



Research on the Practice and Optimization of Macau Urban Bus Priority Policy

Junzhang Chen¹, Yile Chen^{2*}

¹City University of Macau

²Macau University of Science and Technology

Corresponding Author: Yile Chen 2009853gat30001@student.must.edu.mo

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ABSTRACT

The policy of "bus priority" solves the problem of urban residents' travel and is an important part of urban construction. This paper analyzes the research progress and implementation of "bus priority" at the current stage in China and the problems existing in the current situation of urban transportation in the practice of "bus priority" in Macau through literature analysis. The results show that although large cities in China have better implemented the "bus priority" policy, there are large differences among cities, the coverage is small, most small cities have less literature, and the investment in research and construction is insufficient. At this stage, people pay more attention to the punctuality, convenience, benefit and convenience of public transport. The author provides some feasible reference suggestions for the future development environment, infrastructure construction, social value and economic level of "bus priority" in Macau.

INTRODUCTION

Research status under the guidance of "bus priority" policy "bus priority" policy originated in Paris, France, in the late 1960s, and was later followed by cities at home and abroad; Brazil, the United States, Britain, France, Switzerland, Japan, Singapore and other foreign cities have also gradually carried out a series of practical activities on the "bus priority" policy. However, the domestic research and implementation of the field of "public transport priority" started late, and the research is biased towards government policies and systems, urban public transport system concepts and plan-ning, and quantitative analysis of model evaluation software.

THEORETICAL REVIEW

According to the analysis of the relevant literature of "public transport priority", it is found that the published research literature has the following characteristics:

①the literature focuses on the public transport system system system and poli-cies, concepts and planning of large cities in China, and there is less research on the quantitative analysis of public transport system;

②The research method is single, and the dynamic models of "intersection dy-namic priority" and "bus priority" are mainly established for large cities. Due to the complexity of comprehensive cities, there are many factors to be considered compre-hensively, so whether the results of verification are applicable to any time and any city, and whether the results of verification are extensive remains to be studied. Reasonable policies, laws and regulations can guide the whole city to operate in an orderly manner under constraints, and the advanced concept of "public transport priority" can be fur-ther promoted. However, the development level of cities varies, and the implementa-tion effect may be greatly reduced. Although many regions have formulated policies for "public transport priority", there are more general principles and fewer detailed rules, and less incentives to encourage travel. The concept of public transport system based on local conditions and perfect planning and design make the city more "grounded". Relevant scholars have introduced "economics", "cultural infiltration" and "sociology" into the development strategy of "public transport priority", which not only enriches the content, but also makes the urban design more inclusive and extensive. These belong to qualitative analysis, which are relatively superficial. At the same time, they are also facing problems such as non real-time data acquisition and lagging pro-cessing. The grand plan of planning and design is an idealized model built by the de-signer according to the future needs, which is cutting-edge. However, the reality brought by the external environment will be encountered during the site construction, which will increase the difficulty of construction. Although the quantitative analysis of "public transport priority" is supported by relevant data, it is challenging for schol-ars who have not systematically studied research methods to obtain data and conduct in-depth analysis. Therefore, there are few research literatures on the qualitative and quantitative combination of "public transport priority".

Chen Xuewu and others proposed that the number of non-public vehicles in cities should be reasonably controlled and private car travel should be

reduced in the parking charge mode. Tao Lingxia discussed the internal relationship between "public transport priority" and "sustainable transportation", and made an in-depth interpretation of the "public transport priority" policy document in Shanghai. Shi Jing and others support the establishment of bus only road system and bay platform. Guo Juan pointed out that it is necessary to strengthen the formulation policy of rail transit ticket prices, introduce the "intelligent transportation" management system, and establish a pricing review and cost constraint mechanism model. Fang Shujuan and others studied the management method of "bus priority", proposed the collection of "bus special tax", deduced the formula of collection amount, and discussed the advantages and disadvantages of the collection of "bus special tax". Jinzhiyun et al. Studied in depth the technical and institutional issues of the current urban "bus priority" development, emphasizing the coordination role between the government, public transport enterprises and citizens.

