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Research on the Selection Criteria of Customized Shuttle Bus Stations

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Abstract

In the era of rapid development of big data, in order to give full play to the efficiency of transportation infrastructure, ensure the safety of residents, and strive to improve the operation efficiency and management level of transportation system, China has implemented intelligent transportation in major cities in recent years. Intelligent transportation mode can make the transportation system have the ability of perception, prediction, analysis, control and so on. Its implementation greatly improves the overall operation efficiency and level of urban transportation system. In this context, customized shuttle bus came into being. The customized shuttle bus generally serves from the community to the unit, from the unit to the community, providing morning and evening rush hour pick-up service for medium and long-distance commuters. As an innovative transportation service between traditional public transportation and private transportation, customized shuttle bus can not only make up for the inconvenience brought to commuters by existing means of transportation, but also solve the problem of "commuting difficulty" in the city. Moreover, the customized shuttle bus adopts energy-saving and environmental protection electric vehicles, aiming to advocate green travel, energy conservation and emission reduction, and has social public services The nature of business. Based on the above two aspects, the customized shuttle bus has been rapidly promoted in many cities. However, the customized shuttle bus is still in the initial stage of development, and the development trend in major cities is not stable. There are still many problems to be solved, which directly or indirectly affect the loyalty of medium and long-distance commuters to choose customized buses as the primary means of transportation. Among them, the rationality of the layout of customized bus stops greatly affects the travel mode choice of this special group. In general, considering that these special groups often have higher requirements on convenience and travel time efficiency in the choice of transportation tools, this paper considers it necessary to set up a set of customized bus station selection criteria, so that the selected stations can better meet the convenience and travel time efficiency of such groups On the requirements to improve the attraction of customized shuttle bus, so that it can better play its advantages.

Keywords

Customized shuttle bus; Site Location; Cluster; Smart transportation.

1. INTRODUCTION

The traditional public transport can not bring convenience, comfort and fast ride experience for the passengers with medium and long commuting distance due to the problems of more stops, midway or transfer, long driving journey and crowded environment in the vehicle. Although the enterprise charter service can solve the travel problem of employees in a certain enterprise to a certain extent, it is still a private means of transportation, and the vehicle and

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road resources have not been integrated and optimized. If the enterprises in the same industrial park adopt the enterprise bus service, it is inevitable that some enterprises will have insufficient bus occupancy rate, similar bus stops and overlapped bus routes. It can be imagined that if the enterprise bus service is widely promoted in the city, it will inevitably lead to low vehicle operation efficiency and aggravation of resource waste.

In order to promote the construction of smart city, improve the overall operation efficiency and management level of urban transportation system, and promote the good development of urban traffic in the direction of more safe, reliable, convenient, efficient, intelligent and comfortable, in recent years, the major cities have built the Internet of things, cloud computing, big data and other advanced technologies as the support, collect all kinds of urban traffic information, and manage urban traffic It is a smart transportation service system with the whole process of control and public travel.

In this context, customized shuttle bus is brewed out to meet the travel needs of medium and long distance commuters. It can provide morning and evening shuttle service for commuters in the same or similar living and working areas. A customized shuttle bus can carry commuters from different enterprises who have the same or similar travel geographical location (including departure and destination), optimize personnel allocation and improve passenger occupancy. At the same time, it has the advantages of comfortable interior environment, less parking times, reducing total driving mileage and reducing carbon emission, which can effectively make up for the shortage of existing public transport tools. Especially in the new epidemic situation, the customized shuttle bus has the advantages of traceability, safety, relative independence and stability, which further promotes the implementation of customized shuttle bus between cities.

The location of customized shuttle bus sites is usually considered as a clustering problem. The operators of customized buses cluster the geographic location data of passenger travel demand collected on relevant platforms, and select the appropriate clustering center point as the alternative site of customized shuttle bus. However, due to the particularity of its service object, the customized shuttle bus is designed to provide shuttle service for medium and long distance commuters. These groups often have more diversified requirements in the choice of means of travel, especially in the three aspects of travel comfort, travel time efficiency and convenience of transportation. Obviously, a reasonable location of customized shuttle bus station can not only bring convenient riding experience for passengers, but also make most of passengers arrive at the nearest bus stop in a short time. At the same time, the location of customized bus station also comprehensively considers the vehicle road environment, which can effectively improve the time efficiency of shuttle bus operation.

