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| RESEARCH ARTICLE

Research on Urban Congestion Control Strategy Based on Smart Traffic Management System

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| ABSTRACT
With the rapid economic development, the scale of cities has expanded, the population of cities has increased, the number of motor vehicles has increased, the contradiction between traffic supply and traffic demand has increased, and traffic congestion has appeared in major cities. Many countries have proposed planning and construction measures and policies in the current smart transportation development and construction. The construction of smart transportation requires a complete management system for planning. The article selects smart transportation in some countries and regions to conduct inductive analysis in the smart transportation management system construction measures and put forward suggestions for my country's smart transportation construction to effectively alleviate urban congestion.

| KEYWORDS
Smart transportation; smart traffic management system; urban congestion

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1. Introduction

The city along with the rapid development of economy, population increase, rising, hinder motorized travel demand increased, the traditional travel mode and the existing urban road traffic system has been unable to meet the requirements of people, the contradiction of traffic supply and traffic demand growing, global each country cities in different levels of traffic congestion (Qigang et al., 2021). With the construction and development of smart cities, smart transportation construction plays an increasingly prominent role. As an innovative urban development governance mode under the development of information technology, it can effectively alleviate the problem of traffic congestion in cities, improve the efficiency of urban traffic operation, improve the quality of urban life, and improve the happiness index of residents(Lorena et al., 2021).

In the construction of intelligent traffic, a convenient, intelligent, simple and perfect intelligent traffic management system is necessary. The system can make reasonable travel guidance before residents' travel, and adjust the road broadcast information, road instructions and public transport operation at any time on the road(Le et al., 2021; Pradhan, 2021).

Countries all over the world are making construction in intelligent urban traffic and improving urban road traffic. Choose ten countries and regions, this paper analyzes its intelligent transportation construction, extract for planning and design of intelligent traffic management system, through the qualitative analysis method, the comprehensive summary, was "experiment" results, to our country, national condition and traffic planning and its status quo, strive for the development of intelligent traffic management system construction in our country, provide some useful policy reference and revelation, In order to improve the current situation of road congestion in many cities in China.

2. Literature Review

In the 21st century, many countries around the world have started the construction of smart cities, and smart transportation is an important part of smart cities. Intelligent transportation is also an important national strategy in China. In 2012, the Ministry of Transport issued the Development Strategy of Intelligent Transportation in The Transport Industry (2012-2020). In 2015, it issued the Implementation Plan of Promoting "Internet +" Convenient Transportation to Promote the Development of Intelligent

Transportation. In 2017, it issued the Action Plan of Intelligent Transportation to Make Travel More Convenient (2017-2020). In 2019, China issued an outline for building a Transport Power. It points out the importance and necessity of intelligent transportation in the construction outline and makes clear the major tasks of intelligent transportation, one of which is to alleviate traffic congestion.

It mainly contains four technical levels: the first level is the technical level of intelligent vehicles, the second level is the intelligent transportation system, the third level is the intelligent transportation data technology, and the fourth level is the travel-oriented intelligent shared transportation service technology.

An intelligent traffic management system plays an important role in the construction of intelligent traffic. The system, through advanced monitoring, control and information processing, traffic management departments and drivers, provides real-time road traffic guidance, control, and emergency response to emergencies(Linhui et al., 2021). The intelligent traffic management system includes a traffic positioning and monitoring system, traffic control system and traffic management system (Table 1). Information is integrated and transmitted from the four directions of "human-vehicle-road-ground" to effectively alleviate traffic congestion, reduce surface road pressure, and improve travel smoothness and comfort.

