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An Understanding of Behavior Difference as for Students and Workers Using Public Transits in Chongqing, China

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Abstract
Various studies on students or workers using public transits have been conducted. However, few studies consider behavior difference between them under same context. This study intends to determine factors influencing students and workers using different public transits for elastic travel on weekends in Chongqing, for a better understanding of behavior difference between the two typical travel population in cities. This study utilized the data from Chongqing Travel Survey in 2015 for analysis. Two set of binary logistic regression model were employed for significant factor determination. The results showed that travel expense and time walking to station were the collective significant factors influencing students and workers using public transits for elastic travel in Chongqing. However, gender and travel purpose only significantly influenced students using public transits for elastic travel in Chongqing, and time walking to destination and travel comfort only significantly influenced workers using public transits for elastic travel in Chongqing. Besides that, based on the model results, this study revealed the behavior difference of students and workers in Chongqing using public transits for elastic travel. And the researching findings in this study aimed at providing an original direction of thinking for public transits operators about differentiating with students and workers to balance the traffic resource between bus and rail transit.
Keywords: Balance, Behavior Difference, Chongqing, Elastic Travel, Public Transits

1. Introduction

Some scholars have already determined the factors influencing students or workers using public transits for commuting travel. Golob (2003) presented that factors influencing workers using public transits for commuting travel generally referred to travel distance, departure time, travel accessibility (Jungyul, 2000), whether traveling during peak hours and socio-demographic factors. However, Boyd et al. (2003) stated that age, gender, status (undergraduate or gradate), safety concerns (Al-Rukaibi et al., 2006), cost, individual attitudes (Shannon et al., 2006), travel distance (Gould et al., 2007) and environmental factors (Kate et al., 2013) were generally determined to be significant factors influencing students using public transits for commuting travel.

Furthermore, some special factors determined to influence workers using public transits for commuting travel were development density of cities (Myung-Jin et al, 2013) and trip chain choice (Kun et al., 2010). And some special factors determined to influence students using public transits for commuting travel were living alone or having friends nearby (Jiangping, 2012), enjoyment of different modes of transportation (Bonham & Koth, 2010) and cultural factors (Páez & Whalen, 2010).

It was true that there were some collective factors influencing students and workers using public transits, such as travel distance (Golob, 2003; Gould et al., 2007). And there were some special factors influencing students and workers using public transits respectively.

However, those factors were determined under different contexts. Such as Myung-Jin et al., (2013) conduced their investigation with commuting workers in Seoul, Korea. Jiangping (2012) limited his or her research among commuting students in Los Angeles, United States. And there was no significant or only a few values to compare the behavior characteristics between workers in Seoul, Korea and students in Los Angeles, United States. Because the research findings could not be applied to students in Seoul, Korea or workers in Los Angeles, United States.

On the other hand, those studies above-mentioned usually focused on students and workers' commuting travel (going to school and going to work), a kind of rigid travel. Actually, travel can further fall into three types, namely rigid travel, elastic travel and mixed travel (Hu et al., 2014). Under some rigid travels, like going to work, going to school and business trip, travelers can easily make choices due to many constraints (e.g., time, location)

and daily repeatability (HUANG et al., 2008). But elastic travels (shopping, recreation, tourism, visiting relatives and friends) may have more mode choices for the uncertainty, susceptibility and optionality among them (Hu et al., 2014). And currently non-work related travels have received much attention from many scholars (Ettema & Schwanen, 2012; Schlich et al., 2004). Meanwhile, since rigid travel may take place everyday while elastic travel may not, that is to say, students or workers may go to school or work on every weekday, but maybe not go shopping on every weekend, so there should be some behavior difference between rigid travel and elastic travel that required to be compared and revealed.

Last but not the least, most of the concerns in aforementioned studies lied in travelers using public transits or private car, and those studies were designed to balance the sharing ratio of public transits and private car, or switch travelers from private car to public transits by behavior intervention. However, this study was to explore travelers' (only students and workers in this study) choices between bus and rail transit. And this study was proposed based on the current situation in Chongqing, and aimed at balancing the sharing ratio of rail transit and bus. Because according to the Chongqing Travel Survey in 2005, more than 70% of travelers chose rail transits for elastic travel, and only less than 30% of travelers chose rail transits for elastic travel. And that would intensify the burden of rail transit, on the contrary, chances were that the bus sometimes may operate with almost empty. So that would result in huge waste of traffic resource.

