STUDY ON METHODOLOGY FOR PROJECT PLANNING OF TRANSPORTATION SYSTEM AT SURBURBAN AREA OF THE LOCAL CORE CITIES BASED ON NEW IDEAS CONSIDERING THE NEEDS AND SUPPORT OF INHABITANTS*

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1. Background

Recently, it has been promoted greatly of the introduction of city monorail or the new transportation system (people mover) into littoral area of large cities or local core cities and its suburban area in Japan. It has the transport capacity between a subway and a bus, and the construction costs are cheaper than a subway. When there is suitable demand, it is necessary to take advantage of this kind of public transportation facility, which is also good to save energy and easy to maintain, and make it as a basic transportation infrastructure in suburban area of the local core cities.

This study is centered with the people mover construction plan in Kusatsu City and Otsu City of Shiga Prefecture. The two cities are the core cities in the so-called Konan Region, which is located in the southern part of Lake Biwa. Neighboring to the Kyoto-Osaka-Kobe Metropolitan, this region has great chance to develop quickly during these years. With the nice natural environment and convenient access to the large metropolitan area, the region has an increasing population, which reached 600,000 in 2005, especially in Kusatsu City, whose population increase rate has been kept at 8% level these years. In the coming future, the Otsu-Konan Region is to be the administration and economy center of the city group network surrounding the southern part of Lake Biwa; to form the science, culture and industrial zone with universities, research institutions and other art and culture facilities; to build up the comfortable urban zone with high level life in the good nature and historical environment. The people mover under planning will be a very effective support for this region to realize the three targets.

Regarding the main problems in this area, transportation problem should not be neglected. In details, the public transportation is only the bus system provided by several bus companies. The service level is quite limited and at the same time, the private car use continues increasing these years, which gives great pressure to the current road network and environment. According to the statistic data, 53.6% of the travels are realized my car, only 27.1% taking railway or bus. From the questionnaire survey, over 42.7% people did not think the bus network worked well. The public transit facilities like people mover are quite necessary to improve the living environment.

The study considers the High Speed Surface Transportation (HSST) as one of the alternatives of people mover. HSST has been developed as a new transit type for either inter-city or intra-urban transportation. One line has been constructed and put into use in Aichi World Exhibition, which is the first commercial application in Japan. HSST provides fast and quiet transportation service, and is good to the environment. And the maintenance and operation cost is lower compared to other traditional transits.

As the decentralization is forwarded, the local cities need the support of public participation. Especially for the large investment of public infrastructure like people mover, it is important to survey and analyze the willingness-to-pay (WTP), which will be very helpful to ensure the financial feasibility of the project.

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2. Main Issues Related to the Project

