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The Forecasting Model of Bicycle Parking Demand on Campus Teaching and Office District

Junbin Xu[a], Zhiyong Zhang[a] , Jian Rong[a*]

[a]*Key Lab of Transportation Engineering of Beijing, Beijing University of Technology, P.O. Box 100124, Beijing，China*

Abstract

In order to forecast the demand of the campus teaching and office district bicycle parking generation rate more accurate with the introduction of multi-model, which regarding affects are not carried on more considerations with the other parking demand influencing factor according to the actual investigation and study data. The paper analyzes the three types of regional architecture characteristics of bicycle parking demand, and gives the parking demand - supply forecast model which based on the parking generation rate model. The model considers the trip distance, parking distance, the facility cycling rate and the use factor which are also integrated in the model, thus obtains the number of bicycle parking facility which should construct actually. Finally the paper proposes a calculation example to expound the practical application of this model.

Keywords: campus; teaching and office district; bicycle; parking demand; forecasting model introduction

1. Introduction

To use and management convenient, a relatively well-equipped campus will frequently concentrate the building facilities according to the different characteristics of the used functions .Form a few different function areas, the most core functional areas as follows: the teaching and office district. The teaching and office district which is the most teachers and students often proceed towards in the daily life, their constructions mainly include the teaching facilities (classroom building, laboratory and so on), public

* Corresponding author. Tel.:+ 8610-15210835052; fax: +8610- 6739-1509.
E-mail address: haha19871105@126.com.

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facilities (library, etc) as well as the administrative office buildings. The core behavior of the teaching and office district is taking class, Self-study and administration. The subject of trip are the teachers and students in the university, and the major travel tools is the bicycle.

The campus teaching and office district area attracts a large amount of bicycles which can be found by actual research, the parking generation rate model is conventionally employed in forecasting the bicycle parking demand. Although you can calculate more quickly within the region according to the university campus teaching and office buildings which use different types of indicators. However, the different calculation model type is for the construction of bicycle parking facilities which does not conduct a good survey on the bicycle parking rate, and some buildings would have a bicycle parking of the relative concentration time in the peaks. Sometimes the bicycle parking facilities will be no place to park, sometimes there are so many unoccupied parking space. With the carefully analyzed on bicycle parking demand data and corresponding influence factor, and it is necessary to give a set of suitable the campus teaching and office district forecasting method of bicycle parking demand.

The parking demand forecast model in this research area, domestic and foreign experts, scholars have carried out some researches. The main object of their researches are in urban transport within the more important vehicle parking demand forecast. According to projections used by the different parking requirements based data. The parking demand forecast model will be divided into the following three categories: The parking generation rate model, based on correlation analysis of parking demand forecast model, the traffic - parking demand model.

Combination of these three predictions as well as advantages and disadvantages of each method of application conditions, the paper decides to adopt this model in the parking generation rate based on parking demand - supply forecast model. Consider the bicycle parking properties in the campus teaching and office district, the parking demand from the effects of bicycle parking, thus the obtained should be the construction of the actual number of bicycle parking facilities.

2. The analysis of the campus teaching and office district bicycle parking characteristic

Due to the different core behavior of the three teaching building in the campus teaching and office district, the different travel time leads to different bicycle parking demand, therefore this paper according to relevant traffic survey and analysis, analyzed from various views which the different behavior of bicycle parking in the three kinds of architectural in the campus teaching and office district. The parameter demarcation builds the foundation for the parking demand forecast model.

2.1. Different distribution of the bicycle parking time

To study the distribution of the bicycle parking time has an important meaning, the different building types among the university teaching office area do not have the same peak parking periods. Therefore if the buildings cluster distance is quite near, they can share collaborative parking resources. With the investigation and analysis from the parking accumulative total distribution which can see various buildings bicycle parking has the obvious peak time in the campus teaching and office district.

The school buildings which the peak time is at 9:30 am and 15:30 pm, mainly are between the first and the second class and between the third and the forth class of this recess period parking demand is large in the campus teaching and office district. The teachers and students goes on a journey the more frequent time section, the peak period is from 9:30 to 11:30 which lasted two hours.

The library of the campus teaching and office district which the peak time is at 9:45 am and 15:15 pm, the peak time is just as the same as teaching building. The teachers and students are often willing to go to

the library to have self-study and enrich their extracurricular life, after the first two classes, the peak period is from 9:45 to 11:15 which lasted for one and half hours.

