Urban Public Transport Choice Behavior Analysis and Service Improvement Policy-making: A Case Study from the Metropolitan City, Chengdu, China.

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ABSTRACT

As the metropolitan city in Western China, Chengdu has been suffered from serious traffic congestion. The strategy of urban public transport priority was put into agenda to relieve traffic congestion. But the public transport sharing rate is only 27% in Chengdu which is much lower than the developed country. Consequently, it is of great importance to study the measures to improve the service, and provide technical support to the policy-makers. This paper selected the traffic corridor between Southwest Jiaotong University district and downtown as the experiment subject. The orthogonal design method was used to generate stated preference questionnaires. Some variables were used to define the utility of the three alternatives and construct the Logit model. Then, the relationships between the cost, time variable and the choice probability of the public transport were analyzed. According to the results, we found that the workability of Multinomial Logit (MNL) Model was better than Nest Logit (NL) model. The low bus ticket price cannot achieve good result except for increasing the stress of the government finance. We also put forward some effective measures to improve the level of service, including built Bus Rapid Transit systems, reducing the access time to Metro and bus stop, limiting parking supply to control the car use.

INTRODUCTION

With the rapid development of urbanization in China, congestion has been an important issue that has a considerably negative impact on the further development of the society. Among various congestion reduction measures, public transit is regarded as an effective and desirable strategy, Therefore, providing transit service has become a priority. However, the transit service is still far from satisfactory in terms of coverage and service quality, the transit cannot support the public transport priority policy to relieve the congestion. We must improve the service of the transit according to the science analysis.

As one of the most important international metropolitan cities in Western China, Chengdu is experiencing rapid urbanization and population growth. The population of the whole municipality has exceeded 14 million, of which eight million inhabitants are in the 598 square kilometers main urban area with density up to 7,400 inhabitants per square kilometer. According to Chengdu 2012 census, the average GDP of Chengdu resident has increased to more than $9000(*1*). more and more people can afford a private vehicle and there are more than 1000 new vehicles registration issued every day Currently, vehicle ownership in Chengdu is as large as 2 million, ranked the third place of metropolitan cities in China. However, high vehicle ownership deteriorates the traffic congestion problem in Chengdu. According to the latest survey, the traffic demand on many arterials in the urban area is approaching the capacity during morning and evening peak periods. Thus, it is critical to evaluate and prioritize transportation demand management strategies to mitigate congestion. Two different approaches are to develop public transport (include metro and surface transit) and to reduce the use of personal vehicles. After first applied in 1960's, the discrete choice model is widely adopted in the transportation policy evaluation and policy establishment. The in-depth understanding of travel demand is important to determine the public transit development strategies. As the critical mode in urban transportation system, the public transit plays an essential role in relieving and alleviating current urban traffic congestion, especially when the transit is the only means to solve the congestion problem. Accordingly, the modal choice preference of passengers under the different level of service conditions and the primary attributes that significantly affect their transit choice decisions are analyzed so that the current bus transit level of service can be improved with high effectiveness and efficiency.

The paper explores the impacts of diverse factors on the traveler choice behavior utilizing the survey data by SP questionnaire. The questionnaire is designed by the orthogonal design. Therefore not only the factors that influence the choice behavior can be identified, but the LOS of transit providing to the travelers can be guaranteed.

