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Research Article

Analysis on Time Window of Shared Parking in Hospitals Based on Parking Behaviors

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Hospitals are essential components of a city; huge traffic demand is generated and attracted, causing contradiction between parking supply and demand. By sharing parking berths, limited space can serve more demand which is beneficial to alleviating parking problems. Aimed at improving the capacity of shared parking, the paper analyzes four parking groups in typical hospitals, which are medical staff, outpatients, emergency patients, and visiting groups. The parking demand of medical staff is rigid. For outpatients and visiting groups, longer walking distance is acceptable and more attention is paid to parking fee. By contrast, emergency patients can accept shorter walking distance and focus more on convenience due to urgency. Under this circumstance, parking behaviors selection models are established by means of Multinomial Logit Model. On this basis, time value is adopted to calculate the tolerance of alterative parking time. Moreover, this paper explores the variation of time window, under different parking impedance. A case study is conducted and suggests that start and end point of a certain time window can be influenced by external factors.

1. Introduction

As an indispensable part of the city, hospitals generate and attract a huge amount of traffic every day; meanwhile, contradiction between parking supply and demand is serious in most hospitals. Most of the parking demand is concentrated in the day due to outpatient service while demand in night is much lower. However, the supply of parking berths in hospital parking facilities is relatively constant; facing such ever-changing demand, there will be unbalanced use of the parking resource, manifesting in the fact that parking facilities in daytime are insufficient to meet the demand but at night there are plenty of idle berths [1]. Shared Parking [2–4] refers to a measure that one parking lot serves the adjacent buildings to meet the needs in all kinds of buildings by means of taking advantage of the differences between demand for time and space among several land uses. By sharing parking facilities in hospitals with other land uses nearby, purpose of alleviating regional parking problems can be achieved [5]. Similar to traffic impedance, parking impedance contains parking fee, walking distance from the parking lot to destination, parking duration, and such factors influencing decision-making when one parks his car. In the implementation of shared parking, the impact of parking impedance variation is different due to the properties of different parking groups, and the parking behavior under different circumstances is also inconsistent.

As for parking behavior, Kelly and Clinch [6] proposed that wide discrepancies exist in the sensitivity of the two groups, business travelers and noncommercial travelers. Waerden et al. [7] summarized the existing parking behavior choices on the parking fee. By using Multinomial Logistic Model, the main factors which will influence parking time, like parking purposes, parking prices, and parking fee payers, and so on, are selected and confirmed by Ruan [8]. Simicevic and Milosavljevic [9] built a model to analyze the elasticity of parking prices, indicating that increasing parking cost will reduce the parking demand. Guo et al. [10] proposed a static game theoretic model to capture the competition among drivers for parking berths.

Table 1: Time-varied characteristics of parking demand.

	Weekdays	Weekend
Parking occupancy	(a) Parking demand is high during the day with two climaxes: 7:00–11:00 and 13:00–16:00, while in the night parking mainly occurs in 18:00–20:00. (b) 11:00–13:00 witnesses low parking demand in daytime, and from 20:00 to 6:00 the next day, the need decreases and becomes steady.	Similar to that of weekdays
	In the long run, parking occupancy is relatively stable.	
Entrance and exit	(a) Four peaks exist in entrance distribution, 6:00–8:00, 10:00–11:00, 14:00–16:00, and 18:00–20:00.	(a) From the view of entrance, there are peaks but comparatively flat.
	(b) Three peaks exist in exit data, 11:00-12:00, 15:00–17:00, and 20:00–21:00.	(b) Exit peaks appear in 10:00–11:00 and 16:00–17:00.
	(c) From 22:00 to 6:00 the next day the number of vehicles entering and exiting hospitals is small.	(c) In the night it remains in a low level.
Parking duration	80% of the vehicles park less than 3 hours in the hospitals. The majority of vehicles park within 1.5 hours.	

In terms of shared parking, Iman [11] applied GIS in modeling the parking supply and demand. Jia [12] introduced shared parking theory and pointed out that shared parking can solve parking problems in hospitals.

However, there are few researches that covered the sharing method of specific land use types considering both the time-varied characteristics of parking demand and the properties of the parking groups. Additionally, further research should be done on the particular shared parking strategy and method to guide the policy implementation.

