Private Car Switched to Public Transit by Commuters, in Shanghai, China

Ling Wang¹, Linbo Li ²*, Bing Wu¹, Yufang Bai¹

Abstract

In order to effectively attract commuters from private car to public transit, this paper aimed to find out the target population and the attributes of public transit which needs improvement. The research was based on a survey of private car commuters in Shanghai. The survey covered perceptions of public transit and private car service performance, the importance degree of trip attributes, and private car commuters’ intention to switch to public transit. The findings indicate that the target population is female and short distance commuters, because female and short distance private car commuters have lower trip demand and are more likely to switch to public transit. The analysis of Difference-Importance shows that public transit attributes of comfort and timeliness require improvement, and the measures strengthening public transit’s comfort level should be taken first.

Keywords: private car commuters; public transit; service performance; target population; Difference-Importance analysis

1. Introduction

With traffic congestion increase in urban areas, considering how to switch private car to public transit for travelers and increase transit share becomes more and more important (Ory et al. 2004). The biggest competitor of public transit in Shanghai is private car, and travel mode’s service performance will influence travelers’ travel mode choice (Beira o & Cabral 2007; Zhou, Gould, & O’Flahert 2007), it is critical to study the service performances of public transit and private car.

What attributes could be used to evaluate service performances of public transit and private car? Transit service performance could be evaluated by many attributes, for example, accessibility, reliability, frequency,

*Corresponding author. Tel: (86) 021-69583007; Fax: (86) 021-65663299
E-mail address: llinbo@tongji.edu.cn
travel time, cost, comfort level, security, network coverage and cleanliness (Hensher, Stopher, & Bullock 2003; TRB 2003; Ohnmacht & Scherer 2010; Tyrinopoulos & Antoniou, 2008). Among these attributes, reliability, cost, convenience and travel time are the most important (Stradling, Meadows, & Beatty 2000; Kingham, Dickinson, & Copsey 2001). In terms of private car, many studies suggest that monetary costs, freedom, travel time, comfort, availability and reliability are its main evaluation attributes. In addition, cost and travel time are deemed as the most important attributes (Gärling et al. 2002; Steg, Geurs, & Ras 2002; Li, et al. 2010; Hagman 2003). Other studies provide more detailed strengths of private car, such as “know what I can expect”, “have own private space”, and “can listen to music” (Beira & Cabral 2007). There are plenty of attributes that could be used to simultaneously measure the service performances of transit and private car, for example, comfort level, timeliness, reliability, convenience, relaxation, cost and security.

Which travel attributes are important for private car commuters? Travelers’ demands on transportation system vary for different trip purposes. When travelers’ demand on some attribute, for example convenience, is higher, so is the importance degree of this attribute. Previous studies show that travelers’ demands on comfort level, timeliness and fares are higher than that on other attributes (Wibowo & Chalermpong, 2008). Furthermore, transit commuters’ choice will be influenced by the convenience, travel time and reliability of public transit (Loukopoulos, et al. 2004), and they prefer shorter travel time to low fares and comfort (Ohnmacht & Scherer 2010). However, these studies care more from the public transit customers’ view, and the results could be used to retain customers but not to attract other new customers, especially those commuters by private cars.

If travelers’ satisfaction with some attribute of private car is higher than that of public transit, it means that this attribute of public transit is not good enough and needs improvement. However, it is not practical for transit to simultaneously improve all attributes which are not good enough, especially when funds are limited or travelers do not think this attribute is important. What’s more, one attribute with high importance degree does not mean that it needs improvement due to its good status. Hence, it is a question what attributes need urgently to be improved if transit agencies intend to let travelers switch private car to public transit. The question depends on attributes’ importance degree and whether it is good enough.

Researchers have proved that gender and commuting time would have impact on commuting mode choice (Limtanakool, Dijst & Schwanen 2006; Schwanen, Dieleman & Dijst 2004; Zhou, et al. 2007). For instance, women are less likely to drive an automobile to work than men, and all travelers are more likely to refuse to use transit and increase the probability of driving when the commuting distance increases beyond three or four miles. However, would women or short-distance commuters using private car be more willing to change their current commuting mode to public transit? The answer is not given by other researches yet. However, this question is important because it can help transit agencies make right policies which attract more people to switch to transit.

