Empirical research on residents' acceptance of reserved parking

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Abstract. Recently, the rapid development of new technologies such as artificial intelligence, cloud computing, big data, etc. has profoundly affected the complex and open urban transport system. Many new modes of traveling represented by reserved parking have been spawned under the impetus of new technologies. At present, in the field of reserved parking, scholars have carried out in-depth research on the construction of the reserved parking system and the formulation of parking space allocation strategies. However, fewer scholars have paid attention to the fairness of reserved parking. Therefore, this paper conducts an empirical study on the acceptance of residents of reserved parking using the questionnaire survey and data analysis method, analyses the decision-making process of residents' travel modes and the factors influencing the acceptance of reserved parking, researches the acceptance of residents' overall reserved parking mode, and explores the acceptance of residents' reserved parking with different personal attributes. The study found that the overall resident acceptance of reserved parking is 71.61%. Among residents with cars, the acceptance of reserved parking is higher for those groups of residents who are aged 60 or above, have a college/vocational-technical college degree, have a monthly income between RMB 7,000-11,000, and are in retirement or working in the private sector. In contrast, residents in other classifications may face more considerations in accepting parking by reservation, such as flexibility in scheduling, financial costs, special needs of their work, long-established personal parking habits, and awareness of the emerging concept that leads to a conservative attitude towards reserved parking.

Keywords: Intelligent transportation, reserved parking, acceptance of residents, questionnaire survey.

1 Introduction

With the development of modern science and technology, advanced technologies represented by artificial intelligence, blockchain, cloud computing, big data, and large models have widely and profoundly affected all aspects of human society[1-3], which have raised many complex problems while enhancing the operational efficiency of the

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system and improving the quality of human life. The integration of new technology and conventional transport modes in the enormous, open, and intricate urban transport system has given rise to a plethora of new business forms, including reserved and shared parking and personalized passenger transport services. The emergence of these new forms advances the green, low-carbon, and sustainable growth of the transportation sector in addition to enhancing the intelligence of the transportation system.

In the area of reserved parking, numerous academics have conducted extensive research on the design of the system and the strategy for allocating parking spaces. The strategies for first-reserved-first-served, auction-reserved, and permit-reserved parking are the three main categories of the reserved parking strategy[4-7]. At present, the majority of researchers concentrate on the efficiency of reserved parking, with very few investigating the equity. Ensuring the equity of reservation parking strategies is crucial for the establishment of a sustainable intelligent transport system and will play a significant role in future intelligent parking.

Fairness, according to Viegas, is an essential indicator of popular acceptance; which means that a policy's ability to be successfully enacted with the backing of the broader public rests heavily on how fair it is[8]. Fortunately, there has been extensive and thorough research on the fairness of congestion charges, which informs research on the equity of reserved parking. The three primary areas of research on congestion charge fairness are equity evaluation, optimization research, and empirical research based on public acceptance[9-13].

Recently, Chen et al. explored the efficiency of three reserved parking strategies through the expected social cost minimization model and proposed a vertical equity index for reserved parking to quantify the fairness of reserved parking[14]. To gain a deeper understanding of residents' acceptance of the new parking mode of reserved parking, this paper carries out an empirical study using the questionnaire survey method after analyzing the decision-making process of residents' travel modes and considering the factors affecting the acceptance of reserved parking. Combined with the field research data, it analyses the overall acceptance of residents, studies the acceptance of different socio-economic attributes of residents on the parking reservation mode, and gives suggestions to improve the acceptance of reserved parking.

The structure of this paper is as follows. Section II analyzes the decision-making process of residents' travel modes and discusses the influencing factors of the acceptance of reserved parking modes. Section III describes the implementation situation of the questionnaire survey. Based on the research data, section IV analyzes the overall acceptance of the residents, and explores the acceptance of the residents' reserved parking in the classification of different personal attributes. Section V summarizes the conclusions of the study and proposes directions for future research.

2 Analysis of Factors Influencing the Acceptance of Reserved Parking

The cost of travel (including the cost of public transportation travel versus the cost of travel by car) and parking quotas are important factors that affect the efficiency of

reservation, and these factors also affect the travel choice behavior of residents. Without considering residents' personal factors (i.e., socio-economic and psychological factors), the process of residents' travel mode decision-making is shown in Figure 1.