Therefore, this study attempted to fill in the gap by investigating the factors influencing students and workers using bus or rail transit for elastic travel under same context. And the research findings were expected to contribute to a better understanding of behavior difference of students and workers using public transits for elastic travel in Chongqing, and further provide a rationale for public transit operators in Chongqing to balance the passenger flow between bus and rail transit for a better utilization of traffic resource.

Nevertheless, something should be emphasized here. Above all, for convenience of study, the elastic travel in this study only referred to the choice between shopping travel and recreation travel, and the public transits in this study only referred to the choice between bus and rail transit. In addition, the same context in this study did not mean merely students and workers were from the same city (Chongqing), but also only the same indexes for students and workers would be contained in this study. For example, the index "income" would not be included in this study, since most students had no income. But the index "travel expense" would be included, since both students and workers had response to the index.

2 Aims And Objectives

This study aimed to provide a better understanding of behavior difference as for students and workers using public transits for elastic travel in Chongqing. Furthermore, the research findings could further offer an original thinking direction for relevant bus operators, to implement different and targeted policies to students and workers for attracting most of them. Therefore, the objectives in this study can be formulated as follows.

(1) to determine the significantly collective factors influencing students and workers using public transits for elastic travel in Chongqing

(2) to determine the significantly different factors influencing students and workers using public transits for elastic travel in Chongqing

(3) to attempt to reveal and understand the behavior difference as for students and workers using public transits for elastic travel in Chongqing

3. Data Source

The data used in this study were from Chongqing Travel Survey in 2015 conducted by students from Chongqing Jiaotong University. Moreover, during Chongqing Travel Survey in 2015, 600 questionnaires for students and workers were collected after five weekends' random sampling survey. And after eliminating various invalid questionnaires, 535 valid questionnaires were available for further analysis, with valid rate up to 89.17% (Table 1).

Table 1: Valid Rate of Questionnaires

Group	Collected	Valid	Valid Rate
students	347	308	88.76%
workers	253	227	89.72%
Total	600	535	89.17%

Furthermore, Chongqing Travel Survey was to investigate the factors influencing elastic travel mode choice, so the survey was only implemented on weekends, while those rigid travels (going to school or work) and some elastic travels during weekdays were not concerned in Chongqing Travel Survey.

At the same time, the data used in this study only referred to the same items in the questionnaire used in Chongqing Travel Survey. In other words, this study limited the data to the same scales for students and workers to avoid the influence of different items on students and workers using public transits for elastic travel. Last but not the least, the public transits in this study only referred to the choice between rail transits and bus, while the

elastic travel in this study only referred to the choice among recreation travel and shopping travel.

4. Method

After the data were selected from Chongqing Travel Survey, the reliability analysis and validity analysis were implemented to test the reliability and validity of the data. And the total Cronbach's Alpha of the data reached 0.801, with Kaiser-Meyer-Olkin Measure of Sampling Adequacy arriving at 0.917. The results indicated that the data used in this study were reliable and valid to some extent.

After data ready for analysis, two sets of binary logistic regression model were employed to determine the significant factors influencing students and workers using public transits for elastic travel respectively. Logistic regression model currently has a wide range of applications in many fields, especially in medicine, social sciences and business economics (Peeters et al., 2012). And logistic regression model has a better performance as for exploring the relationships between categorical variable and a set of explanatory variables, especially when the categorical variable is binary (Geng and Sakhanenko, 2016; Trigila et al., 2015). At the same time, the dependent variable in this study was the choice between bus (Y=0) and rail transit (Y=1). The independent variables in this study were the influencing factors in the survey.

