPS Devices, Onboard Cameras, LiDAR Systems	Real-time data collection on transportation environment, vehicle status, and cargo information
Network Layer	5G Communication, V2X (Vehicle-to-Everything), Cloud Computing, Edge Computing	High-speed data transmission, reliable storage, and low-latency communication
Platform Layer	Big Data Analytics, AI Algorithms, Blockchain Technology, Digital Twin Systems	Data processing, analysis, verification, and decision support information generation
Application Layer	Route Optimization, Fleet Dispatching, Cargo Tracking, Predictive Maintenance, Smart Delivery	Transform intelligent capabilities into specific business functions and operational improvements

From the perspective of sustainable development, the application of ITS in the logistics industry reflects the triple value of economy, society and environment. At the economic level, ITS can reduce fuel consumption by 25-35% through optimizing transportation routes, reduce equipment failure rate by 40% through predictive maintenance, and save more than 30% of operating costs by improving vehicle utilization [10]. The application of artificial intelligence technology in logistics, for example, through intelligent path planning can shorten the transportation time by nearly 50%, significantly improving the logistics efficiency and economic benefits [2]. At the social level, intelligent transportation system reduces the probability of traffic accidents. Studies have shown that the application of autonomous driving technology can reduce traffic accidents by up to 90%, which not only reduces casualties and property losses, but also reduces the impact of traffic congestion on the quality of life of urban residents [11]. At the environmental level, ITS is important for realizing the green transformation of the logistics industry. Through intelligent traffic flow management and vehicle operation optimization, fuel consumption can be reduced by 18%, carbon dioxide emissions by 25%, and overall operational emissions by 21.2% [12]. The popularization and application of electric self-driving vehicles further strengthens the environmental benefits. Globally, logistics companies are actively responding to the sustainable development goals, FedEx through the deployment of Aurora (Aurora) powered self-driving trucks, annual carbon emissions by 35%, while realizing more than 200 million U.S. dollars in cost savings [13]. These practices have fully proved that ITS is not only a product of technological innovation, but also an important way to promote the sustainable development of the logistics industry.

As an important part of the intelligent transportation

system, digital twin technology provides an innovative method for the optimization and management of logistics network. Digital twin by building a virtual mirror of the physical logistics system, can reflect the real-time location of goods, transport vehicle status and distribution center operations [14]. This virtual mapping technology allows enterprises to carry out transportation route simulation, cargo flow prediction and emergency plan testing in a virtual environment, thus reducing decision-making risks and improving response speed. A large logistics enterprise using digital twin technology to establish the whole chain system, not only can track the location of goods, but also based on real-time traffic conditions to predict the best distribution routes, the transportation time and cost significantly reduced [15]. In addition, real-time monitoring of temperature, humidity and other environmental parameters through the integration of IoT sensors ensures the safe transportation of perishable goods and significantly improves service quality.

The combination of blockchain technology and IoT further enhances the transparency and security of the intelligent transportation system. The distributed ledger characteristic of blockchain provides a tamper-proof storage mechanism for logistics data, which effectively solves the problem of information asymmetry and lack of trust in the traditional supply chain [16]. Blockchain technology shows unique advantages in food and pharmaceutical logistics and other areas that require high product traceability. Walmart's blockchain-based food traceability system shortens the mango source tracking time from 6 days to 2.2 seconds, dramatically improving the transparency of the supply chain and the ability to safeguard food safety [17]. Logistics giants such as DHL are also utilizing blockchain and IoT to improve the transparency of transportation, and provide more reliable logistics services for their custom-

ers through real-time monitoring and tamper-resistant data records. These technological innovations have injected new vitality into the intelligent transportation system and promoted the development of the logistics industry in the direction of greater intelligence, transparency and credibility.

3. Current challenges of ITS

Although ITS shows great development potential and application value, it still faces many challenges in actual deployment and operation. These challenges involve technical, economic, regulatory and social dimensions, and require the concerted efforts of governments, enterprises and research organizations to overcome.

