

Study on the Deployment of Bus Lanes in Small and Medium-sized Cities

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Abstract. Practicing the development concept of traffic priority and green travel, alleviating the current situation of traffic congestion, and improving the efficiency of public transportation travel is closely related to the traveling population. In this paper, by analyzing the current situation of the development of bus lanes in small and medium-sized cities and the comparative study of bus lanes in large cities at home and abroad, we propose the construction mode of bus lanes suitable for the development of traffic in small and medium-sized cities and the proposal of setting standards. It also takes the Chengguan District of Lhasa City as an example to study and develop the construction mode and setting standards of bus lanes that meet the urban characteristics of Lhasa City.

Keywords: Public Transportation, Bus Lanes, Setting Standards, Small and Medium-sized Cities.

1. Introduction

Due to the accelerated urbanization of small and medium-sized cities and the lack of a complete urban public transportation system, there are often problems with conventional public transportation that is not attractive enough, the layout of the traffic network is not reasonable enough, the setting standards for dedicated bus lanes have not been established, and public transportation cannot meet the daily travel needs of residents. In addition, due to the lack of bus lanes on some roads, the public transportation system often interacts with private cars, cabs and non-motorized vehicles in the urban transportation system, which exacerbates the traffic congestion caused by the high traffic flow.

Zhang Kaisheng used VISSIM and Synchro microsimulation model to verify that the efficiency of bus operation on the road section before and after the opening of the bus lane is improved and the negative impact on the intersection is in a reasonable range [1]. Xiao Yue et al. improve the problems of conflict between buses and social vehicles and ambiguous right-of-way division through more reasonable traffic organization design and effective operation management, conflict with social vehicles and ambiguous right-of-way division [2]-[3]. Chen Liang and others have analyzed in detail the form of bus lane setting, intersection handling, bus port layout and local specifications in Beijing, Shenzhen and Seoul, which are good guidance and reference for Chongqing [4]. Cai Shaoquan elaborated the important role of people-oriented bus lanes, analyzed the problems of developing bus lanes, and proposed that the key to priority development of public transport is in right-of-way priority; the key to right-of-way priority is in planning control; the key to planning control is in the adjustment of the control plan ideas, and the concept of changing from road network planning to right-of-way planning [5]-[6]. The bus lane system used in the city of Curitiba, Brazil, has effectively increased the attractiveness of bus travel; Ottawa has used a bus priority approach to increase operating capacity in the city center and a systematic expansion approach to attract passenger traffic in the periphery of the city, allowing limited funds to create more bus lanes; and the UK's guarantee of public transport rights-of-way priority is key to implementing bus priority [7] [8].

Based on the above analysis and comparison of the development of urban bus lanes at home and abroad, urban transportation development should focus on local conditions, the overall urban planning as the core, combined with the consideration of residents' travel patterns and urban

topography, religion, environmental conditions and other conditions, to establish a suitable transportation network for urban development. Focus on the priority of public transportation and improve the attractiveness of public transportation to city residents. Due to the low volume of bus traffic and passenger traffic in small and medium-sized cities, urban road conditions and urban traffic flow cannot meet the standards, and urban residents travel mainly by slow-moving traffic and motorcycles.

2. Analysis of the current situation of dedicated bus lanes in small and medium-sized cities

2.1. Bus lane layout standards do not match the current state of urban traffic development

Small and medium-sized cities are relatively slow development with large cities, urban centers and old urban areas are more concentrated population, travel demand is relatively large, but due to the historical impact of the old city, more ancient buildings, road conditions are relatively poor, mostly two-way four-lane and two-way six-lane section, the road grade is low, road expansion, reconstruction is more difficult, traffic congestion is serious.

Due to the small urban population of small and medium-sized cities relative to large cities, the traffic flow cannot reach the large city bus lane set standards, large city bus lane layout standards for small and medium-sized city traffic development is not fully applicable, and road conditions do not fully meet the large city bus lane set standards, private cars, cabs, non-motorized vehicles affect each other, blind construction will only aggravate the current stage of small and medium-sized cities Traffic congestion and other problems.