Literature review

The discrete choice model research belonged to the content of micro-econometrics when it is first introduced in 1950's. The theoretical fundamental of the discrete choice models is the random utility theory. This model can analyze both individual and household's behaviors which is sensitive to the traffic policy. Discrete choice model is widely used in the demand prediction and analysis, evaluation of the effectiveness of the traffic strategies, such as park-and-ride operation, congestion pricing, and electronic toll collection, etc. Among the practices of public transit LOS study, many of researches are from the perspective of management and operation cost(*2-4*), while the researches that investigate important factors in the travelers mode choice behavior to support urban transportation management decisions are not thorough. Eboli examined the level of service of the public transit, and adapted MNL model to analyze the essential factors that shape passenger's service satisfaction and compute quality index of transit service(*5*).Tirachini obtain the best operating scenario after comparing the different transit operating cost, profit and welfare conditions and he presented that the minimum waiting time and cost can be achieved if transit operates under the optimized environment while rail transit can increase the minimum in-vehicle time value(*6*).Garrido used discrete choice model built on the basis of SP survey data to calculate the public transit service weight, and then applied the ordered results in accordance with the importance of the attributes by public transit passengers to the general linear planning method to examine different level of service weights and then the comparison between the outcomes was made(*7*). Pina pointed out that the public sector management produced more favorable performance than private sector based operation from the perspective of urban public transport efficiency after comparing the transit services provided by private company and government sponsored company in Catalonia area, Spain(*8*).

The discrete choice model has been applied in various professional researches since it was introduced. Currently, Many researches on public transit are conducted from the perspective of management and operation cost, whereas the researches that investigate important factors on the travel mode choice decision-making behavior to support urban transportation management decisions are relatively scarce. As a critical mode in urban transportation system, the public transit plays an essential role in relieving and alleviating current urban traffic congestion, especially in China where the transit priority development is considered to be the only feasible option. Therefore, the state-of-art discrete choice model is applied to analyze the preference of passengers under different levels of service conditions and determine the attributes that significantly affect their travel choice behavior, in order to improve the public transit service efficiency. The study does not only provides valid decision support to transit LOS improvement strategy, but also promotes the knowledge of discrete choice model application in China

THE STATED CHOICE SURVEY DESIGN

As is illustrated in Figure 1, traveler's travel mode preference is collected between Southwest Jiaotong University (SWJTU) areas and downtown areas (Tianfu Square) through Preference Survey under different level of services.

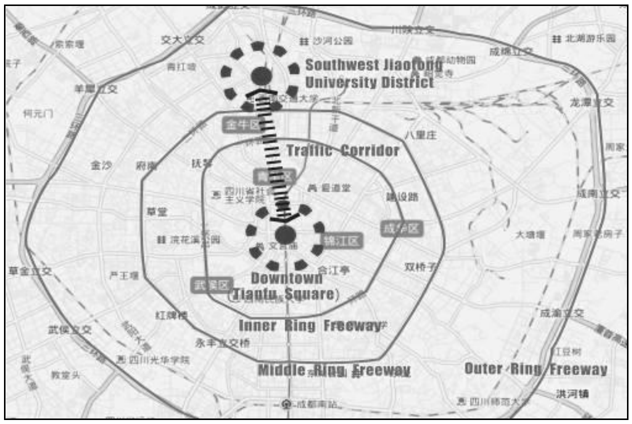


Figure 1 Transport corridor between SWJTU district and downtown

The alternative sets including in this study bus, metro, and car. It is worth noting that Taxi is not included in the alternative set because the primary objective of the study is to analyze the impacts of bus LOS on choice behaviors, instead of mode split in corridor. Consequently, the attributes of the alternatives are cost, in-vehicle time, waiting time, access time and egress time etc. The alternative specified attribute for car is the parking time defined as the time to find a spot to park. The attributes are illustrated as Table 1.

Table1. Level of alternative attributes

Travel Mode	Attributes	Level 1	Level 2	Level 3
Bus	Cost	1	3	
	Waiting Time	5	10	15
	In-vehicle Time	40	60	
	Access Time	5	10	15
	Egress Time	5	10	15
Metro	Cost	2		
	Waiting Time	5		
	In-vehicle Time	10		
	Access Time	10	20	
	Egress Time	10		
Car	Cost	30		
	In-vehicle Time	25		
	Egress time	5	20	

The full factorial design has shown to negatively influences on survey since the number of attribute combination is large. Thus orthogonal design was chosen to achieve appropriate attributes combinations. The orthogonal design would ensure the independence of each attribute and keep off incorrect results translated from rooted multicollinearity problem of the attribute. The accuracy of model results can be improved effectively. The paper applies orthogonal design to obtain 16 mutually orthogonal attribute combinations .Table2 shows an example of stated choice experiment.