To understand private car commuters’ attitudes toward public transit and private car, the following questions should be answered: (1) the perceptions of public transit service performance; (2) the perceptions of private car service performance; (3) the attributes’ importance degree during commuting. Furthermore, commuters’ intention to switch to public transit was also included in the questionnaires in order to determine the target population.

This study firstly described the background information of case site, the survey procedure and the responders’ characteristics. Secondly, the study descriptively analyzed private car commuters’ satisfactions toward public transit and private car, attributes’ importance degree and intentions. Thirdly, the study took cross analysis to find the target population, and then employed a Difference-Importance analysis method to find out which public transit’s attributes need improvement. Fourthly, conclusions were drawn, which were followed by acknowledgements.
2. SURVEY

2.1. Background Information

Recent studies indicated that automotive population would reach no less than 269 million in 2030 in China, and the predicted average annual growth rate was 9.6% that was far larger than other countries (Huo, Wang, Johnson, & He 2007; Hao, Wang, & Yi 2011). The automobile development in Chinese cities, such as public transit and private mobility in Shanghai, is ahead of the majority of cities in China.

Public transit system of Shanghai is outstanding and consists of bus, rail transit and taxi. The bus system in Shanghai is one of the most advanced systems in China. At the end of 2009, bus system operated 16,000 buses and 38,000 bus stations with 86% ground area coverage (within 500m of catchment). At the same time, the transit rail system is the best in China (National Bureau of statistics of China 2011). The scale of rail transit is 355 kilometers long and has 11 lines with 225 railway stations with an average distance of 1.52 kilometers between rail stations. Bus’s and transit rail’s shares in Shanghai had increased significantly (5.2%) from 1995 to 2009. At present, many cities are building a better public transit system following the example of Shanghai.

On the other hand, the increase rate of private mobility’s share (12.1%) is much higher than those of bus and transit rail’s share(5.2%). Private car is the main driving force for Shanghai’s automotive population growth, which accounted for 55.8% of total vehicle population growth from 2002 to 2011 (National Bureau of statistics of China 2002-2011). Income and population density are the main driving force for car ownership growth (Dargay, Gately, & Sommer 2007), and Shanghai’s Disposable Income Per Capita along with population density is in the top rank of China(National Bureau of statistics of China 2011). Hence, the number of private cars in Shanghai will largely increase in the future (Hao et al., 2011). Among all trip purposes in Shanghai, work-commuting travel accounts for 40.9% which ranks first (Shanghai Municipal Urban and Rural Construction and Transportation Commission 2010). Accordingly, private car commuters are the main population which transit should attract in Shanghai. If Shanghai further improves its public transit share by switching private car to transit by commuters, this will set an example for other cities.

2.2. Survey Content

Since taxi is not green and energy-saving as buses or rail transit, the questionnaires on public transit only referred to buses or rail transit, and the respondents can totally understand this. The questionnaires covered five sections with 31 questions. The first section was private car commuters’ satisfaction on public transit. The second section investigated their satisfaction on private car. The third section was about the attributes importance degrees during commuting. The fourth section asked about private car commuters’ intentions to switch to transit, and the final section collected general demographic information.

Seven attributes, which are comfort level, timeliness, reliability, convenience, relaxation, cost, and security, were used to measure commuters’ satisfaction on the service performances of public transit and private car. Responders valued the same seven attributes’ importance degree, and if an attribute receives a higher score, commuter’s demand on this attribute is higher. Respondents’ satisfaction rating and attributes’ importance degree were based on a 5 points Likert scale from “not at all” to “very much”, which were represented as 1 to 5.

Acceptability, willingness, consideration and transferability were proposed to evaluate respondents’ intentions to switch to transit. The accurate statements are shown in Table 1. All ratings used the following 5 points Likert Scale: (1) don’t agree at all, (2) hardly agree, (3) neutral, (4) partially agree, and (5) fully agree. The 5-point-
based Likert data were treated continuously in this study, because the intervals between points were approximately equal, and the rating could be treated continuous when the Likert scale has 5 points or more (Yu 1989; Morgan, Leech, Gloechner, & Barrett, 2004).

