TRAVEL MODE CHOICE SUPPRESSION IN LARGE-SCALE RESIDENTIAL AREAS ON THE CITY PERIPHERY: CASE STUDY OF JINHEXINCHENG, SHANGHAI, CHINA

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ABSTRACT

Chinese big cities are reforming the old downtown and substandard housings are being demolished. The government relocates residents to large-scale residential areas on the city periphery, where residents often find transport service unsatisfactory but still use transit for their most frequent trips. Very few studies have focused on suppressed travel especially suppressed travel mode choice in this kind of area. To understand the travel mode choice suppression and provide policy suggestions for the area, this study conducts a survey in Jinhexincheng, describes the travel mode choice condition, estimates an integrated mode choice and latent variable model, analyzes transit satisfaction scores and provides transit improvement suggestions. Results show 41 percent of the resident samples use transit for their most frequent trips, but only 18.55 percent find transit service quality satisfactory. 71.77 percent of the transit rider samples acknowledge that they “have no other choices, have to travel by transit”. Integrated choice and latent variable model indicates that “have to travel by transit” feeling (significant latent variable) has a negative effect on transit mode choice. The retired tends to have less of this feeling. Transit satisfaction scores show that “car crowdedness during peak hours” and “most-frequent trip’s travel time” are the most unsatisfactory aspects of the transit service. They should be improved first, in order to prevent “have to travel by transit” riders from giving up transit once they become richer and purchase cars in the future. This supports transit decision-making in developing countries’ similar areas.

Keywords: Travel Mode Choice Suppression, “Have to Travel by Transit”, Integrated Choice and Latent Variable Model, Satisfaction Score, Large-Scale Residential Areas on the City Periphery
INTRODUCTION

Over the past decades, Chinese cities have undergone enormous spatial restructuring due to the economic growth and urban development. Shanghai, a large, populous and complex city, is a key case of such restructuring.

Shanghai is in the process of suburbanization and central city redevelopment. Urban residents rapidly migrate to the periphery area. Some migrants have relocated willingly to modernized housing or for other lifestyle reasons (1). Some migrants have chosen to live on the periphery because of the unacceptable high housing price or the rising downtown rent. Others have to move outside the center as a result of the urban old houses demolition and relocation.

In order to reform the old downtown area and improve living condition, substandard residential houses are demolished. Residential land use in China is centrally planned, tightly regulated and strongly enforced by the government. So the government relocates the residents to large-scale residential areas on the periphery of Shanghai. The case area named Jinhexincheng is one of these residential areas.

Since these residents are placed in large-scale residential areas by the government, it is important for the government to provide good living and transport conditions. However, interviews show that residents find transport conditions in the area very unsatisfactory. 40.2 percent of the residents who joined the questionnaire study in Jinhexincheng find transport service unsatisfactory (2). This relates to the transit or transport service in this area is not as good as that in the city center.

With this unsatisfactory condition of the transport service, 41 percent of them still use transit for their most frequent trips. This is surprising. Do residents have no other travel mode choices but to travel by transit? Is travel mode choice being suppressed in the area?

With the objective of understanding the travel mode choice suppression condition and providing policy suggestions for the area, this study is formed. The presence of the suppressed travel mode choice (have to travel by transit) is an indication of possible future transit rider loss when residents’ income increases and they purchase cars. To avoid this from happening, it is essential to understand the travel mode choice suppression condition and give relative policy suggestions to the area. This study supports transit/transport planning and decision-making for this type of area.

This paper has 7 sections in total. This first section gives an introduction to the paper, with the study background, raise of the topic, study objective, research content, and paper structure. The second section is the literature review. The third section describes the survey site, sampling approach and survey data. The last section is the summary and conclusion.