Liu Shuyin analyzed the current situation of urban transportation development in China, and proposed the need for quantitative evaluation of the performance of public transport priority development. Lu Li came to the view that "public transport priority" is the primary choice for contemporary people to travel from the ethical connotation of "public transport priority" and the international perspective of "public transport priority". Zeng Ying and others analyzed and interpreted the current policies of urbanization and urban public transport development in China. Hou Jianlin studied Baotou's "bus priority" policy from an economic perspective. Li Ye et al. Summarized the examples of the development of "bus priority" in international cities and put forward the development framework of "bus priority" in cities. Zhao Ming and others paid attention to the construction of Kunshan's "public transport priority" development system, and called for reasonable guidance of citizens to deviate from public transport. Su Xiaolan discussed the current traffic situation in Nanjing and put forward suggestions and measures for implementation; Duan Junhu introduced the "public management related theory". Tan Jia and others believe that due to the insufficient investment of the government, urban people do not pay attention to the development significance of the current "bus priority", and call on relevant departments to do a good job in publicity and provide effective support to relevant public transport enterprises. Chen Zhixing and others studied the development policies of "bus priority" in Shanghai, Shenyang, Suzhou, Chengdu and Zhengzhou, and put forward the concepts of subsidies, tax collection, right of way priority and the introduction of intelligent traffic management system. Starting from the way residents travel, Zhang Nan analyzes the "bus priority" traffic network system and the bus only entrance and establishes a performance related mathematical model. Zhang Bin used the model method to make a quantitative analysis of the impact of the Bay station on motor vehicles and non motor vehicles. Yang Yi analyzed the spatial structure, suppliers and demanders of Guangzhou and introduced the intersection dynamic priority model. In the research on the Countermeasures for the development of public transport in Nanjing, Liu Yang used VISSIM for quantitative analysis, compared the priority of public transport signals with

microscopic traffic simulation tools, and came to the conclusion that the priority of public transport signals can reduce the pedestrian delay at the intersection. Liu Tengfei proposed a bus priority control model under coordinated control, using two control methods: active priority and self-adjusting priority, introducing a time window into the adaptive model, establishing a bus priority control model and selecting MOPSO for optimization. Finally, the simulation was realized on the VISSIM platform, and it was believed that there could be less bus delays but little impact on branch coordination.

Zhao Bei compares the advantages and disadvantages of urban residents' travel behavior (RP) and travel intention (SP), discusses the methods of attribute and scenario design in the design of SP survey scheme, takes Changchun City, Jilin Province as an example, takes the "bus priority" measure as a hypothesis, discusses driving preferences, surveys urban residents, and establishes a MNL model for residents' choice of travel mode according to the principle of utility maximization, And introduce the relevant theory of synergetics into the travel mode of residents. Ma Xinhui and others used the simulation software VISSIM to analyze the problems caused by the use of direct parking or bay parking at bus stops. For example, when the road saturation is 30%, 60% and 80% respectively, the Bay parking mode is longer than the straight parking mode when passing through the website, and the parking time and passenger waiting time increase with the increase of passenger flow density. Based on the idea of game theory, Didi conducts quantitative research and verification with the construction of residents' choice of travel mode, user loyalty and game analysis in the North Bund area of Hongkou, Shanghai; On the basis of the model construction, Shanghai was selected to establish the SP survey multi scenario model, and it was concluded that the intelligent transportation strategy was better than the conventional strategy. Reasonable policies, laws and regulations can guide the whole city to operate in an orderly manner under constraints, and the advanced concept of "public transport priority" can be further promoted. However, the development level of cities varies, and the implementation effect may be greatly reduced. Although many regions have formulated policies for "public transport priority", there are more general principles and fewer detailed rules, and less incentives to encourage travel. The concept of public transport system based on local conditions and perfect planning and design make the city more "grounded". Relevant scholars have introduced "economics", "cultural infiltration" and "sociology" into the development strategy of "public transport priority", which not only enriches the content, but also makes the urban design more inclusive and extensive. These belong to qualitative analysis and are relatively superficial. At the same time, they are also facing problems such as non real-time data acquisition and lagging processing; The grand plan of planning and design is an idealized model built by the designer according to the future needs, which is cutting-edge. However, the reality brought by the external environment will be encountered during the site construction, which will increase the difficulty of construction. Although the quantitative analysis of "bus priority" is supported by relevant data, it is challenging for scholars who have not systematically