In order to solve these problems above, the paper takes equipped parking facilities of hospitals as research object, aiming at enhancing shared parking capacity in different situations. According to the previous study on time-varied characteristics of parking demand, parking population in hospitals is divided into four groups, and the characteristics of parking behavior are investigated and analyzed. In addition, changes in different scenarios in time window of shared parking are explored based on several parking groups.

2. Feasibility Analysis of Shared Parking in Hospitals

2.1. Time-Varied Characteristics of Parking Demand in Hospitals. Hospital parking facilities not only possess public parking properties, but also show different occupancy characteristics over time because they are attached to hospitals. Based on parking data of Nanjing First Hospital, the time-varied characteristics of parking demand are summarized in Table 1.

2.2. Appropriate Conditions for Shared Parking in Hospitals. From the time-varied characteristics of parking demand, the occupancy of parking berths is constantly changing, taking on peaks and troughs. Additionally, in the long run, the change is relatively stable. Therefore, it can be considered to share parking berths in hospitals with other land uses nearby in order to relieve the contradiction between parking supply and demand in the area.

To improve efficiency, shared parking is classified into two periods, short-time shared parking (7:00–17:00) and long-time shared parking (17:00–7:00 the next day), corresponding to outpatient and emergency service, respectively. However, in the daytime, parking occupancy is already high due to its own needs, in order to meet the elastic demand bought about by its fluctuation, it is not possible to open and share parking lots once there occurs a free berth. Only when certain conditions are met, shared parking becomes feasible. Based on the previous research, when both berth condition and duration condition are satisfied, hospitals can implement shared parking. Berth condition refers to the fact that the occupancy should be less than 0.85 of the maximum berth occupancy, while duration condition means that the minimum duration for shared parking is 1.5 hours. The time period determined in accordance with such a principle is called the initial time window.

3. Analysis on Parking Behaviors of Different Parking Groups

When making parking choices, drivers are easily affected by external factors and alter their established decisions, and different types of drivers behave differently. Therefore, it is of great significance to study the parking behaviors of users of hospital parking lots, which is beneficial to analyze the effects of parking behavior changes on time window of shared parking.

3.1. Classification of Users of Parking Facilities in Hospitals. As equipped facilities of hospitals, the main purpose of

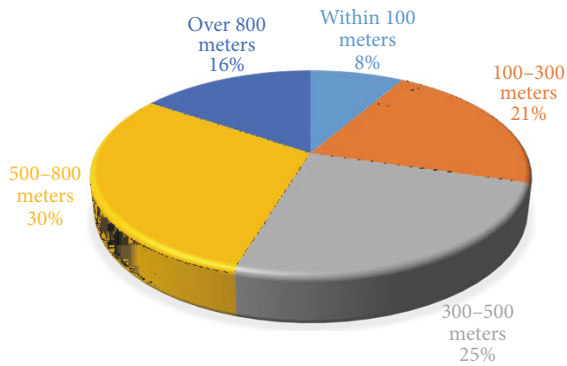

Figure 1: Statistical distribution of the maximum acceptable distance.

parking lots is to ensure the parking demand of patients and doctors. In order to analyze characteristics of different groups using parking facilities in hospitals more accurately, the article divides the parking population into four main groups, medical staff, outpatients, emergency patients, and visiting groups.

Parking behavior is the traveler's individual behavior, and it is a combination of several factors such as personal attributes and properties of parking lots. Taking Nanjing First Hospital, Nanjing Drum Tower Hospital, and Zhongda Hospital Southeast University as survey respondents, questionnaires are distributed in parking lots, waiting areas, and inpatient departments, respectively, to explore the parking behavior selection patterns of different parking groups.

3.2. Comparative Analysis on Parking Behaviors of Four Groups according to the Survey

3.2.1. Analysis of Parking Behavior of Medical Staff. Among all the parking populations in hospitals, medical staff are a special group. According to the survey, their entrance and exit of hospitals is particularly regular, concentrated in the morning and evening peaks; thus their parking duration is relatively fixed. Secondly, most medical staff have access to parking permits so that they do not have to pay parking fee. Thirdly, most hospitals set up separate parking berths for medical staff to ensure that their parking berths will not be diverted. Therefore, the influence of external factors on medical staff is extremely small.

3.2.2. Analysis of Parking Behavior of Outpatients

(1) Parking Duration. According to the on-site survey, parking duration of outpatients is mainly within 4 hours, accounting for 90% of the proportion, of which 1 hour makes up 42% while 1-2 hours and 2–4 hours take up about 20%, respectively. It is consistent with the parking duration distribution characteristics of hospitals.