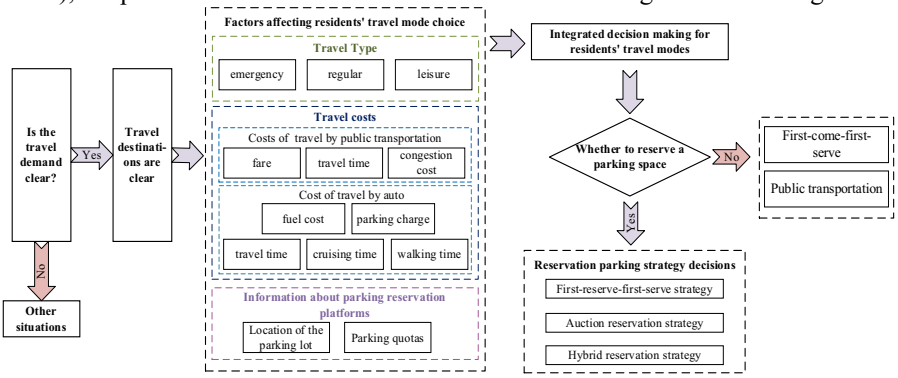

Fig. 1. The flowchart of residents' travel mode decision-making.

As can be seen from Figure 1, when the residents clarify the travel destination, they will make a comprehensive decision based on the type of travel, the cost of travel, and the location of parking spaces and parking quotas provided in the parking reservation platform, and then choose the appropriate mode of travel.

However, the willingness of residents to schedule trips through the reserved parking mode is influenced by several factors. Looking at all the influencing factors, we categorize them into two types, i.e., macro-factors and micro-factors. On the one hand, macro factors such as the degree of socio-economic development, the level of intelligent technology, the promotion of the concept of reserved parking, and the parking inducement policy have a certain impact on the behavior of residents' choice of reserved parking strategy. On the other hand, micro-factors such as residents' personal attributes (i.e., socioeconomic factors), travel attributes and travel mode attributes also affect residents' decision-making. This paper utilizes the questionnaire method to focus on the influence of personal attributes on the acceptance of reserved parking modes.

3 Questionnaire Survey

The questionnaire survey used a combination of offline and online methods to collect research data, and the interviewees covered 31 provinces in China, which provided rich information support for the research on the acceptance of the reserved parking model through multi-geographic data collection.

To ensure the reliability of the research conclusions, we screened the questionnaire and regarded the questionnaires with logically contradictory answers before and after, checkmarks rich in regularity and incomplete answers as invalid questionnaires. Subsequently, after data screening, 620 valid questionnaires (202 offline and 418 online) were finally obtained. The validity rate of the questionnaires was 86.59%.

4 Analysis of the Acceptance of Reserved Parking

Figure 2 demonstrates the distribution of overall reservation parking acceptance among the residents in this study. As can be observed in Figure 2, 47.26% of the overall number of residents with a car chose to reserve parking, and 24.35% of residents without a car are willing to reserve parking assuming that they will own a car in the future. The total percentage of both types of residents choosing the reserved parking mode is 71.61%, which indicates that the reserved parking mode has a high acceptance among residents, but there is still a need to strengthen the promotion of the concept of scheduled trips. Particularly for the group of residents with cars, it is necessary to conduct publicity through television, the Internet and the media to enhance the level of residents' understanding of the advantages of reserved parking, and to make further efforts to expand the mode's social influence in order to achieve wider popularization and application.

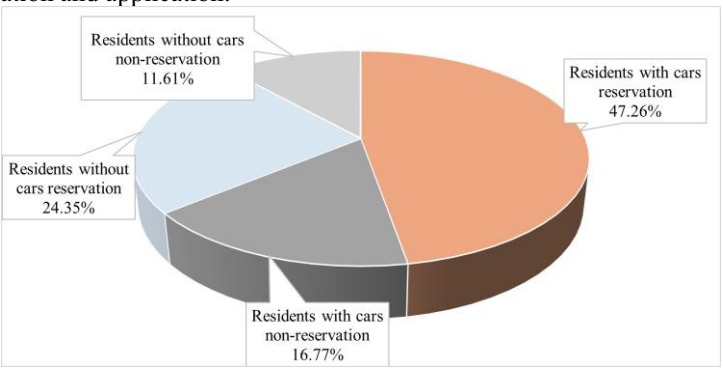

Fig. 2. Distribution of residents' overall parking reservation acceptance.

In addition, 73.80% of the residents in the car-owning group chose the reserved parking mode. Next, we statistically analyzed the sample of car-owning residents in terms of age, education, monthly income, and occupational attributes, respectively, in order to fully understand the acceptance of the residents' reservation parking mode under different personal attribute classifications in the car-owning group, so as to put forward suggestions for the promotion of reserved parking.

Figure 3 demonstrates the acceptance of residents with cars in different age classifications, and it can be seen that residents aged 60 and above have the highest acceptance of the reserved parking model, followed in order by residents aged 18-30, 31-45 and 46-60.