In between the third section and the last section are three major sections of this paper. The first one describes the travel mode choice condition. The second one is the suppressed travel mode choice: “have to travel by transit” model analysis. It addresses the following questions: Do residents have no other travel mode choices but to travel by transit? Is travel mode choice being suppressed? If so, how is this affecting the travel mode choice in general? What are the demographic characteristics of this “have to travel by transit” feeling? The third one aims to answer the following questions: For the transit riders who “have to travel by transit”, what are their most unsatisfactory aspects of the transit service? To prevent them from giving up on transit once they become richer and purchase cars in the future, what aspects of the transit
service need to be improved with a high priority? It analyzes transit satisfaction scores and provides transit improvement suggestions.

LITERATURE REVIEW

Residents started to live in large-scale residential areas on the city periphery since 2005. Not many studies focused on the residents’ travel behavior, especially the suppressed travel mode choice condition.

Existing literatures studied suppressed travel from several different aspects. Some found that the vehicle license limitation policy suppressed car ownership (3). Suppressed travel likely reflected a combination of influences: reduced car ownership, more judicious and selective use of cars for particular trip purposes, and multiple-occupant car share trips (4). Some measured and estimated suppressed travel with enhanced activity-travel diaries, focusing on the dynamics of the scheduling process (5). Others studied car drivers’ compliance with the route advice, finding that the advice did not merely suppress but also changed the way drivers evaluated route alternatives (6).

Travel suppression can be caused by many different reasons. Some trip-activity suppression happened due to road network problems, for example link failures (7). In response to road pricing, trip suppression and non-motorized travel were the most popular alternatives for non-commuting trips (8). Built environment contributed to the suppressed travel condition in the Chinese large-scale residential area on the city periphery (9).

When studying city periphery residents’ travel behavior, travel dissatisfaction and suppression, a large proportion of the literatures analyzed residents or different groups of residents in developed countries and advanced economies, like in the United States, Europe (10-13). Studies looked into developing countries are fewer. In the case of China, the country as a whole is still undergoing urbanization. People are moving to the city. However, some of the big cities have come to the suburbanization due to the high density in the city center. There are outward movements of urban population and industries from the city center. Also, the city is becoming polycentric with sub-centers and industrial zones being built in the suburbs (2). Previous literatures mostly focused on these sub-centers before large-scale residential areas existed, when studying Chinese city periphery residents’ travel issues and dissatisfaction (15-17).

China’s current suburbanization is characterized by residential decentralization due to old city regeneration and the development of affordable housing in the suburbs (2) (14). In the central city redevelopment process, large-scale residential areas on the city periphery play an important role and become the focus of the studies.

Regarding the travel dissatisfaction and suppression of the residents who are living in large-scale residential areas and new towns in the suburbs, most studies worked on understanding the travel issue and residents’ or central city migrants’ travel behavior. Yang (18) found that a move to Beijing’s periphery lengthened commute time more than a move to the urban core, and the “reluctant” movers had more travel time increase in average. Cervero and Day (1) (19) (20) studied the impacts of the relocation to outlying areas in Shanghai, finding that job accessibility levels declined dramatically following the move, matched by increased motorized travel and longer commute durations. Wang et al. (22) studied the social welfare housing communities which were located on the urban fringe. They could be
generally characterized as automobile-oriented communities, with longer distance traveled. And the travel time to workplace was the highest among all different kinds of housing communities. Pan et al. (21) studied the central city migrants’ travel characteristics and concluded that when making relocation policies, travel needs should be considered as a major factor. Guan (23-26) studied different resident groups’ travel behaviors in large-scale residential areas and analyzed transport policies for the region.

In the existing literatures, most studies focused on residents’ travel characteristics and travel dissatisfaction. To our knowledge, very few studies have worked on the residents’ suppressed travel especially the travel mode choice suppression (have to travel by transit) in the large-scale residential area on the city periphery. The presence of the suppressed travel mode choice (have to travel by transit) is an indication of possible future transit rider loss when income increasing and cars being purchased. To avoid this from happening, it is essential to understand the travel mode choice suppression condition and give relative policy suggestions to the area. To provide such travel mode choice suppression knowledge and support policy decision-making, this study is formed.

