

Research on Evaluation Index of Smart Transportation for Xiamen City

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Abstract

In the current era of informatization, Intelligent transportation has become an important part of urban development. In the face of a complex integrated intelligent transportation system, how can government departments more effectively guide the construction of intelligent transportation? It is necessary to have a complete intelligent transportation evaluation system for evaluation, Based on the construction model and theoretical design provided by the top-level framework of "Smart Transportation" in Xiamen, this paper conducts an in-depth study of the content of smart transportation, starting from the three dimensions of the achievement of Xiamen's transportation operation goals, smart transportation supply performance, and smart transportation public service quality. With the goal of building Xiamen's intelligent transportation evaluation system, this paper explores the development of smart city construction from the perspective of smart traffic, and further provides exploratory construction suggestions for Xiamen smart traffic management.

Keywords

Smart transportation; index evaluation system; analytic hierarchy process; fuzzy comprehensive evaluation.

1. Introduction

At present, with the rapid development of the information society, intelligence and big data have become the theme of the times. With the crystallization of the integrated development of informatization and transportation, "smart transportation" is becoming a brand-new model of contemporary transportation development. As early as 2019, the State Council of China issued the "Outline for Building a Powerful Transportation Country", which pointed out the construction of a modern and high-quality comprehensive three-dimensional transportation network and a multi-level, integrated comprehensive transportation hub system. In 2021, the "Fourteenth Five-Year Plan for National Economic and Social Development of the People's Republic of China" promulgated by the Chinese government puts forward a number of tasks and requirements for transportation, covering comprehensive transportation channels, network information platforms, etc., and is important for accelerating the construction of transportation power. Deploy. With the release of the "14th Five-Year" development plan, local governments have successively issued plans for the construction of regional smart transportation. At present, the evaluation of smart transportation is still based on the evaluation of social experts, which lacks the depth and breadth of evaluation, and it is difficult to form a relatively complete evaluation index system. The purpose of this article is to study the construction of smart transportation in Xiamen, find out the evaluation indicators for smart transportation construction, and quantitatively evaluate the citizens' sense of transportation experience and sense of acquisition through the construction of the evaluation system.

2. Literature Review

Smart transportation is a new model for the development of modern transportation. It is defined internationally as the basis of intelligent transportation, incorporating high-tech IT technologies such as the IOT, cloud computing, big data, and mobile internet collects traffic information through high-tech to provide real-time transportation. The purpose of building smart transportation is to provide citizens with better life and work services, and to enhance residents' sense of gain and accomplishment in urban transportation.

2.1. Foreign research status

Foreign research on smart transportation can be traced back to the 1960s and 1970s. Developed countries represented by the United States, the European Union, and Japan, from policy planning to infrastructure construction, they give full play to the combination of technological advantages and urban status quo to establish the smart transportation development path of domestic cities. Scholar Lawton J (2016) believes that technologies such as the IOT, clean energy, big data, and quantum computing will shuffle traditional transportation modes and promote the development of smart transportation. Then Muhammad Aqib (2019) and others pointed out that smart transportation integrates the big data agency's high-performance computing technology, which can quickly and real-time predict traffic, and has the technology of self-learning ability. It can be seen that M. Mazhar Rathore mentioned in the research that smart transportation is a product of smart cities. It uses the IOT technology to process traffic information to improve the travel efficiency of residents. Since its development, many foreign scholars have further explored the relationship between information technology, transportation construction, and transportation management, and achieved quite important series of research results.

2.2. Domestic research state

In China, where information technology is highly developed, Z.H.Wu, B.Xiao, and L.Wang (2019) pointed out in their research that new technologies such as big data, the internet, artificial intelligence, blockchain, and supercomputing have become wisdom in terms of technical support for smart transportation. Scholars such as Y.K.Yuan and Y.Zhang(2015) mentioned in their research that the key technologies of smart transportation are intelligent identification and wireless sensor technology. From an overall point of view, domestic and foreign scholars have continuously in-depth research on smart transportation from different perspectives and have summed up many research results with reference value, which have promoted the development of smart transportation in the current era.

