

Effects of Tsukuba Express Project on the Residents' Travel Behavior

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Abstract: The Tsukuba Express line commenced operations in August 2005, connecting Tsukuba city and Tokyo metropolitan, Japan. Based on the Tsukuba Express Railway Project, the transportation system includes road network and local bus network which had greatly restructured Tsukuba City and its surrounding area. The objective of this paper is to understand the impact of Tsukuba Express Railway Project on the actual travel pattern and behavior of the residents of the surrounding areas of Tsukuba Express. The study conducted panel data survey before and after Tsukuba Express' operation. Results indicated that residents' patterns and modal choices have changed significantly.

Key Words: *New Railway Project, travel behavior, access mode choice model*

1. INTRODUCTION

Tsukuba Express (TX) opened in August 2005 connecting Tsukuba city and Akihabara in Tokyo (figure 1). TX project had planned lessen the rush hour commuters of JR Joban Line, as well as to provide good residential areas along with the TX line. This project is fully a new rail project, with new residential areas and shopping centers built around twenty new railway stations. The alternative modes of traveling to Tokyo include JR Joban line and highway bus. The trip takes about 70 minutes and 90 minutes by using Joban line and highway bus, respectively. The access time to Tokyo has greatly shortened the travel time in 45 minutes with the TX line connecting the 58.3km distance. The study assumes that the travel behavior of the residents who live in the surrounding area of TX line has changed with TX operation. It is important to analyze the impact of new



Figure 1 Operation area of TX

railway project because the results could show and improve any future projects in the area whether analysis show a positive and/or negative results. In terms of the transportation planning, understanding the change of residents' travel behavior before and after the use of new railway project is required. Panel survey is one of the possible ways to understand the effect of new railway project. The change of the residents' travel behavior of the residents could be analyzed using panel survey (Kitamura, 1990) because the survey questionnaires are given to the same respondents in two different periods (before and after the new railway project in this study).

The target area of survey is Tsukuba city and the surrounding region along with the TX line (see figure 2). The modal share of private vehicle in this area accounts for 79.0 % (Miyazaki, 2006). This rate is relatively high when compared with the Tokyo metropolitan area (40.9 %; the data is available at 4th Person Trip Survey, 1998). The main reason for this was the inconvenience of the public transportation before TX operated in this area. On the other hand, it is also necessary to improve the level of bus service in order to achieve an 'environmentally sustainable' city. In 2008, Tsukuba city manifested to reduce the CO₂ emission to 50 percent by 2030. Considering the CO₂ emission reduction need, car dependent city is not effective. Therefore, improving the level of bus service is one of the alternatives to reduce the CO₂ emission. TX project was regarded as the opportunity for Tsukuba city to improve the bus service and get out of car dependent city.

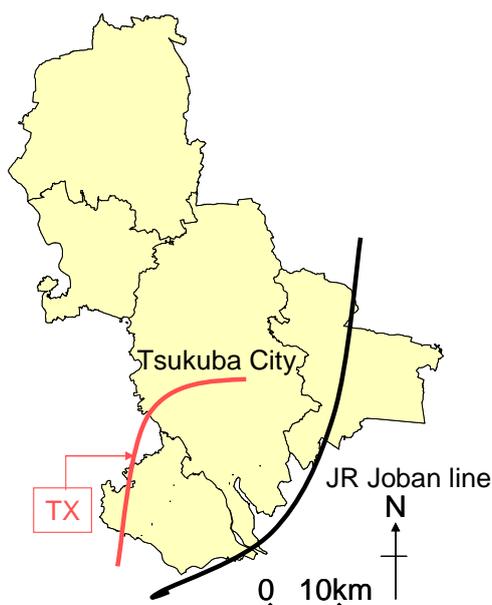


Figure 2 Target area

Now, the transportation infrastructure of this area has improved due to the new railway project. This includes the new road construction, the local bus network re-construction and new railway station establishment. This improved transportation infrastructure may change the residents' travel behavior or mode choice. In this light, this study aims to find out the change of residents' travel behavior before and after the TX project. Moreover, this study analyzes the change of residents' behavioral intention from the viewpoint of one's consciousness.

