ISSN: 2664-9640

Review on parking choice behavior in urban road sections

Wenjing Wang

School of transportation, Chongqing Jiaotong University, Chongqing 400047, China

Abstract

This paper reviews the research results of parking choice behavior, and summarizes the research status of parking behavior from two aspects of influencing factors and research methods. It is pointed out that parking time and economy are the most important factors affecting parking decision-making. Toll management can effectively alleviate the imbalance of on-road and off -road parking. Parking guidance facilities and intelligent parking information will become a major factor affecting parking choice behavior in the future. For the research methods, it mainly summarizes the non aggregate model and multi-objective decision-making method. Among them, non aggregate models mainly include various logit models, and multi-objective decision-making methods include fuzzy evaluation method and weighting method. Other research methods of parking behavior, including prospect theory and utility maximization theory, are also summarized.

Keywords

Parking behavior, research methods, influencing factors.

1. Introduction

In recent years, China's national economy has developed rapidly, and the process of urbanization and industrialization has accelerated. Car ownership has also increased significantly, and the demand for traffic travel in major cities is rising. However, the supply of static traffic facilities such as parking facilities can not well meet the parking demand of cars, and the problem of car travel and parking is becoming increasingly prominent. Facing the traffic problems caused by this phenomenon, many scholars pay attention to it. Some studies pointed out that by analyzing the traffic characteristics, mastering the law of vehicle parking and increasing the supply of parking spaces, the problem of parking difficulty can be effectively alleviated. To master the parking law, it is necessary to study the parking choice behavior of parking people.

Parking choice in parking behavior mainly refers to the choice of parking location and facilities when pedestrians park. Parking choice is not only related to people's family characteristics, travel characteristics and parking habits. It is also related to berth conditions and parking facilities. Therefore, the analysis of people's parking behavior, parking environment and parking situation can improve the utilization efficiency of berths, improve people's travel efficiency, and save time and economic cost. This paper studies the influencing factors and analysis methods of parking behavior, in order to provide a theoretical basis for parking management and the construction of parking facilities.

2. Influencing factors of parking behavior

2.1. Parking purpose

Every trip has a certain purpose, and the purpose of parking will affect people's choice of parking location and facilities. Travel purpose is the origin of travelers' travel behavior and has a fundamental impact on their parking behavior [1]. As the motivation of parking, the purpose

of parking often affects the proportion of people choosing to drive, and then affects the parking choice behavior. Parking people sometimes prefer to use walking time to exchange parking fees, that is, parking people are sometimes willing to park their cars in a parking place with a long distance but a low parking rate; When parking people go shopping, they prefer to choose the aboveground parking lot close to the destination [2]. Travel purpose is an important feature of travel behavior. It leads to travel demand and is the premise of parking behavior. Travelers with different travel purposes have different sensitivities to some parking factors. Commuters are less sensitive to parking charges and more sensitive to walking distance after parking; On the contrary, non commuter travelers have high sensitivity to parking fees and low sensitivity to walking distance after parking [3].

2.2. Time influencing factors

Parking search time, driving time to the parking lot, parking waiting time and walking time to the destination are the time spent in the whole parking process. The waiting time of each parking lot is different. If the parking system is more contaminated, drivers have insufficient parking experience, and the road condition is not very good, under this condition, the impact of parking search time is more obvious. Due to different travel purposes, the parking time of travelers is also different. If the parking time is short, the convenience of parking and taking cars is more considered, so they prefer to choose aboveground parking lot; If the parking time is long, it will pay more attention to parking safety and comfort, and the willingness to choose underground parking lot is stronger [4]. Since the saturation of parking facilities usually reaches more than 0.8, or even supersaturation (illegal parking), different parking start times (i.e. whether they are in the peak period of vehicle parking) will have an impact on the choice of parking facilities [2]. The walking time from parking to the destination is one of the most concerned factors for parking people, which is also the reason why the use efficiency of on-road parking is higher than that of off-road parking in many cities in China. For parking people, the shorter the distance from the parking facilities to the destination, the better. Gong Chengjie and Li Wenling [5-6] both analyzed the impact of walking time after parking on parking behavior, and believed that the walking time after parking directly affects the travelers' sense of experience of one-time travel behavior, which has an important impact on travelers' decision-making. For larger cities, the greater the tolerance of walking time, and the smaller the tolerance of smaller cities. A survey shows that travelers' walking time after parking is generally within 3-5min. If it exceeds this time range, travelers are likely to continue parking and cruising and look for closer parking options. Li Chao [2] believes that the convenience of parking facilities will also have a certain impact on the parking time. Parking people tend to choose parking places with less waiting time and convenient access to cars.