2.3. Analysis of the status quo of smart transportation for Xiamen

Xiamen City has set up a big data smart transportation management framework initially consisting of "one center, six systems, and 21 subsystems." Up to now, the achievements of smart transportation in Xiamen include the comprehensive transportation operation information smart platform of Xiamen, the Xiamen transportation credit information management system, the Xiamen traffic incident handling system, the smart highway system, the smart bus brain, the smart transportation convenience service system, the smart guidance system platform. Intelligent network connection technology application and 5G technology application. In the "Xiamen's 14th Five-Year Comprehensive Transportation Plan" (2020-2025), it is proposed: focus on consolidating "a hub", that is, building an international comprehensive transportation hub city; optimizing the "two-tier network", that is, optimizing the regional comprehensive three-dimensional transportation network And the city's high-quality transportation network; perfecting the "three systems", namely, perfecting a modern transportation service system that is satisfactory to the people, a leading national smart

transportation management system, and a powerful transportation industry governance system. The smart transportation construction target of "safe, convenient, efficient, green and economic" modern comprehensive transportation system is basically established by 2025.

2.3.1. Comprehensive traffic information platform

The core goal of the construction of Xiamen's big transportation information sharing service platform is "data aggregation, management and sharing". The big transportation platform includes a big transportation information sharing service platform, a comprehensive information management platform, and an information application management platform. It is called "one library, one map, one platform" for short.

Through the construction of Xiamen's large transportation platform, Xiamen Transportation Bureau diagnosed Xiamen transportation, condensed business consensus, promoted project realization, and realized dynamic tracking and rolling development through the "data chain". So as to realize the "integrated image library" management of Xiamen's traffic big data resources. The platform basically realizes the collection of 60 transportation industry data in 7 categories, and has accumulated access to more than 3,500 video resources covering national and provincial arterial roads, urban arterial roads, four bridges and one tunnel, and key hubs, continuously improving the visual level of road network guarantee; At the same time, the vertical connection department, the provincial industry supervision platform, the integration of the internal transportation information system, and the external city public safety management platform have further deepened the degree of information sharing and interconnection.

At present, the big traffic information sharing service platform has aggregated the dynamic and static business data of more than 20 units in Xiamen, with more than 100 million daily update records. It has initially built the ability to intensively manage big traffic data resources and promoted the realization of cross-departmental and cross-level information. Interconnection and sharing and exchange of government information resources.

In addition, the construction of Xiamen's large transportation platform has also promoted the "support project" of traffic static and dynamic data resources covering infrastructure and operation monitoring, and has truly realized the "integrated library" management of traffic big data resources, and established more than comprehensive transportation map system with 200 layers can realize the functions of spatial analysis, comprehensive query, operation display and dynamic statistics, and can provide information support of "data global view" for industry management and decision analysis. In addition, based on the aggregation of the above-mentioned data resources, the big transportation platform has completed the comprehensive management applications of 7 industries including the recognition and evaluation of traffic operation status, the recognition of bus passenger flow and operation characteristics, and the precise monitoring of road transportation, and improved the "Xiamen Transportation" WeChat public account, providing one-stop services such as public travel inquiries, travel planning, ticket purchase, and complaints.

The construction of Xiamen's big transportation platform plays a fundamental role in the construction of Xiamen's smart transportation system as "convergent," "perceivable," and "evaluable". Breaking the important milestone project of comprehensive urban transportation management, marking the development of smart transportation in Xiamen will take a new step, providing better decision-making support for the management and services of the transportation industry in Xiamen, and enhancing information sharing among members of the Office of Transportation, Safety supervision, business collaboration and decision analysis capabilities.