Many studies aim to understand the effect of new railway projects (such as Kodama and

Kamata, 1986; Kakimoto and Ando, 1994; Nomura et al., 2001), few studies analyzed the change of residents' travel behavior based on panel survey. Nishii et al. (1999) analyzed the change of mode share by commuters and visitors to Kyoto by using panel survey data. Mohri et al. (1995) analyzed the transferability of modal choice model after operating Chiba Urban Monorail. These studies focused on the actual modal shift. In this study, however, the target city is known as a car dependent one before TX operation and it seems hard to be able to shift to the public transportation if the analysis is just focused on the actual travel behavior. Therefore, not only the change of actual travel behavior but also resident's intention to change the behavior is observed in this study. The feature of this study is 1) to compare the travel behavior before and after the new railway project and 2) to focus on the change of level of public transportation service based on the panel data conducted in 2005 and 2006.

2. THE SURVEY OUTLINE

2.1 The Survey Outline

The panel survey was conducted before and after the TX operation. The first survey (Wave 1) was conducted on July 30 to August 7, 2005 before the operation of the TX service. The second one (Wave 2) was done on July 15 to 23, 2006 after the TX operation start. Both surveys were based on home based survey at surrounding area of TX line. These surveys were done in cooperation with University of Tsukuba Urban Transportation Laboratory and National Institute for Land and Infrastructure Management. Table 1 shows the outline of survey.

Table 1 The survey outline

Date	Wave1:July 30 to August 7, 2005 Wave2:July 15 to 23 , 2006
Method	Face to face interview
Target area	Tsukuba city and surrounding area
Contents	Socio-demographic characteristics (gender, age, occupation, employment status, driver license) Trip characteristics to Tokyo (number of trip, purpose, line hole, access, egress, activity diary(weekday and holiday), frequency of using car, bike and bus Behavior intention (intention of using a car)

2.2 Data Collection

The data in Wave 2 was collected using same respondents and the same questionnaire in Wave 1. In other words, this study obtained the panel data. Table 2 shows the number of households requested to answer the survey and the number of respondents. 1,500 households were requested of cooperate in the survey and 1,067 (71.1 % of residents requested) households returned wave 1 survey. Likewise, the 666 of the 976 households responded to the questionnaire in wave 2, which amounted 68.5 %. The number of households requested in wave 2 survey was smaller than that of the wave 1 survey. The reason for this is that there are some residents who refuse to cooperate the questionnaire. The questionnaire return rate was quite high (71.1 % and 68.5 % respectively). The number of residents requested and respondent in the survey is shown on table 2. A total of 793 usable respondents were collected as the panel data.

Table 2 The number of targeted sample

	wave1		wave2		panel
	household	person	household	person	person
Target	1,500		972	1,716	
Requested	1,485		713	1,354	
Responds	1,067	1,822	666	1,070	793



Figure 3 Characteristics of respondents (gender)

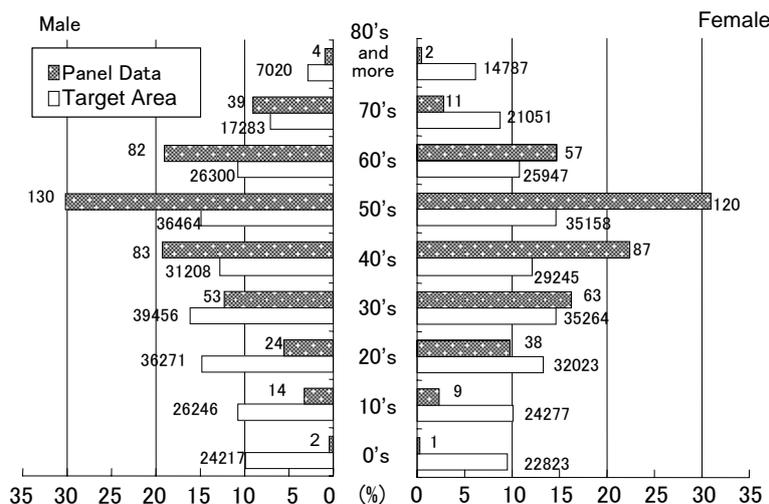


Figure 4 Characteristics of respondents (age)

The socio-demographic characteristics of the respondents are shown on figure 3 and 4. The number of male and female respondents is almost same (figure 3).

