VERIFICATION STUDY ON PLANNING SYSTEM FOR CONSTRUCTION OF NEW TRANSIT AND RELATED PUBLIC FACILITIES INCLUDING HYBRID CONCEPT*

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1. Background

Rapid development of the modern society has been causing more and more serious environmental problems. Improvement of public transportation is quite focused by most of the governments to release the current heavy traffic situation. And recently, all kinds of New Transportation Systems, on the other words, People Movers have been well promoted and constructed here and there in the world. People Mover is a fully-automated, grade-separated rail transit system. It is positioned over bus, LRT, but below metro in land transportation by speed and capacity.

The study is centered with the High Speed Surface Transportation (HSST), a kind of People mover, and its vehicle is propelled by a linear-motor along a track over which it magnetically levitates without using any wheels. It is an influential urban transit system with the performance and economy superior to conventional traffic systems. The HSST creates neither noise nor vibration pollution and it is also an epoch-making traffic system for being environmentally friendly. One line has been constructed and put into use in Aichi World Exhibition, named as Linimo.

Kusatsu City and Otsu City are located in Shiga Prefecture, with a total population of about 460 thousand, annual visitors over 1.5 million. Provided with nice nature around Lake Biwa, more and more immigration is expected to be settled in this area. Last year the increase of Otsu City and Kusatsu City reached 8% and 4.6% respectively. This blooming area has several industrial zones inside and supplies plenty of labors for Kyoto-Osaka-Kobe metropolitan at the same time.

The area has very good connection with neighboring cities, with several main national roads and railways crossing it. However, the transportation condition in this area is growing worse and worse, since increasing population also brings increasing volume of road traffic. Congestions happened often, which cause influence not only to the live of the local residents, but also to the crossing traffic. About 53.6% transportation are realized my car, only 27.1% taking railway or bus. Over 32.7% people did not think the bus network worked well. There is a strong desire for the development of new public transit.

The subject area for the new transit lies in the center part of the two cities, with three universities: Ryokoku University, Shiga Prefecture Medical University, and Ritsumeikan University. The planned HSST line will connect these three universities and the residential area to be ended with JR Kusatsu and Ishiyama Station (shown in Figure1), totally about 11 kilometers, and it is to be extended in the future.

Not only the new transit, but also the related public facilities are discussed in this study. Since the new transit is expected to connect those spots like universities, factories, hospitals and those residential zones. The urban activities will be encouraged most probably. In this study, Seta park area is chose as the spot for public sports center, where one station is planned to be built. From the survey, information was concluded that about 47.1% population did not have sports in daily life. 40% of them took the choice of lack of time. Second popular reason

* Keywords: new transit, public facilities, hybrid
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was the lack of sports facilities. Daily sports activities are regarded as one the important elements for high living quality. New transit can provide the residents more convenient access to sports center. At the same time, the public sports center is taken into consideration as one the most attractive related facilities to the new transit.

Fig.1 Study Area and Line under Consideration

2. Planning System for Transportation and Related facilities

People realize different social activities, which can be observed from behaviors and psychology viewpoints, based on transportation and land use as shown in Fig.2. Improvement of transportation facilities and development of urban facilities has close relationship with the activation of social and economical activities. Various traffic behaviors have been observed and simulated to explore the relationship from the systematic viewpoint. It is necessary to implement various system analyses about the mechanism of traffic behaviors in actual urban activities aiming to establish an effective project planning system. Behaviors can be defined by OD data, time and so on. In the past study, the traffic behaviors and shopping behaviors were simulated by Yamada, K. & Haruna, M. (2000). The effective and practical hybrid model analysis method for planning and designing traffic facility was developed to release the traffic congestion caused by visitors to large scale shopping center in the district around the shopping center.

In the related study, we tried to analyze the phenomena from social psychology prospect, and concluded the utility function for residents, which was defined based on the frameworks of social psychology. We assume that when people get satisfied, they will take consumption behavior, support behavior (investment), and immigration behavior. And these behaviors will contribute a lot to the urban development and constructions of such facilities. So, we define maximizing the utility of people as the objective function in optimization model. Furthermore, there will be many constraints to ensure the feasibility of the construction from physical conditions including area, financial conditions including total budget and so on.