Additionally, the elaboration of Logistic regression model can refer to the classic references from Cox (1958), Walker & Duncan (1967) and McCullagh & Nelder (1989), and this study would not focus on that. But after the model results reached by SPSS, this study evaluated the overall significance of model by Chi-square test, the goodness of fit of model by Hosmer-lemeshow test and the predictive accuracy of mode by Nagelkerke R Square, to make sure the model results were statistically significant. However, multicollinearity test was also conducted in this study to avoid the influence of model sensitivity. And finally, the model results were interpreted with the help pf odds ratio.

When it comes to the interpretation of Logistic regression model results, odds ratio (OR), risk ratio (RR) and absolute risk reduction (ARR) are the three major ways to quantifying how strongly independent variable is associated with dependent variable under a given population, while odds ratio is the most used.

In statistics and probability theory, the odds of an event are the rate of probability at which the event occurs and does not occur, namely odds are equal to p/(1-p). And the upper bound of its range is unbounded, that is, it can take values in all non-negative values. Moreover, the event is more likely to occur when the odds is greater than 1. On the other hand, odds ratio denotes, with other condition unchanged, the rate of the odds of event occurrence when certain independent variable changes by one unit. And if the OR of certain variable is more than 1, then the variable has a positive influence on the event occurrence. Otherwise the variable has a negative influence, namely the odds of event occurrence decreasing with the increase of the certain variable in value.

Moreover, by the interpretation of variables, this study revealed the behavior difference between students and workers using public transits for elastic travel in Chongqing. However, this study also attempted to understand the behavior difference between students and workers by the influencing power of significant factors. And as for the influencing power of significant factors, this study employed rate of change (RC) to evaluate the strong-and-weak attributes of significant factors. In addition, the rate of change in this study referred to the relative change rate, and the rate of change for odds of certain variable could computed as follows.

$$RC = \frac{\left|\text{odds}_1 - odds_0\right|}{odds_0} \bullet 100\%$$

$$= \frac{\left|OR \bullet odds_0 - odds_0\right|}{odds_0} \bullet 100\%$$

$$= \left(\left|OR - 1\right|\right) \bullet 100\%$$

5. Results

5.1 Model Results

SPSS was used to perform the binary logistic regression analysis in this study. Additionally, this study forwardly added variables based on maximum likelihood ratio, namely only the constant was in the model at first and then other variable would be added into the model with certain order. And likelihood ratio test was employed to evaluate the goodness of fit of model after certain variable added. So if "-2 Log Likelihood" of model was less than the former one after certain variable added, then the variable added should be kept in the model, otherwise it should be eliminated. While the iteration continued until the "-2 Log Likelihood" could not be smaller any more or the parameter estimates changed by less than 0.001.

Besides that, this study adopted 95% confidence level, adding the variable where $\alpha \leqq 0.05$ and removing it when $\alpha > 0.05$. And the final results (Table 2) showed "TE, TWS, TP, GD" and "TE, TWS, TWD, TC" were the significant factors influencing students and workers using public transits for elastic travel in Chongqing

respectively.

Table 2: Variables in the Equation

	variables	explanation	level	coefficient	odds ratio	RC
students	TE	travel expense	scale	2.760	15.799	1479.9%
	TWS	time walking to destination	scale	.569	1.766	76.6%
	GD	gender	1:female	1.056	2.874	187.4%
	TP	travel purpose	1:recreation	1.152	3.166	216.6%
	constant			-9.933	.000	
workers	TE	travel expense	scale	2.820	16.780	1578.0%
	TWS	time walking to station	scale	2.343	10.412	941.2%
	TWD	time walking to destination	scale	1.756	5.790	479.0%
	TC	travel comfort	scale	4.355	77.828	7682.8%
	constant			-8.199	.000	

5.2 Results Evaluation

Furthermore, the Chi-square test was employed to evaluate the overall significance of the two models (Shi-Liwen, 2015; Wang & Guo, 2001), and the results demonstrated the variables in the equation had significant explanatory power to students and workers using public transits for elastic travel, since both the p-values from Chi-square test for the two models were lees than 0.05. Moreover, Hosmer-Lemeshow test was used to evaluate the goodness of fit of the two models (Shi-Liwen, 2015; Wang & Guo, 2001), and the results illustrated that the there was no significant difference between the predicted values and observed values in the two models, with both p-values from Hosmer-Lemeshow test larger than 0.05. At the same time, Nagelkerke R Square (0.905, 0.803) showed that both the two models had an acceptable predictive accuracy.