The reason for this is probably because older residents aged 60 and above prefer to avoid the uncertainty of finding a parking space, and the stability and planning advantages of the reserved parking model aptly satisfy the psychological needs of the older group. Residents aged 18-30 are at the beginning of their careers and have less autonomy of time decisions, and while this group of residents lives a faster pace of life and is more accepting of new technologies, they may be more concerned about immediacy, such as using instantaneous services such as shared bikes and online rides

rather than reserving a parking space in advance. As a result, residents aged 18-30 are more but less receptive than older age groups to the reserved parking model. Residents between the ages of 31-60, on the other hand, are typically in an upward/relatively stable period in their careers and families, and this group of residents faces more time pressures in their lives and work. While reservation parking saves cruising time when looking for a parking space, it increases advance planning time, which is not very cost-effective for residents aged 31-60. Therefore, they may prefer to use traditional methods to solve their parking problems and are conservative about the newer model of parking reservation.

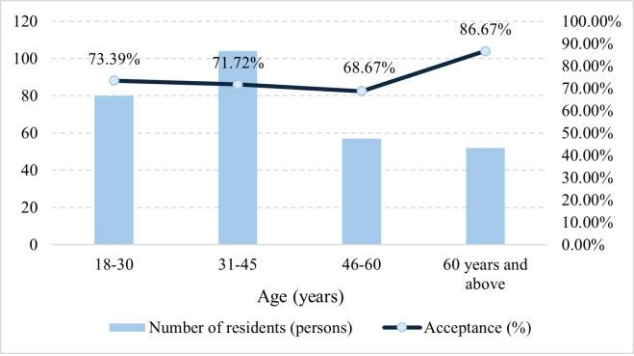

Fig. 3. Acceptance of residents with cars in different age categories.

Figure 4 illustrates the acceptance of residents with cars in different educational classifications, and it can be found that residents who graduated from college/vocational-technical colleges have the highest acceptance of the reserved parking model, and residents with bachelor's degrees are in the second place in terms of acceptance. While high school and below and to master's degree and above residents' acceptance of reserved parking is lower than the overall acceptance of residents with cars (i.e., 73.80%). There are multiple reasons for this phenomenon, and interviews can be used in future research to further understand the actual perceptions of residents in different educational level classifications about the reserved parking model.

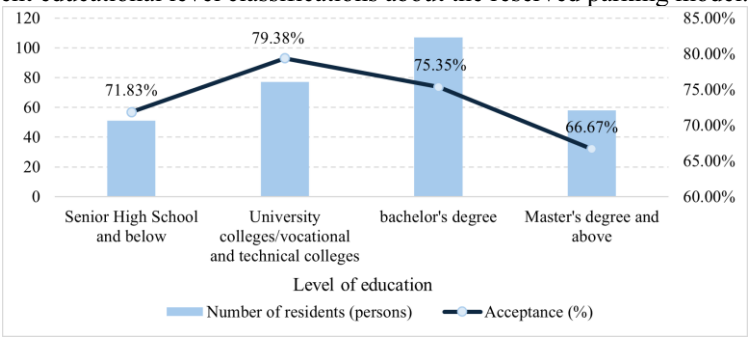

Fig. 4. Acceptance of residents with cars in different educational categories.

Figure 5 demonstrates the acceptance of residents with cars in different monthly income classifications. From this figure, it can be seen that residents with incomes between 7,000 and 11,000 RMB have the highest acceptance, followed by residents between 3,000 and 7,000 RMB, while residents with incomes above 11,000 and below 3,000 RMB are less accepting of reserved parking. This may be due to the fact that residents with income levels between 7,000 and 11,000 RMB are in a relatively stable financial situation, with a certain amount of disposable income and without a lot of pressure to invest. They are more willing to enhance their quality of life through reserved parking.

Figure 6 illustrates the acceptance of residents with cars in different occupational categories. It can be found that retired residents have the highest level of acceptance of the reserved parking model, followed by residents working in the private sector. Residents who are self-employed or freelance and those who are studying are slightly less receptive than the overall level (i.e., 73.80%). Residents of organizations and institutions were much less receptive than the overall level, at 60.18%. It is a result of retired people's leisure time, preference for advance travel planning, and willingness to reserve parking. Employees in the private sector appreciate efficiency, consider parking reservations seriously, and drive a lot for work. Freelancers and independent contractors have erratic schedules and are less accommodating when it comes to parking reservations. Due to their hectic academic schedules and low incidence of car ownership, students are not very accepting of parking issues and are not sensitive to it. Because they often enjoy free or inexpensive parking, employees of businesses and organizations are the least receptive to reserved parking.