SURVEY SITE AND DATA

Survey Site

This study focuses on the large-scale residential area on the city periphery in China. The large-scale residential area refers to an area of 2 km\(^2\). And it has a population of 30-50 thousand with a major function of providing affordable housing and residence. On the city periphery means it is not located in the central city. In the case of Shanghai, on the periphery refers to outside of Outer Ring Road (Figure 1) which is the symbolic boundary between the Shanghai central city and the suburbs.

The case area Jinhexincheng (meaning Golden Crane New City in Chinese), Jiading District is a residential area located to the west of downtown Shanghai and outside of the Outer Ring Road (Figure 1). It is approximately 2km\(^2\) with a registered residents’ population of 28 thousand until March 2012.

Jinhexincheng consists of ten housing projects. Eight of them are for the relocated residents whose central city old house was demolished. The other two of them are market-rate housings. These ten housing projects were completed between 2005 and 2008. Residents started to move in since 2005. At the time of the survey, Jinhexincheng had limited retail shopping and only a few small grocery stores and had no metro service. Conventional buses connected residents to the central city.
FIGURE 1 the Location and Map of the Study Site Jinhexincheng, from the City Center Old House to the City Periphery Large-Scale Residential Area.

Sampling Approach and Survey Data

Since census data and other data source cannot provide useful dataset for newly developing areas at a detailed level, field study for local transport conditions, questionnaire survey and interviews with residential committees and residents were conducted by the research team in 2011.

Residents above 16 ages old were asked to complete a self-reported or with-interviewer-guide survey on their travel behavior, transit preference and personal attributes. Each person was asked the only-one most-frequent trip, the trip purpose and mode choice, etc. In this beginning stage of the area’s research, transport planning and transport supply, satisfying all travel needs is impossible due to the lack of funding and resource. Studying the most frequent trip is our priority for now.

A random sampling approach was adopted. Invitations were randomly mailed, 413 persons replied to it. After the process of contacting them and letting them fill in the questionnaires, 320 residents’ 320 valid trips (one person one trip) were collected.

All different travel purposes are divided into three categories (for overall 320 trips): go to work, school and related activities count as subsistence travel with a sample size of 161 trips; go shopping for necessaries, pick up others and go to hospital count as maintenance travel with a sample size of 143 trips; go out for dining, entertainment, leisure and social activities count as recreational travel with a sample size of 16 trips. As mentioned above, in this
beginning stage, studying the most frequent trip is our priority for now. In this study, we focus on residents’ most frequent subsistence and maintenance travel, rather than recreational travel. So the final valid sample contains 304 residents’ 304 trips, including subsistence travel 161 trips and maintenance travel 143 trips.

**TRAVEL MODE CHOICE CONDITION**

There are six travel modes in Jinhexincheng: car, transit, motorcycle or moped, bicycle, shopping shuttle bus and walking. The mode shares of them for the most-frequent subsistence and maintenance trips are shown in Figure 2.

41 percent of the resident samples use transit for their most frequent trips. Compared to the Shanghai central city’s transit share 34.9 percent in 2011 (27), more residents are using transit in this large-scale residential area’s sample. However, only 18.55 percent of the transit riders find transit overall service quality satisfactory. This shows that even through residents find transit service unsatisfactory, they are still traveling by transit.

Why do residents still travel by transit when facing the unsatisfactory transit service? Why not use other travel mode, like car? The author believes that it is related to: owning a car with its license costs too much for the residents and there is no effective car share system yet. Car is not unaffordable in Shanghai: average Shanghai employee’s annual income is approximately 53 thousand CNY in 2011 (28); a new car costs about 30 thousand CNY (29); a second-hand car is cheaper than this. However, the Shanghai vehicle license is too expensive to afford.