2.3. Economic factors

For parking choice, parking cost is undoubtedly an important factor affecting how to make a decision. Under similar conditions of other conditions (such as parking difficulty, etc.), travelers certainly prefer low-cost parking services. Both Yang Mengmeng [7] and Wang Zhenyu [3] believe that parking fees have become an effective method to realize the balanced utilization of off-road parking resources. Yang Mengmeng investigated the factors of parking behavior and found that the parking rate has the greatest impact on people's parking behavior. It is pointed out that the charging price of off-road parking facilities is generally higher than that of on-road parking, resulting in that the choice of parking people is biased towards on-road parking, while the utilization rate and turnover rate of off-road parking can not meet the expected standard, which also leads to the waste of off-road parking resources. Therefore, it is concluded that parking charging is an effective method to realize the balanced utilization of on-road and off-road parking resources. In addition, the parking fee will also have an impact on the travel destination. For work and business travelers, the parking fee will affect their choice of travel

mode, but will not change their travel destination; However, for travelers for shopping, entertainment and leisure, parking fees have a significant impact on the choice of their travel location [2]. However, some studies have shown that parking people are not sensitive to parking costs, that is, parking costs have no significant impact on parking choice behavior. This is because the payers of parking expenses are different. If the parking expenses can be reimbursed, the sensitivity of the payers to the expenses is very low. At this time, administrative means should be considered [4]. Therefore, the parking cost has a major impact on people's travel. At the same time, the adjustment of parking supply and demand through the cost can effectively alleviate the imbalance of parking supply and demand, on-road and off-road parking.

3. Parking choice behavior model

3.1. Multi objective decision making method

Multi-objective decision-making method is a mathematical method to select and sort a variety of schemes containing multiple attributes according to a certain rule. In the study of parking choice behavior, multi-objective decision-making methods mainly include analytic hierarchy process and fuzzy decision-making. The weight of evaluation index is usually determined by subjective weight method and objective weight method. Su zhouyu and Li Chao [10] established a multi-objective and multi constraint parking selection model aiming at the most convenient use of drivers, short walking time and lowest travel cost, and calculated the alternative set of the model by using the subjective and objective weighting method and the scheme ranking method based on distance entropy. The model can comprehensively rank multiple alternative parking lots, so as to provide reference for drivers to choose parking lots. Although the subjective weighting method to determine the weight is simple, the human factors are too strong, and the objective weighting method relies too much on samples, which has the disadvantage of ignoring the subjective qualitative analysis of evaluation indicators. Therefore, TOPSIS method is also widely used. Yang Siyu put forward the grey Markov prediction method for the prediction of spare berths in the parking lot by investigating and analyzing the parking law. Taking the parking people in the business district as the research object, under the condition of scientifically and accurately predicting the vacant parking space of the parking lot, the active parking lot selection model is established by using TOPSIS method. Zheng Shudan et al.used entropy weight TOPSIS method to determine the weight of influencing factors, comprehensively considered the factors of parking selection, determined the final comprehensive prospect value of scheme selection, and ranked the closeness of all parking schemes, so as to make parking selection decision. Ning Ruichang established the parking lot selection model under the reservation mode, determined the grey entropy decision method according to the characteristics of parking lot selection decision, and proposed the optimal parking lot selection model based on grey entropy to achieve the goal of recommending the optimal parking lot for users. According to different parking behavior processes, Li Chao [2] summarized and cluster analyzed the main factors affecting parking choice, established the parking choice evaluation index set, and studied and analyzed the parking characteristics and parking choice behavior of business district. Taking the users of parking facilities as the research object, this paper establishes a parking choice model under the condition of active guidance, simulates and analyzes the parking choice behavior of parking people in the business district, and verifies the accuracy of the model through an example. Fuzzy evaluation method also has a certain application in the research of parking behavior. Zhou Xin [14] described the evaluation indexes of the parking lot by using the two type fuzzy set under the time-varying domain, combined with the fuzzy comprehensive evaluation method to comprehensively evaluate the parking lot in different parking time periods, and obtained the satisfaction level of the target parking lot in different parking time periods, so as to provide theoretical guidance