To judge how much people get satisfaction, it follows the expectance theory, which regards the satisfaction as the distance from expected level to real level. In the simulation model, planning alternatives are assumed to be constructed thoroughly, that's to say, planning alternatives represent the real level. Then we can predict roughly the proportion of satisfaction, which will help to the prediction of the volume in consumption, investment and immigration. The information simulates the effect of each planning alternatives and they will be feedback to the optimization model to tell us the direction to modify the plan. The simulation model and optimization model can be incorporated into such a cycle mechanism, because the expectance can hardly be satisfied at the first time. There will be usually a process of improving satisfaction level step by step. We defined it the hybrid modeling system or hybrid planning system, as shown in Fig.3. We design the stages to implement the construction from

new transit, and step to wide plan including related facilities. In the later part, a case of building a public sports center next to one station is given as the example of related facility planning problem.

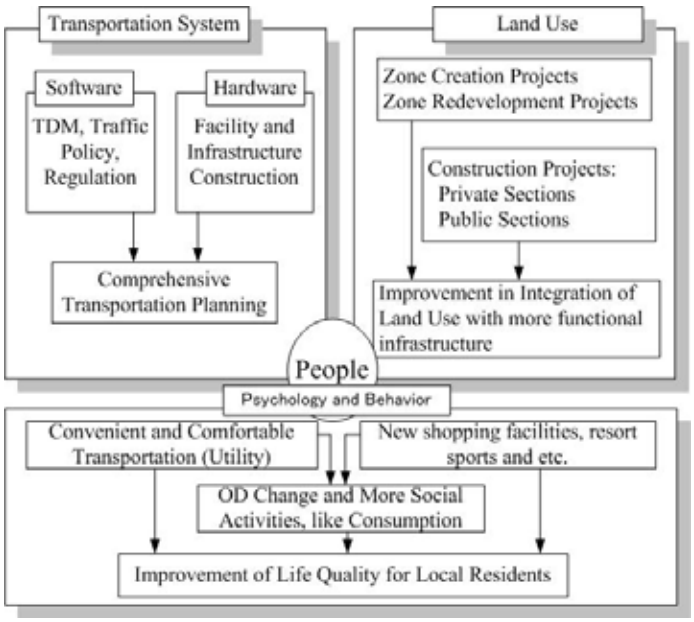

Fig. 2 System Structure

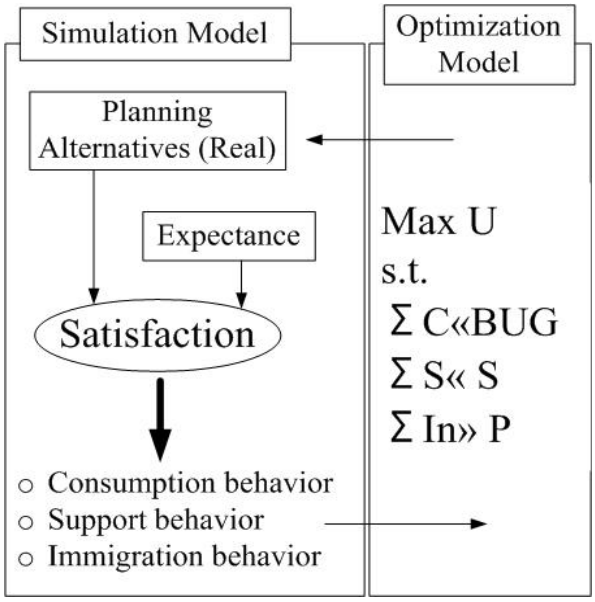

Fig.3 Hybrid Planning Model

3. Planning for Public Sports Center at One Station

Fig.6 Image of Public Sports Center with 7 Facilities

Against the background of new transit construction plan, the plan of a public sports center close to one station was also discussed in the following parts. The research area is the Seta Park located in Otsu City, as mentioned in the first part, covering 128000 square meters. The area around has been under development for residential zones. So more population is expected to live there and with the accessibility improved by new transit, the area has a high potentiality to gathering more visitors for activation the nature and land resource.