Table 1 Statement of Intention

| Intention   | Statement                                      |
|-------------|------------------------------------------------|
| Acceptability | Commuting by transit is highly acceptable       |
| Willingness  | Be highly willing to commute by transit         |
| Consideration | Considering about commuting by transit very regularly |
| Transferability | Switching the commute mode from private car to transit is very easy |

2.3. Data Collection

The data were obtained from a self-administered survey between January 5th and January 12th in 2012 in parking lots at workplaces and residential areas. 460 private car commuters took part in this survey, and 460 questionnaires were previously retained for further analysis. After the data of cases, including missing, blurred and repeated data on important variables to the present study (55 observations), and obviously contradictory data in two closely-related items (11 observations) were cleaned, a total of 394 effective observations were used in the analysis with an effective recovery rate of 85.65%.

Table 2 shows the results of reliability and validity. The lowest Cronbach’s coefficient alpha and KMO values are 0.721 and 0.718 respectively, and Bartlett’s test value is 453.851 (p=0.000). These analysis results indicate that the reliability and validity of the study are sufficient (Robert & DeVellis, 1991).

Table 2 Reliability and Validity of Survey

| Dimensions                  | Alpha value | KMO value | Bartlett’s Test | df  | p-value |
|-----------------------------|-------------|-----------|-----------------|-----|---------|
| Satisfaction on public transit | 0.791       | 0.802     | 547.095         | 21  | 0.000   |
| Satisfaction on private car  | 0.721       | 0.764     | 453.851         | 21  | 0.000   |
| Importance of attributes    | 0.820       | 0.822     | 987.812         | 21  | 0.000   |
| Intention                   | 0.890       | 0.810     | 638.324         | 6   | 0.000   |

2.4. Sample Characteristics

Table 3 shows the sample characteristics of survey. 50.3% of the respondents were female, 56.9% fell into the 26 to 40-year-old age group, and 54.3% were employees. 16% responders’ family have owned no less than 2 cars. Commuting time was given in accurate date by the responders, and this study classified commuting time into three categories, which were 0-30, 31-60 and above 60 minutes. The average one-way commuting time is 40.3 minutes, and it is slightly lower than the average commuting time by all modes in Shanghai (47 minutes) (Chinese Academy of Sciences 2010), revealing that trips by private cars take shorter time.

If private car commuters switch to transit, 66.8% would choose rail transit as the main public transit mode. This data are skewed toward rail transit compared to Shanghai commuters transit modes’ shares (rail transit, 33.0%; bus 67.0%) in 2009 (Shanghai Municipal Urban and Rural Construction and Transportation Commission 2010). There is a gap between intention and reality owing to the limited rail transit coverage. But this reflects
travelers’ preference to rail transit, because it has an advantage over other congested modes during peak time (Kingham et al. 2011).

### Table 3 Sample Characteristics of Survey

| Items                      | Categories                      | Effective percentage |
|----------------------------|---------------------------------|----------------------|
| Gender                     |                                 |                      |
|                            | male                            | 49.7%                |
|                            | female                          | 50.3%                |
| Age(year-old)*1            |                                 |                      |
|                            | 18-25                           | 25.1%                |
|                            | 26-40                           | 56.9%                |
|                            | >40                             | 18.0%                |
| Education                  |                                 |                      |
|                            | Junior diploma or under         | 2.3%                 |
|                            | High school diploma             | 4.8%                 |
|                            | College diploma                 | 32.2%                |
|                            | Bachelor Degree                 | 38.6%                |
|                            | Graduate degree and above        | 22.1%                |
| Monthly income*2           |                                 |                      |
|                            | Less than ¥2,000                | 3.3%                 |
|                            | ¥2,000 to ¥4,000                | 9.6%                 |
|                            | ¥4,000 to ¥6,000                | 15.0%                |
|                            | ¥6,000 to ¥10,000               | 44.9%                |
|                            | Above ¥10,000                   | 27.2%                |
| Occupation                 |                                 |                      |
|                            | Non-resident worker             | 2.6%                 |
|                            | Employee                        | 54.3%                |
|                            | Manager                         | 16.9%                |
|                            | Businessman                     | 8.7%                 |
|                            | Teacher                         | 5.5%                 |
|                            | others                          | 11.9%                |
| Car ownership              |                                 |                      |
|                            | 1                               | 84.0%                |
|                            | 2 or more                       | 16.0%                |
| Commuting time (min)       |                                 |                      |
|                            | 0-30                            | 48.7%                |
|                            | 31-60                           | 42.0%                |
|                            | >60                             | 9.3%                 |
| Alternative transit mode   |                                 |                      |
|                            | Bus transit                     | 33.2%                |
3. DESCRIPTIVE ANALYSIS