In Shanghai and other major Chinese cities, there is the vehicle license restriction policy. Since 1994, Shanghai has instituted a local vehicle-license auction. Only with this local vehicle license, a car can be driven into the Shanghai central city (within the Outer Ring Road in Figure 1). Suburban cars with Shanghai C license are forbidden from entering the inner ring road. And cars with nonlocal licenses are forbidden from driving on the elevated expressway network in the central urban area during peak hours. In the local vehicle-license auction, average price is approximately 50 thousand CNY in 2011 (30), which can be used to purchase two cars.

Vehicle license limitation policy has suppressed car ownership in Shanghai (3). Only 18.42 percent of the Jinhexincheng samples own cars. With this low car ownership rate, residents may have to travel by transit.

Among all six possible travel modes (car, transit, motorcycle or moped, bicycle, shopping
shuttle bus and walking), shopping shuttle bus serves shopping trips. By bicycle and walking can only reach limited destinations nearby. Car ownership rate is too low. So there are only transit and motorcycle/moped left for most residents when traveling to general destinations. This can explain why transit and motorcycle/moped have first and second highest mode shares. If someone does not have a motorcycle or moped available, he or she will have to travel by transit. Suppressed travel mode choice condition may exist in this area.

SUPPRESSED TRAVEL MODE CHOICE: “HAVE TO TRAVEL BY TRANSIT” MODEL ANALYSIS

In the sample, 41 percent of the resident samples travel by transit in their most frequent trips (124 transit riders out of the overall 304 residents’ sample). Among these transit riders, 71.77 percent answered the direct transit preference question with “have no other choices, have to travel by transit” (Figure 3). Over 70% of the transit riders in the sample acknowledged that they “have to travel by transit” and this attracts the researcher’s attention.

FIGURE 3 the Answers of the Transit Preference Question in the Jinhexincheng Transit Rider Sample (124 Transit Riders).

In the large-scale residential area, some residents’ travel mode choice is under suppression. They have to travel by transit. How is this affecting samples’ mode choice in general? What are the demographic characteristics of this “have to travel by transit” feeling? This section will address these research questions.

With the data collected from Jinhexincheng, an integrated choice and latent variable model is estimated in Python Biogeme (37). It employs the simultaneous maximum likelihood estimation method. This results in consistent and efficient estimates of the model parameters (32). The model structure and results are shown in Table 1.

The likelihood ratio test between multinominal logit model and the following model shows that there is a 99.5 percent degree of confidence that the following model is different from and better than the multinominal logit model.
TABLE 1 Results of the Integrated Choice and Latent Variable Model for Subsistence and Maintenance Travel Mode Choice

<table>
<thead>
<tr>
<th>Parameter Number</th>
<th>Description</th>
<th>Coeff. Estimate</th>
<th>Robust Std Err</th>
<th>Robust T-Test</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Choice Model:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>12 alternative-specific constants:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Car for subsistence travel</td>
<td>3.99</td>
<td>0.86</td>
<td>4.64</td>
<td>0.00</td>
</tr>
<tr>
<td>3</td>
<td>Transit for subsistence travel</td>
<td>2.90</td>
<td>0.58</td>
<td>5.01</td>
<td>0.00</td>
</tr>
<tr>
<td>4</td>
<td>Motorcycle/moped for subsistence travel</td>
<td>2.55</td>
<td>0.73</td>
<td>3.48</td>
<td>0.00</td>
</tr>
<tr>
<td>5</td>
<td>Bicycle for subsistence travel</td>
<td>0.55</td>
<td>0.81</td>
<td>0.67</td>
<td>0.50</td>
</tr>
<tr>
<td>6</td>
<td>Shopping shuttle bus for subsistence travel</td>
<td>3.20</td>
<td>1.01</td>
<td>3.17</td>
<td>0.00</td>
</tr>
<tr>
<td>7</td>
<td>Walking for subsistence travel</td>
<td>0.00 fixed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Car for maintenance travel</td>
<td>1.56</td>
<td>0.78</td>
<td>2.01</td>
<td>0.04</td>
</tr>
<tr>
<td>9</td>
<td>Transit for maintenance travel</td>
<td>1.98</td>
<td>0.39</td>
<td>5.09</td>
<td>0.00</td>
</tr>
<tr>
<td>10</td>
<td>Motorcycle/moped for maintenance travel</td>
<td>1.51</td>
<td>0.62</td>
<td>2.44</td>
<td>0.01</td>
</tr>
<tr>
<td>11</td>
<td>Bicycle for maintenance travel</td>
<td>0.99</td>
<td>0.58</td>
<td>1.71</td>
<td>0.09</td>
</tr>
<tr>
<td>12</td>
<td>Shopping shuttle bus for maintenance travel</td>
<td>2.28</td>
<td>0.54</td>
<td>4.21</td>
<td>0.00</td>
</tr>
<tr>
<td>13</td>
<td>Walking for maintenance travel</td>
<td>0.00 fixed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Travel cost (CNY)</td>
<td>-0.05</td>
<td>0.04</td>
<td>-1.10</td>
<td>0.27</td>
</tr>
<tr>
<td>15</td>
<td>Value of time (CNY/hour)</td>
<td>20.30</td>
<td>14.50</td>
<td>1.40</td>
<td>0.16</td>
</tr>
<tr>
<td>16</td>
<td>Latent variable -“have to travel by transit”</td>
<td>-0.29</td>
<td>0.18</td>
<td>-1.60</td>
<td>0.11</td>
</tr>
</tbody>
</table>