(2) Acceptable Maximum Walking Distance. In shared parking, the acceptable walking distance is directly related to whether or not travelers are willing to accept another parking lot as an alternative option and the extent of the willingness if the preferred parking lot cannot satisfy their demand. The maximum acceptable distance for outpatients is demonstrated in Figure 1.

The distribution of maximum acceptable distance is relatively uniform. Outpatients willing to accept walking distance less than 500 meters accounted for half of the proportion. 1/3 of the population are able to accept distance less than 300 meters, while more than 15% of the respondents choose more than 800 meters.

(3) Factors Concerned Most in Parking. From Figure 2, parking fee, distance between parking lot and destination, and number of vacant berths of parking facilities are the most concerned factors in parking of outpatients, and each one of them accounts for more than 50%.

About 40% of the population regard parking duration and parking safety as their most concerned factors when parking in hospitals. In comparison, few respondents take type of the parking lot and convenience into consideration, in which type of the parking lot means whether the parking lot is on or off street and convenience means whether it is easy for travelers to go to the parking lot.

(4) Waiting Time for Parking in Hospitals. It is the ratio of waiting or not when parking is roughly 1 : 1 based on the survey. Besides, the majority of the waiting time is less than 10 minutes.

3.2.3. Comparative Analysis on Parking Behaviors of Four Groups according to the Survey. The other two groups are analyzed in a similar way. Due to various parking purposes, sensitivities of their own and external factors on different groups vary greatly, thus influencing the parking behaviors, as displayed in Table 2.

3.3. Construction of Parking Behavior Selection Models of Different Parking Groups. Parking behavior selection refers to a subjective choice that a certain driver would make after taking his own characteristics, socioeconomic attributes, and other factors into consideration when parking. In terms of behavior selection, the disaggregate model is widely used in many literatures. Based on various influencing factors, the selection model chooses the most effective scheme from

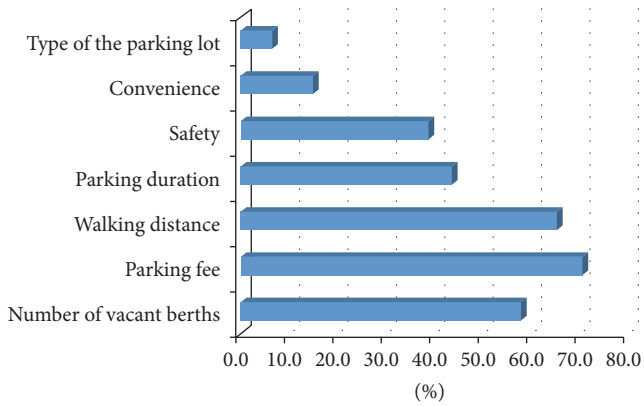

Figure 2: Statistical distribution of factors concerned most.

Table 2: Comparison of parking behaviors of four groups.

	Medical staff	Outpatients	Emergency patients	Visiting groups
Parking duration	Rigid	45% within 1 hour, 93% within 4 hours	61% within 1 hour, 94% within 4 hours	50% within 1 hour, 96% within 4 hours
Acceptable walking distance	—	8% under 100 meters, 46% over 500 meters	26% under 100 meters, 18% over 500 meters	10% under 100 meters, 37% over 500 meters
Most concerned factors	—	Parking fee and walking distance	Number of vacant berths and walking distance	Parking fee and walking distance
Waiting time	—	Relatively long	Rarely wait	Rarely wait

multiple alternatives. Therefore, selection results of different parking groups in hospitals are analyzed by this method.

The disaggregate model is based on the utility theory, that is, each option has a specific quantitative utility value. When travelers make decisions in a trip, they will choose one of the most effective options, which is the so-called maximum utility hypothesis.

Multinomial Logit Model [13–16] is used in the paper to explain the travelers' parking behaviors, given that the decision-making process of hospital parking lot users contains several alternatives.

3.3.1. Parameter Calibration of Multinomial Logit Model. According to the results of previous analysis, parking behaviors of four groups vary significantly due to different parking purposes and that of medical staff is relatively rigid; parking behavior selection models are constructed separately for only three groups, outpatients, emergency patients, and visiting groups.