The number of respondents in their 40's and 50's is greater than the actual number in the study area. On the other hand, the number of respondents in their 20's and 30's returned the survey is small compared with the actual number (figure 4). One of the reasons for this is the difficulty of responding the questionnaire. The residents who are engaged in a full time job tend to have less time to respond since it takes about 30 minutes to answer all the questions.

3. THE CHANGE OF RESIDENTS' TRAVEL BEHAVIOR

3.1 Trip Generation

The number of trip generated from target area to Tokyo is shown on table 3. The respondents who did not travel to Tokyo both before and after the TX operation were excluded for the net trip. The number of gross trip (including all the respondents who did not travel to Tokyo) showed no statistical difference with the number of net trip. Therefore, the number of trip generated to Tokyo did not change significantly after the TX operation.

	Net trip		Gross trip	
	wave1	wave2	wave1	wave2
trip/month	3.25	3.11	2.19	2.10
t-value	-0.739		-0.739	
N	516		767	

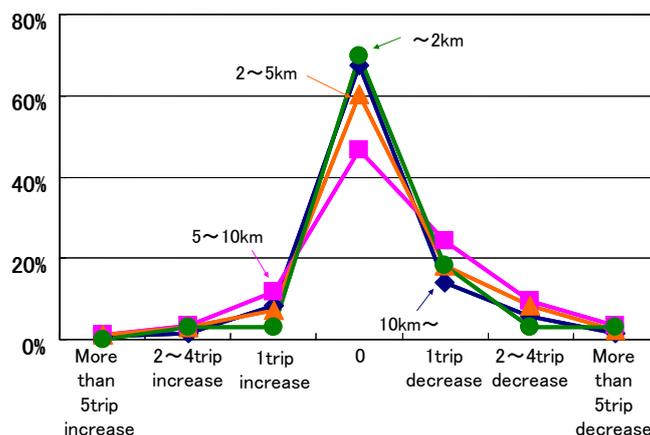


Figure 5 The number of trip to Tokyo (Joban line and highway bus user)

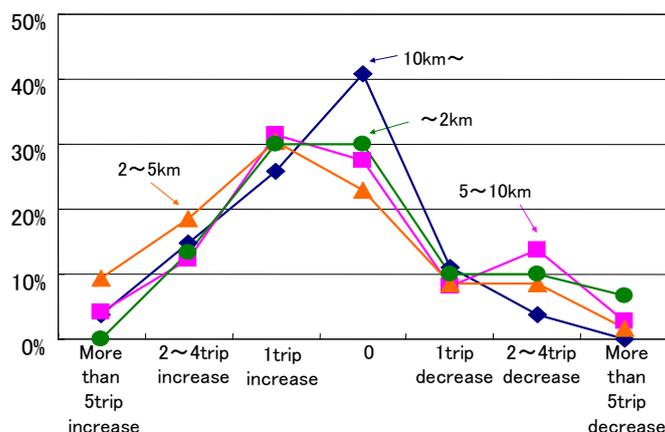


Figure 6 The number of trip to Tokyo (TX user)

However, it tends to increase when the viewpoint of the access mode and the distance to TX station are accounted for. Figure 5 shows the number of trip changed after the start of TX operation for the Joban line and highway bus users who travel to Tokyo. Figure 6 shows the

number of trip changed for the TX users. These figures suggest that the number of trip to Tokyo increased for the TX users compared with the other modes users. Moreover, the lines drawn on each figures indicate the distance to TX stations from each residents. The result shows that the shorter the distance to TX stations, the more trips generated to Tokyo. It suggests that the residents who live near the TX stations tend to increase the number of trips to Tokyo.

3.2 Mode Share

The modal split of travel to Tokyo by the residents who lives in the target area is shown in figure 7. The rate of using the TX accounted to be over 50 % after the TX opening. On the contrary, the rate of using the Joban line resulted to be 29.9 %, it decreased from 70 %. Likewise, the rate of using the highway bus slightly decreased (22 %) in comparison with the rate before the TX project (35 %). Meanwhile, the share of the car use for traveling to Tokyo did not change.