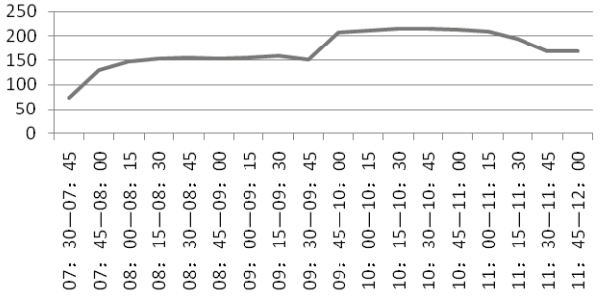

Fig. 1. The distribution of teaching building bicycle parking demand

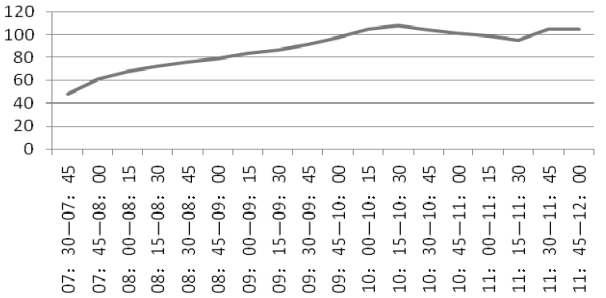

Fig. 2. The distribution of library bicycle parking demand

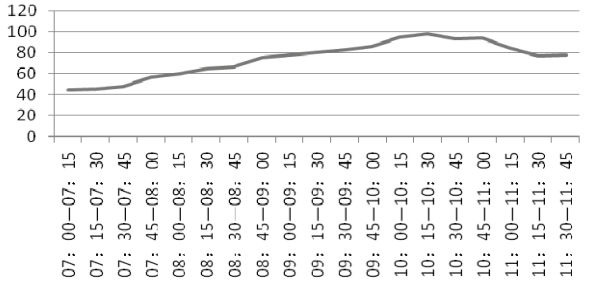

Fig. 3. The distribution of building bicycle parking requirements

The office building of the campus teaching and office district which the peak time is at 9:45 am and 15:00 pm, just because of the main and travel of the bicycler habits .The teachers and students are often used to work in the middle of the travel time period, the peak period is from 9:45 to 11:15 which lasted for one and half hours.

According to the graph you can clearly find from the 11:30 to 12:00 lunch period, there are many bicycles to park in the original parking facility. The main reason is the distance from the teaching and office district to dining room is not very far. The teachers and students are willing to take the walk place of the riding bicycle in this time section, therefore the corresponding bicycle parking demand will have a small down trend. But the magnitude of the drop is not fast and great.

2.2. Different length of bicycle parking time

The length of bicycle parking time can reflect the characteristics of bicycle parking resources occupation, and then calculate the district parking facilities of the turnover. The calculation of the university campus as an important indicator of demand for bicycle parking, the classroom building, the library as well as the office building bicycle parks when long carries on the investigation and study, get these value of three kinds of architectures in the peak time bicycle parking facilities ratio, used as the teaching office campus parking demand model calibration in the turnover rate to be considered.

Table 1. The length of bicycle parking time in the campus teaching and office district

Proportion (%)	Parking time (min)						Average expectation
	0－30	30－60	60－120	120－180	180－240	＞240	
Teaching building	6	5	28	27	32	2	140 min
Library	26	14	15	26	18	1	100 min
Office building	37	15	7	7	32	2	100 min

By the above table, self-study is the core behavior of the teaching building. The parking time is less than 2 hours which accounts for the total 39%, the parking time is 2-4 hours has accounted for 61%. Therefore it may obtain the length of bicycle parking time is about 140min in the teaching building. According to the distribution of bicycle parking demand which the peak time is last for 2 hours, may obtain the single parking facility cycling rate of the teaching building is probably 0.85.

Borrowing books as the main behavior in the library, its parking time is less than 1 hour has accounted for 40%. Self-study is the core behavior of the library, the parking time is 1 hour or more accounted for 60%, Therefore it may obtain the length of bicycle parking time is about 100min in the library. According to the distribution of bicycle parking demand which the peak time is last for 1.5 hours, may obtain the single parking facility cycling rate of the library is probably 0.9.