studied research methods to obtain data and conduct in-depth analysis. Therefore, there are few research literatures on the qualitative and quantitative combination of "bus priority".

METHODOLOGY

This paper takes Macau as the research object, through the analysis of the domestic literature on "bus priority", discusses the practical dynamics and current situation of "bus priority" in Macau at this stage, analyzes the problems of roads and transportation in Macau at this stage, the current policies formulated by relevant functional units, the implementation of "bus priority" policy by public transport companies and the existing problems of people's satisfaction, and puts forward corresponding solutions, so that the actual situation of "bus priority" in Macau can be optimized, and suggestions can be made for Macau's future traffic development.

RESULTS

Current Situation and Practice of Public Transport Services in Macau Practice and Operation of Buses in Macau

Macau's public buses originated in 1919. Until 2010, Xinma road first implemented the "bus lane". In 2011, the Macau government adopted the government led approach, mainly adopting the "government led, market operation" approach to operate services, so as to reasonably ensure the safety of citizens. In 2016, the "bus stop announcement" app was launched, which allows real-time query of waiting stations and prediction of congestion every ten minutes within 60 minutes (Figure 1-2); In terms of civil air defense, you can also check the refuge center, but it is concentrated in the old urban area of Macau, and the number of roadside areas off the island is small. The study found that the bus routes departing in front of the yamala on the Macau Peninsula are the most, and the least is the University of Macau; Route 26a has the highest mileage and the largest number of stations.



Figure 1. Bus Stop Announcement App



Figure 2. Real Time Traffic Situation in Macau - Congestion Coefficient
Data Source: <http://mrw.so/5taRog> Self drawing after interception

Practice and Operation of Light Rail in Macau

Macau light rail planning originated in 2007. The government proposed a phase I construction plan, which was opened to traffic on December 10, 2019,

with a total length of 9.3 kilometers, covering Taipa's main residential areas and sea, land and air transportation ports (Figure 3); From the comparison of ticket prices, the charge is mop 6 within three stops, mop 8 within six stops and mop 10 within ten stops (Figure 4). However, according to the latest display on Macau light rail official website, in order to cooperate with the cable replacement project of the whole line, the passenger service of Taipa line of light rail will be suspended from October 20, 2021.



Figure 3. Route Map of Macau Light Rail Taipa Line
Source: <http://mrw.so/64He0j>



Figure 4. Macau Light Rail Fares
Source: Macau Daily

DISCUSSION

Current Situation under the "Bus Priority" Policy in Macau

The Contradiction between Traffic Demand Increases, and The Supporting Infrastructure Is Imperfect

As of June 2021, the number of non local employees in Macau has reached 172261, and the groups with the highest daily mobility include non local tourists, business per-sonnel, students, immigrants, etc. Although the Macau government takes "bus priority" as the core of the overall development of land transportation, increasing the number of buses, improving the carrying capacity of buses, and reducing the waiting time of pas-sengers, there are also shortcomings. First, the overall service quality is not high. In addition, Macau has narrow roads, many bends and slopes, and many one-way lines, which can only accommodate one bus or car. If motorcycles, private cars, and com-mercial vehicles travel together at the same time, It is easy to cause traffic congestion in the morning and evening rush hours.