Moreover, statisticians generally presented that if correlation coefficients are less than 0.75, then there is no significant multicollinearity existing with the data (David & Michael, 2005). And the correlation matrix (Table 3) for this study indicated that correlation efficient between every two variables was less than 0.75, therefore, there was no significant multicollinearity among variables in the equation.

Table 3: Correlation Matrix of Variables

		constant	GD	TP	TWS	TE
students	constant	1.000				
	GD		1.000	.066	.132	-.022
	TP		.066	1.000	.248	.150
	TWS		.132	.248	1.000	-.065
	TE		-.022	.150	-.065	1.000
		constant	TWS	TWD	TE	TC
workers	constant	1.000				
	TWS		1.000	.453	.203	.453
	TWD		.453	1.000	.304	.414
	TE		.203	.304	1.000	.408
	TC		.453	.414	.408	1.000

Besides that, the model classification table (Table 4), from another aspect, showed the two set of binary logistic regression model had a satisfactory accuracy for predicting students and workers' elastic travel mode choice with public transits. And the total percentage of cases with accurate prediction was up to 90.6% (students) and 94.% (workers).

Table 4: Classification Table

	observation		prediction		
			travel mode		percentage revised
			bus	rail transit	
students	travel mode	bus	65	12	84.4
		rail transit	17	214	92.6
	total percentage				90.6
workers	travel mode	bus	69	4	94.5
		rail transit	8	146	94.8
	total percentage				94.7

6. Discussion

As showed in the Table 2, travel expense (TE) and time walking to station (TWS) were determined to be the

collective significant factors influencing students and workers in Chongqing using public transits for elastic travel. Moreover, the odds ratio of TE and TWS were more than 1. So both travel expense and time walking to station had the positive influence on students (15.799>1; 1.766>1) or workers (16.780>1; 10.412>1) using rail transit for elastic travel in Chongqing. In other words, under the same context, if the time walking to rail transit station and bus station increase at the same time, there would be a higher probability for students and workers in Chongqing using rail transit for elastic travel. And the similar situation would happen with travel expense. Some students or workers in Chongqing would switch from bus to rail transit with the growth of travel cost.

Therefore, the first research finding in this study was that travel expense (TE) and time walking to station (TWS) were the collective significant factors influencing students and workers using public transits for elastic travel in Chongqing.

However, during the following discussion, some behavior differences between students and workers in Chongqing using public transits for elastic travel were found.

First of all, although travel expense (TE) and time walking to station (TWS) were the collective significant factors influencing students and workers in Chongqing using public transits for elastic travel, but workers were more sensitive to travel expense (TE) and time walking to station (TWS) than students, since both the odds ratio of travel expense (TE) and time walking to station (TWS) for workers were larger than that for students (16.780>15.799; 10.412>1.766).

In other words, with travel expense (TE) changed by one unit, the odds of workers in Chongqing using rail transit for elastic travel would be 16.780 of that before changed, and the corresponding value was 15.799 for students. In addition, the rate of change of odds caused by per unit of travel expense (TE) change was 1578.0% for workers and 1479.9% for students. And the rate of change of odds caused by per unit of time walking to station (TWS) change was 941.2% for workers and 76.6% for students. Therefore, workers were more easily to be influenced by the change of travel expense (TE) and time walking to station (TWS) than students when choosing public transits for elastic travel.

Secondly, gender (GD, 0.029<0.05) and travel purpose (TP, 0.036<0.05) only had a significant influence on students using public transits for recreation travel and shopping travel in Chongqing. While time walking to destination (TWD, 0.000<0.05) and travel comfort (TC, 0.002<0.05) solely significantly influenced workers using public transits for recreation travel and shopping travel in Chongqing.

Thirdly, since gender (GD) only had a significant influence on students, not workers, using public transits for recreation travel and shopping travel in Chongqing, so female students and male students had significant behavior difference as for choosing what kind of public transportation mode for elastic travel, but there was no significant behavior difference among female workers and male workers.