Based on this, this paper thinks it is necessary to design a set of scientific and reasonable criteria for the selection of customized shuttle bus stations, so that the layout of customized shuttle bus stations can better meet the diversified needs of passengers and give better play to the service function of customized buses.

2. LITERATURE REVIEW

2.1. Research on Auxiliary Public Transport Planning

Customized shuttle bus, which is an auxiliary public transport mode in demand response transit (DRT), was first appeared in foreign countries. Domestic and foreign research on auxiliary public transport mainly focuses on the following aspects: (1) establishment and evaluation of public transport demand response mode; (2) design of DRT intelligent dispatching system; (3) research on operation mode of auxiliary bus; (4) formulation of auxiliary bus fare

Daganz [1] considered three different bus transfer modes, namely: (1) regardless of the starting and ending points of each passenger, the bus always stops at a certain station and looks

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for the next nearest stop. (2) Buses always give priority to the nearest pick-up point and the nearest feasible destination to pick up passengers in turn. (3) The bus provides pick-up service for a fixed number of passengers. A simple analysis model is established to predict the average waiting time and average riding time of passengers in demand responsive transportation system under the three modes, so as to evaluate the performance of different DRT systems. Horn [2] built a multimodal demand response system model framework litres-2 to evaluate the performance of conventional bus, taxi and other demand responsive services. The proposed model can provide certain reference for traffic planners and related operators to understand the performance of public transport system. Rahimi [3] and others proposed that the performance of a DRT system can be analyzed by monitoring whether the DRT system operates effectively, whether waste areas are generated, and resource deployment.

Cayford and Yim [4] designed an intelligent DRT dispatching system using advanced public transport system (APTS) technology. When the passenger demand is low, the system adopts the "on demand" service strategy. When the passenger demand is high, the intelligent DRT system will provide services for passengers according to the fixed schedule and route.

Liu [5] and other scholars have systematically summarized and analyzed the whole process from the generation background, concept evolution to operation planning of China's customized shuttle bus, which provides reference for relevant academic researchers, customized bus operators and traffic planners. Zhao Xin and Shao Yaqi [6] discussed the operation mode of customized shuttle bus in Beijing from the aspects of operation subject, station planning, route design and fare formulation. Fu Xiao [7] and other scholars have expanded the traditional ats-sam super network to study the impact of customized shuttle bus operation on travelers' activities and travel behavior.

Chang [8] and other scholars have respectively constructed the public transport welfare maximization model of fixed line and flexible line, and explored the influencing factors of the difference of ticket price and welfare between the two. Gong Huawei [9] and other scholars studied the equilibrium of the two sides in their pursuit of maximum fare revenue by constructing a game model between customized shuttle bus and conventional bus. On the basis of systematic analysis of China's customized shuttle bus.

2.2. Bus Stop Location Method

Gleason [10] considered how to set up a bus stop on a bus line to ensure that the distance from each passenger to the bus stop does not exceed the specified distance when the number of stops is the minimum. A 0-1 integer variable is used to indicate whether a stop is set at the location. This model is a typical set covering problem.

Moura and Alonso [11] proposed a two-stage model to explore the optimal location of bus stops. In the first stage, from the macro level, the distribution of bus stops in the whole transportation network is considered to minimize the cost of the whole network. In the second stage, from the micro level, the setting of bus stops along urban roads is considered to maximize the service efficiency of bus stops.

Ceder [12] and other scholars considered the problem of how to select an optimal group of parking points among the given possible parking places for buses with a single vehicle route. The influence of terrain factors on driving speed, driving time and operation cost is added in the model.