Tab.1 The content and significance of smart traffic management system

Main system	Subsystem	Content	Significance
Intelligent traffic management system	Traffic control system	Control signal time	Adjust signal light waiting time in real-time to increase traffic rate.
		Control the parking classification of public vehicles	According to the driving purpose and driving speed, public transport vehicles can be divided into each stop, quasi emergency stop, emergency line, emergency.
		Control of public transport lines	According to the road congestion information, temporary adjustment of public transport routes, reasonable arrangement of public transport routes according to the road information, reduce route duplication.
		Control lane direction and number	According to the direction of traffic flow in the rush hour, the number of two-way lanes can be adjusted by using lane dividers; According to the traffic flow, adjust the one-way road operation direction, speed up the traffic efficiency.
	Traffic location monitoring system	Monitor traffic congestion	Monitor road passage time, road vehicle speed, etc., feedback traffic system terminal in real-time, update traffic condition information.
		Monitor road vehicle operation information	Monitor vehicle type, speed, density and other information, optimize traffic organization, adjust traffic flow.
	Traffic management system	Emergency incident management system	Through monitoring real-time information feedback, at any time to activate special emergency procedures, such as road construction, accident information, etc., to help maintain good road order.
		No parking charging system	Realize no parking charge, reduce pass time, reduce waiting time, and alleviate congestion.
		Driver demand management system	According to the requirements of the travelling personnel, the travel route can

		be recommended immediately, and the traffic information and parking service information can be provided to reduce the road travel time.

Data source: The author collated according to relevant policy data

3. Research Object and Method

3.1 Methodology

Studies are qualitative analysis, according to the different countries of the existing intelligent transportation construction management, selection of effective measures to ease traffic congestion, comparative analysis, qualitative analysis of information extraction and intelligent traffic management system, the comprehensive summary, one is "experiment" results and provide a reference for the construction of the intelligent traffic management system in our country.

3.2 Selection of Research Objects

This study selected the construction and management of intelligent transportation in ten different countries and regions, including Austria, Germany, France, Italy, the United States, Japan, Spain, Singapore and Hong Kong.

The construction of intelligent transportation in various countries has achieved remarkable overall results, reducing the efficiency of urban traffic management and improving the quality of urban life. Among them, Vienna, Austria, was voted one of the top 10 cities with the best quality of life in the world in 2019, with the world's best-performing public transport system. With 3.5 million inhabitants, Berlin is one of the focal cities in the world. Berlin is one of the most vibrant cities with a century-old modern urban transport system but without traffic congestion. The traffic in Berlin, Germany, can be rated as world-class. Barcelona, Spain, received 9 million tourists in 2017, and its metro system carries more than 390 million trips every year. The smooth operation of urban transportation is based on an intelligent transportation system. Tokyo has the largest transportation infrastructure in the world, and the intelligent maintenance system in intelligent transportation plays a crucial role. Cities in selected countries have a large number of residents and tourists, which effectively alleviates urban road congestion and stabilizes urban operation through smart transportation.

It is very important to improve intelligent and humanized intelligent traffic management systems. Through summarizing and analyzing the construction measures of intelligent traffic management in ten countries and regions, relevant information of intelligent traffic management systems is extracted for qualitative analysis.

3.3 Practice overview of the research object

Based on the summary of case studies of intelligent traffic management systems in different countries and regions (Table 2), classification and summary are made according to the following three categories of management systems: traffic control system, traffic positioning detection system and traffic management system(Demanuele et al., 2012; Dwivedi & Khire, 2018; Yokota et al., 2004).

Tab.2 Typical case of the smart traffic management system

countries	measures	Practice points	Classification system	The practical application
Austria	Road information board	The information board updates the road information in real-time, showing the vehicle type, speed, density, and other information, which helps maintain the good order of the road.	Traffic location monitoring system	Monitor road vehicle information, control traffic flow, optimize traffic organization, alleviate road pressure.
	App real-time public vehicle location	Update public transportation information in real-time to provide a reference for travellers and effectively improve the frequency of public transportation trips.		Monitor the information of public transport vehicles, provide accurate and convenient information for travellers, increase the use of public transport, and reduce the number of car trips.
	Auxiliary control center activates	The auxiliary road center can be manually controlled to activate special procedures at any time, such as road	Traffic management system	Real-time correction of road information, provide road