Fourthly, since travel purpose (TP) only had a significant influence on students, not workers, using public transits for recreation travel and shopping travel in Chongqing, so workers had less concerns about travel purpose than students when determining what kind of public transportation mode for elastic travel.

Fifthly, since time walking to destination (TWD) and travel comfort (TC) solely significantly influenced workers, not students, using public transits for recreation travel and shopping travel in Chongqing, so workers cared more about time walking to destination (TWD) and travel comfort (TC) than students when making decision on elastic travel mode choices.

Last but not the least, when it comes to the influencing power of significant factors, travel expense (TE) and travel purpose (TP) were the most influential significant factors influencing students in Chongqing using public transits for elastic travel, which was followed by gender (GD), and time walking to station (TWS) was the last factor in terms of influencing powers among all the significant factors. However, travel comfort (TC) and travel expense (TE) were the most influential significant factors influencing workers in Chongqing using public transits for elastic travel, which was followed by time walking to station (TWS) and time walking to destination (TWD) accordingly.

7. Conclusion

7.1 Objective Addressed

Objective 1: to determine the significantly collective factors influencing students and workers using public transits for elastic travel in Chongqing:

travel expense (TE) and time walking to station (TWS) were the collective significant factors influencing students and workers in Chongqing using public transits for elastic travel.

Objective 2: to determine the significantly different factors influencing students and workers using public transits for elastic travel in Chongqing:

gender (GD) and travel purpose (TP) only had a significant influence on students, rather than workers, using public transits for recreation travel and shopping travel in Chongqing. While time walking to destination (TWD) and travel comfort (TC) significantly influenced workers, rather than students, using public transits for recreation travel and shopping travel in Chongqing.

Objective 3: to attempt to reveal and understand the behavior difference as for students and workers using public transits for elastic travel in Chongqing:

1) workers were more sensitive to travel expense (TE) and time walking to station (TWS) than students when using public transits for elastic travel in Chongqing.

2) female students and male students had significant behavior difference as for choosing what kind of public transportation mode for elastic travel, but there was no significant behavior difference among female workers and male workers.

3) workers had less concerns about travel purpose than students when determining what kind of public transportation mode for elastic travel in Chongqing.

4) workers cared more about time walking to destination (TWD) and travel comfort (TC) than students when making decision on elastic travel mode choices in Chongqing.

5) travel expense (TE) was the most influential significant factor influencing students in Chongqing using public transits for elastic travel. However, travel comfort (TC) was the most influential significant factor influencing workers in Chongqing using public transits for elastic travel.

6) time walking to station (TWS) had the minimal influence on students in Chongqing using public transits for elastic travel among all the significant factors. However, the one had the minimal influence on workers using public transits for elastic travel among all the significant factors was time walking to destination (TWD).

7.2 Summary of This Study

Students and workers are the two major travel groups in the city, and their travel mode choices significantly affect the urban traffic structure. Currently, the distribution of passenger flow among public transits in Chongqing is unfavorable, with more than 70% of the elastic travelers loaded to rail transit. And the unreasonable decision-making should be responsible for that to some degree. As the research findings in this study demonstrated, gender and travel purpose only significantly affected students using public transits for elastic travel, while time walking to destination and travel comfort did not. So the relevant bus operators in Chongqing should pay more attention to the influence of gender and travel purpose on students using bus for elastic travel. At same time, more attention should be devoted by relevant bus operators in Chongqing to those workers with higher demand for travel time (or time walking to destination) and travel comfort. Otherwise, imposing the same policies on different travel population will inevitably leads to some side effects. Consequently, this study recommends that traffic managers should implement different strategies to different travel population.

In addition, as mentioned in the introduction in this study, it is true that there definitely should be some behavior difference as for students and workers using public transits. However, few studies try to reveal what exactly the behavior difference is, and even no previous study focuses on the behavior difference among elastic travels. But that makes sense and the research findings could reveal what exactly the behavior difference is. And further, the corresponding traffic strategies could be formulated to attract targeted students and workers to use bus for elastic travel. So that the relative balance of passenger flow between bus and rail transit could be reached, and the public transit resource could still get reasonable utilization.

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