3.1. Satisfaction

Figure 1 shows private car commuters’ satisfaction on service performances of public transit and private car. The average values of satisfaction on these two transportation systems are almost the same, that is, public transit value is 3.18 and private car value is 3.20. However, responders’ attitudes to some attributes are obviously different, for instance, comfort level and relaxation. With comfort level, the service of private car is deemed the best, and service provided by public transit is deemed the worst though it is also comfort. In terms of relaxation, satisfaction degree on public transit is the highest and satisfaction degree on private car is the lowest.

![Figure 1 Satisfaction on Public Transit and Private Car](image)

Paired sample test is showed in Table 4. The study finds that the differences among reliability, convenience and security are not significant. On the other hand, the satisfaction differences of comfort, time, relaxation and cost between these two systems are significant and the order of absolute differences is relaxation (0.94), comfort (0.93), timeliness (0.39) and cost (0.33). Among these four attributes, relaxation and cost of transit are better than those of private car, but private car commuters think public transit is not as comfort and timeliness as private car.

| Attributes | Comfort | Timeliness | Reliability | Convenience | Relaxation | Cost | Security |
|------------|---------|------------|-------------|-------------|------------|------|----------|
| Mean       | 0.93    | 0.38       | 0.08        | 0.07        | -0.94      | -0.33| -0.08    |
| SD         | 1.641   | 1.879      | 1.560       | 1.258       | 1.598      | 1.805| 1.390    |
| t          | 11.178  | 4.076      | 1.131       | 1.138       | -11.634    | -3.600| -1.069   |
| sig. ( bilateral) | 0.000   | 0.000      | 0.259       | 0.256       | 0.000      | 0.000| 0.286    |

3.2. Importance

The importance degree reflects commuters’ demand degree. Table 5 shows the sequence of importance degrees: convenience, timeliness, reliability, security, comfort, relaxation and cost. The generality of these results
are implied by the facts that they are in line with previous research findings from other countries (Hagman 2003; Ohnmacht & Scherer 2010; Loukopoulos et al. 2004).

By taking the satisfaction and importance degree into consideration, we can explain why private car commuters choose private car. From the analyses on satisfaction, the study finds that private car commuters deem convenience (ranked as the first important one), reliability (ranked as the third) and security (ranked as the fourth) do not have a significant difference, but private car could provide shorter time (ranked as the second) and is a more comfortable travel (ranked as the fifth). However, public transit could only provide more relaxation and cheaper cost which ranks the last. Because private car provides better attributes that commuters deem more important, private car commuters are willing to choose cars.

Table 5 Importance Degree of Attributes during Commuting

| Importance | Comfort | Timeliness | Reliability | Convenience | Relaxation | Cost | Security |
|------------|---------|------------|-------------|-------------|------------|------|----------|
| Mean       | 3.90    | 4.39       | 4.30        | 4.47        | 3.69       | 3.38 | 4.24     |
| SD         | 1.006   | 0.970      | 0.918       | 0.868       | 1.019      | 1.170| 1.033    |

3.3. Intention

Under the premise that transit is available, when switching to transit, commuters would firstly think about whether the service of transit is acceptable, and then if they are willing to accept this transit. Subsequently, commuters begin to consider “how about trying taking transit?” sometimes, and “would transferring bring about problems?” or “Is it hard for me to switch to transit?” This study adopted four items to measure the four stages above that are acceptability, willingness, consideration and transferability. The statistics are showed in Table 6.