Macau's buses are large and less flexible, and the intersection is delayed for a long time because the road is too narrow. Once the bus turns rapidly, it is easy to cause the vehicle to lose control, and the passengers in the bus will fall down due to unsteadiness, causing physical and mental damage to the citizens and bad experience. On the other hand, the bus exhaust noise is too large, causing serious air pollution; The bus platform is small, the length and ductility are insufficient, the number of people is small, and the sunshade and rainproof facilities of the platform itself are insufficient. It is difficult to wait for trains in hot and rainy days. The survey found that the bus station infrastruc-ture is not complete, and many bus stations do not even have platforms, leaving only one stop sign (Figure

5-6); The failure to maintain the canopy of some bus stops regularly also led to rust and water leakage in rainy days (Figure 7).



Figure 5.No Platform at Butterfly Valley Road Bus Station



Figure 6.No Platform at Machang Damau Bus Station

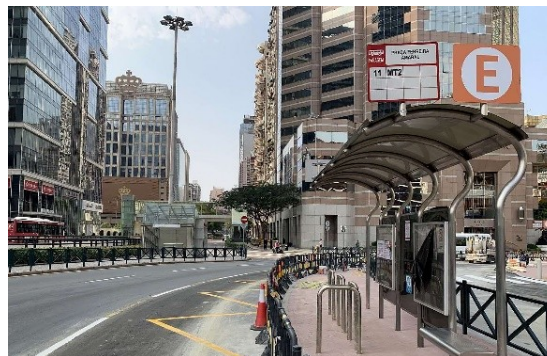


Figure 7.Yamala Qiandi Bus Station

Source: Wikipedia Source: Selfie Source: Macau Li Bao

The Implementation of Public Transport Priority Strategy Is Not in Place, and The Service Quality Is Quite Different from The Expectations of Citizens

Since 2015, Macau bus companies have conducted surveys on passenger satisfaction, including overall satisfaction with bus service and waiting time in Macau, with a full score of 10 points. According to the cluster histogram, the overall satisfaction of passengers has not changed significantly in the past five years, but the change range of Macau bus service satisfaction is larger than that of waiting time, and higher than that of waiting time. It can be seen from the analysis that in the past five years, although Macau has tried its best to increase the investment in the optimization of service resources and encourage more citizens to take public transportation, it has lagged behind in the updating of vehicles, the construction of websites, the establishment of information systems, and the restrictions on the off peak travel time of private cars and motorcycles, which have not been introduced and handed over to the relevant departments for implementation, resulting in insufficient traffic regulation in the old urban area and many traffic blind spots. The phenomenon of crowds in rush hours has not changed. In order to shorten the stay time at the bus stop, individual drivers have closed the door before boarding, and even kept crossing the stop. Citizens often complain in the local group of Macau on the social platform Facebook. It

reveals that the current overall service level of public transport needs to be improved, and there is still a large gap between the service quality and the expectations of citizens.

Insufficient Capital Investment and Unmet Travel Needs of Residents

It can be seen from the statistical analysis of waiting time of public bus passengers in Macau that the statistics of waiting time induced by passengers in the four quarters from 2015 to 2019 show that the waiting time gradually shortens with the increase of time, but the change range is weak. The waiting time in the first quarter of 2019 is longer, and the waiting time in the fourth quarter is shorter; The following conclusions are drawn not only from the longitudinal comparison of passenger induction waiting time in different regions of Macau every year from 2015 to 2019, but also from the horizontal comparison of various regions in each year:

From 2015 to 2019, the waiting time of St. Francis' parish and Cotai reclamation on the outlying island is longer, while the waiting time of Wangde parish and St. Andoni parish on the island is shorter; With the increase of years, the growth rate of waiting time in St. Franciscan parish and Cotai reclamation accelerated. Compared with the old urban area of the island where tourists, labor personnel, students and business personnel are dense, the outlying Island Road around the urban area is far away, there are fewer buses, and there are few tourism observations. The economic development level of the road around the urban area is not as fast as that of the old urban area and taizai district. At present, there are still villages, and prisons and police training camps are set nearby, which is remote and low playability compared with the island. Therefore, there are few bus shifts, resulting in long waiting time. For a long time, the investment in public transport in this region was insufficient, making it difficult for the region to develop. Although the Wangde church area and St. Andoni church area on the island are densely populated, the waiting time has not changed much in the past five years, indicating that the contradiction between traffic supply and demand has increased with the increase of population over time, and the limited road resources are difficult to meet the unlimited transportation convenience needs of the growing people.