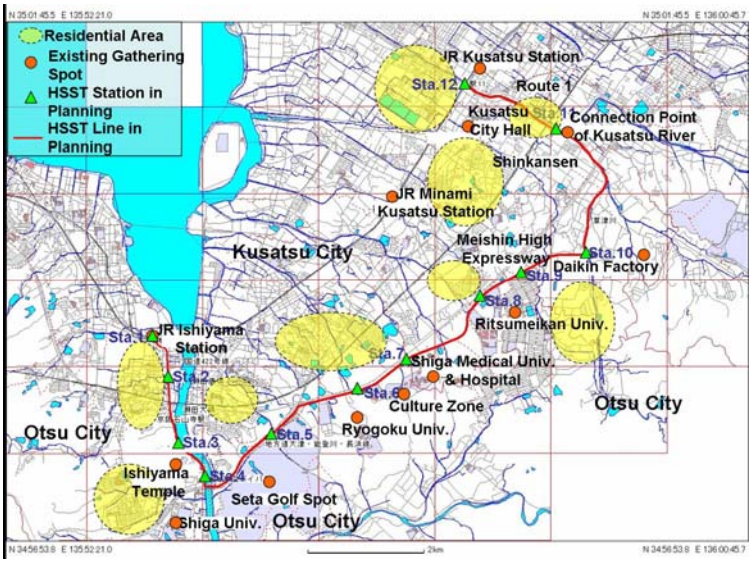

Figure 1: Proposed Line and Stations

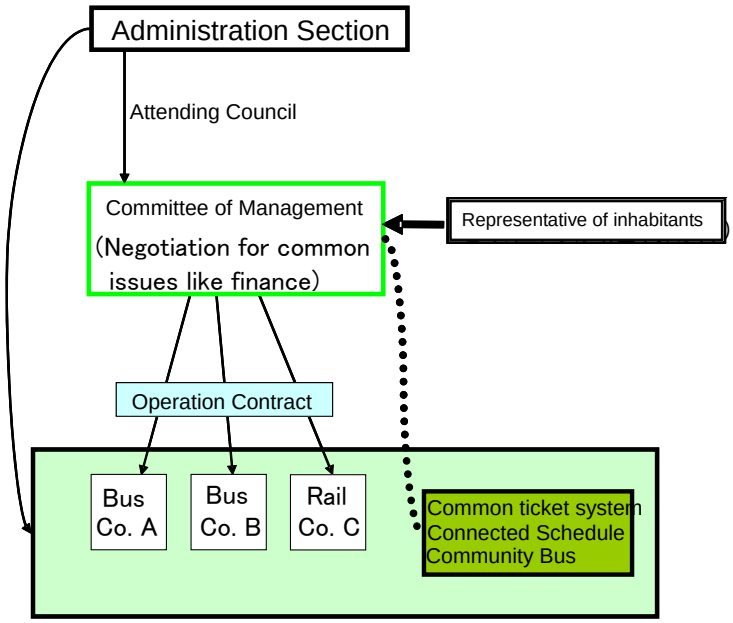

Figure 2: Proposed Management Framework

(1) Project Introduction

Figure 1 shows the proposed line, which will cross three universities and the residential areas to be ended with JR Kusatsu and Ishiyama Station, totally about 15.6 kilometers, and it is to be extended in the future. This article is the study on the first period of HSST, which is 6.4 kilometers long (from Station 8 to Station 12 in Figure 1), and 2 more stations are added.

(2) Public Participation

One management framework is proposed (Figure 2). Public participation includes two main aspects: the participation in management and operation, and the willingness to pay with the insurance of refund. Based on the questionnaire survey made in 2005, from the 152 samples, we predict the possible amount of the money to be collected from the local households (Table 1). They should be convinced that they were attending and contributing to the improvement of their own life.

Table 1: Prediction of Willingness to Pay Based on the Questionnaire Survey

Zones	Household Category	Is people mover necessary?	Number of Households	Number of WTP Households	Amount of the Money (JP Yen)
Along the Proposed Line	1 Person	Yes	5,259	3,825	286,868,734
	1 Person	No	2,630	0	0
	2 & More Persons	Yes	7,580	5,685	639,562,159
	2 & More Persons	No	7,134	984	152,522,434
Summary			22,603	10,494	1,078,953,327
Not Along			23,572	8,941	1,154,215,172
Total			46,175	19,435	2,233,168,500

3. Feasibility Study Based on Ridership Prediction

In order to make the ridership prediction, the person trip survey and related preference survey were made to larger scale including employees, students, householders and so on. 334 samples of 1000 distributed were collected. In the preference questionnaire, the access and egress distances to the proposed HSST stations were surveyed; besides, we also proposed a shuttle bus system of community level to connect the HSST station and each part of residential area. In the MNL model, some conventional variables like cost and travel time were included, and variables related to distance and the bus systems were considered.

In this study, HSST will serve as a kind of the mid-distance transportation, the MNL model was made with three traffic mode of mid-distance level: bus, personal car and HSST. The MNL model is listed as the following.

$$P_m = \frac{\exp(V_m)}{\sum_{m=1}^{3}\exp(V_m)} \qquad \text{m=1: personal car; m=2, bus; m=3, HSST}$$

$$V_{1n} = \beta_1 Z_{1n1} + \beta_2 Z_{1n2} + \beta_5 Z_{1n5} + \beta_6 Z_{1n6} + \beta_9$$

$$V_{2n} = \beta_4 Z_{2n4} + \beta_5 Z_{1n5} + \beta_6 Z_{1n6} + \beta_{10}$$

$$V_{3n} = \beta_3 Z_{3n3} + \beta_5 Z_{1n5} + \beta_6 Z_{1n6} + \beta_7 Z_{1n7} + \beta_8$$

Table 2: The Parameters for the MNL Model

Variables		Commute to work		Commute to School		Others	
		Parameter	T Value	Parameter	T Value	Parameter	T Value
Sex (1=male,0=femail)	β1	1.31240	3.67333				
Age	β2	-0.03510	-0.14407				
Distance to HSST stations (m)	β3	-0.00055	-0.83521	-0.00051	-1.44497	-0.00089	-1.27030
Distance to Bus stations (m)	β4	-0.00014	-2.25908	-0.00024	-0.51135	-0.00217	-1.50040
Traffic time (minute)	β5	-0.09530	-0.84788	-0.04050	-2.84129	-0.01643	-0.92305
Traffic cost (yen)	β6	-0.00560	-0.41672	-0.00526	-2.46148	-0.00210	-1.05510
Frequence in rush time (round/hour)	β7	0.12830	0.74975	0.22450	1.91247	0.02150	3.24160
Shuttle bus (1=yes, 0=no)	β8	3.53020	2.27488	0.70870	2.51780	1.62630	1.20480
Dummy of private car (1=yes, 0=no)	β9	1.24530	1.40768	-1.60310	-4.58630	1.65830	0.08547
Dummy of bus (1=yes, 0=no)	β10	1.00120	3.95320	1.31030	3.23310	0.81210	1.21530
Hitting ratio		77.3%		70.1%		65.5%	

Here, P_m is the choice probability of using transportation m; Z_{mni} is the i th variable of individual from zone n when using m; V_{mn} is the utility for individual from zone n when using m; βis the parameter for each variable; and the values are shown in Table 2.