Table 6 Descriptive Statistics of Intentions

| Intention | Acceptability | Willingness | Consideration | Transferability |
|-----------|---------------|-------------|---------------|----------------|
| Mean      | 4.06          | 3.77        | 3.73          | 3.62           |
| SD*       | 0.792         | 0.852       | 1.073         | 0.913          |

*SD represents Standard Deviation

It is lucky that commuters don’t reject to take transit. Transferability is the least attribute, but it’s significantly above 3 (neutral), representing that commuters are easy to switch to transit, so transit improvement would be valued. However, the degrees of acceptability, willingness and consideration are all higher than that of transferability. This means that some private car commuters do think public transit is good enough, but they would not transfer to public transit.

4. METHODOLOGICAL APPLICATION

4.1. Target Population

Gender is a basic character of a person, while commuting time is a major attribute of a travel. Hence, this study analyzed the target population from these two aspects. The results are shown in Figure 2.

- Gender

The average importance degree of female is lower than that of male by 0.16, especially the attributes of relaxation (0.44), comfort level (0.30) and reliability (0.25), and the only attribute that females consider more about than males is the cost (0.08). Females’ intention of taking transit is higher than males’, and especially, the
consideration is 11.6% higher than males. Consequently, females are more likely to change their present commuter modes to transit compared to males.

- **Commuting Time**

  The average importance is larger when commuting time is longer. The importance degree of costs of long distance (above 60min) commutes rises by 2.47 compared to that of short distance (less than 30min). This is consistent with Shanghai’s situation: when time increases, the travel fee increases significantly especially for private car (a number of long distance highways charge for road-tolls). The importance of timeliness also increases by 0.82 and timeliness is deemed as the most important attribute from the aspect of long distance commuters. Furthermore, long distance commuters’ intentions descend by an average of 0.33 compared to short distance group’.

![Cross Analysis of Gender and Commuting Time](image)

From the study above, it can be known that female and short distance private car commuters are more willing to switch to public transit even though they are private car commuters at present. Hence, in order to attract commuters to switch private car to public transit, the target population should be female and short distance traveler.

### 4.2. Difference-Importance Analysis

The more the satisfaction difference is, the higher the need to improve the inferior mode is. Hence, it can be known from satisfaction differences that which attributes are good enough and which attributes should be
improved. At the same time, if an attribute has a higher importance degree, and commuters are satisfied with this attribute of a transportation mode, the possibility for commuters to choose this transportation mode would definitely higher. The improvements aiming at attributes with higher importance degrees would get a better return.

Accordingly, when an index positively combines satisfaction difference with importance of an attribute together, the high quantity improvement of this index would mean that this attribute needs improvement and the improvement will be worthy. This study proposed a Difference-Importance (DI) analysis to express this index:

\[ DI = (\text{Difference} \times \text{Importance}) \]

Where: Difference=satisfaction difference of one attribute (private car minus public transit)
Importance=importance of the same attribute

Public transit policy makers often have to decide the timetable and the degree of effort to improve the attributes of transit, or evaluate the relative priority of measures when they intend to switch private car to transit. When time, funds, and effort are limited, this decision is especially important. Difference-Importance (DI) analysis can solve this problem. When the DI rating is high, this attribute should take a preference order and receive a great effort.

The results of DI analysis of Shanghai’s public transit are shown in Table 7. The DI index of comfort, timeliness, reliability and convenience is higher than zero. As for reliability and convenience, they are very important but the satisfaction difference is small, their DI values are low. Hence, there is no need to improve reliability and convenience of transit right now. Meanwhile, because transit’s relaxation, cost, and security are good enough, there is no need to improve these attributes at present.