(1) Selection of Variables. The variables of parking behavior selection models based on MNL are composed of two parts, the characteristic variables of travelers parking in hospitals and the characteristic variables of optional alternatives. Combining the parking behavior survey conducted in the previous section and the analysis of the influencing factors, the variables selected in the paper are illustrated in Table 3.

(2) Selection of Alternatives. As the influencing factors changes, the optional alternatives these three groups will choose are listed in Table 4 as follows.

(3) Parameter Calibration. Based on the questionnaire survey data, parameters in the parking behavior selection models are calibrated by Stata for three parking groups.

① *Outpatients*. The parameter calibration result is displayed as follows, in which Log likelihood is 90.578, LR chi2 is 47.36, and P value is 0, so the model is significant. In addition, Pseudo R^2 is 0.4116, indicating that the model fits well. It is suggested that variables of parking fee, walking distance, and parking duration are significant since the significance test proved that these factors were the important ones to the decision-making process of outpatients.

$$\ln\left(\frac{P_2}{P_1}\right) = -8.068 - 0.327X_1 - 0.966X_2 + 0.680X_3 + 0.704X_4 + 0.963X_5$$

$$\ln\left(\frac{P_3}{P_1}\right) = -16.110 + 0.217X_1 - 0.955X_2 + 0.683X_3 + 0.532X_4 + 1.772X_5$$

Table 3: Variables selected in the model construction.

Variables	Symbol	Values	Corresponding parameter
Age	X_1	21–30, 31–40, 41–50, 51–60, and over 60 years old take values of 1, 2, 3, 4, and 5 separately	θ_1
Income	X_2	Under 5000, 5000–10000, and 10000–15000 and over 15000 yuan take values of 1, 2, 3, and 4 separately	θ_2
Parking fee	X_3	Raised by under 30%, 30%–50%, 50%–80%, and 80%–100% and over 100% take values of 1, 2, 3, 4, and 5 separately	θ_3
Walking distance	X_4	Under 100, 100–300, 300–500, and 500–800 and over 800 meters take values of 1, 2, 3, 4, and 5 separately	θ_4
Parking duration	X_5	Within 1 hour and 1-2, 2–4, 4–6, and over 6 hours take values of 1, 2, 3, 4, and 5 separately	θ_5

Table 4: Alternatives that three parking groups will choose.

Alternative	Value	Symbol
Keep choosing hospital parking lots	Choice = 1	P_1
Postpone or advance parking	Choice = 2	P_2
Choose alternative parking lots	Choice = 3	P_3
Change the ways of traveling	Choice = 4	P_4

$$\ln\left(\frac{P_4}{P_1}\right) = -9.175 - 0.175X_1 - 1.276X_2 + 0.869X_3 + 0.882X_4 + 1.387X_5. \quad (1)$$

② *Emergency Patients.* Different from outpatients, due to the urgency of treatment, it is not likely that emergency patients will change the travel time or parking time under any circumstance. Therefore, the option of postponing or advancing parking is removed when modeling parking behaviors of emergency patients. After calibration, only walking distance is significant for emergency patients, as illustrated in Table 5.

③ *Visiting Groups.* Analogously, a conclusion is drawn from the calibration result that variables of income, parking fee, walking distance, and parking duration are significant.

3.3.2. Comparative Analysis on Parking Behaviors of Four Groups according to the Model. To sum up, parking behaviors of three different parking groups vary widely because of various parking purposes and their own characteristics.

(1) Visiting groups are affected by the most factors as a result of randomness of their traveling, such as income, parking fee, walking distance, and parking duration. Emergency patients own only one contributory factor considering their urgency of treatment, which is walking distance.

(2) Walking distance is the most significant factor among the three groups, while parking fee is more concerned in the decision-making process of outpatients and visiting groups.

(3) It can be found by comparison that the parameters of walking distance in the model of emergency patients overweigh those of outpatients. For emergency patients, the changes in the probability of parking choices caused by the change in unit walking distance is greater than that for outpatients, indicating that the emergency patient is more sensitive to the walking distance.

(4) Parking fee and walking distance can greatly influence the parking behaviors of different parking groups as these two factors passed all the tests of significance in different models.

4. Adjustment of the Time Window of Shared Parking

When the factors that affect the parking behaviors of different parking groups vary, parking occupancy will change accordingly, resulting in the changes of the occupancy curve and further the time window of shared parking.

4.1. Premise and Line of Thought. Because the sharing period at night is long and can basically satisfy the parking demand

Table 5: Parameter calibration of parking behavior selection models for emergency patients.