Work as the main behavior in the office building, its parking time is 1 hour or more accounted for 48%. But the work is just as the core behavior in the office building, the parking time is less than 1 hour of proportion accounted 52% of the total, Therefore it may obtain the length of bicycle parking time is about 100min in the office building. According to the distribution of bicycle parking demand which the peak time is last for 1.5 hours, may obtain the single parking facility cycling rate of the office building is probably 0.9.

3. The bicycle parking demand - supply forecast model in the campus teaching office district

3.1 The analysis of factors affecting demand for bicycle parking

The bicycle is the major travel tool in the most campus teaching office district, the parking demand is affected by the number of students within the campus, the ownership of bicycles' level, the campus teaching office different utilization condition of land affect the different bike attraction rate and bicycle parking facilities and utilization ratio, trip distance of departure from the destination, the distance between the destination and the bicycle parking facilities, and the level of parking service(including parking safety, parking comfort, etc.) and many other factors.

Table 2. The effect factors of the bicycle parking facilities in the campus teaching office district

Sort Properties	Selection sequence（%）				Average expectation
	1	2	3	4	
Travel distance	34	29	21	16	2.19
Parking distance	39	38	12	11	1.95
Parking capacity	20	19	42	19	2.6
Service level	6	15	25	54	3.27

This paper is just to understand how two important factors (travel distance and stopping distance) affect the teachers and students the way of the influence degree of the travel decision in the campus teaching office district. This way to survey the various influencing factors with the appropriate research, the survey results are shown as Fig. 4.

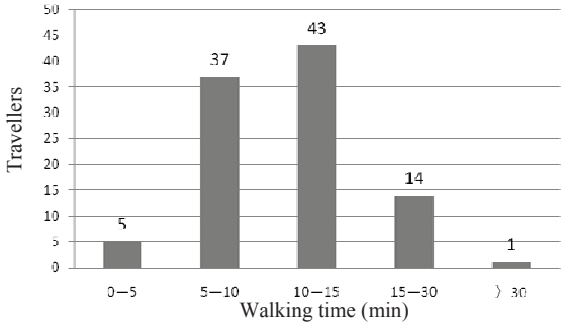

Fig. 4. The general distribution of teachers and students travel distance in the campus

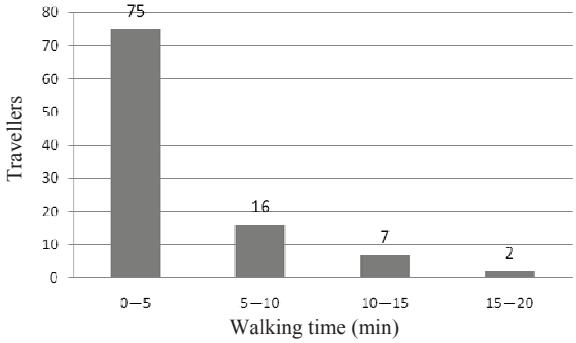

Fig. 5 The acceptable probability distribution of students and teachers parking within walking distance

The teachers and students travel time of the campus is in general distribution mainly concentrates on foot 5-10 minutes time and 10-15 minutes, which occupied the total separately 37% and 43%. The teachers' and students' travel time may refer to the normal value which according to the campus journey present situation selection walk time 10-15 minute achievement university campus, whichever is the impact rate of 1, travel from the other sections according to their impact on the rate and the percentage derived by dividing the percentage of the standard value. It can be found walking for 15-30 minutes and 30 minutes of bike riding was low, the instead of less by bicycle to the teaching work area, this may be

due to the distance to their destinations is too far away. Resulting decline in the rate to attract students and thus affect the part of the trip proportion of the total occupied population.

The teachers and students travel acceptable parking walking distance of time mainly concentrated in 0-5 minutes and 5-10 minutes which are accounted for 75% and 16% on campus. Selected according to the campus parking status are 0-5 minutes walking time as the teachers and students can stop walking distance of the reference standard value. Takes its influence rate is 1, the other parking within walking distance of the percentage rate based on their percentage of the standard divided by the value derived.

3.2 The parking demand-supply forecasts model

(1) The forecast model

$$x_i = \frac{\alpha_i \times R_i}{\rho_i \times \gamma_i} \times \eta_i \times \varepsilon_i \quad (1)$$

where x_i is for the campus class i construction which is the bicycle parking demand in the rush hours; α_i is for the campus class i construction which is the bicycle parking demand in the rush hours; R_i is for the campus class i construction which is the number of trips during peak hours to attract; ρ_i is for the campus class i construction which is the bicycle parking facility cycling rate during the peak hours(when $\rho_i<1$， it takes 1); η_i is for the campus class i construction which is the influence rate of the bicycle travel distance; ε_i is for the campus class i construction which is the influence rate of bicycle parking distance.