From the parameters and simulation experiments, it is found that the shuttle bus influence the usage of HSST greatly, and so does the distance to HSST stations. In this study, only the first period project is dealt with. The related area is divided into five zones centering with the five stations. The OD data have been collected based on the zoning. The share and the amount of ridership by HSST have been calculated with the initial setting of ticket price and station positions and so on. In the following section, we will use the prediction model to provide useful information to the hybrid planning system (Figure 3).

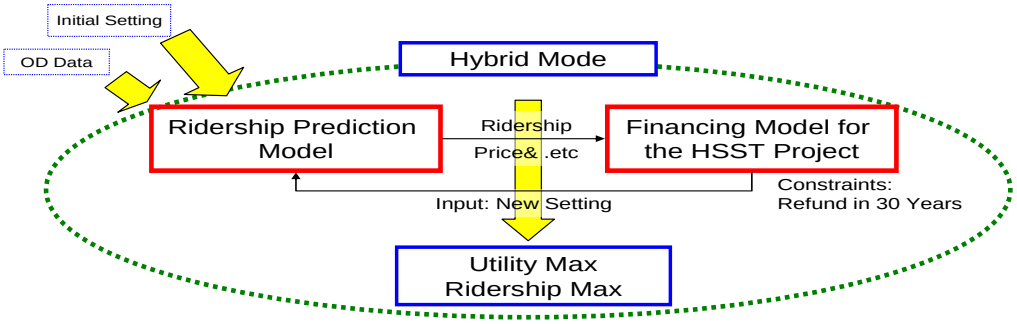

Figure 3: The Hybrid Planning System

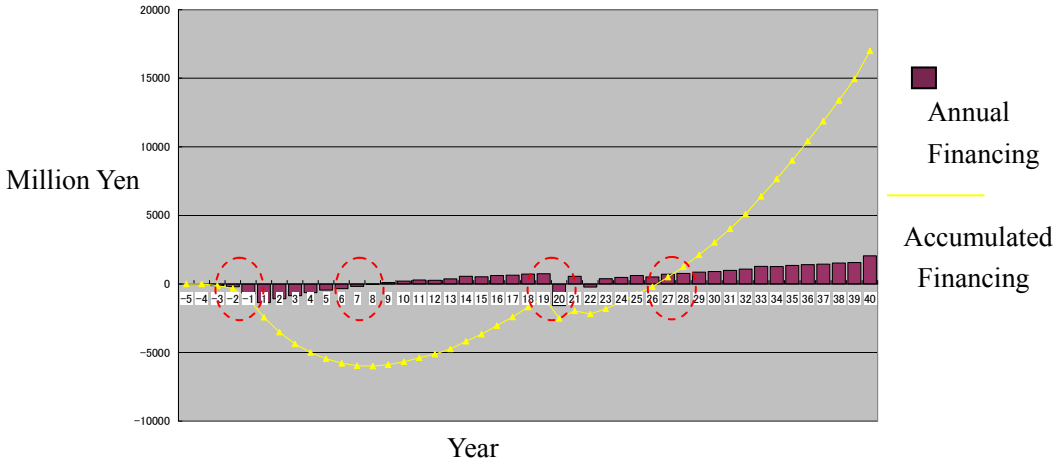

Figure 4: Financing Simulation with the Optimal Solution

The HSST project has been doubted about the huge investment and its refund. So financing problem is the one of the key-points and difficulties to realize this project. In this study, the financing simulation model was made based on the practical reference from the HSST construction company and it contains the cost of construction, the proportion of each investment source and its interest, the cost of operation and maintenance, the income from tickets and so on.

In this study, the hybrid system combines the ridership prediction model and the financing model. The maximum of HSST utility and ridership can be obtained by information cycling between two models. In this article, we show the application of the price setting as the planning variables. The amount of ridership changes according to the price. The information of ridership and price is inputted into the financing model. Figure 4 shows the financing simulation with the optimal solution concluded from the hybrid system. The average ridership of the first year is 29,673persons/day and the average ticket price is 211.84yen/person. The figure shows that in the 7th year, the annual financing will turn into the black, and the accumulation financing will get rid of the red in the 27th year, considering once large maintenance in the 20th year. By this analysis, we can ensure the financing feasibility to some extent.

4. Conclusion

This study deals with the public participation based on the questionnaire survey. Furthermore, the ridership is estimated and the financing simulation is made to ensure the feasibility of the project.

Reference

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