The technological challenge is the first and foremost. The core of ITS lies in the in-depth integration of multiple advanced technologies, while the compatibility and interoperability between different technologies often become the bottleneck of system deployment. There are many brands of IoT devices and different communication protocols, resulting in non-uniform data collection and transmission standards [18]. Logistics involves warehousing, transportation, customer service and other aspects of the data dispersed and different formats, cleaning and integration of the high cost. Real-time requirements on the technical architecture has put forward a serious test, path optimization, anomaly detection and other scenarios require real-time processing of massive amounts of data,

the traditional architecture is difficult to meet this demand [19]. Although the automatic driving technology has made great progress, the perception ability, decision-making reliability and safety in the complex traffic environment still need to be further improved. Edge scenario processing - i.e., those extreme situations that have a low probability of occurrence but must be considered - remains a major technical obstacle to the commercialization of autonomous driving [20].

Infrastructure investment and construction lags constitute the second major challenge. The efficient operation of ITS relies on well-developed digital infrastructures, including 5G network coverage, Telematics communication facilities, intelligent traffic signaling systems, and electric vehicle charging piles. However, the construction of these infrastructures requires significant capital investment and long construction periods. The U.S. Federal Highway Administration estimates that the modernization of the highway system requires an annual investment of \$125 billion, and the share of intelligent systems in the project budget is increasing [21]. For developing countries and small and medium-sized logistics enterprises, high initial investment costs are often a major barrier to technology adoption. Retrofitting of self-driving trucks is particularly costly and is not economically feasible for existing trucks due to the need for safety modifications to the vehicle architecture and the addition of hardware such as LiDAR and redundant braking systems [22].

Table 2: Key Challenges for ITS Deployment

Challenge Category	Specific Issues	Impact Level	Mitigation Strategies
Technical Integration	Device compatibility, data standardization, real-time processing, edge case handling	High	Develop unified protocols, implement hybrid architectures, invest in AI systems
Infrastructure Investment	High initial costs, 5G network deployment, charging infrastructure, roadside equipment	High	Public-private partnerships, government subsidies, phased implementation
Data Security & Privacy	Cybersecurity threats, data breaches, ransomware attacks, privacy compliance (GDPR, CCPA)	Critical	Advanced encryption, blockchain integration, multi-layer security protocols
Regulatory Framework	Policy lag, liability issues, cross-jurisdictional differences, insurance complexities	Medium-High	Regulatory sandboxes, pilot programs, international cooperation
Talent & Skills Gap	Shortage of interdisciplinary experts, insufficient training programs, knowledge transfer	Medium	Industry-academia collaboration, specialized training, talent retention programs

Data security and privacy protection issues are of increasing concern. Intelligent transportation systems rely on the collection, transmission and analysis of large amounts of

data, which contain sensitive information such as customer addresses, cargo information, vehicle tracks, and so on. Data leakage or malicious use may lead to serious conse-

quences. In August 2024, JAS Worldwide, a global freight forwarding company, suffered a ransomware attack that affected customer service, billing systems and data integration, and service disruption lasted for several days [23]. The growing threat of cybersecurity has prompted governments to strengthen regulation. The UK government introduced the Cyber Security and Resilience Act, which aims to strengthen national cyber defense capabilities and protect critical infrastructure [23]. Logistics companies must seek a balance between the use of data to create value and protect data security, which requires companies to invest significant resources for network security protection, data encryption and compliance management. The cybersecurity market size for connected vehicle infrastructure is expected to grow from USD 1.99 billion in 2024 to USD 5.26 billion by 2029, at a CAGR of 21.2% [12], reflecting the huge demand for cybersecurity solutions.