Table 2 Choice task example of the stated choice experiment

Travel mode	Cost	Waiting time	In-vehicle time	Access time	Egress time	Parking time
A Bus	3	10	60	5	10	0
B Metro	2	5	10	10	10	0
C Car	3	0	25	0	0	5
Your choice :						

DESCRIPTIVE ANALYSES OF THE DATA

The main objective of the stated preference survey is to obtain the choice preference of respondents towards new metro between SWJTU district and downtown areas. In this paper, face-to-face surveys were conducted. The total number of valid samples acquired from the survey is 1552. By establishing four age intervals, each questionnaire was able to collect the age information from the surveyed sample population. The average age of survey samples is 32. Similarly, five income ranges were established to evaluate the income levels of the respondents. The corresponding survey sample attributes of each questionnaire are shown in Table 3. The monthly average income of survey samples is 3445(Yuan). The gender rate between male and female is 1.02. All those are consistent with the last city wide census, which indicate that the sampling bias is minimal. Besides, the trip purpose from SWJTU district to downtown areas is almost shopping and entertainment, which is reasonable and predictable because downtown areas is the central district of commercial, leisure, and cultural activities. The rate of car ownership is about 30% and is a result of the fact that the rate of vehicle possession in Chengdu ranks first in the whole nation.

Table 3 Statistical results of the surveyed sample population

Sex	Number	Ratio	Trip purpose	Number	Ratio
Man:1	784	50.5%	Shopping	842	54.2%
Female:0	768	49.5%	Entertainment	542	34.9%
Car ownership			Working	97	6.3%
Yes:1	459	29.57%	Go to school	7	0.5%
No:0	1093	70.43%	Other	64	4.1%
Income			Age		
＜2000	399	25.7%	18~24	393	25.3%
2000~4000	681	43.9%	25~50	1027	66.2%
4001~6000	327	21.1%	51~60	78	5.0%
6001~8000	92	5.9%	>60	54	3.5%
＞8000	53	3.4%			
Total	1552	100%	Total	1552	100%

As aforementioned, the orthogonal design can guarantee the independence between each alternative attributes. It is worthwhile verifying the independence. The common practice is to calculate the auxiliary linear regression coefficient R for each alternative and compare with the testing threshold value as 1.94. Then, each R value for all alternatives is obtained as shown in Table 4.

Table 4 the orthogonal test results of the stated preference experiment

Alternative	R_{cost}	$R_{waiting\ time}$	$R_{in\text{-}vehicle\ time}$	$R_{access\ time}$	$R_{egress\ time}$	$R_{parking\ time}$
Bus	0.845	0.437	0.2	0.497	0.337	0
Metro	0	0	0	0.301	0	0
Car	0	0	0	0	0	0.617

As shown in Table4, the auxiliary regression coefficient of cost in bus alternative is 0.854 which is below the threshold value as 1.94 defined before. Thus, it can conclude that there is a favorable orthogonality between cost attribute of bus and other attributes of bus alternative. Similarly, the orthogonality of attributes in the three alternatives (see Table 3) is also ensured. Therefore the validity and accuracy of the model results can be ensured because the multicollinearity cannot influence the model results.

MODEL CONSTRUCTION

The utility function that the alternative *i* will be chosen by traveler *n* can be expressed as following(*9*).

$$P_n(\mathrm{i}) = P(U_{ni} \geq U_{nj}) \quad (1)$$

In random utility theory, utility is considered to be a stochastic variable and the utility function is classified into two categories which are presumed to display a linear relationship, that is, one is deterministic component V and the other is random error ε. So the utility function of alternative i for the traveler n is

$$U_{ni} = V_{ni} + \varepsilon_{ni} \quad (2)$$

When random error ε are assumed to be independently and follow the Gumbel distribution, the general formula of Multinomial Logit (MNL) model can be written as

$$P(i) = \frac{e^{V_{ni}}}{\sum_{j \in C_n} e^{V_{nj}}} \quad (3)$$

According to alternative attributes analyzed during the questionnaire design process and the basic formulation of Logit model utility function, the alternative attribute utility variable and traveler's utility variables can be presented as Table 5 and 6