2.2. The layout of the bus lane network is not perfect, the site layout is not reasonable

Due to the further acceleration of urbanization, the gap between the early road network construction and urban development in small and medium-sized cities is gradually increasing, and the road conditions are gradually unable to meet the travel needs of urban residents, but due to the poor carrying capacity of the road network system of dense buildings in the urban center, the structure of the main and secondary roads is not reasonable enough level, the lack of overall planning of the public transport system, the setting of dedicated bus lanes is not complete, many institutions and institutions, the Residential areas, such as large traffic flow, relatively concentrated, high repetition rate of bus lines, while in some new urban areas there is a lack of dedicated bus lanes, less bus lines, unreasonable scheduling of bus vehicles and other issues. Part of the bus station layout is also unreasonable, there is a lot of travel demand for the area is not set up bus station, while some of the fewer mobile areas are set up stations, the site between the spacing is not set.

2.3. Bus lane markings need to be optimized

Intersection bus lanes are not set up well enough, some intersections are not set up bus lanes straight, turning lanes. Bus and social vehicles mixed, intertwined phenomenon is serious, especially the bus stop set in the intersection inlet road, to turn left bus vehicles need to move from the outermost side of the road across a number of lanes inward, the passage is very inconvenient; bus lane and borrow the right turn lane between the common intertwined length set distance is short, right-turning vehicles may conflict with the straight bus vehicles, there is a greater safety hazard.

2.4. Transit travel is less attractive to urban residents

Because the public transport system in small and medium-sized cities is not perfect, accessibility is relatively low, due to station settings, route planning and other issues, the bus to achieve "door-to-door" transport more difficult, and even need to transfer, the public transport system in small and medium-sized cities is not standardized, the number of vehicles on the operating routes is not enough,

residents wait longer to travel, social vehicles cannot lend a way to run, resulting in a waste of road resources, affecting the willingness of residents to choose public transport travel.

3. City bus lane setting comparison analysis

By comparing the traffic conditions and the setting of bus lanes in each city, we study the setting standards and types of bus lanes in each city, and provide reasonable suggestions for the development of public transportation in small and medium-sized cities, with a view to solving the traffic problems faced by small and medium-sized cities now.

3.1. China's existing bus lane setting norms

Set bus lanes should take into account the conditions of urban roads and public transport supporting facilities, social vehicle interference, passenger demand and other factors, according to the city's own conditions to choose a reasonable form of bus lanes, only to reach a certain passenger flow is necessary to set up bus lanes. Therefore, the city bus lane setting specifications should refer to the city bus planning and traffic organization planning and other requirements. At present, the domestic city bus lane setting standards are mainly based on the 2004 Ministry of Public Security developed the "bus lane setting" and the newly drafted "bus lane setting conditions standards" in 2014 [9]-[11].

3.2. Comparison of bus-only lane setting conditions in domestic cities

Against the main basis for the setting of domestic bus lanes, the cities combined with the actual situation of the city itself, based on the specific situation of urban traffic development, appropriate adjustments to the construction standards, the development of new standards in line with urban development, as shown in Table 1.

Table 1. Comparison of setting standards for city bus lanes

City	Lane Requirements	Peak hour one-way bus passenger flow/(passenger/h)	Peak hour one-way bus flow/(vehicle/h)	Share of public transportation passenger flow/%	Public transportation delivery speed/(km/h)	Setting situation
Beijing ¹	One-way 3 lanes or more	≥4000	≥150	3 lanes≥30 4 lanes≥25	≤40	Should be set
Beijing ²	One-way 2 lanes or more	≥1500	≥60	2 lanes≥50 3 lanes≥30	≤20	Should be set
Shandong	One-way 3 lanes or more	≥4000	≥90			Should be set
Tianjin	One-way 3 lanes or more	≥2000	≥50			Should be set
Shanghai	One-way 3 lanes or more	≥4000	≥90			Should be set
Taipei	One-way 3 lanes or more	≥2000	≥50			Should be set

Note: 1 represents high speed roads; 2 represents urban roads and highways.