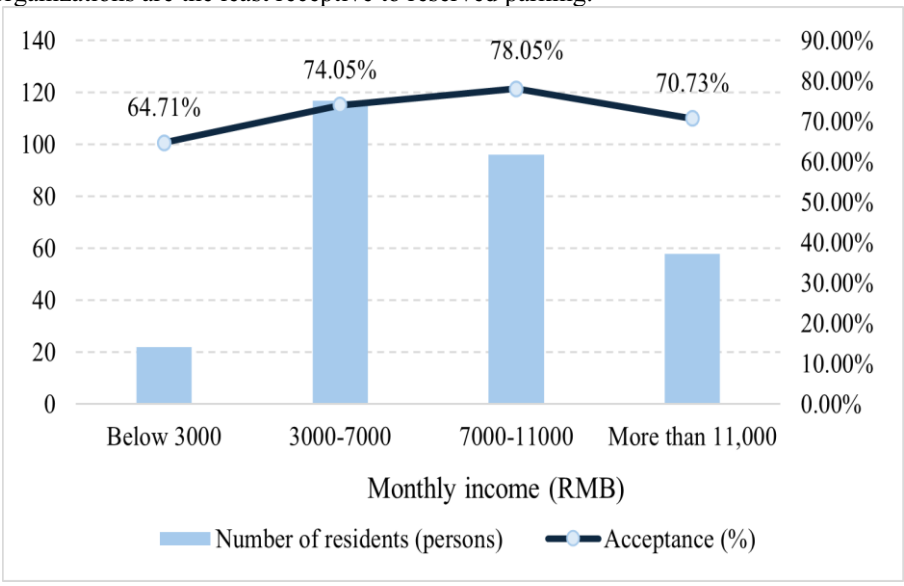

Fig. 5. Acceptance of residents with cars in different monthly income categories.

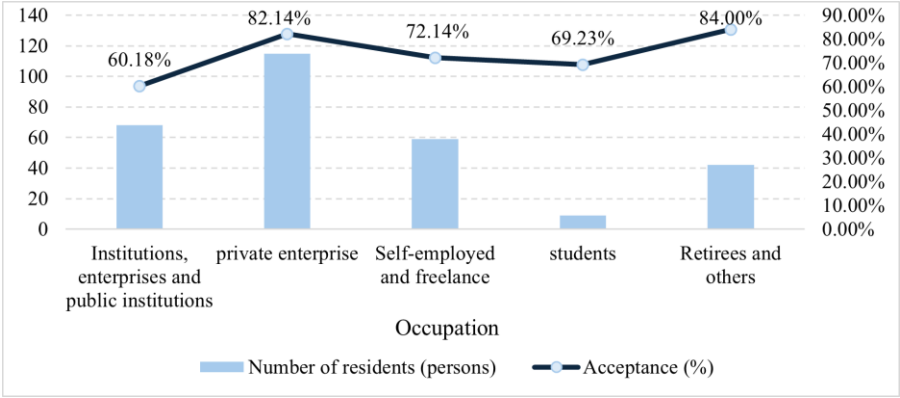

Fig. 6. Acceptance of residents with cars in different occupational categories.

5 Conclusions

This paper conducts a resident acceptance study on reservation parking, a new parking model. The study found that residents aged 60 and above, graduated from university colleges/vocational and technical colleges, with monthly incomes ranging from 7,000 to 11,000 RMB, and working in the retired or private companies have a very high acceptance of reserved parking, while residents in other classifications may be affected by a variety of factors such as flexibility of time, economic factors, work demands, personal habits and perceptions and so on showing a slightly lower acceptance level. Through the analysis, this paper puts forward the following three suggestions to improve the acceptance of the reserved parking model:

1. In the future, during the development of the parking reservation platform, a simpler presentation should be adopted to optimize the parking reservation process and minimize the complexity of the user's operation to meet the reservation needs of residents with different attributes.
2. Publish the detailed operational guide for the reservation parking platform, including how to register, reservation process, fee instructions, reservation cancellation, etc., to reduce the user's learning costs.
3. Develop a pricing plan for reserved parking that is acceptable to residents, and give users certain incentives at the beginning of the rollout, such as discounts for first-time users, rewards for points for long-term users, or discounts for specific time slots.

In the future, the influence of travel attributes and travel mode attributes on the acceptance of the reserved parking mode can be further explored by using the discrete choice model on the basis of this paper, so as to continuously optimize the reserved parking mode to provide residents with better planned travel services.

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