Then the utility functions of three alternatives can be formulated as equation (4).

$$\mathrm{V}_{(\mathrm{bus})} = \mathrm{ASC}_1 + \beta_1 \times X_{11} + \beta_2 \times X_{12} + \beta_3 \times X_{13} + \beta_4 \times X_{14} + \beta_5 \times X_{15} + \beta_7 \times X_{17} + \beta_9 \times \mathrm{X}_{19} + \beta_{11} \times X_{111}$$

$$\mathrm{V}_{(\mathrm{metro})} = \mathrm{ASC}_2 + \beta_1 \times X_{21} + \beta_2 \times X_{22} + \beta_3 \times X_{23} + \beta_4 \times X_{24} + \beta_5 \times X_{25} + \beta_8 \times X_{28} + \beta_{10} \times X_{210} + \beta_{12} \times X_{212}$$

$$\mathrm{V}_{(\mathrm{car})} = \beta_1 \times X_{31} + \beta_3 \times X_{33} + \beta_6 \times X_{36} + \beta_{13} \times X_{313} \quad (4)$$

Where, V denotes the utility function

ASC_1 and $ASC_2$are the alternative-specific constant variables;

X_{ni} denotes utility variable, $i=\{1, 2, \ldots, 13\}$, $n=\{1, 2,3\}$

β_i denotes the unknown parameter of utility function , $i=\{1, 2, \ldots, 13\}$.

Table 5 Utility definition of constant and alternative specific

Utility	Constant		Alternative-specific					
			Cost	Waiting time	In-vehicle time	Access time	Egress time	Parking time
Variable	ASC_1	ASC_2	X_{n1}	X_{n2}	X_{n3}	X_{n4}	X_{n5}	X_{n6}
Bus(V_{n1})	1	0	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	*0*
Metro(V_{n2})	0	1	X_{21}	X_{22}	X_{23}	X_{24}	X_{25}	*0*
Car(V_{n3})	0	0	X_{31}	*0*	X_{33}	*0*	*0*	X_{36}
Parameter	ASC_1	ASC_2	β_1	β_2	β_3	β_4	β_5	β_6

Table 6 Utility definition of decision-maker

Utility	Decision-Maker						
	Age_1	Age_2	$Income_1$	$Income_2$	Sex_1	Sex_2	Car ownership
Variable	X_{n7}	X_{n8}	X_{n9}	X_{n10}	X_{n11}	X_{n12}	X_{n13}
Bus(V_{n1})	X_{17}	*0*	X_{19}	*0*	Male:1 Female:0	0	0
Metro(V_{n2})	*0*	X_{28}	*0*	X_{210}	0	Male:1 Female:0	0
Car(V_{n3})	*0*	*0*	*0*	*0*	*0*	*0*	Yes:1 No:0
Parameter	β_7	β_8	β_9	β_{10}	β_{11}	β_{12}	β_{13}

MODELING RESULTS

Table 7 shows the MNL and NL model estimation parameter results. The Nlogit software is selected to calibrate the parameter which is the premier tool for estimating discrete choice models(*10*).