Cheng [13] et al. Proposed a two-level optimization model with the minimum bus stop spacing as the top objective function and maximizing the bus station coverage coefficient as the bottom objective in order to explore the optimal station spacing of Urban Bus Rapid Transit (BRT). The author thinks that there is a linear relationship between bus stop coverage

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coefficient and passenger flow attraction, so as to explore the influence of BRT passenger flow attraction on station spacing setting.

Different from the factors considered in the site selection of conventional bus stops, customized bus stops are mainly set up by clustering the starting and ending points of passenger travel demand. At present, there are few studies on the location of customized bus stops at home and abroad.

Sun Yue [14] and other scholars analyzed the distribution characteristics of passenger travel demand points, and considered that the traditional K-means clustering algorithm based on partition was greatly affected by outliers, and proposed to use density based spatial clustering algorithm with noise (DBSCAN) to divide traffic districts, and further divided the more important traffic zones according to the importance of traffic zones. Because DBSCAN algorithm can only output cluster results, but can not output center point, the author considers the distance factor to select the appropriate center point.

2.3. Bus Route Design Model

Ellegood [15] and other scholars use the continuous approximation model to evaluate the mixed load strategy of public transport. Research shows that when the proportion of stations shared by passengers going to multiple destinations is large and the distance between the destinations to which passengers go is relatively close, the mixed load strategy is more conducive to providing services for a larger area.

The existing research on customized bus route design is less, and most of them refer to the traditional bus route design model.

Tong [16] and other scholars proposed a customized shuttle bus service network optimization model, which was established to solve the following two problems: (1) under the condition of ensuring the minimum load rate of vehicles, increase the number of customers of each customized shuttle bus, and ensure that operators can obtain long-term benefits. (2) The bus line is designed to meet the passenger travel time and the starting and ending points. The Lagrange decomposition algorithm based on spatiotemporal prism is used to solve the model.

3. ESTABLISHMENT OF SITE SELECTION CRITERIA FOR CUSTOMIZED SHUTTLE BUS

3.1. Planning

The station setting should not only consider the convenience of passengers arriving at the station, but also consider whether the road environment around the station is conducive to the smooth operation of vehicles, so as to ensure the travel time efficiency of passengers. On this basis, we developed a set of custom bus site selection criteria:

1. Priority should be given to setting up stations in areas where passenger travel demand is more intensive, where the number of people is large and the distribution is relatively concentrated, so it is more necessary to set up stations for these areas. Compared with those in the relatively sparse travel demand area, the stations set in the demand intensive area can cover more travel demand points within the service radius to meet the travel demand of more passengers. At the same time, in order to shorten the walking distance of passengers to the station as far as possible, so that passengers can enjoy more convenient ride service, it is also necessary to consider the distance between the location of the station and the surrounding passenger demand points.

2. In order to ensure the travel time efficiency of passengers, the location of the station should also consider the connection with the surrounding bus stops, and try to select the area with bus lane nearby. This is because, in the peak period of morning and evening commuting, the road is

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easy to be congested. Due to the right of way with priority, the customized bus on the bus lane can avoid long-term detention on the road. At the same time, the customized bus can also travel on the bus lane at a speed higher than that of the conventional bus, so as to shorten the travel time of passengers.

3. The location of the site should also consider the relationship with neighboring sites, and try to ensure that each site serves independently. In other words, the number of duplicate demand points covered by two or more adjacent stations within the service radius should be as small as possible. In this way, it can not only avoid increasing the number of stops of vehicles due to unnecessary station settings, thus prolonging the travel time of passengers, but also save the cost of setting up stations for enterprises.

3.2. Conclusion

The rationality of choosing the location of the customized shuttle bus station will directly affect the passenger's riding experience. Reasonable layout of bus stops is not only convenient for passengers to get on and off, but also conducive to the smooth passage of vehicles, improve the travel time efficiency of passengers, and give full play to the advantages of customized buses.

This paper starts with the diversified travel needs of the medium and long-distance commuters who serve the customized shuttle bus, and analyzes what characteristics or criteria the customized shuttle bus station layout should have in order to meet their travel needs. The establishment of this set of criteria can play a guiding role in the design of clustering algorithm for the selection of customized bus stations.

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