2.3.2. Smart Transportation System

One is credit information management. In order to strengthen the in-depth application of credit data in Xiamen, the Xiamen Traffic Operation Monitoring Command Center further developed the second phase of the Xiamen Traffic Credit Information Management System and put it into trial operation. The biggest feature of the second phase of the system is the establishment of traffic credit modeling, which will use the sorted information elements such as traffic permits, penalties, red and black lists as data sources for legal person modeling and profile analysis. After modeling, it should give credit subjects appropriate scoring ratings, and show credit subjects through five dimensions: basic information, contract performance behavior, industry behavior, behavior preference, and credit use behavior. Not only that, the system also cooperates with the Xiamen City Credit Platform to realize information interconnection and joint reward and punishment management. At present, the system has gathered the basic information of more than 7,000 enterprises, more than 60,000 employees, and more than 70,000 pieces of credit information, helping to clarify the credit status of credit entities in Xiamen City and providing a scientific basis for classified and hierarchical supervision.

The second is the handling of traffic incidents. In the past, various departments of the Xiamen Municipal Transportation Bureau had problems in traffic management, such as information barriers, lack of coordination and linkage, and efficient emergency response. Therefore, in order to promote the internal multi-level linkage of various departments, realize the whole-process control of pre-monitoring and early warning, coordinated management during the incident, and post-incident disposal evaluation, a set of Xiamen traffic incident handling system has been established. Relying on GIS technology, the system intuitively aggregates information such as traffic emergency level, place of occurrence, and processing progress of each unit on an "emergency command map". It can also identify potential traffic emergency events in advance, and formulate emergency teams and response measures. . In addition, the Xiamen Traffic Command and WeChat Mini Program was set up to connect with the Xiamen traffic incident handling system in real time, forming a closed loop of emergency incident handling including incident reporting, incident handling, work order dispatch, tracking feedback, and retrospective.

2.3.3. Smart Bus

Starting in 2019, Xiamen Public Transport Group has developed and introduced two sets of key intelligent systems under the premise of the top-level design of "a set of decision-making platforms" and "multiple sets of information systems". Among them, the flexible bus system is oriented by OD behavior, realizes flexible serialization of routes in peak intervals, and provides key data indicators of passenger experience accurate to the shift, such as waiting time, congestion times, accurate OD, etc. Today, there are 150 "flexible buses" on the island. Every morning rush hour, 388 large passenger flow sections and 16 section bridging tasks are performed on average in 97 large passenger flow sections on the island, and the difference between up and down is realized on 18 tidal routes. In order to achieve a 17% increase in peak capacity, a digital multi-level network layout will be realized. This year, it will expand to four districts outside the island, adding more than 200 flexible buses on and off the island. In this way, the problem of peak capacity is solved, the congestion of the peak interval is reduced, and the comfort of the citizens is increased.

The intelligent guidance system collects the can line data in the car, automatically recognizes the driver's bad driving behavior, interacts with the vehicle power system through the can protocol, and automatically optimizes it. While achieving safe and energy-saving driving, it contributes to the millisecond-level full data of the can line to establish an accurate file covering the driving behavior of the entire group of drivers.

2.3.4. Smart Highway System

Focusing on the three aspects of public travel services, road maintenance safety and informatization supervision, the Highway Center of the Xiamen Municipal Transportation Bureau innovated application scenarios, introducing intelligent networked active luminous signs, early warning systems for dangerous road sections beyond the visual range, and early warning wizards.

In December 2020, the intelligent networked active luminous sign was successfully put into use on Chenggong Avenue, showing real-time traffic congestion in the direction of Xiamen Bridge and Xinglin Bridge in the direction of the island. Intelligent networked active luminous guide signs use big data fusion to prompt road congestion, forecast arrival time, and actively guide drivers to choose the best route, which has the advantages of "data fusion, time and space travel, intelligent management". The pilot commissioning is a breakthrough in the intelligent "zero" of Xiamen's traffic signs, further building a smart city transportation network and building an intelligent highway transportation infrastructure.