	special programs in real-time	construction, accident information and other emergency events.		information, to avoid road congestion.
Germany	Complementary traffic lines	There is basically no overlap between public transport routes and subway routes, except for important stations. Most of them run in a certain area and do not cross the whole city, which effectively alleviates the pressure of ground transport.	Traffic control system	Reduce the overlap between ground and underground transportation routes, improve the speed of public transportation, and relieve the pressure of ground transportation.
	Multiple types of online information services	The online information service center provides private and public transportation route planning, real-time traffic information, parking service information, etc.	Traffic location monitoring system	Monitoring road vehicle information gives real-time information and possible future road operation status information.
	Road information board updated in real-time	The road information board updates the road conditions and congestion conditions in real-time, providing drivers with reasonable planning and choice of travel routes.		Monitor road vehicle information and update information board in real-time.
France	Traffic information board	The traffic information board provides the time to arrive at a reference point instead of the time when the road is blocked, which effectively provides time estimation for the travellers and effectively alleviates their irritability.	Traffic location monitoring system	Monitor road vehicle information and traffic flow for reference.
	Define traffic area	Periodic qualitative analysis of traffic areas can improve the limited waiting time of each traffic intersection.		Regular monitoring of traffic intersections and reasonable regulation of traffic lights waiting time.
	Electronic toll collection system	Tolls are based on drivers' use of the road and damage caused to the road, and tolls are changed according to the busy time of the road.	Traffic management system	Adjust the different charges during peak hours and non-peak hours to control traffic flow.
Italy	Instant Bus service	At special bus stops, passengers can call a terminal to request a bus reservation, change the bus from its scheduled route, and change the time at the station behind it.	Traffic control system	Improve the convenience of public transport, increase the use rate of public transport.
	Urban traffic monitoring	The traffic monitoring center is composed of three parts: the traffic condition center, the traffic information database and the multimedia center. It provides residents with fast, immediate, comprehensive and reliable traffic information.	Traffic location monitoring system	The traffic flow information is monitored on the road, and the data is saved and summarized by the information library, and then the multimedia center updates the information in real-time and feeds it back to the passengers.
	No parking toll system and other automatic toll systems	Through the computer network, communication system and a variety of sensors to realize the parking charge, save travellers through the pass time.	Traffic management system	Vehicles through the road city boundary pass without stopping to pay to avoid road congestion improve traffic speed.
	Variable speed limiting device	Calculate the best speed limit based on traffic congestion to avoid further congestion caused by frequent start-stop traffic during rush hour.		According to the real-time traffic flow and road conditions, adjust the road speed limit sign prompt,

			Traffic control system	speed up the peak traffic speed, reduce the accident, but also can save a lot of gasoline consumption reduce exhaust emissions.
America	The variable lane	HOV lanes are restricted to cars or buses with more than two passengers during morning and evening rush hours. The number of HOV lanes can be increased at any time, depending on the volume of traffic and weather conditions, by using movable fence technology; Another application is variable direction one-way. During business hours, traffic flows mostly from outside the city to the city; it was just the opposite during off-duty hours.		Adjust the number of lanes and the direction of one-way street operation according to traffic flow, effectively alleviate road congestion in peak hours and increase traffic efficiency.
	Road information is updated in real-time	The computer monitors the city's traffic status and the system's own performance and can change the information in a second.	Traffic location monitoring system	Monitor traffic flow information, real-time road condition, comprehensive road performance, real-time change prompt system.
	Traffic guidance system	The system, through the driver input destination, according to the latest road information, reasonable arrangement of the best route.	Traffic management system	Provide road travel system prompts according to drivers' needs.
	Tram parking classification	According to its running speed and the number of stops, trams can be divided into stopping at each station, quasi-express, express, express and extra-urgent, etc. Reduce congestion time through parking classification.	Traffic control system	According to peak and off-peak road operation conditions, set up the public transport parking category.
	Bus priority system	By controlling priority signals and setting priority routes, buses can be given priority to pass, and citizens are encouraged to use public transport.		We will control the road priority of public transport and encourage people to travel by public transport.
Japan	Traffic information supply system	Provide road information to drivers through road information boards, radio stations, road test broadcasts and vehicle information communication systems. Real-time release of traffic jams, traffic accidents, vehicle traffic restrictions, traffic control time and other information, optimize traffic organization, adjust traffic flow, improve road conditions.	Traffic location monitoring system	Monitor traffic flow information, road operation, real-time release change road information prompt board.
	Vehicle movement monitoring system	The vehicle monitoring system provides the driving position of buses, taxis and trucks to the driving management personnel to help the vehicles run effectively and promote smooth traffic.		Estimate road conditions based on vehicle types and systems and provide road traffic recommendations to drivers.
	Driving dynamic induction system	Recommend the route to the destination with the shortest travel time to the driver through the app so	Traffic management system	According to the needs of travellers, provide road travel