Though the importance degree of comfort is not the highest, its satisfaction difference is much greater than other attributes’, so the DI rating is highest. As a result, in the view of private car commuters, comfort level may be the biggest weakness of transit system. In order to attract private car commuters, comfort level needs the maximum improvement and the effect significantly more than other attributes. Since the load factor, air conditioning and cleanliness of bus interior and exterior, and the availability of shelter and benches at bus stop will significantly affect passengers’ satisfaction on comfort level (Laura & Gabriella 2011; Wang et al. 2012), the improvement on these issues will be valued.

Timeliness is very important for mode choice and the difference between these two systems ranks only second to comfort, so measures should be adopted to reduce travel time, such as bus priority lanes, bus priority at signalized intersections and increase transit frequency.

Table 7 Result of DI Analysis

| Attribute   | Satisfaction Difference | Importance | DI value |
|-------------|-------------------------|------------|----------|
| Comfort     | 0.924                   | 3.90       | 3.60     |
| Timeliness  | 0.386                   | 4.39       | 1.69     |
| Reliability | 0.089                   | 4.30       | 0.38     |
| Convenience | 0.072                   | 4.47       | 0.32     |
| Relaxation  | -0.937                  | 3.69       | -3.46    |
| Cost        | -0.327                  | 3.38       | -1.11    |
| Security    | -0.075                  | 4.24       | -0.32    |
5. CONCLUSIONS

The commuters’ satisfaction on public transit and private car is neutral as a whole. The best services provided by public transit and by private car are relaxation and comfort level. The responders think that transit is seriously in short of comfort level, and private car lacks relaxation most. Meanwhile, they don’t think that the reliability, convenience and security of private car and public transit are different.

In general, private car commuters consider convenience, timeliness and reliability as three most important attributes during commuting. The reason why private car commuters choose private car is that it can provide service which they deem very important. In detail, private car could provide shorter time (the second important one) and more comfortable travel (the fifth important one). However, public transit could only provide more relaxation (the sixth important one) and cheaper cost (the seventh important one).

Finally, the target population should be female and short distance private car commuters in order to let commuters switch private car to transit. Public transit policy makers should take measures to improve transit’s comfort level and timeliness.

ACKNOWLEDGMENTS

This research was supported by National Natural Science Foundation of China (No. 70901057), and Doctoral Program Foundation for Young Teacher of Institutions of Higher Education of China (No. 20090072120011). The authors thank Zhi Dong for providing guidance.

REFERENCES

Beirão G., Cabral J.A.S. (2007). Understanding attitudes towards public transport and private car: A qualitative study. Transport Policy, Vol. 14, pp. 478 – 489.

Chinese academy of sciences (2010). China's New-Urbanization Report 2010 Institute of Policy and Management. Science Press, Beijing

Dargay J., Gatley, D. and Sommer M. (2007). Vehicle ownership and income growth, worldwide: 1960-2030. Energy Journal, Vol. 28, pp. 143-170.

Gärling, T., D. Eek, Loukopoulos P., et.al. (2002). A conceptual analysis of the impact of travel demand management on private car use. Transport Policy, Vol. 9, pp. 59-70.

Hagman O. (2003). Mobilizing meanings of mobility: car users’ constructions of the goods and bads of car use. Transportation Research Part D: Transport and Environment, Vol. 8, pp. 1–9.

Hao H., Wang, H. Yi R. (2011). Hybrid modeling of China’s vehicle ownership and projection through 2050. Energy, Vol. 36, pp. 1351-1361.

Hensher D.A., Stopher P., Bullock P. (2003). Service quality -developing a service quality index in the provision of commercial bus contract. Transportation Research Part A: Policy and Practice, Vol. 37, pp. 499-517.

Huo H., Wang M., Johnson L., et.al. (2007) Projection of Chinese motor vehicle growth, oil demand, and CO2 emissions through 2050. In Transportation Research Record: Journal of the Transportation Research Board, No. 2038. Transportation Research Board of the National Academies, Washington, D.C., pp. 69-77.

Kingham S., Dickinson J., Copsey S. (2001). Travelling to work: will people move out of their cars. Transport Policy, Vol. 8, pp. 151-160.