Lagging regulatory policies and legal frameworks also constrain the promotion and application of ITS. The commercial operation of new transportation tools, such as self-driving vehicles and unmanned delivery robots, involves complex legal issues, such as the division of responsibility, insurance claims, and the application of traffic rules. At present, most countries and regions have not yet established a perfect regulatory system. The U.S. federal government has not yet promulgated a unified regulation of automated driving, although most states allow automated driving system testing, but the policy differences between the states [22]. Although the European Union has approved the type certification regulations for self-driving vehicles, there are still differences in implementation among member states [22]. Regulatory uncertainty increases the compliance risk for companies and affects the incentive to invest in the technology. Drone delivery is subject to strict airspace control, limiting its large-scale application in urban environments [24]. The establishment of a unified and clear regulatory framework that adapts to the development of the technology is an important guarantee for the healthy development of ITS.

Talent shortage and skill development are also challenges that cannot be ignored. The development, deployment, and operation and maintenance of ITS require interdisciplinary professionals, including software engineers, data scientists, system architects, cybersecurity experts, and transportation planners. However, the talents cultivated by the current education system are often difficult to meet the needs of the industry. Intelligent logistics for intelligent manufacturing needs to have comprehensive analysis and decision-making capabilities, multi-disciplinary integration and innovation capabilities and system analysis, diagnosis and optimization capabilities of composite talents [25]. Logistics industry as a traditional labor-intensive in-

dustry, in the process of transformation to technology-intensive, requires a lot of investment in staff training and skills upgrading, which puts forward higher requirements for the human resource management capabilities of enterprises.

Market acceptance and social awareness also affect the speed of ITS promotion. Despite the maturity of the technology, public trust in self-driving vehicles is still limited, especially in terms of safety. Media reports on self-driving accidents often raise questions about the reliability of the technology. Logistics companies need to balance the relationship between technology investment and short-term returns when introducing new technologies, as high expectations may lead to disappointment and resistance. Public education, technology popularization and demonstration of successful cases are essential to enhance social awareness and acceptance of ITS.

4. Future Development of ITS

Looking into the future, the development of ITS in the logistics industry will present three major trends: in-depth integration of technology, expansion of application scenarios and reconstruction of industrial ecology. Technological innovation will continue to promote the enhancement of system capabilities, emerging application scenarios will continue to emerge, and the multi-party collaboration of the industrial ecology will accelerate the commercialization of technology landing.

The maturity and commercialization of self-driving technology will be the core driving force for the future development of intelligent transportation systems. In 2024, the United States launched the first fully automated freight corridor, connecting Texas and California's major distribution centers, making the transport time reduced by 25%, reducing operating costs by 30% [13]. Kodiak and other companies have planned to carry out driverless heavy-duty truck testing in 2024 [26]. Kodiak and others have planned to test driverless heavy-duty trucks in 2024 [26]. Self-driving trucks will first be commercialized in predictable environments, such as highways, using a hub-to-hub operational model: trucks will travel automatically between transfer hubs, while urban distribution and loading/unloading operations will still be done manually [22]. This hybrid model balances technical feasibility and economic efficiency, and the market for self-driving trucks is expected to reach \$405 billion by 2035 [22].

Vehicle to vehicle communication (V2X) technology will build the neural network of intelligent transportation. V2X enables vehicles to communicate in real time with other vehicles, road infrastructure, pedestrians, and cloud platforms to achieve collaborative sensing and collaborative

decision-making. By 2034, more than 90% of the global market is expected to adopt 5G-based C-V2X communication technology, and the number of new connected vehicles in China can reach 30 million per year [12]. V2X technology not only improves traffic safety and smoothness, but also creates scalable business models for energy management and smart infrastructure. Studies have shown

that V2X applications can reduce fuel costs by 25-35%, improve path optimization efficiency by 40%, and save 55% in maintenance expenditures [12]. Pure cellular V2X can be deployed at a cost 40-45% lower than solutions requiring roadside units, saving €275 million in the EU and \$375 million in the US by 2035 [12].