Choice	Coef.	Std. err.	z	$P > \|z\|$
1		(Base outcome)		
3				
X_1	0.0304	0.3283	1.09	0.926
X_2	0.5523	0.3648	1.51	0.130
X_3	−0.4332	0.3738	−1.16	0.246
X_4	0.9024	0.4125	2.19	0.029
X_5	0.5294	0.3641	1.45	0.146
_cons	−6.6961	2.2524	−2.97	0.003
4				
X_1	−0.1466	0.2675	−0.55	0.584
X_2	−0.6188	0.3010	−2.06	0.40
X_3	0.5789	0.3440	1.68	0.092
X_4	0.7792	0.3771	2.07	0.039
X_5	−0.2328	0.3251	−0.72	0.474
_cons	−2.4335	1.5856	−1.53	0.125

of other land uses nearby, no adjustment is applied to long-time shared parking, and adjustment is for short-time shared parking only. Given the rigidity of the parking demand of medical staff, the group is not taken into consideration when regulating.

By means of varying parking impedance to affecting the probability of parking behavior selections of four groups in different parking duration distribution, the number of parked berths in different time periods is changed so that the occupancy curve varies and the time window is adjusted. Based on the concept of time value in economics, the maximum time advanced or delayed that different groups can accept is calculated to determine the start point of a parking period under the influence of various parking impedance.

4.2. Tolerance of the Changes in Parking Time. Different from other types of land use, due to diverse parking purposes of travelers, only parts of the population are willing to adjust their arrival time to avoid the time period when parking fee in hospitals gets changed in a certain period. However, the tolerance of changes in parking time varies among different parking groups. The maximum value of acceptable adjustment time is confirmed according to the time cost of different parking groups.

(1) Time Perception Costs. As a resource, time is capable of creating value of goods in actual production activities. Time value refers to the monetary performance of the amount of benefit increase due to the passage of time and the amount of loss due to the nonproductive waste of time. In terms of the users of parking facilities in hospitals, because travelers will have a perception of cost on a certain trip, when changing the parking time, whether delayed or ahead of time, corresponding loss will be brought forth.

(2) Acceptable Degree of Time Adjustment. Owing to different parking purposes, the perceived time cost of the three groups is not the same; generally, emergency patients perceive more time cost than outpatients, and the visiting groups perceive the least. As a result of different time perception costs, the penalty cost of parking in advance or delayed varies accordingly.

As mentioned above, emergency patients are not contained in this section as it is almost impossible to change their arrival and departure time, so time adjustment is not implemented in this group.

Assume that the time value of outpatients, emergency patients, and visiting groups on scheduled time is τ_i yuan/minute; the penalty cost of parking in advance is τ_{iE} yuan/minute, and the penalty cost of parking delayed is τ_{iL} yuan/minute.

The significant factors influencing parking choice of these three groups are parking fee X_1 and walking distance X_2; when the two factors change, the extra cost travelers should bear is

$$z = \Delta X_1 \cdot t_i + \frac{\Delta X_2}{v} \cdot \tau_i, \tag{2}$$

where t_i denotes the parking duration of three groups, $i = 1, 2$ (represents outpatients and visiting groups respectively). ΔX_1 denotes the variation of parking fee, yuan/minute. ΔX_2 denotes the extra walking distance caused by saturation of the initial parking lot, meter.τ_i denotes the time cost of parking on scheduled time, yuan/minute. v denotes walking speed.

According to the penalty costs of different groups parking in advance or delayed, the maximum length of acceptable adjustment time ΔT_{ij} can be calculated:

$$\Delta T_{ij} = \frac{z}{\tau_{ij}}, \tag{3}$$

where j refers to arriving at parking lot in advance or delayed, represented by E and L, respectively.

4.3. Model of Adjustment of Time Window of Shared Parking. Parking behaviors of travelers will change along with the variation of parking impedance, thus influencing parking occupancy in different periods and further resulting in changes of the time window. Adjustment of the time window is to investigate the impact and its degree of different impedance on the time window of shared parking. The specific steps of the adjustment are as follows.

(1) Predict Berth Occupancy. According to the historical data, berth occupancy Q_t of each time period t is predicted by suitable models.

(2) Determine Initial Time Window of Shared Parking. The initial time window of shared parking is determined by the forecasting method established above.