Laura E,Gabriella M. (2011) A methodology for evaluating transit service quality based on subjective and objective measures from the passenger’s point of view[J]. Transport Policy, Vol 18, pp.172-181.
Li J., Walker J.L., Srinivasan S., et al. (2010). Modeling private car ownership in China: Investigating the Impact of Urban Form across Megacities. Projection of Chinese motor vehicle growth, oil demand, and CO2 emissions through 2050. In Transportation Research Record: Journal of the Transportation Research Board, No. 2143. Transportation Research Board of the National Academies, Washington, D.C., pp. 76-84.

Loukopoulos P., Jakobsson C., Gärling, T. et al. (2004) Car-user responses to travel demand management measures: goal setting and choice of adaptation alternatives. Transportation Research Part D: Transport and Environment, Vol. 9, pp. 263-280.

Limtanakool N., Dijst M., Schwanen T. (2006) The influence of socioeconomic characteristics, land use and travel time considerations on mode choice for medium- and longer-distance trips. Journal of Transport Geography, Vol. 14, pp. 327-341.

Morgan G.A., Leech N.L., Gloechner G.W., et al. (2004). SPSS for Introductory Statistics: Use and Interpretation, Second Edition. Lawrence Erlbaum Associates, Inc., New Jersey.

National Bureau of statistics of China (2002-2011). Statistical Yearbook of the Republic of China (2002-2011). China statistics Press, Beijing.

Ohnmacht T., Scherer M. (2010). More comfort, shorter travel time, or low fares: Who prefers what in rail transit? Comparing preferences of commuters, holiday and Leisure travelers, business travelers, and shoppers in Switzerland. In Transportation Research Record: Journal of the Transportation Research Board, No. 2143. Transportation Research Board of the National Academies, Washington, D.C., pp. 100-107.

Ory, D.T., Mokhtarian, P.L., Redmond, L.S., Salomon, I., Collantes, G.O., and Choo, S. (2004). “When is commuting desirable to the individual?” Growth and Change, Vol. 35, No. 3, pp. 334-359.

Robert F., DeVellis (1991). Scale development: theory and applications, Third Edition. Sage Publication, Inc., California.

Schwanen, T., Dieleman, F., Dijst, M., (2004). The impacts of metropolitan structure on commute behavior in the Netherlands: a multilevel approach. Growth and Change, Vol. 35, pp. 304–333. Shanghai Municipal Statistics Bureau (2001-2011). Shanghai Statistical Yearbook. China statistics Press, Beijing.

Shanghai Municipal Urban and Rural Construction and Transportation Commission (2010). The report of fourth comprehensive transportation survey of Shanghai. Shanghai.

Steg L., K. Geurs, Ras M. (2002). The effects of motivational factors on car use: A multidisciplinary modeling approach. Transportation Research A, Vol. 35, pp. 789-806.

Stradling S.G., M.L. Meadows, and Beatty S. (2000). Helping drivers out of their cars Integrating transport policy and social psychology for sustainable change. Transport Policy, Vol. 7, pp. 207-215.

Transportation research board (TRB) (2003). Transit Capacity and Quality of Service Manual (TCQSM), 2nd Edition, part 3. Washington, D.C.

Tyrinopoulos Y., Antoniou C. (2008). Public transit user satisfaction: Variability and policy implications. Transport Policy, Vol. 15, pp. 260-272.

Wang L., Wang Y., Wu B., et al. (2012). Analysis on factors affecting regular bus operational comfort level. Journal of Chongqing Jiaotong University (Natural Science). Vol.31, No.6, pp. 1211-1214.

Wibowo S.S., Chalermpong S. (2008). Frequency of transit use and access characteristics: case study of Metro Manila. CD-ROM. Transportation Research Board of the National Academies, Washington, D.C.

Yu X. (1989). Structural equation models for ordinal variables: an analysis of occupational destination. Sociological Methods & Research, Vol. 17, 1989, pp. 325-352.

Zhou J., Gould J., Flahert S.O. (2007). Commute Travel: How does proximity influence mode choice GIS analysis of a large urban university. CD-ROM. Transportation Research Board of the National Academies, Washington, D.C.