Compare the different conditions of setting bus lanes in cities at home and abroad, and choose a reasonable type of bus lane according to the development needs of the city. For the reality that small and medium-sized cities have poor road conditions, relatively low bus traffic and passenger flow, and relatively low input of bus resources, this paper provides ideas for setting bus lanes in small and medium-sized cities by comparing the mode of setting bus lanes in various cities at home and abroad.

4. Lhasa city bus lane operation countermeasures and planning exploration

4.1. The current situation of bus lane development in Lhasa

Lhasa, the prefecture-level city and capital of Tibet Autonomous Region, covers an area of 29.64 million square kilometers. By the end of 2020, the city has 3 districts and 5 counties under its jurisdiction, with a resident population of 867,891,000. Lhasa bus has a total of 522 operating vehicles and 38 operating lines. Lhasa bus unilateral operation of the total mileage of 736.7 km, the annual mileage of 27 million kilometers of operation Lhasa bus daily average passenger volume of about 230,000 people.

Lhasa city bus lane restricted hours for weekdays from 7:00 a.m. to 10:00 a.m., 17:00 p.m. to 20:00 p.m. These two time periods in addition to buses and other social vehicles allowed, other vehicles are prohibited to drive into. During national holidays, the bus lane is open and no longer subject to the restrictions of the time slot. Performing emergency tasks of special vehicles, yellow large (medium) buses, school buses, social vehicles that can prove to rescue the distressed are allowed to run during the hours of operation in the bus lane.

From the analysis of data in recent years, Lhasa City, motor vehicle ownership to 25,000 to 30,000 units per year at an increasing rate. Up to now, Lhasa City motor vehicle ownership of more than 272,000, motor vehicle driver ownership of more than 198,000, non-motorized vehicle ownership of nearly 300,000, at the same time, as an international tourist city, long-term stay in the pull of foreign vehicles about 40,000 to 80,000, accounting for about 1/2 of the region's motor vehicles and driver ownership of 1/3, located in the forefront of the country.

4.2. Main problems in the development of bus lanes in Lhasa

The current standard is too high. Not established with the city's development of bus lane setting standards, Lhasa city road conditions are relatively poor, the city's main roads are mostly one-way three lanes, compared with the domestic city bus lane setting standards, Lhasa city peak hour one-way bus passenger flow and peak hour bus flow are currently unable to meet the bus lane setting standards.

Insufficient bus capacity. At present, Lhasa bus only 522, bus lines 38, the number of vehicles put on each operating line is insufficient, in the restricted time period, the special lane bus vehicles are not fully loaded, and social vehicles cannot run by lane, and some lines of bus vehicles less, resulting in a longer waiting time for city residents, bus travel is less attractive.

Bus lane settings are not complete. Some intersections are not set up for buses to go straight, turn lanes. So that the bus and social vehicles mixed. Especially in the case of bus stops set up at the intersection of the import road, left-turning bus vehicles need to move inward from the outermost side of the road across multiple lanes, the passage is very inconvenient; right-turning social vehicles and direct bus vehicles conflict, bus lanes and right-turning lanes together intertwined length is not enough, there is a greater safety hazard.

Road resource utilization is not enough. Due to the relatively poor road conditions in Lhasa, the city center of the old city more ancient buildings, in the bus lane restriction time period, the social vehicle traffic lane reduction, and due to the peak season of tourism in Lhasa, the increase in social vehicles, resulting in the section of social vehicles running speed drop, congestion problems aggravated.