According to the information collected by pilot survey before, sports facilities are quite needed for residents and students' daily life. So centering sports center, the planning problem was set up for efficient and effective development in research area. In January 22, 2006, 310 sets of questionnaire were distributed and 162 sets (52.2%) were useful. Information about residents around was collected. Twelve items about the sports center were surveyed with 7 Likert scale from not important to strongly important to capture residents hope and advice. The scale of the sports center is chose as the first item which people care most, followed by surrounding environment as the second and parking as the third and public transportation as the fourth.

Regarding these hints, we forward the planning problem to the scales of each functional facility inside the sports center. Mathematical programming with constraints was applied for the optimization, taking the form of Cobb-Douglas function:

$$Y = F(X_1, X_2, X_3 \cdots X_n) = X_1^{a1} \cdot X_2^{a2} \cdot X_3^{a3} \cdots X_n^{an} \qquad (0 < a_1, a_2, a_3 \cdots a_n < 1)$$

$$MaxU = \alpha_k (u_1)^{\alpha_1} (u_2)^{\alpha_2} (u_3)^{\alpha_3} \cdot \cdot \cdot (u_7)^{\alpha 7}$$

$$u_k = \beta \ln X_n + \varepsilon_n$$

U : *Total Utility*

u_1 : *Evaluation for grand*

u_2 : *Evaluation for tennis court*

u_3 : *Evaluation for multi – functional gym*

u_4 : *Evaluation for training – gym*

u_5 : *Evaluation for martial room*

u_6 : *Evaluation for pool*

u_7 : *Evaluation for multi – functional ground*

X_n : *area for each facility*

$\alpha, \beta, \varepsilon$: *parameters*

S .t.

$$\sum_{i=1}^{11} X_i \le A$$

A : *Total availabe area*

Regression	β	ε	R square
Ground	3.064757	-23.5759	0.694672
Tennis Court	3.008517	-18.7519	0.719944
Multi-functional Gym	3.857202	-23.1828	0.659983
Training-Gym	4.674358	-20.9026	0.760874
Martial Room	4.199967	-22.5777	0.716216
Pool	3.494538	-15.8555	0.748779
Open Ground	3.114125	-17.5591	0.766838

Coefficient	α
Ground	0.210603
Tennis Court	0.057393
Multi-functional Gym	0.12274
Training-Gym	0.138344
Martial Room	0.06219
Pool	0.575053
Open Ground	0.012093
Constant	-0.28098

R Square
0.725419

Table1. Optimal Area Distribution Pattern

Facilities	Area (㎡)	Satisfaction
Ground	11986.98	5.207024
Tennis Court	3082.413	5.416881
Multi-functional Gym	2100	6.32359
Training-Gym	350	6.479501
Martial Room	900	5.99217
Pool	625	6.641484
Multi-functional Ground	955.6075	4.811059

Total Satisfaction	6.453774
Constraints	20000 ㎡

In the planning model, seven facilities, which are Ground, Tennis Court, Multi-functional Gym, Training Gym, Martial Room, Pool and Open Ground (shown in Fig.6), are taken as planning variables. Objective is the maximization of the total utility, regarded as the total satisfaction. The multi-regression method was applied to get the parameters (shown in Table2) between the utility and the area of each kind of facility, based on the information collected from questionnaires. Table3 shows the optimal pattern concluded from the optimization model. With this area distribution pattern, the public sports center can reach the satisfaction of 6.454.

4. Conclusion

This article is centered on the construction planning of the new transit and related facilities. The planning system including hybrid concept is proposed. The planning problem of public sports center is shown as part of the system with verified results. And more practical calculation will be continued to evaluate the effect of the whole system.

Reference

1) Yamada, K. & Haruna, M.: A Hybrid Planning Model Analysis for Traffic Facility Planning and Design Method, Civil and Environmental Engineering Conference Volume4，The Asian Institute of Technology, pp.47-56, 1999