The train broke down on the first day of the trial operation of Macau light rail, causing passengers to get off halfway. At that time, there was chaos on the scene due to the failure to guide passengers in time. When taking the urban rail transit, the author found that there were too few seats on the train, and many elders had no place to sit. In the train guide table, there were only Chinese data, but no English data, which caused more inconvenience to foreign tourists; At this stage, Taipa line of light rail is opened to facilitate the residents of Taipa District, while residents and expatriates working on the island cannot enjoy the convenience brought by light rail. Compared with buses, Macau light rail has been questioned by many local residents and foreign tourists in terms of ticket price setting, and most people report that the ticket price setting is unreasonable.

In the future planning of Macau light rail, it is planned to extend to the Macau Peninsula and lead to ma'ge temple. The east line is planned to be built underground. Although the impact of the line on the residents of the island is

reduced, Macau itself is located at the mouth of the Pearl River, and there is a lot of silt, which has an impact on the construction area. If the method of digging while doing is adopted, it will cost more, and the construction on the seabed will also affect the nearby sea area (Figure 8).

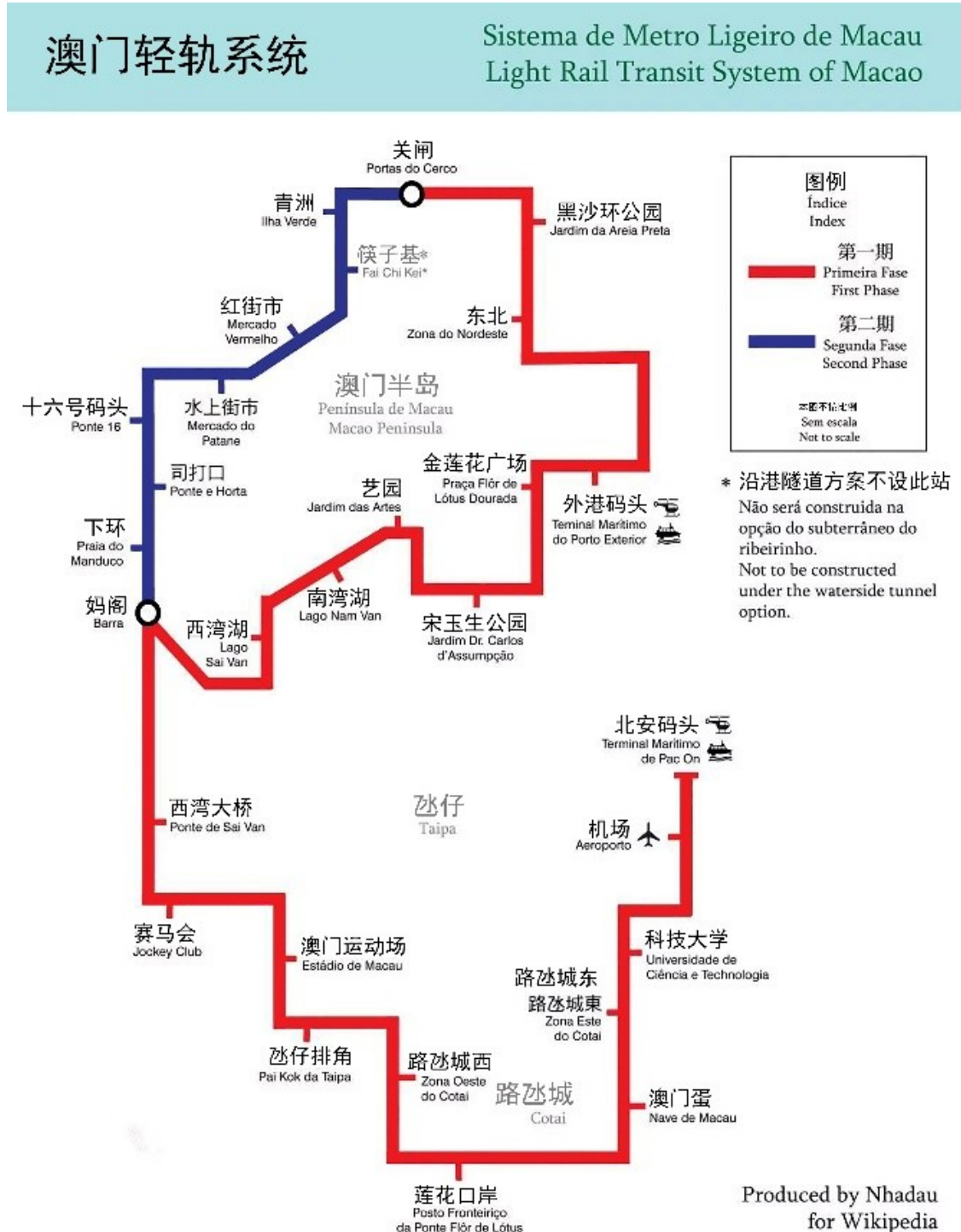


Figure 8. Macau Light Rail Planning Map
Source: [Http://Mrw.So/63vxmb](http://Mrw.So/63vxmb)

Optimization Suggestions Under the Guidance of "Bus Priority" Improve Infrastructure and Alleviate Traffic Conflicts

Vigorously developing urban public transport is conducive to accelerating urban construction, alleviating traffic pressure, reducing environmental pollution and providing more jobs. First of all, Macau bus companies can learn from the relevant experience of the mainland on exhaust gas treatment, and apply natural gas to oil synthetic fuel clean energy to exhaust devices to reduce the emission of bus exhaust. In view of the cross impact of motorcycles and private cars on the urban public transport system, laws are formulated and implemented to limit the chaos of illegal driving, and citizens are encouraged to use public transport for