**Latent Variable Model:** “Have to travel by transit”

- **Structural Model:**
  16 Male dummy (the male is 1, otherwise 0) | 0.08 | 0.13 | 0.65 | 0.51 |
  17 Retired dummy (the retired is 1, otherwise 0) | -0.36 | 0.16 | -2.21 | 0.03 |

- **Measurement Model:**
  Indicator 1 Complaint towards transit | 1.00 | -- | -- | -- |
  Indicator 2 Transit service quality meets expectation | 0.50 | 0.08 | 6.41 | 0.00 |

**Summary Statistics:**
- Number of observations: 304
- Rho bar: 0.60
- Draws: 100
- Final log-likelihood: -952.04

**Model Structure:**

Each person has one most-frequent trip in the sample. The choice set includes six travel modes: car, transit, motorcycle or moped, bicycle, shopping shuttle bus and walking.
The following data is entered into the model: the trip purpose, mode choice, alternative attributes (travel time and cost), personal sense of transit, demographic characteristics (gender, age, retirement, Shanghai permanent residency, education, apartment ownership, driver’s license, car desire, central-city-old-house-demolished relocated resident or not, years living locally, and years living in Shanghai), and availabilities of the travel modes (car, motorcycle or moped, bicycle ownership and shopping shuttle bus awareness).

This model has two sets of alternative-specific constants separately for subsistence and maintenance travel. With six travel modes, it has 12 alternative-specific constants in total (Table 1).

The value of time is 20.3 CNY/hour (CNY means China Yuan, the money name in China, 1 United States Dollar (USD) = 6.21 CNY, 20.3 CNY/hour = 3.27 USD/hour). In Chinese value of time literatures, the value of time is in the range of 9-34 CNY/hour (1.45-5.48 USD/hour) (26). The value of time in this model is reasonable compared to the existing literatures’ Chinese value of time. The value of time is reasonable shows that this model is acceptable.

The significant latent variable is named “have to travel by transit” in this model. This feeling has a negative effect on transit mode choice. For demographic characteristics, the model indicates that the retired tends to have less of the “have to travel by transit” feeling. Other demographic characteristics are insignificant.

The “have to travel by transit” latent variable has two significant indicators. They are obtained from the questionnaire survey, using the Likert five-level scale. The “have to travel by transit” feeling (latent variable) has a positive effect on both “complaint towards transit” and “whether transit service quality meets the expectation” indicators. The effect to the “complaint towards transit” indicator is stronger.