The MNL and NL models are applied in this paper. In the NL model the bus and metro alternative are merged into public alternative level while car stays at a single level as private alternative. The IV value of the public alternative level is falling into the range from 0 to 1 and statistically significantly. The results validate the division of NL model level structure is true. As be shown in table6, the value of goodness-of-fit of NL model (ρ^2=0.208) is slightly exceeding the MNL model (0.208). But the difference between them is not big enough to show NL model performs much better than MNL model. So, in this paper the hypothesis test is used to test the statistical significance between NL and MNL model. The hypothesis test is correlation about the value of IV and 1 which is defined as T-test. The hypothesis test can be shown as follow:

H_0: the NL model can be integrated into MNL model

H_1: the NL model cannot be integrated into MNL model

The T-test value can be computed by the equation 5

$$\text{T-test} = \frac{\text{IV} - 1}{\text{Stderror}} \quad (5)$$

With substituting the *IV* and Stderror values with 0.685 and 0.307, respectively, the T-test value was -1.02. The value is falling in to the rejection region *(-∞,-1.96) ∪(1.96,+∞)* The results indicated that the null hypothesis cannot be rejected within the 5% confidence interval, which mean NL model can be integrated into MNL model. Finally, the MNL model parameter estimation results are determined as the ultimate results.

Table 7 the MNL and NL model estimation results

Variable	Multinomial Logit	Nested Logit
Bus constant	-5.138（-2.963）	-8.466（-1.576）
Metro constant	-4.819（-2.774）	-8.169（-1.513）
Cost	-0.381（-6.452）	-0.387（-6.461）
Waiting time	-0.007（-0.511）	-0.008（-0.614）
In-vehicle time	-0.016（-2.723）	-0.016（-2.754）
Access time for metro	-0.096（-8.674）	-0.103（-8.576）
Access time for bus	-0.04(-2.800)	-0.041(-2.786)
Egress time	-0.022（-1.595）	-0.023（-1.594）
Parking time	-0.063（-4.431）	-0.065（-4.533）
Sex-Bus	-0.841（-3.544）	-1.199（-1.969）
Sex-metro	-0.783（-3.476）	-1.136（-1.892）
Age-bus	0.197（2.838）	0.245（2.035）
Age-metro	0.049（0.724）	0.098（0.815）
Income-bus	-0.903（-7.496）	-1.220（-2.545）
Income-metro	-0.581（-5.336）	-0.889（-1.897）
Car	3.016（9.464）	3.007（9.463）
Inclusive value parameters(IV)		
Public		0.685（2.229）
Private		1（Fixed Parameters）
Log likelihood function	-1137.128	-1136.633
Number of observes	1552	1552
ρ^2	0.2085	0.2088

Note: t-values are in brackets in columns two and three.

The alternative specific constant represents the average impact of some factors that are not included in the explanatory variables on the traveler's utility. The bus constant and metro constant obtained from the MNL model are both statistically significant. Because of some non-quantifiable variables aren't included in the explanatory variables, such as, safety, comfortable.

In-vehicle time is generic variable for three alternatives. The parameter symbol is correct and statistically significant. Currently, the distance between the corridors is 12 kilometers, but the average travel time for the bus is relatively long. (Approximately 40 minutes).when the new metro will operate the In-vehicle time can reduce to 10 minutes the choice probability of metro will be improved significantly.

The cost is also generic variable. In addition, the cost of private car is the total of fuel cost and parking fee while the cost of bus and metro is the ticket price. The cost parameter is valid and statistically significant, which mean the higher the cost of certain alternative, the less possibility of alternative is chosen.

The Access time is specific variable for bus and metro separately. According to the results, the variable of Access time is all significantly which mean the bus alternative and metro alternative is not good at conveniences. Because of the subway system has not been formed into a network, so there remain significant limitations associated with riding the metro, and the distribution of the bus lines is not even in the SWJTU district.

The Egress time and Waiting time are generic variables for bus and metro. These variables are not significantly, which mean accessibility and schedule adherence of the bus and metro is good

Parking time is specific variable for car alternative. The parameter is negative and also statistically significant indicating that the longer parking time used by travelers, the less possibility that they plan trips with cars.

Besides, age, income, gender, and private vehicle ownership are considered to be explanatory variables in the study. The median and low-income groups tend to choose bus to make their trip. Male travelers don't show a preference to the transit mode, while the older people prefer bus. The dummy parameter "if owning the private car" is significantly which indicates car would be the predominant mode by travelers who own cars.