From April 2021 to the present, the number of accurate services provided by the early warning wizard has reached more than 2 million, and the number of services reached 890,000 in July alone. In the same year, in order to improve road safety and prevent traffic accidents, Xiamen City Transportation and Highway Center developed an early warning system for dangerous road sections beyond the visual range. The system is the first to be applied on Provincial Highway 217, integrating multiple technologies such as radar detection, AI intelligent algorithm, microwave detection and triggering, and releases incoming traffic signals to vehicles through intelligent roadside terminals, realizing two-way motor vehicles within 500 meters at both ends of the curve. Early warning.

2.3.5. Application of 5G Technology

In September 2018, Xiamen's 5G-oriented car networking smart BRT demonstration application project was officially released. Up to now, the project has built a 5G vehicle-road collaborative big data platform, completed the intelligent transformation of 60 kilometers of BRT roads and 5 traffic light intersections in Xiamen City, as well as 50 BRT buses, 1 self-driving bus, and 1 self-driving car. The intelligent networked transformation of logistics vehicles has released six intelligent networked applications: beyond-the-horizon anti-collision, real-time vehicle-road coordination, green wave traffic and guidance, optimal vehicle speed control, safe and precise parking, and unmanned driving. In August 2020, it successfully passed the acceptance review of the expert group organized by Xiamen Public Transport Group, marking that the project has officially become the first intelligent networked vehicle-road collaboration project that has been verified by a mature business model in China. In 2021, 432 5G base stations will be fully laid on Xiamen Metro Line 3 to achieve full coverage of 5G network signals.

3. Smart city evaluation index selection and analysis framework

3.1. Evaluation index selection

With the rapid economic development, Chinese cities have entered a period of accelerated development. As of 2020, the number of motor vehicles in Xiamen has reached 1,709,063. At the same time, population expansion, resource shortage, environmental damage and other issues have made traffic congestion a major "urban disease" restricting the development of Chinese cities, including Xiamen. On the other hand, the inadequate construction of transportation information has led to an increase in the cost of citizens' travel, and the inconvenience of citizens' travel has indirectly led to a decrease in citizens' sense of urban acquisition.

In order to evaluate the actual results of the smart transportation construction in Xiamen in a comprehensive and multi-dimensional manner, this paper uses the study of the smart construction situation in Xiamen as an entry point. Aiming at the weight requirements of the smart transportation evaluation index, the analytic hierarchy process is used to divide the evaluation objects and goals into several levels. And gradually refine, classify and organize into three-level indicators, starting from the seven indicators of traffic management level, traffic safety level, traffic environmental protection level, traffic facility level, traffic innovation level, traffic information service level, and travel convenience to build Xiamen City Smart transportation evaluation system.

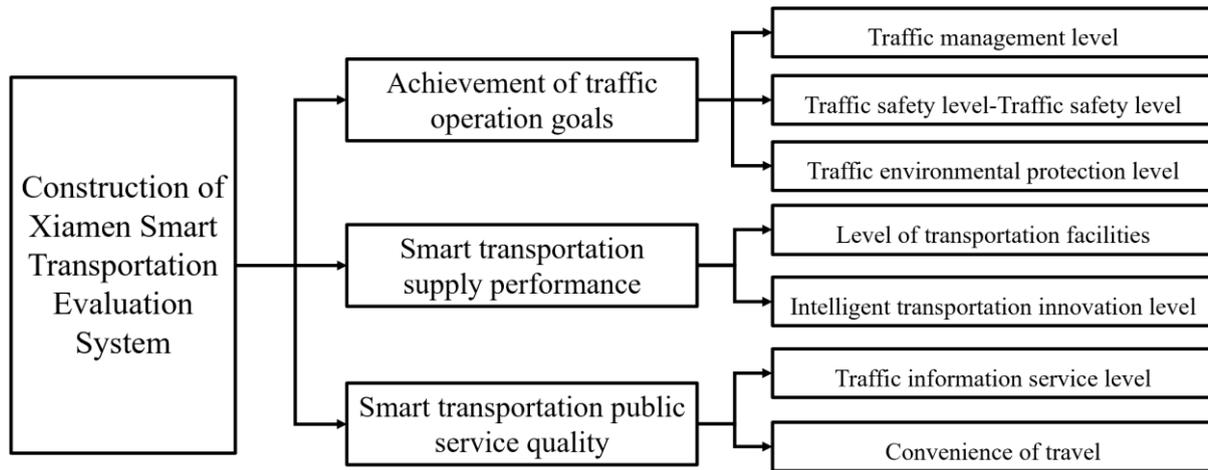


Figure 3-1: Indicator selection dimension map of Xiamen Smart Transportation Evaluation System