Comparing the integrated choice and latent variable model’s result to the direct transit preference question’s result above (with an answer choice of “have no other choices, have to travel by transit”), the researcher finds that the two match with each other. Both of them prove that there is a “have to travel by transit” condition (travel mode choice suppression) in Jinhexincheng, the large-scale residential area on Shanghai city periphery.

**TRANSIT SATISFACTION SCORE ANALYSIS AND TRANSIT IMPROVEMENT SUGGESTIONS**

Since “have to travel by transit” condition (travel mode choice suppression) exists in Jinhexincheng, we can imagine that once these “have to travel by transit” residents become richer and purchase their own cars, motorcycles or mopeds, they are likely to change their travel mode choice and give up on transit. For these transit riders who “have to travel by transit”, what are their most unsatisfactory aspects of the transit service? To prevent them from giving up on transit in the future, what aspects of the transit service need to be improved? This section aims to answer these research questions.

41 percent of the resident samples travel by transit in their most frequent trips. Among these transit riders, 71.77 percent acknowledge that they “have no other choices, have to travel by transit” when answering the direct transit preference question (Figure 3). The following section focuses on these transit riders who “have to travel by transit”. Their satisfaction towards different aspects of the transit service is studied. The author tries to
understand what aspects of the transit service are the ones that they find unsatisfactory. So that these aspects of the transit service can be firstly improved to save the future passenger loss. There are 89 transit riders who “have to travel by transit” in the sample. Their satisfaction scores towards different aspects of the transit service are in Table 2.

**TABLE 2 “Have to Travel by Transit” Riders’ Satisfaction Scores towards Different Aspects of the Transit Service**

<table>
<thead>
<tr>
<th>Number</th>
<th>Different Aspects of the Transit Service</th>
<th>Satisfaction Score (Average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Car crowdedness during peak hours</td>
<td>1.81</td>
</tr>
<tr>
<td>2</td>
<td>Most-frequent trip’s travel time</td>
<td>2.21</td>
</tr>
<tr>
<td>3</td>
<td>Operating hours (first and last service time)</td>
<td>2.64</td>
</tr>
<tr>
<td>4</td>
<td>Waiting time</td>
<td>2.67</td>
</tr>
<tr>
<td>5</td>
<td>Most-frequent trip’s travel cost</td>
<td>2.76</td>
</tr>
<tr>
<td>6</td>
<td>Number of lines/stops</td>
<td>2.83</td>
</tr>
<tr>
<td>7</td>
<td>Service quality considering fare (cost performance)</td>
<td>2.93</td>
</tr>
<tr>
<td>8</td>
<td>Transfer between different lines (time or distance)</td>
<td>3.00</td>
</tr>
<tr>
<td>9</td>
<td>Transfer with other travel modes (time or distance)</td>
<td>3.06</td>
</tr>
<tr>
<td>10</td>
<td>Punctuality</td>
<td>3.07</td>
</tr>
<tr>
<td>11</td>
<td>Speed</td>
<td>3.15</td>
</tr>
<tr>
<td>12</td>
<td>Transit overall service quality</td>
<td>2.92</td>
</tr>
</tbody>
</table>

**Satisfaction Score:** Respondents give 1 to 5 scores to different aspects of the transit service. 1 is very dissatisfactory, 2 is dissatisfactory, 3 is neutral, 4 is satisfactory, and 5 is very satisfactory. The higher the score is, the better transit service quality the item has. Items with low scores are the ones that should have a high level of priority when the transit service is being improved, so that we can prevent the “have to travel by transit” riders from giving up on transit in the future.

In Table 2, there are 11 aspects of the transit service and one overall item. The aspects with satisfaction score 3 or above are the neutral to satisfactory ones, shown in green in the table. Satisfaction scores between 2.5 and 3 are the not satisfactory ones, shown in yellow in the table. Satisfaction scores below 2.5 are the ones that have a high priority when transit is being improved, which are shown in red in the table.