According to the analysis in this part above, cost, in-vehicle time, access time and individual characteristics have considerable effects on traveler's transit choice behavior, while owning automobile is a significant factor that contributes to the possibility of choosing automobile as favorable mode.

POLICY ANALYSIS

The model results demonstrates that in-vehicle time, cost, access time are playing a significant role in traveler's choice behavior. We should evaluate quantifiably the effects of these variables on the traveler choice behavior so that the transportation policy can be better supported by the results. To assess and quantify such impacts of these variables, the elasticity method has been adopted. The direct point elasticity in the discrete choice model is(*9*):

$$E_{X_{IKQ}}^{P_{iq}} = \frac{\partial P_{iq}}{\partial X_{ikq}} \cdot \frac{X_{ikq}}{P_{iq}} \tag{6}$$

Equation (6) can be applied appropriately in this case to measure the changes to the choice possibility (P_{iq}) of alternative i with respect to the marginal change of attribute K. If the utility formal is defined as linear, the equation (6) can then convert to a simpler equation as equation (7)

$$E_{X_{IKQ}}^{P_{iq}} = -\beta_{ik} X_{ikq} \left(1 - P_{iq}\right) \tag{7}$$

Where β_{ik} is the coefficient of variable X_{ikq}.

In economics, the demand is considered to be elastic if the absolute value of the elasticity is greater than one. Inelastic if the value is less than one, and unit-elastic if the value equals to one. Accordingly, the estimation results of the elasticity regarding to significant attributes are shown in Table 8.

Table 8 Direct point elasticity of choice probability

Variable	Value	Elasticity
Cost for bus	-0.413	inelastic
Cost for car	-6.55	elastic
In-vehicle time for bus	-0.454	inelastic
Access time for bus	-0.362	inelastic
Access time for metro	-0.440	inelastic
Parking time	-0.392	inelastic

From Table 8, we can conclude that the choice possibility of bus is inelastic to these significant attributes, since the absolute elasticity value each variable is less than one. This is also true for parking time in car alternative. The effect of shortening In-vehicle time is better than reducing the cost, while the effect of reducing cost is superior to shorten access time for bus.

However, the elasticity value of bus in terms of cost is -0.413 which means that the increase of one percentage of cost will reduce 0.413 percentage of the choice possibility. Thus we can draw the conclusion that the benefit from the increase of cost can offset the loss resulted from the reduction of ridership of bus, we can improve the bus ticket price. The Figure 2(a) illustrates the choice possibility change with the cost. It is apparent from the diagram that the price of bus ticket should not exceed 3(Yuan) in order to maintain the choice possibility larger than 30 percent ceteris paribus. (This is thought to be a critical line to guarantee the dominant status of transit in the transportation market in China). The bus cost can be reduced to 1 (Yuan) and free transfer if applying smart transit ID card in Chengdu, then the choice possibility of bus could be 40.7%. But the government financial subsidy for the public transit is as high as billion Yuan which accounting for more than 0.13% of Chengdu's GDP. If we raise the bus fee to 2.5 Yuan, its choice possibility is 30.1%. The bus still keeps the dominant status of transit in the transportation market. According to these results, we should raise the ticket properly. It is not only decrease the stress of the government finance but also improve the service level by the increased benefit.

According to model results, more travelers would switch to bus if shortening the in-vehicle time. The length of Bus transit lane is only 270km and the bus lane is concentrated in the central area in Chengdu. That cannot support the entire bus transit system. Now the in-vehicle time could be 40min by bus in this corridor, the choice possibility is about 20%. The government is planning to build the BRT (Bus Rapid Transit) and increase the bus transit line which can shorten the in-vehicle time. So, if the BRT can be operated the in-vehicle time can reduce to 25min, the choice possibility will increase to 41.2%, from Figure 2(b). The bus transit will become the primary travel mode in this corridor.