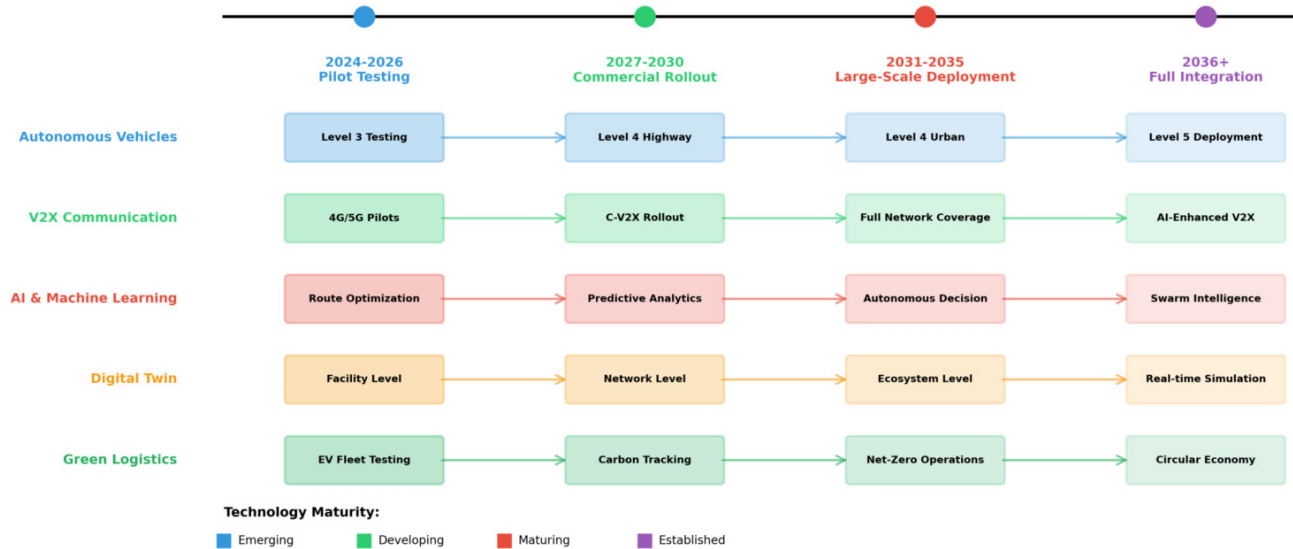


Figure 1: Roadmap for the future technological evolution of intelligent transportation systems

Artificial intelligence and machine learning technologies will empower intelligent transportation systems with stronger autonomous decision-making capabilities. Large-scale language models and deep learning algorithms can handle complex multivariate optimization problems, providing more accurate solutions for transportation scheduling, demand forecasting and anomaly detection [27]. Artificial intelligence can analyze multi-dimensional data such as transportation demand, road conditions, and weather in real time to generate optimal scheduling solutions, compressing response time from hours to minutes in unexpected situations [19]. Massachusetts Institute of Technology Center for Transportation and Logistics launched the Intelligent Logistics Systems Laboratory, is researching how to combine artificial intelligence, machine learning and operations research optimization methods, in order to deal with the logistics industry is facing a major challenge [28]. The lab focuses on three directions: augmented intelligence (human-machine collaborative decision-making), autonomous intelligence (robots that perform tasks autonomously) and collective intelligence (multi-intelligence collaborative optimization). These studies will drive the evolution of intelligent transportation systems from automation to intelligence and from single to collective intelligence.

Drones and delivery robots will play an increasingly important role in last-mile delivery. Drones are particularly suitable for small parcel delivery in congested urban areas and remote areas due to their fast and flexible characteristics [24]. Amazon, UPS and other companies have carried out drone delivery pilot projects in several regions. Ground delivery robots, on the other hand, have shown potential for application in closed or semi-enclosed environments such as campuses and communities. startups such as BitBotRobotics have developed an autonomous delivery system that combines computer vision, LIDAR maps, and AI path optimization to safely navigate in urban and remote environments and handle heavy loads of goods [12]. In the future, drones and self-driving vehicles will form a mixed flow model: drones are responsible for the last kilometer of rapid delivery, self-driving trucks undertake long-distance trunk transportation, both complement each other and synergize to build a more efficient distribution network [24]. Digital twin technology will provide a powerful tool for the overall optimization of the logistics network. The future digital twin system will cover the entire logistics ecosystem, from warehouse facilities to transportation vehicles, from the cargo unit to the global logistics network, to achieve a full range of digital mapping [29]. By inte-