“Car crowdedness during peak hours” and “most-frequent trip’s travel time” are the most unsatisfactory ones among this area’s transit riders who “have to travel by transit”. To prevent the “have to travel by transit” riders from giving up on transit once they become richer in the future, these two aspects should have the highest priority to be improved. Then, operating hours (first and last service time), waiting time, most-frequent trip’s travel cost, number of lines/stops, and service quality considering fare (cost performance) need to be improved too.

These above are the transit service improvement suggestions. About the overall transit service quality, the satisfaction score shows that it is between dissatisfactory and neutral. This proves that the transit service in Jinhexincheng, one of the large-scale residential areas on the city periphery, needs to be improved.
SUMMARY AND CONCLUSION

Residents in the large-scale residential area on the city periphery often find transport service unsatisfactory but still use transit for their most frequent trips. In this study, residents’ travel mode choice suppression (have to travel by transit) is analyzed and transit improvement suggestions are provided.

First, travel mode share and transit satisfaction study show that 41 percent of the 304 resident samples use transit for their most frequent trips, but only 18.55 percent of the transit riders find transit overall service quality satisfactory. This indicates that even though residents find transit service unsatisfactory, they are still traveling by transit. Car ownership is being suppressed by the vehicle license limitation policy. Only 18.42 percent of the samples own cars. With this low car ownership rate, transit and motorcycle/moped have first and second highest travel mode shares.

Then, travel mode choice suppression (have to travel by transit) in the area is proven by both the direct transit preference question and the integrated choice and latent variable model analysis. And the two types of results match with each other:

In the direct transit preference question, 71.77 percent of the transit rider samples acknowledged that they “have no other choices, have to travel by transit”. In the integrated travel mode choice and latent variable model, the “have to travel by transit” feeling is a significant latent variable and has a negative effect on transit mode choice. Both indicate the travel mode choice suppression exists in the area.

In the integrated travel mode choice and latent variable model, the “have to travel by transit” latent variable has a positive effect on both “complaint towards transit” and “whether transit service quality meets the expectation” indicators. Among the two indicators, the effect to the “complaint towards transit” indicator is stronger. For demographic characteristics, the model indicates that the retired tends to have less of the “have to travel by transit” feeling. Other demographic characteristics are insignificant.

In the end, to provide transit improvement suggestions and prevent the “have to travel by transit” riders from giving up on transit, transit satisfaction score analysis of the 89 transit riders who “have to travel by transit” is conducted. Results show that for the overall transit service quality, the satisfaction score is between dissatisfactory and neutral. This proves that the transit service needs to be improved. And among all different aspects of the transit service, “car crowdedness during peak hours” and “most-frequent trip’s travel time” are the most unsatisfactory ones. These two aspects should be improved with a high priority. In this way, future transit rider loss can be avoided.

In conclusion, for large-scale residential areas on developing countries’ city periphery, transit riders find transit service quality unsatisfactory. With car ownership being suppressed, the “have to travel by transit” feeling exists and affects residents’ travel mode choice. It is called travel mode choice suppression in this paper. We can imagine: with the “have to travel by transit” feeling, these transit riders will giving up on transit once they become richer and purchase vehicles on the city periphery. To prevent such thing from happening and to promote transit priority in these areas, transit service needs to be improved and “car crowdedness during peak hours” and “most-frequent trip’s travel time” are the ones need to be improved first among all different aspects of the transit service. Customized bus or community bus can be one solution. These transit improvement suggestions support transit
development decision-making in the area.

This paper provides residents’ suppressed travel mode choice study in the large-scale residential area on the city periphery in the developing country. It focuses on this area’s transit riders who “have to travel by transit”. Such study method and study process can be applied to many other similar large-scale residential areas on the big and populous cities’ periphery in developing countries.

There are limitations in this study that await to be further studied. In the future, more valid samples should be collected in order to provide more solid and significant results. Time series data needs to be collected to evaluate the suppressed travel mode choice condition’s change in the developing country over time.

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