(3) Assume Proportion of Three Groups. Since the arrival of different groups is random, for operability, the proportions of outpatients, emergency patients, and visiting groups are assumed according to actual situation.

(4) Determine the Number of Arrival in Different Duration Distributions. Using historical data to fit the parking duration distribution function, the number of arrivals R_{tm} in different duration m is determined.

(5) Calculate the Acceptable Adjustment Time of Each Group under Changed Impedance. After changing the parking impedance, that is, parking fee or walking distance, the acceptable adjustment time of each group can be calculated under different parking durations.

(6) Decide the Selection Probability under Changed Impedance. By building the parking behavior selection model, the probabilities that three groups make different choices under various parking duration distribution can be computed accordingly. Among them, the probability of maintaining the scheduled trip is recorded as P_1, and the probabilities of changing the start point of parking, choosing the alternative parking lot, and selecting another means of transportation refer to P_2, P_3, and P_4, respectively.

(7) Compute the Number of Arrivals under Changed Impedance R'_{tm}.

$$R'_{tm} = R_{tm} \cdot P_1 + R_{(t+n)m} \cdot P_2, \quad n = \ldots, -2, -1, 0, 1, \ldots, \tag{4}$$

where the statistical interval is set to be A minutes; if the acceptable adjustment time is $\Delta T_{ij} \in [0, A]$, it is considered that no changes take place in parking time, which means $n = 0$. If $\Delta T_{ij} \in [A, 2A]$, the parking time is adjusted to the previous (in advance) or the next (delayed) time period and $n = -1$ or 1, and so on.

(8) Adjust the Number of Departures in Different Time Periods D'_t.

$$D'_t = D_t - R_{(t-k)} \cdot (P_3 + P_4) \pm R_{(t-g)} \cdot P_2, \quad k, g = 1, 2, 3, \ldots. \tag{5}$$

The changes of the number of departures in a certain time period are composed of two parts, one is the number decreased because of changing parking lots or means of transportation by the travelers in previous time periods; the other is the number increased or reduced due to early or late arrival at the parking lots.

(9) Figure Out the Berth Occupancy under Changed Impedance Q'_t.

$$Q'_t = Q_{t-1} + R'_{tm} - D'_t. \tag{6}$$

(10) Redefine the Time Window of Shared Parking. Based on the berth condition and duration condition, the adjusted time window is redefined after changing the parking impedance.

5. Case Study

5.1. Time Window of Shared Parking under Varied Parking Fee

(1) Initial Conditions. The number of berths occupancy is predicted from historical data and the forecast interval is defined as 15 minutes. The initial time window for short-time sharing is 11:45–13:45. For convenience, it is assumed that, during the initial time window, 11:45-13:15 mainly serves emergency patients and visiting groups, accounting for 70% and 30%, respectively, while 13:15–13:45 mainly serves outpatients.

(2) Determination of the Variation of Parking Fees. In [17–20], when analyzing the impact of parking fee on parking behavior, the minimum variation causing changes in behaviors is set to be 1-2 yuan. Given the fact that the current parking fee in hospitals in Nanjing is 6 yuan/hour, the lower bound of variation in parking fee is 30%. Additionally, the upper bound is set to be 100% in consideration of the tolerance of raised parking fee and operability.

(3) Acceptable Adjustment Time of Each Group. Consulting the penalty cost mentioned in references [21], the time perception costs of each group are determined by the time value in Table 6.

The acceptable adjustment time of each group is calculated after raising the parking fee by 30% and 100%; the result is demonstrated in Table 7.

(4) Number of Arrivals and Departures in Different Time Periods under Changed Fee. Based on the parking behavior selection model, the selection probability of outpatients and

Table 6: Time perception costs of each group.

Parking groups	τ_E/(yuan/min)	τ/(yuan/min)	τ_L/(yuan/min)
Visiting groups	0.15	0.20	0.25
Outpatients	0.20	0.30	0.40

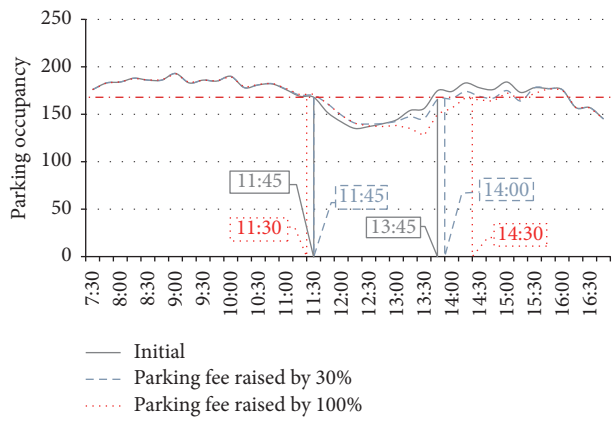

Figure 3: Time window after changing parking fee.

visiting groups is computed when the parking fee is increased by 30% and 100%. The emergency patients are not taken into consideration as they are insensitive to the change of parking fee. Then the number of arrivals and departures in each time period can be calculated.