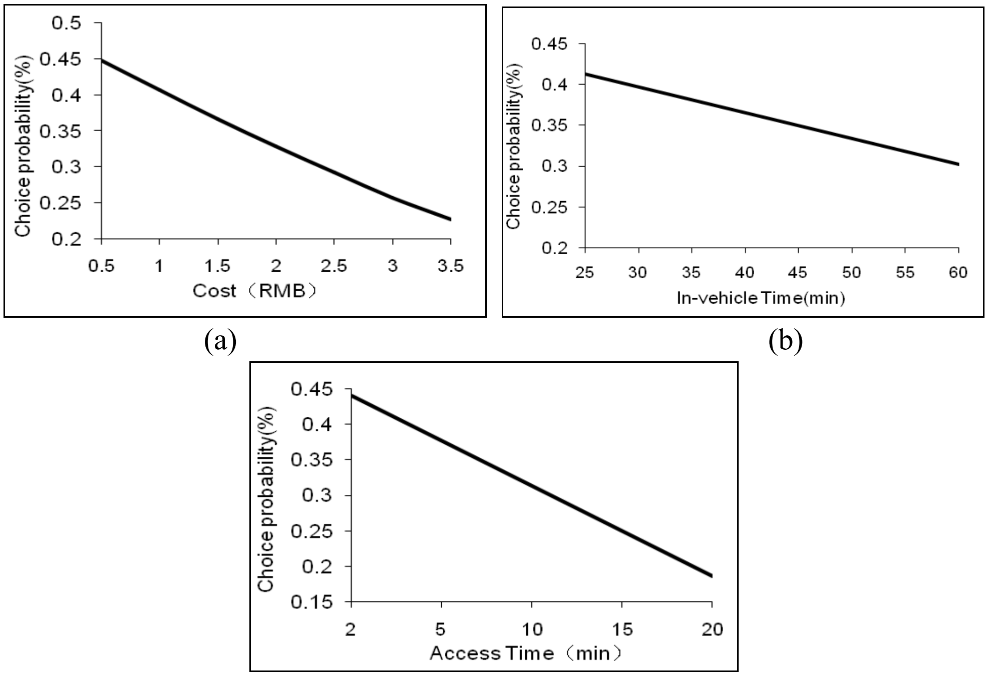


Figure 2 the relationship between variables and the choice probability of bus.
(a) Cost, (b)In-vehicle time (c) Access time

The reduction of access time would significantly increase the choice possibility of bus as illustrated by Figure 2(c). For this reason, optimizing the layout of urban transit routes and the bus stop can decrease the access time to 10 minutes. As a result the bus patronage percentage will increase to 31.2% which guarantees bus transit to be the dominant mode. Transit routes arrangement optimization and transit stop coverage rate increment would be particularly effective to enhance the ridership of bus transit in Chengdu considering the low coverage rate of transit stops along the minor routes.

According to the planning, the access time to the metro station from SWJTU to downtown area is about 20 minutes by walking as illustrated by Figure 3. The choice probability of metro alternative is 47.8 %. In comparison, if we enhance the connection with the ground buses to form the feeding of the passengers to the metro. The access time will reduce to 10 minutes and the metro sharing percentage will increase 16.5%. These operation strategies can not only utilize the public transportation facilities more efficiently, but also attract more passengers to switch to the public transit.