for drivers to choose the parking lot according to their preferences; Finally, the interval type II fuzzy comprehensive evaluation is used to evaluate the real-time remaining parking spaces of a large underground parking lot, and the satisfaction level of parking spaces at a certain time is sorted according to the driver's personal preference, so as to facilitate the selection of the optimal parking space. Zheng Hebin.established the parking search model and parking selection model, used the fuzzy analytic hierarchy process to analyze the feasibility of the model, determined the optimal parking scheme, and provided the parking lot priority decision-making method according to the needs of drivers, so as to reduce the time for drivers to find parking spaces, so as to alleviate the traffic pressure. On the premise of analyzing and evaluating the parking behavior of drivers in a certain area, this paper establishes a comprehensive evaluation model based on the theory of Chen Rui's parking behavior and the data of Chen Rui's parking behavior. Pan Sheng et al.selected the five main indicators that affect the choice of users' parking behavior, calculated the weight of the five impact indicators by using the weight of genetic algorithm to determine the weight index of each attribute, and built a collaborative recommendation model for users' parking behavior decision, so as to realize the active guidance of travelers within the scope of destination.Two or more

3.2. Non aggregate model

When the subjective weighting method gives weight to each evaluation index, there are differences in the subjective judgment of different researchers, and the evaluation results will be biased. Therefore, the non aggregate model based on the expected utility theory is also the main means for scholars to study the parking choice behavior. The non aggregate model also has the characteristics of simple structure, small requirements for sample size and strong persuasion of modeling results, which makes it the most widely used in the research of parking choice behavior. Logit model is often used in the research of parking choice behavior based on non aggregate model.

It is relatively early to use logit model to study parking behavior in foreign countries. Based on the questionnaire survey results, hunt et al. used hierarchical logit model to analyze the data to analyze the probability of decision-makers' final choice of on-road or off-road parking decision. Han Xue made a quantitative analysis on the influencing factors of parking lot selection and established a logit model for discrete selection of shared berths. After testing, parking rate, walking distance after parking, parking information and convenience of parking lot have a significant impact on parking decision-making. Among the non aggregate models, the most widely used and mature model is the multinomial logit model, that is, MNL model. The model is a mathematical model based on the data of RP survey and SP survey, assuming that the random error terms of each parking choice scheme are independent of each other, and the parameter values of each influencing factor are obtained by the maximum likelihood estimation method to predict the parking choice behavior of parking people. Yuan Zhihua conducted research based on travel data and built a multiple logit model for driver parking facility selection. Taking the driver's personal attribute, family attribute, vehicle attribute and travel attribute as utility variables, and selecting three kinds of parking facilities: toll parking lot, free parking lot and illegal parking area as the driver's parking selection limb, this paper constructs the car parking facility selection model in the central area of the city, and determines the corresponding variables and value methods in the model. Based on the survey data, Wang Hao et al. introduced prospect theory to study the value function based on parking time and parking cost, established the value function curve and estimated the corresponding parameters. The value function is integrated into multiple logit models. The result shows that the parking price adjustment has a significant impact on the parking behavior of bus users. Li Xuhui established the mixed logit model, the prospect theory selection model of heterogeneous reference points and the classical random regret minimization model respectively, and used the absolute difference to compare

and analyze the description degree of the three models on the parking choice behavior. The results show that the model based on the bounded rationality hypothesis can better describe the parking choice behavior of decision makers. Cheng Aiwen [4] established a parking choice model based on the random utility theory to describe the choice of travelers in underground parking lot, on-road parking lot, off-road parking lot and three-dimensional parking lot. Combined with the survey data, the parameters of the characteristic variables of the parking lot selection model are calibrated and tested by using biogeme analysis software. The results show that the travel purpose, the walking distance to the destination after parking, the parking time and the parking experience are the significant factors affecting the parking choice. Then the corresponding elastic analysis is carried out on these significant factors to quantitatively describe the influence of the significant factors on the parking choice rate.