grating historical data and real-time data, the digital twin can carry out accurate demand forecasting, resource allocation optimization and emergency response preview. Port digital twin system has been applied globally, through the construction of virtual models of terminals, berths, loading and unloading equipment, to achieve real-time monitoring, analysis and optimization of port operations,

significantly improving operational efficiency and resource utilization [30]. With the development of sensor technology, big data and artificial intelligence, the application of digital twins in the field of logistics will be more extensive and in-depth, becoming an important means to achieve intelligent, efficient and green development.

Table 3: Key technologies and application prospects for the future development of intelligent transportation system

Technology Domain	Development Timeline	Expected Impact	Market Projection
Autonomous Vehicles	2024-2030: Highway deployment 2031-2035: Urban integration	Transit time -25%, Operating costs -30%, Accidents -90%	USD 405B by 2035
V2X Communication	2024-2026: 5G-C-V2X pilots 2027-2034: 90% market coverage	Fuel costs -25-35%, Route efficiency +40%, Maintenance -55%	3B connected vehicles by 2034
AI & Machine Learning	2024-2027: Predictive analytics 2028+: Autonomous decision-making	Response time: hours→minutes, Demand forecast accuracy +35%	Embedded in all systems
Unmanned Delivery	2024-2027: Urban pilots 2028-2035: Hybrid logistics model	Last-mile cost -40%, Delivery speed +50%, Coverage expansion	Mixed drone-vehicle fleets
Digital Twin	2024-2028: Facility level 2029-2035: Ecosystem integration	Real-time optimization, Predictive planning, Risk reduction -30%	Full logistics network
Green Logistics	2024-2030: EV fleet transition 2031-2040: Net-zero operations	CO ₂ emissions -35%, Energy efficiency +18%, Circular economy	Carbon neutral by 2040

Green logistics and sustainable development will become an important direction of ITS innovation. In the context of global response to climate change, logistics enterprises are facing increasing pressure to reduce emissions. The promotion of electric self-driving vehicles, the construction of green warehousing facilities, path optimization algorithms based on artificial intelligence, and the participation of carbon offset projects will become the standard practice of logistics enterprises [23]. DHL Group and Envision Group cooperate to carry out comprehensive cooperation in the areas of logistics solutions, sustainable aviation fuels, green energy, and net-zero industrial and logistics park joint development [23]. Intelligent Transportation Systems (ITS) Intelligent transportation systems will provide technological support for achieving carbon neutrality in the logistics industry by optimizing transportation processes, improving energy efficiency and promoting clean energy applications.

The synergistic development of the industrial ecosystem will accelerate the commercialization of ITS. Successful deployment of ITS will require close cooperation among automakers, technology providers, logistics companies, communications operators, government agencies and research institutions. Cross-industry alliances and standardization organizations will play a key role in promoting technical standards harmonization, facilitating data

sharing, and coordinating regulatory policies [31]. Siemens' collaboration with NVIDIA combines the Siemens Xcelerator platform and the NVIDIA Omniverse cloud API to provide real-time generative AI-driven intelligent transportation system visualization solutions for intelligent transportation systems [32]. Aurora's long-term partnership with NVIDIA and Continental is dedicated to the development and deployment of self-driving trucks [13]. These collaborations not only accelerate technological innovation, but also reduce the R&D risks and costs of individual companies, promoting the rapid development of the entire industry.

Policy support and regulatory innovation will create a favorable environment for the development of ITS. Governments are adjusting their regulatory frameworks to provide more flexible policy space for the testing and commercialization of new technologies. The European Union approved regulations for type certification of self-driving vehicles, providing a legal basis for technology deployment [22]. China has issued national guidelines for self-driving cabs, encouraging companies such as Baidu and Wenyuan Zhixing to scale up operations and expand into international markets [26]. The government has also incentivized companies to increase technology development and application through financial support, tax incentives, and infrastructure investment. With the

maturity of technology and the improvement of social awareness, a more perfect regulatory system will be gradually established to clear the obstacles for the large-scale application of ITS.