		as to improve the driving convenience, disperse the traffic flow and eliminate traffic congestion.		conditions reasonable guidance of travel routes.
Spain	Intelligent traffic lights	Through road information feedback, the waiting time of signal lights can be adjusted in real-time to relieve road pressure.	Traffic control system	To the road running vehicles and operating conditions, reasonable regulation of intersection traffic lights waiting time.
	Interactive display of bus station information	Through effective interaction with passengers, bus stations push targeted information to users.	Traffic location monitoring system	Monitor the public transport operation information, change the prompt version information in real-time, relieve the impatience of waiting staff, encourage the induction of public transport travel.
Singapore	Intelligent nodes update road information	Smart nodes will play a role in supporting road navigation beacons. The driving path can be adjusted so that it is safe to cross partially constructed roads (surfaces cleaned, trees trimmed, or edges cut).	Traffic location monitoring system	Adjust the prompt of the traffic information board in real-time according to the monitoring information of the road node.
	Bicycle monitoring network	Singapore's Land Transport Authority is developing a 700km monitoring network of dedicated red cycle lanes to promote cycling.		Monitoring not only motor vehicle road conditions but also monitoring non-motor vehicle lane information improves safety and convenience, encouraging and inducing green travel.
	Floating fee system	In the peak hours, the fees for vehicles entering the city are greatly increased, and in other hours, the fees are correspondingly reduced to balance the traffic flow during peak and off-peak hours to some extent and ease the traffic congestion.	Traffic management system	According to the traffic flow information and road condition information in peak hours and non-peak hours, adjust the amount of fees and traffic flow.
Hong Kong, China	Travel time display system	Provides the estimated travel time from the location of the travel time display to each tunnel exit. The system enables drivers to identify the time required for each cross-sea route through the travel time indicator before arriving at the main diversion points.	Traffic location monitoring system	Monitoring road information and traffic flow, the system evaluates the road passing time at each key intersection by calculating and updating the road information prompt in real-time.
	Cycling friendly development area	Cycle paths and bike parking improvement projects at 100 locations, with an increase of about 1,000 bike parking Spaces, to encourage cycling.		Monitoring not only motor vehicle road conditions but also monitoring non-motor vehicle lane information, improving safety and convenience, encouraging and inducing green travel.
	Traffic and accident management system	The traffic and Incident Management system has a number of functions, including automatic accident detection, integration of transport contingency plans, provision of traffic	Traffic management system	Monitor road information and traffic flow information, reasonably predict the possibility of road accidents, real-time control of road

	information to stakeholders, dissemination of traffic information to the public, and coordination of existing and future traffic control and surveillance systems.	traffic flow to avoid accidents. In case of an accident, adjust the road information board in real-time.
Automatic toll collection system	Using the vehicle identification system and information transmission system, realize the parking charge.	Vehicles through the road city boundary pass without stopping to pay to avoid road congestion improve traffic speed.

Data source: Author collated according to relevant literature

4. Results and Discussion

4.1 Analysis of key points of the intelligent traffic management system

The traffic control system includes road control and public vehicle control. Road control includes signal lamp control, lane layout, etc. According to the vehicle traffic information and road traffic rate in the peak period of the road, the waiting time of the road intersection signal lamp is adjusted to increase the traffic rate(Julián et al., 2021). Through the calculation of intelligent traffic systems, the speed of vehicles can be controlled, congestion in rush hours can be relieved, traffic flow speed can be accelerated, car accidents can be reduced, gasoline consumption can be saved, and exhaust emissions can be reduced. The number of lanes can be adjusted according to the traffic flow by using the movable fence technology to relieve road pressure and speed up traffic efficiency. Variable lanes can also change the running direction of lanes and increase the number of lanes in the direction of heavy flow according to the congestion situation in the direction of traffic flow at peak times so as to increase traffic efficiency and alleviate congestion.