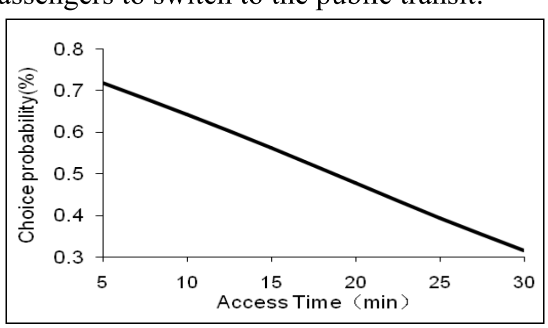
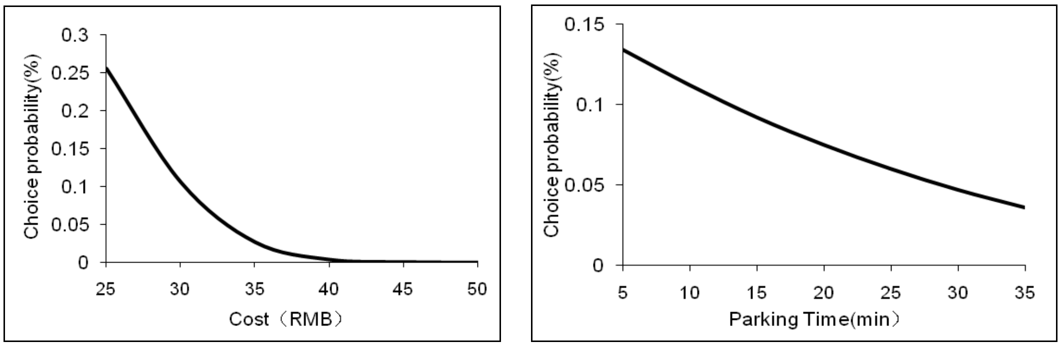


Figure 3 the relationship between access time and choice probability of metro

Besides, the relationship among the cost, parking time and metro choice possibility is observed from Figure 4. As shown in figure 4(a), 10.6 % of passengers would select private car as their favorite transport mode when it costs 30(Yuan), but when they have to spend 45(Yuan) on their personal vehicle travel, the percentage decrease remarkably to 0.074%. The cost in the study is assumed to be the sum of parking fee and fuel cost. If the cost keeps increasing, the possibility would further decrease and approach to 0. The increase of the trip cost of cars would considerably decrease the choice possibility of private car. Thus, high cost can restrict the private car use and make more passengers transfer to public transport mode.



(a) (b)

Figure 4 the relationship between variables and choice probability of car
(a)Cost, (b) parking time

Similarly, the Figure 4(b) indicates the influence of the parking time to the use of private car. Now some streets in Chengdu downtown area allow on-street parking which make drivers can find parking spots easily within 5 minutes, 13.4% travelers will choose private car. Conversely, on-street parking and parking spots limitation in downtown in order to increase the parking time. If the parking time exceeds 20 minutes less than 7.49% of travelers would drive cars. Therefore, appropriate adjustment of the parking supply can restrict the use of personal vehicles. Finally, the effect of increasing the cost is better than increasing parking time on controlling the private car, which is consistence with the elasticity.

CONCLUSIONS

This paper analyzed the traveler's choice behavior through discrete choices model in Chengdu. The cost, in-vehicle time, access time and income were the essential factors that have a significant impact on the choice behavior. Some suggestions were provided after quantifying the influence of these factors on the choice possibility of bus alternative. Such as, building bus transit lanes and operating BRT to shorten bus in-vehicle time, optimizing transit network and enlarging transit stop coverage area. Especially, the low bus ticket price policy in Chengdu cannot achieve a good result. The government should improve the ticket price and use the profit to develop the infrastructures of the transportation, for example, set up the bus transit lane or BRT in order to improve the service level of bus to realize the public transport priority. The bus ticket price cannot be set too high. Because of the median and low-income travelers tend to choice bus to make their trip.

The metro is new travel mode in this corridor. We want to make the metro attract more travelers. It is important to enhance the connection with the ground buses to form the feeding of the passengers. Meanwhile, some other effective strategies like controlling parking supply and increasing trip cost need to be taken to limit private car using. If these strategies can be carried out together, we can lead the private car users to choice public transit and improve the choice probability of public transit.

In this paper, it is also confirmed that a more complicated model doesn't necessarily provide better results in the practical application scenarios, by the comparison between MNL and NL models. The Bus and metro constant displayed noticeable distinct in terms of the statistical significance derived from MNL model. The main reason is that some non-quantifiable variables aren't included in the explanatory variables, such as, safety, comfortable.

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