4.3. Lhasa city bus lane system planning

4.3.1. Lhasa city bus lane operation and planning suggestions

The existing bus lanes to adjust the special lane limit, shorten the peak hour bus lane limit length, improve the utilization of road resources. As the city's population continues to increase, the flow of people continues to increase, the existing traffic stops and bus vehicles can no longer meet the normal travel needs of residents, so you need to increase public transport investment, increase the number of existing bus trips and bus stop settings, improve the frequency of departures, further improve public

transport facilities, increase the increase in traffic supervision to enhance the attractiveness of public transport travel to urban residents. Further strengthen law enforcement, illegal occupation of the road, illegal parking and other vehicles that affect the safe and smooth operation of public transport vehicles.

Open up new bus lines, reduce the bus blind spot, increase the number of bus lines from the core area of Lhasa City, the more distant areas of the bus lines, additional bus-only, build a bus-only lane network system, according to the city road conditions and road conditions, can set up bus and motorcycle and non-motorized vehicles combined with special lanes or bus priority lanes. According to the proportion of urban motorcycle and non-motorized travel and urban traffic supervision and other factors in different sections set up different types of bus lanes.

The establishment of public transport and motorcycles, non-motorized vehicles combined with special lanes to enhance the awareness of bus priority, some roads bus lanes to bus priority lanes, social vehicles need to give way to public transport, large vehicles and large buses, vehicles through the intersection to borrow the right turn shall not be parked on the special lanes, encounter co-intersection and, large vehicles and large buses need to pay attention to the courtesy.

4.3.2. Lhasa city bus lane setting standards opinion

According to the city bus lane setting standards comparison study, small and medium-sized cities bus lane setting standards should be based on the "national standard", and combined with the city's own traffic development and city size to adjust the bus flow and bus passenger flow and other setting indicators, in addition, should also consider the following factors.

(1) based on the bus priority perspective, when the road bus operation is affected by social vehicle congestion resulting in bus operating speed is much lower than social vehicles (bus trip speed and car speed ratio greater than 2.0), should consider setting up a bus lane.

(2) When the proportion of bus passenger flow in the channel passenger flow is not less than 30%, it should be set up bus lanes; when 60% of the roadway to meet the conditions for marking, the entire road should be marked bus lanes.

(3) rail transit in the near future can be combined with the actual demand, supporting the bus lane, to cultivate passenger flow for rail transit. Bus-only lanes should be strictly in accordance with the bus-only lane setting standards planning and construction, other types of bus-only lanes, bus priority lanes combined with the current state of urban traffic optimization.

Table 2. Lhasa city bus lane passenger flow standards

Lanes/Bar	Ideal transit ridership share/%	Set passenger flow/(person/peak hour)	
		Should be set	Appropriate settings
2	45	≥1200	≥1000
3	40	≥1000	≥800
≥4	35	≥800	≥600

Through the analysis of road traffic conditions in Lhasa city and the standard setting of urban bus lanes, the standard setting of bus lanes in Lhasa city is considered from the aspects of traffic demand and road conditions.

5. Conclusion

The public transportation system in small and medium-sized cities has not been perfected yet, and the city was shaped earlier, and many institutions and institutions, residential communities, etc. are basically concentrated in the urban area, which makes the traffic pressure in the urban area increasing day by day. Public transportation is not attractive enough for urban residents, therefore, vigorously developing conventional transportation and promoting the priority development of public transportation has a profound impact on urban development. The construction of bus-only lanes is an important measure to develop public transportation development, reasonably guiding residents to travel and improving the utilization of road resources by redistributing the right-of-way, effectively improving the situation of the proliferation of private cars.

The construction of bus-only lanes in small and medium-sized cities can be set up bus-only lanes or bus priority lanes, or combined with motorcycles or non-motorized vehicles to establish priority lanes, and adjust the setting time of bus-only lanes, improve the bus-only lane supporting facilities, form a complete bus-only lane network system, and constantly improve the setting standards for bus-only lanes in conjunction with urban development. For special periods such as tourist peaks and holidays, set specific operating standards to protect urban residents travel and effectively achieve bus priority.

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