travel, such as promoting regular activities such as bus discounts. Shuttle buses are set up in popular entertainment places such as the new Lisboa Hotel and the Venetian every 10 minutes to and from the port. When the roads and buses are congested during peak hours, the crowded people can be guided to take the shuttle bus in the entertainment center to alleviate the overload pressure that the bus will face. At the intersection of multiple public transport lines, such as the front of yamala, comprehensive public transport transfer hubs and other infrastructure can be established, the area of supporting parking lots can be increased, and the transfer distance and time can be further shortened.

Learn from the proportion and setting methods of mainland bus stops, set the distance between stops and intersections, reasonable station spacing, website location and land area according to Macau's urban planning norms, pay attention to the planning of bus stops, and increase the length and depth of the stops. Bus waiting points with no stops for high-frequency use should be set with stops to ensure that people can wait orderly in summer and rainy days (Figure 9).



Figure 9. Platform Setting Reference
(Image Source: Taken by the Author)

Implement the Development Strategy of "Public Transport Priority" and Improve Service Quality

The study found that the increase in the number of No. 50 bus models increased the percentage of passengers, indicating that more people took buses from the old city to Luzhi District, especially the second stop in front of Yamala. As the largest transfer station in the old city, a large number of people took the bus from here to Taizi in the morning and evening rush hours every day, so taking the bus in the adjacent cities can save waiting time. Bus companies can consider increasing the number of No. 50 buses and reasonably guide the flow of people to take No. 50 bus to the border inspection building to exit from Hengqin port, which is faster than Gongbei port with heavy crowds. The new Hengqin port has been officially handed over to Macau in March 2020. With the entry-exit mode of one place and two inspections, relevant departments need to improve Macau's legal system of "bus priority" and the public transport system to the roadside border inspection building.