5. Conclusion

Intelligent transportation system, as the core driving force of digital transformation of logistics industry, is profoundly changing the operation mode and industrial pattern of traditional logistics and transportation. This paper draws the following conclusions through the systematic analysis of the theoretical foundation, technical architecture, application status, challenges and future trends of ITS.

Intelligent transportation system builds an efficient, safe and sustainable logistics ecosystem by integrating cutting-edge technologies such as Internet of Things (IoT), artificial intelligence (AI), big data analytics, blockchain and autonomous driving. Technological innovation not only significantly improves the efficiency and service quality of logistics and transportation, but also provides the possibility of realizing the unity of economic, social and environmental benefits. The rapid growth of the global ITS market reflects a high degree of recognition of this technological trend by the industry and the investment community. However, the promotion and application of ITS still faces multiple challenges, such as complex technology integration, high infrastructure investment, data security risks, lagging regulatory policies and talent shortage. The existence of these challenges indicates that the development of ITS is not only a technical issue, but also a multi-dimensional systematic project involving economy, society, policy and ethics.

In the future, the commercialization of self-driving technology, the popularization of Telematics, the improvement of AI decision-making capability, the large-scale application of unmanned distribution, the deep integration of digital twins, and the comprehensive promotion of green logistics will jointly shape the new form of ITS. The progress of technology will promote the continuous expansion of application scenarios, from highway trunk transportation to the last kilometer of urban distribution, from the optimization of a single logistics link to the whole supply chain, intelligent transportation system will cover every corner of logistics operations. The collaborative development of industrial ecosystem will accelerate the maturity of technology and commercialization process, cross-industry cooperation, standardization and policy innovation will create favorable conditions for the large-scale deployment of intelligent transportation system.

For logistics enterprises, actively embracing ITS is not only a strategic choice to enhance competitiveness, but

also a necessary way to realize sustainable development. Enterprises should formulate a step-by-step technology deployment roadmap according to their own business characteristics and development stages, prioritize pilot applications in scenarios with a high degree of standardization and significant benefits, and gradually accumulate experience and capabilities. At the same time, enterprises need to strengthen data governance and network security to ensure the compliance and reliability of technology application. Talent training and organizational change is also the key to the successful implementation of ITS. Enterprises should establish interdisciplinary technical teams and cultivate composite talents with systematic thinking and innovation ability.

For government departments, they should strategically recognize the significance of ITS in improving national logistics efficiency, enhancing industrial competitiveness and realizing the goal of sustainable development. The government should increase investment in infrastructure, promote the construction of 5G network, vehicle networking facilities and intelligent transportation system, and create a good hardware environment for the application of technology. In terms of regulatory policy, it should, on the premise of ensuring safety, provide more flexible policy space for the testing and commercialization of new technologies, and explore a regulatory model adapted to the development of the technology through sandbox regulation and pilot projects. The government should also incentivize enterprises to increase R&D investment and technology application through financial support, tax incentives and industrial funds to cultivate intelligent logistics industry clusters with international competitiveness.

The development of intelligent transportation system is a dynamic evolutionary process, and the interaction of technological innovation, market demand, policy environment and social cognition will continue to shape its development trajectory. In the face of the rapidly changing technology and market environment, continuous research and practical exploration are crucial. Future research can further focus on the applicability and benefit assessment of ITS in different logistics scenarios, the optimization mechanism of multi-technology integration, the technical solutions for data security and privacy protection, the international comparison and reference of regulatory policies, as well as social acceptance and ethical issues. Through the joint efforts of academia, industry and government, ITS will play an increasingly important role in promoting the high-quality development of logistics industry and building a smart logistics ecosystem.

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