3.2. Analysis framework of the evaluation index system of smart transportation for Xiamen

In order to deeply understand and evaluate the construction and management level of smart transportation in Xiamen City, through consulting a large number of data, reports, papers and other literature materials, searching for a large number of indicators related to the evaluation object, soliciting the opinions of many professionals, according to the initial evaluation indicators Logical connection and build a related indicator library. On this basis, weights are set to complete the construction of the Xiamen Smart Transportation Evaluation Index System.

3.2.1. Structural analysis of the index system

The construction of smart transportation is divided into three dimensions: the achievement of traffic operation goals, the performance of smart transportation, and the quality of smart transportation public services for evaluation, from which it is divided into 7 secondary indicators and 29 three-level indicators, and the indicator weights of the three dimensions are adopted. Calculate the value according to the index algorithm to give the final evaluation result.

3.2.2. Indicator Algorithm

Using the fuzzy comprehensive evaluation method, it is divided into five index levels. The evaluation method is to first create a fuzzy subset of each layer, and then select the membership function related to the evaluation index according to the evaluation parameters defined in the relevant literature to determine the degree of membership and quantify each evaluation index to obtain the index level of each layer. Corresponding evaluation value, the index level "1st, 2nd, 3rd, 4th, 5th" means "good, good, fair, poor, bad". The scoring sample table is shown in Table 3-1.

Table 3-1: Fuzzy Comprehensive Evaluation Method Scoring Table

Index level	Level 1	Level 2	Level 3	Level 4	Level 5
Corresponding score range	95,85	85,75	75,65	65,55	55,0

3.2.3. Analysis of index weight

The weight of the first-level indicator system of this evaluation indicator system is set as: $B1-3=(0.3, 0.4, 0.3)$, and other weight settings are shown in Table 3-2.

Table 3-2: Evaluation Index System of Smart Transportation in Xiamen City

First-level index	Second-level index	Third-level index	Variable label	
B1 Achievement of Xiamen City's Traffic Operation Target (0.3)	Traffic management level(0.4)	Intersection channelization rate (0.15)	Y1	
		Intelligent traffic signal control rate (0.15)	Y2	
		Congestion delay index during peak hours (0.25)	Y3	
		Average speed of main roads in built-up areas during peak hours (0.2)	Y4	
		Commuting stress index (0.25)	Y5	
	Traffic safety level (0.3)	Traffic safety level (0.3)	Number of extraordinarily serious traffic accidents (0.25)	Y6
			Fast handling rate of traffic accidents (0.5)	Y7
			Traffic accident mortality rate (0.25)	Y8
	Traffic safety level (0.3)	Traffic safety level (0.3)	Average noise of urban road traffic (0.5)	Y9
			Reduction rate of vehicle pollutant emissions (0.5)	Y10
B2 Xiamen City Smart Transportation Supply Performance (0.4)	Level of transportation facilities(0.5)	Installation ratio of electronic police on road section (0.1)	Y11	
		Coverage rate of smart parking system (0.1)	Y12	
		Coverage rate of in-vehicle mobile payment terminals (0.1)	Y13	
		"Two Passengers and One Endangered" and the network access rate of heavy freight vehicles (0.3)	Y14	
		Intelligent guidance system installation ratio (0.3)	Y15	
		New energy bus ratio (0.1)	Y16	
	Intelligent transportation innovation level (0.5)	Intelligent transportation innovation level (0.5)	Utilization rate of smart transportation APP (0.2)	Y17
			Intelligent transportation system platform construction level (0.25)	Y18
			Wireless sensor detection and monitoring data accuracy (0.15)	Y19
			Real-time traffic status acquisition rate (0.2)	Y20
B3 Xiamen City Smart Transportation Public Service Quality (0.3)	Traffic information service level (0.5)	Alot technology application rate (0.2)	Y21	
		Residents' attention to traffic information (0.33)	Y22	
		Real-time traffic information release (0.33)	Y23	
	Convenience of travel(0.5)	Convenience of travel(0.5)	Residents' satisfaction with traffic travel (0.34)	Y24
			Public transportation sharing rate (0.3)	Y25
			Number of BRT stations (0.1)	Y26
			Number of public transportations per 10,000 people (0.2)	Y27
			Number of parking spaces in social public parking for a hundred cars (0.2)	Y28
			Large public buildings equipped with parking spaces (0.2)	Y29