Figure 8 shows the access mode share by the TX users, the Joban line users and highway bus users. The rate of residents walking to the station is resulted to be over 30 %, it suggests that the highway bus stops are located near the residential area in Tsukuba city. Comparing before and after the TX project, the rate of using local bus increased by the Joban line and highway bus users. This change indicates that the level of local bus service has improved in accordance with constructing the TX stations.

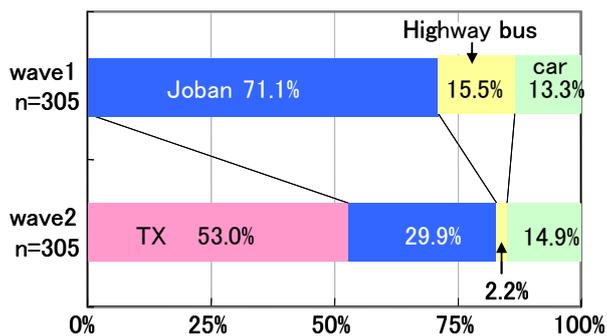


Figure 7 The mode share for traveling to Tokyo

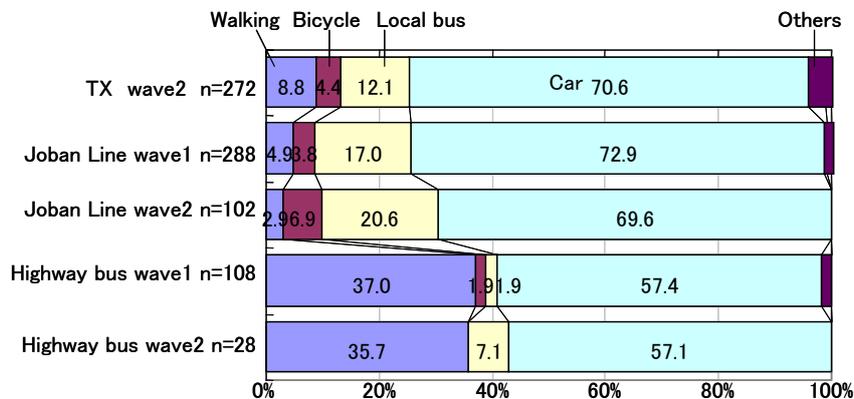


Figure 8 Modal split of Access for trunk mode to Tokyo

3.3 Summary of Chapter 3

It was found out that modal split to Tokyo has changed after TX commenced operation. On the other hand, the number of trips to Tokyo did not change after the TX operated. This observation, however, was also suggested that some residents showed the growing number of trips to Tokyo when it takes the distance to the TX station into consideration. One reason for only a small impact of TX project observed in this study may be caused by the survey design. Since the wave 2 survey was conducted only one year after TX commenced, the residents' life style might not have changed then. As a new residential area has been developed after TX project, the number of population has been growing in Tsukuba. The additional survey would be required in such a growing city.

4. ACCESS MODE CHOICE MODEL

4.1 Model Structure

The disaggregated logit model was estimated for the residents' mode choice behavior of accessing to the railway or bus station. Since the panel data is available, the change of the access mode choice behavior is observable before and after the TX opened.

The explanatory variables are the access time to the station, the access cost, the frequency of bus trips, the dummy of pedestrian and constants (pedestrian, bike and bus). The transportation modes as the choice set are walking, bike, local bus and a car.

4.2 Model Estimation

The result of model estimation is shown in table 4. The results suggest that 1) the hit ratio and likelihood ratio is high enough to say that this model was well estimated, 2) the sign of parameter is consistent and 3) the t-value of access time and cost was improved in the wave 2 model. This indicates that there is a possibility for the residents to prioritize the access time after the TX operation. Some residents forced to use the car to access to the station because there was not enough bus service before the TX started.

This situation has changed (or improved) after operation of the TX. Along the TX line, new stations were established and the bus networks were restructured. The level of public transportation services improved.