(5) The Time Window after Changing Parking Fee. The occupancy curves are illustrated in Figure 3 after changing parking fee and the time window is redefined accordingly.

(a) When parking fee raises by 30%, the time window in the day becomes 11:45–14:00, extending backwards for 15 minutes. As the parking fee does not change too much, the inevitability of medical treatment results in the weak sensitivity so that the time window changes little.

(b) When increasing by 100%, the time window changes to 11:30–14:30, with 15 minutes ahead and 45 minutes backwards. The sensitivity to parking fee gets enhanced so that the magnitude of changes of time window increases accordingly.

In general, due to the particularity of hospital parking population, although the rise of parking fee can change the start and end point of parking time to some extent, the variation scope is limited and relatively small.

5.2. Comparison of Different Parking Impedance. The same method is adopted to explore the changes of the time window when proportion and walking distance vary, illustrated in Table 8.

(a) No matter parking fee or walking distance, changes in parking impedance are bound to influence the initial time window of shared parking.

(b) In terms of start and end point of the time window, the effect of impedance on the end point is larger than that on the start point. Because the start point of initial time window is 11:45 and it is close to the lunch time; the influence caused by various factors remains little.

(c) Among the three types of flexible travel groups, visiting groups are the most vulnerable to external factors, and the emergency patients are the least.

6. Conclusions

Based on the time-varied characteristics of parking demand and the prediction method of time window of shared parking in hospitals, some conclusions have been drawn from the research.

(1) This paper divides parking population in hospitals into four groups, medical staff, outpatients, emergency patients, and visiting groups in order to explore the parking behaviors of each group more precisely.

(2) From the results of survey, medical staff own a rigid parking demand, and their parking behavior is almost free from the external factors. Due to the urgency of illness, the influence of parking impedance, especially parking fee, on emergency patients is relatively small. Moreover, parking fee is the most significant factor impacting parking behavior of outpatients and visiting groups, while walking distance is a sensitive factor of all the three groups.

(3) Multinomial Logit Model of parking behavior selection was established for outpatients, emergency patients, and visiting group, and the differences in the decision-making process were analyzed quantitatively to make up for the deficiency of qualitative analysis.

(4) The procedure of adjustment of time window of shared parking is put forward by introducing the concept of time value and then verified with a case in Nanjing First

Table 7: Acceptable adjustment time.

Parking duration	Raised by 30% (minutes)				Raised by 100% (minutes)			
	Outpatients		Visiting groups		Outpatients		Visiting groups	
	Early	Late	Early	Late	Early	Late	Early	Late
Within 1 hour	5	3	7	4	15	8	20	12
1-2 hours	15	8	20	12	40	23	50	35
2-3 hours	25	13	33	20	72	38	90	56
3-4 hours	25	18	47	28	94	53	110	74
Over 4 hours	50	23	60	36	118	65	140	103

Table 8: Comparison of different parking impedance.

Impedance	Proportion A^*	Proportion B^*
Initial	11:45–13:45	11:45–13:45
Parking fee raised by 30%	11:45–14:00	11:45–14:30
Parking fee raised by 100%	11:45–14:15	11:15–15:00
100-meter walking distance	11:15–14:15	—
800-meter walking distance	11:45–14:00	—

Note. * Proportion A refers to emergency patients and visiting groups account for 70% and 30%, respectively, while proportion B refers to emergency patients and visiting groups account for 30% and 70%, respectively.

Hospital. A conclusion is reached that the start and end point of time window mainly depend on the magnitude of parking impedance, of which visiting groups are the most vulnerable to external factors and emergency patients are the least.

However, there is a large margin of improvement for future research. This research only illustrated the impact of parking behaviors of each parking groups on sharing strategies but did not present the feedback effect of shared parking strategies on parking groups, which is to be explored in the next stage.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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