Public vehicle control includes parking mode and running route of public vehicles. According to the driving destination and speed of public transport vehicles, vehicles are classified for parking, which can be divided into stopping at each station, quasi emergency stop, emergency line and emergency. Different signs are pasted for different vehicles to warn other vehicles and increase road efficiency. According to the road congestion information, real-time adjustment of public transport routes, for example, the reasonable regulation of the peak hours of unmanned taxis to reduce the passage. Reasonable arrangement of road traffic and underground traffic routes, as far as possible important node overlap, reduce route overlap, alleviate road pressure.

Traffic location monitoring system for the main monitoring road congestion and road vehicle running information, and monitor the vehicle type, speed, density, monitoring traffic time, road vehicle running speed information, such as real-time feedback terminal traffic system, road traffic updates, optimizing traffic organization, adjust the traffic flow, relieve congestion phenomenon, improve the pass rate, reduce the pressure on the road.

Traffic management system for the main "human-vehicle-road" three aspects, according to the requirements of travel personnel, immediately recommended car travel routes, road information and parking service information; Bus transfer routes and walking supplementary routes; Non-motorized travel routes. The monitoring and management system of the non-motor vehicle section is added to increase the sense of security and comfort of the travelling personnel and increase the number of non-motor vehicle travelling personnel. To realize charging without parking, reduce the time for vehicles to pass through checkpoints, reduce waiting time and alleviate congestion. Emergency accident management system, through monitoring information, real-time feedback, at any time to activate special emergency procedures, such as road construction, accident information, etc., to help maintain good road order.

4.2 Enlightenment of intelligent traffic management system planning and design

The management system measures of various countries and regions are classified and summarized, and the excellent facility planning is reasonably used for reference in combination with China's national conditions, current traffic management construction and road congestion.

Traffic congestion can be alleviated through road control signal lights and lane numbers in the traffic management system. Adjust the signal light passing and waiting time according to the vehicle running condition at peak hours, increase the traffic rate and alleviate congestion. Many people work in the central area of the city but live in neighbouring cities, such as Beijing, a part of the people who work in Hebei or Tianjin can adjust the number of lanes out of the city and into the city according to the peak traffic conditions. It can also control the number of public vehicles. According to the type of vehicles, such as commuter cars, school buses, buses, trams, etc., parking classification, paste parking signs to remind vehicles in the rear, avoid traffic congestion caused

by parking, and alleviate the occurrence of rear-end accidents. Integrate taxis and public app-hailing vehicles to adjust the number of empty cars on busy roads in rush hours in real time to relieve traffic pressure.

The traffic monitoring system increases traffic monitoring information, such as vehicle type, speed, density, etc. Increase road information display boards and radio broadcasting systems to provide travellers with more perfect and convenient road information.

Under the traffic management system, Public vehicle operation route management reduce road traffic and underground traffic route overlap, only overlapping at important stations, effectively relieving road pressure. Improve the emergency accident management system, improve the processing speed of emergency events, reduce the possibility of road congestion. Strengthen the construction management and monitoring of non-motor vehicle lane construction, increase the possibility of non-motor vehicle choice by pedestrians, and induce green travel.

5. Conclusion

Intelligent traffic can improve the current situation of road congestion and relieve road pressure, and the perfect intelligent traffic management system plays a crucial role. This paper studies and analyzes intelligent traffic management systems in ten different countries and regions. The measures with "positive correlation" are sorted out and then classified to analyze how to regulate road operation and alleviate road congestion.

Each area has its own monitoring, management, and operation planning, through the "human-vehicle-road" and other aspects of planning. From monitoring information summary to vehicle restriction regulation to road information release, and finally to regulate and control the convenience, benefit and serve the people of the intelligent traffic management system. Based on China's national conditions and the current situation of road congestion, nine referential suggestions are put forward from three aspects.

At the present stage, China is in the rising stage of building smart cities and smart traffic. We should actively explore and learn the management system suitable for China's traffic, conform to the construction concept of "people-oriented", build a perfect traffic management system, alleviate and improve the current situation of urban congestion.

Conflicts of Interest: The authors declare no conflict of interest.

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