Table 4 Model estimation of access mode choice

	wave1		wave2	
	parameter	t-value	parameter	t-value
the access time (min)	-0.01476	-1.71	-0.05946	-5.59
the access cost (yen)	-0.001313	-0.365	-0.001264	-1.34
frequency (operation) [bus]	0.07358	3.83	0.03786	2.99
constant [walk]	-2.018	-1.19	0.1740	0.235
constant [bike]	-2.869	-1.80	-2.306	-3.86
constant [bus]	-3.449	-5.64	-2.375	-6.98
Number of observation	277		277	
Likelihood ratio	0.5317		0.4418	
Hit ratio (%)	78.98		76.17	
The value of time (yen /min)	11.24		47.05	

5. RESIDENTS' CONCIIOUSNESS TOWARD A CAR USAGE

The residents who live in the target area highly dependent on the car for the daily travel such as the commuting, shopping and so on. It is often difficult for the car dependent person to use the local bus as the access mode to the station. Fujii (2003) suggested that the person may restrain the car use after establishing the behavioral intention. Behavioral intention represents the person's motivation and it is the necessary condition to alter the one's behavior.

This study analyzed the behavioral intention by asking the respondents; "Are you willing to restrain the car use?" Then the respondents were requested to indicate their levels of evaluation to the item on a 5-point scale (1 = No, I will not; 5 = Yes, I will). All respondents were divided into three groups, that are 'the respondents whose intention of restraining the car use is weak (weak intention)', 'the respondents whose intention of restraining the car use is strong (strong intention)' and 'the respondents who have the middle intention of restraining the car use (middle intention)'.

5.1 Variables of Model

The access mode choice model was developed by using the residents' behavioral intention which was defined in this study. Explanatory variables for this model consisted of: the access time by the intention groups, the access cost, the dummy variable of holding the bicycle and the number of bus operation per day (frequency of bus). The alternative choice set of the access modes are walking, bike, local bus and the car.

5.2 Model Estimation

Table 5 shows the result of model estimation. The results show that 1) the sign of each parameter is consistent and also t-value of each variable and likelihood ratio is statistically significant, 2) t-value of the access time improved after the TX opening, 3) the differences of the access time parameter coefficient were quite large between wave 1 and wave 2 especially for the groups of weak and strong intention. In wave1, the remainder of the access time parameter coefficient of weak and strong intention is 0.0056.((-0.01401)-(-0.008407)). In wave2, the remainder of the access time parameter coefficient of weak and strong intention is 0.03074. ((-0.07926)-(-0.04852)). The remainder of wave2 is bigger than wave1. It indicates that the person whose intention of restraining the car use is weak prioritized the access time for traveling.

Table 5 Access mode choice model estimation by behavior intentions

	wave1		wave2	
	parameter	t-value	parameter	t-value
the access time (weak intention) (min)	-0.01410	-2.07	-0.07926	-4.47
the access time (middle intention) (min)	-0.02393	-1.58	-0.06988	-3.28
the access time (strong intention) (min)	-0.008407	-1.57	-0.04852	-4.58
the access cost(yen)	0.001512	1.43	-0.001253	-1.33
bike dummy	0.3554	1.50	0.2421	1.38
frequency(operation) [bus]	0.04046	3.77	0.03840	3.02
constant [walk]	0.1845	0.0553	0.2084	0.282
constant [bike]	-3.099	-2.76	-3.084	-3.54
constant [bus]	-2.667	-7.49	-2.351	-6.89
number of observation	277		277	
likelihood ratio	0.3925		0.4520	
hit ratio (%)	68.95		76.17	

Since it is convenient for the car users to drive in Tsukuba city (which provided the good road infrastructure and there are no traffic congestions), those who have a weak intention to restrain the car tend to access to the station by car. On the other hand, result also suggested that the person whose intention of restraining the car use is strong tend to choose the alternative modes such as the local bus and walking as the access to the stations.

6. CONCLUSION

Followings are the concluding points obtained from this study;

- 1) The number of trip traveling to Tokyo by the residents who live near the TX stations increased
- 2) The access mode choice behavior was statistically different from the respondents' level of car use intention. This result suggests that the effective travel demand management will be possible by providing the information such as the bus time table, network and the location of bus stop to the residents who are depending on car use since the level of public transportation service has greatly improved after TX opening.

This study discussed the change of residents' travel behavior before and after the TX operated by using the panel data. The future task is to analyze the change of travel behavior individually.

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