3.3. Other models

Some scholars analyze the parking choice behavior of parking people from the perspectives of prospect theory, utility maximization theory, random utility theory and game theory. Hu Xiaohai et al. analyzed the influencing factors in the process of determining the time value of parking choice behavior, applied the utility maximization principle and random utility model to establish the functional relationship between parking utility and influencing factors, established the time value model of parking choice behavior, and calibrated the model parameters by using the maximum likelihood estimation method. Finally, taking the investigation results of parking behavior characteristics in the central area of Chongqing as an example, this paper makes an empirical analysis. Prospect theory studies people's behavior from people's actual decision-making behavior. This theory is in line with the view of limited rational people that "when facing benefits, they tend to avoid risks and when facing losses, they tend to pursue risks" . Zheng Shudan et al. established a decision-making model for holiday parking selection based on prospect theory. In order to determine the reference point of influencing factors of parking selection, multiple regression analysis was carried out on the actual survey data. The value function of each factor affecting the decision-making of parking choice on holidays and the probability importance coefficient function of tourists about travel time are established, and the prospect value of a single factor affecting parking choice is calculated. Based on the expected utility theory, ML model is established to study the influencing factors of tourists' parking choice behavior. Wang Zhenyu [1] analyzed the decision-making process and influencing factors of parking choice behavior, and established a decision-making model for on-road parking choice behavior based on utility theory. Cai Jiaming proposed the parking behavior selection model and parking guidance information configuration optimization model of parking lot, and calculated and optimized the parking behavior probability and parking information configuration combined with examples. Ding Tianlin defined the cost incurred by travelers in the parking process, namely time cost, economic cost and early / late penalty cost. Combined with the mean variance theory, the risk attitude coefficient of travelers is introduced to construct an on-road parking decision-making model considering travelers' risk attitude. Duan Manzhen et al. analyzed the game relationship between parking managers and drivers, introduced Stackelberg game theory, micro described the game relationship between them, and established a parking lot equilibrium utilization model serving personalized parking guidance. Qiao Wenlei et al. constructed the traffic simulation analysis model by using the aggregation method based on the macro basic map. This paper focuses on the two factors affecting travelers' choice, travel time and travel cost, and the interaction between parking fees and bus fares. It is concluded that the increase of bus fares will lead to the increase of cruise delay, and the decrease of parking fees will lead to the decrease of cruise delay.

ISSN: 2664-9640

4. Conclusion

Analyzing and mastering parking behavior and characteristics is the basis for rational planning of parking facilities and effective formulation of parking management policies. By summarizing the existing research results of parking choice behavior, this paper defines the research methods of parking choice behavior and the influencing factors of parking behavior. In terms of research methods, it mainly discusses the non aggregate model, multi-objective decision-making method and other methods, such as prospect theory. In terms of influencing factors, it mainly includes time factors and economic factors. In addition, external information will gradually become an important factor affecting parking behavior.

References

[1] Wang Z. Decision making model construction of on road parking choice behavior based on utility theory [J]. Science and technology innovation, 2020 (29): 125-126.

[2]Li C. Study on parking characteristics and parking choice in urban business district [D]. Chongqing Jiaotong University, 2014.

[3] Wang Z Y. Analysis on influencing factors and Management Countermeasures of on road parking choice behavior [J]. Science and technology wind, 2019 (26): 255-256.

[4] Cheng A W. Parking behavior analysis of urban central business district [D]. Southwest Jiaotong University, 2015.

[5] Gong C J. Research on parking guidance optimization method based on parking lot selection behavior [J]. Southern agricultural machinery, 2017,48 (12): 175.

[6] Li W L, Li J L, Huang H Y. Research on parking space organization of commercial district based on parking behavior survey [J]. Transportation research, 2015,1 (03): 19-24.

[7] Yang M M, LiuY Z. Analysis of on road parking choice behavior [J]. Innovation and application of science and technology, 2018 (36): 63-64 + 66.