On the other hand, bus lanes should be added near major traffic locations in the city, such as schools in the old urban area of Macau, high-density residential areas and popular shops, so as to reasonably form a bus lane network system. Public transport lanes should be divided into perfect signs, markings and other identification systems, so that they can be clearly visible to ensure that pedestrians and car owners can see them. In particular, it is necessary to strengthen the monitoring of public transport lanes and the punishment of violations, truly achieve "dedicated lanes", and improve the running speed and punctuality of public transport vehicles (Figure 10-11).



Figure 10. Bus Lane Practice



Figure 11. Riverside New Street Pedestrian Overpass to Mage Temple

Source: <http://mrw.so/63VXrj>

At the same time, it is necessary to strengthen the coverage of the construction of intelligent transportation system in Macau. In view of the traffic congestion in the old urban area of Macau, and even the phenomenon of private vehicles parked indiscriminately, Macau has set up multiple illegal parking detection systems in the old urban area, while only one system point has been set up in the outlying island, and there is no such system in the more remote roundabout island; An integrated intersection detection system and a red light detection system are also set up in the old urban area. There is no such system in the second island of Lu'an, and the overall coverage of the three is small. The coverage of the old urban area should be expanded, and the areas that can be parked and opened to traffic should be equipped with detection systems to avoid the phenomenon of private car residents parking and misplacing randomly; The detection system should also be gradually installed on the two islands of Cotai to achieve the coverage of the whole administrative region of Macau.



Figure 12. Setting Points of Illegal Parking Detection Station
Source: Reference <http://mrw.so/6xWz71> Baidu map self drawn after interception



Figure 13. Setting Points of Illegal Parking Detection Station
Source: Reference <http://mrw.so/6xWz71> Baidu map self drawn after interception

Increase Capital Investment to Reasonably Meet the Travel Needs of Citizens

In Wangde parish and St. Andoni Parish, bus companies should cooperate with functional units to issue relevant policies to guide residents to travel reasonably, clarify the time period for bus use, and strengthen the intensity of fines for violations, so as to ensure a reasonable control of the number of non motor vehicles. At the same time, great efforts should be made to develop the tourism industry in the church area of Saint Francis on the outlying island. Corresponding guides can be regularly equipped at the entry-exit port of Macau to give publicity and explanation to tourists arriving in Macau. Vehicle guidance can be considered to travel to the urban area of the outlying Island. Public transport companies should also increase the number of public transport in outlying islands, drive the economic development of outlying islands with traffic and people flow, and improve the living standards of the people in the region. From a macro perspective, the government should increase investment, improve its investment and financing mode, and bank credit loans should be tilted to urban public transport to ensure comprehensive and coordinated development. In the future, Macau light rail should also cooperate with the coordinated development of ground public transport. At this stage, the bus station will be as close to the urban rail station as possible to shorten the transfer distance and ensure a good connection between Macau rail transit lines and ground bus lines.

CONCLUSIONS AND RECOMMENDATIONS

Macau has a small land area, dense population and limited resources. Vigorously developing "bus priority" is the only way for the city to achieve healthy and orderly development. This paper analyzes the impact of Macau's implementation of the "bus priority" policy on the people in the process of implementation through horizontal and vertical comparison through relevant literature and data from the Bureau of affairs, and comprehensively analyzes the problems caused by Macau's urban transportation at the current stage, The

results show that the Macau government needs to continue to optimize bus services in order to implement the policy of "bus priority". In the existing research, the development strategy of "public transport priority" in each city is introduced into economics, sociology and other disciplines for correction and analysis, and a combination of quantitative and qualitative methods should be adopted in the research.

FURTHER STUDY

Limited to the limited collection of public data, we can further use a combination of quantitative and qualitative methods to conduct in-depth research on Macau's transportation system in the future.

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