(2) The use of the forecast model

This model is based on the basis of the parking generation rate model, added the rate of bicycle parking turnover and utilization in the peak period, and considering the influence of the factors affecting the corresponding rate. To get the demand number of the bicycle parking facilities in the campus teaching and office district.

a) ρ_i is the number of the average number of vehicles parked in the each bicycle parking facilities in the campus teaching office the peak period. When $\rho_i> 1$, indicating the supply is less than demand, the number of parking facilities have been able to meet the projected parking demand; When $\rho_i <1$, the description of supply is greater than demand, the number of parking facilities, it is necessary to add an appropriate facility to meet the parking demand; When $\rho_i = 1$, the description of the supply is equal to demand.

b) γ_i is the actual amount of bicycle parking facilities and parking supply capacity ratio, the parking facility use factor γ_i with arrives in this region bicycle's stopped time as well as the parking cycling rate ρ_i related. The corresponding to the length of parking time and turnover are improved, the utilization of parking will be corresponding increased, these reduces the correspondingly parking facilities number.

c) The bicycle parking facilities η_i, ε_i of parking facilities will have an impact on demand. After reading the literature and field research results can be found, when travel distance is more than campus teachers and students can accept the biggest walking distance, there are a large part of the trip to choose the bicycle as the travel tool; When the parking distance is greater than a certain value, there are some travellers will choose other transportation instead of riding a bicycle; and when the level of bicycle parking service have corresponding improved, The use of bicycles as a travel tool is more attractive for the travellers, the bicycle parking in accordance with these parameters can be described in the property to determine the measurement of the corresponding value.

4. The calculation example

It forecasts the bicycle parking demand and combines with the forecast data with all kinds of parking facilities, they are just to meet the parking demand in the campus teaching and office district. With the

investigation and the bicycle parking characteristics which are the three kinds of the building in the campus teaching and office district, such as table 3, 4 shows:

Table 3. The three types of bicycle parking demand in the campus teaching and office district in the peak time

Facility type	α_i (parking/100 people)	R_i / people	$\alpha_i \times R_i$
Teaching Building	10.8	1120	121
Library	26.1	161	42
Office building	23	161	37

Table 4. The facility cycling rate , utilization ratio and the influence rate of factors in the peak time

Facility type	ρ_i	γ_i	η_i	ε_i
Teaching Building	0.85	1.5	1	1
Library	0.9	1.2	1	1
Office building	0.9	0.8	1.15	1

According to the survey data in the table, applied the parking demand - supply forecast model to obtain the construction of three buildings required bicycle parking facilities as follows:

$$x_1 = \frac{\alpha_1 \times R_1}{\rho_1 \times \gamma_1} \times \eta_1 \times \varepsilon_1 = 95 = 100 \qquad \alpha_1 \times R_1 = 121 = 130$$

$$x_2 = \frac{\alpha_2 \times R_2}{\rho_2 \times \gamma_2} \times \eta_2 \times \varepsilon_2 = 39 = 40 \qquad \alpha_2 \times R_2 = 42 = 50$$

$$x_3 = \frac{\alpha_3 \times R_3}{\rho_3 \times \gamma_3} \times \eta_3 \times \varepsilon_3 = 59 = 60 \qquad \alpha_3 \times R_3 = 37 = 40$$

Predicted value of parking demand - - supply forecast model compares with predicted value of parking production rate model, the first one is better than the second one.

5. Conclusions

With the questionnaire survey and the actual research form, identified the bicycle parking demand within the length of peak time, parking duration, the rate of utilization and turnover in the campus teaching and office district.

Table 5. The university teaching office building parking index survey result

Building type	Index value				
	The attraction rate	The peak time	The park length	The turnover rate	The utilization rate
Teaching Building	10.8 parking/100 people	120min	140min	0.85	1.5
Library	26.1 parking/100 people	90min	100 min	0.9	1.2
Office building	23.0 parking/100 people	90min	100 min	0.9	0.8

Table 6. The two kinds of influence rates in the campus teaching and office district

Factor	Time					
	0–5min	5–10 min	10–15 min	15 –20 min	16–30 min	> 30 min
Trip distance	0.12	0.86	1	-	0.33	0.03
Parking distance	1	0.22	0.09	0.03	-	-

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