Source: The author self-organized

4. Research conclusions and recommendations

4.1. Research summary

The construction of smart transportation in Xiamen focuses on basic requirements such as safety, service and guarantee, and focuses on the three major transportation components of "people, vehicles and roads". It has built six major sectors including situation assessment, dynamic monitoring, decision analysis, dispatch and command, facility management, and information services. The integrated intelligent transportation system has established a unique "Xiamen Mode" for intelligent transportation. However, based on the existing foundation, Xiamen Smart Transportation still needs to strengthen the interconnection and intercommunication of information among various departments, and coordinate cooperation; it must also keep pace with the times, explore the integration of new technologies and transportation, and continuously improve the level of public service.

4.2. Research recommendations

Combined with the research and analysis of the construction situation and index system of Xiamen's smart transportation, this article puts forward the following suggestions from the top-level design and theoretical level to promote the development of Xiamen's smart transportation.

4.2.1. Make a scientific plan

The government plays a leading role in the construction of smart transportation. The first condition for the development of smart transportation is to formulate a scientific development plan in advance and draw a blueprint for the construction of smart transportation. The construction of smart transportation in Xiamen City should be based on the historical experience of urban development and its own characteristics, as well as the experience of domestic and foreign transportation development. Planning thinking should match the nature, characteristics, functions and history of the city. The first is to refine the content of smart transportation construction, formulate unified standards and norms in information technology and management, clarify the construction goals and tasks at each stage, and build a complete application system in all fields, so that the construction of intelligent transportation has rules to follow and institutional guarantee for long-term development. The second is to plan and implement the business scope of the various departments in the city. Government departments must set up working groups to clarify work responsibilities, refine the division of responsibilities, and establish a complete organizational system to prevent mutual excuses between departments. The third is to prioritize the planning and promotion of representative and exemplary smart transportation construction projects to highlight the characteristics of the city. The construction of a smart city in Xiamen must achieve differentiated positioning and individualized development based on the city's political, economic, social, cultural and other aspects, create distinctive advantages, and avoid blindly following the trend with one thousand cities, so as to enhance the competitiveness and attractiveness of the smart city.

4.2.2. Establish and improve laws and regulations

Sound laws and regulations are a powerful guarantee for advancing the construction of smart cities. The current smart transportation construction requires extensive use of the IOT, 5G, big data, cloud computing, and intelligent identification technology. The ensuing information security problems cannot be underestimated. Xiamen should strengthen the construction of the smart transportation information security system as soon as possible and improve related laws and regulations to prevent large transportation platforms, digital government platforms and other smart city-related equipment and technology platforms from malicious cyber-attacks.

4.2.3. Industry Drive

In the process of the government's promotion of smart transportation construction, it is necessary to actively encourage other subjects to participate, strengthen exchanges and cooperation between government units and enterprises, and give full play to the role of enterprises. By formulating support policies for integrated operators and professional service providers for smart city construction, increasing financial support for the construction of smart industry bases and promoting the development of smart transportation.

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