第24回建設マネジメント問題に関する
研究発表・討論会講演集　2006年12月

Study on Transportation System Planning Aiming to Encourage Labor Supply and Productivity in Industrial Zone

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Transportation seems to play a vital role in urbanization recently. Traveling from home in a residential area to an office in industrial zone, for example, has somehow affected to work performance and satisfaction of time consumption. The model constructed in this paper aims to improve transportation system in order to facilitate labor participation and enhancing productivity of manufacturing forms in industrial zone. Furthermore, analysis of involving data has been applied to find out an effective alternative of transportation urban area, Vientiane Capital. It has been found that shorter time used for transport help employees gain more profit by providing spare time for extra-work for extra-income, extra education for work improvement and more leisure time for life satisfaction.

Keywords: Transportation Planning, labor supply

1. Introduction

Vientiane Capital is the capital of Laos located along Mekong bank in central part of the country. Like other cities across country, road way is the only transportation system existing for commuting in side the city. Some truck roads, Rout Number 13, for example, running through this area connect its center to the neighboring provinces including some eastern cities of Thailand. Local road network and its condition are considered as the best comparing to other cities. Most of people travel to work by motorbikes with full of risk of accident.

According to the local government plan, a new industrial zone will be established in the north of the city separated from current urbanized area and quite apart from district centers where dwelling gather. To travel from some district centers to this industrial zone, passengers need to spend more two hours by motorbike and three hours by bus. Therefore it would cost a lot of expenditure and time for traveling. After this industrial zone is completely constructed, thousands of people will be employed. If a better transportation is applied, saving will obviously increase.

2. Labor Supply Related and Transportation Accessibility Model

Three related components were combined in forming this model including manufacturing in industrial sectors, time consumption in household sector and transportation accessibility in transport sector. Below figure shows the simulation of planning procedure in the model.

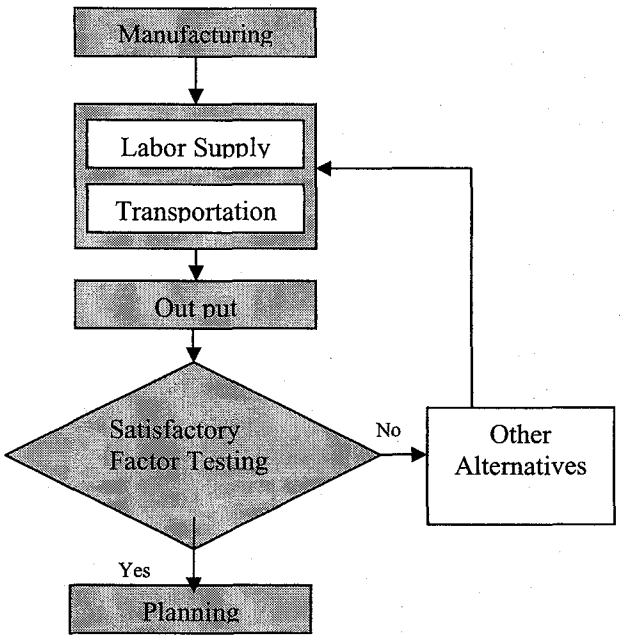

Figure 1. Simulation of Planning Process

(1) Manufacturing Model

It is assumed that there are s $(s=1,....,n)$ types of manufacturing firms located in the industrial zone. These firms produce non-homogenous goods. In production process, four inputs are required: labor (l), capital (k), land lots (x) and advanced technology (A). Production function can be shown as

$$Y_s(A_s, l_s, k_s, x_s) = A_s * (l_s)^{\alpha} * (k_s)^{\beta} * (x_s)^{\sigma} \qquad (1)$$

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Where Y_s is the output of production of firm *s*.
A_s is the technology applied.
l_s, k_s, x_s are labors, capitals and land lots respectively.
α, β, σ are elasticity parameters of using labor, capital and land respectively.

Given p as the price of each item and w as the wage rate then profit equation could be

$$\tau_s = p_s * Y_s - w_s * l_s - p_k * k_s - p_x * x_s \qquad (2)$$

Each firm tries to maximize it profit function subject to production function. From equation (1), lets take a closer look at labor field. Labor demand can be defined as

$$l_s^d = \gamma_s * \left(\frac{p_s * Y_s}{w_s} \right) \qquad (3)$$

Where γ_s is labor elastic parameter;
(p_s, Y_s, w_s) are price of goods generated by firm *s*, outputs of firm *s*, and wage rate in firm *s*, respectively.

(2) Time Consumption Model

Daily time use is classified into three periods: working time (T_w), leisure time (T_e) and traveling time (T_t). Then total time consumption would be

$$T_{total} = T_w + T_e + 2T_t \qquad (4)$$

(3) Transportation Accessibility Model

Employees are assumed to travel by using transportation infrastructure connecting their house in residential area *r* and the work place in industrial zone *s*. Transportation accessibility could be measured as a combination of travel time and monetary cost known as generalize travel cost adjusted for the type of model used. It is defined as

$$T_{rs} = \sum_m \eta_1^m * (w_{rs}^m * c_{rs}^m) + \sum_m \eta_2^m * (w_{rs}^m * t_{rs}^m) + \eta_3^m * d_{rs} + \eta_4 * c_4^H + \eta_5 * \ln I_r^H + \varepsilon \qquad (5)$$

Where η_1^m is the reduction of traveling cost by vehicle mode *m;*

w_{rs}^m is proportion of people who use transport mode *m* between residents *r* to manufacturing firm *s;*

c_{rs}^m is travel costs between resident *r* to work place, firm *s;*

η_2^m is the reduction of traveling hours;

t_{rs}^m is travel hours by mode from resident *r* to work place *s;*

η_3^m is the reduction of time departure from resident *r* to work place *s;*

d_{rs} is time of time departure from resident *r* to work place *s;*

η_4 is car ownership parameter;

c_r^H is the bike ownership by people;

η_5 is parameter of income level;

I_r^H is worker's incomes;

ε is an error term.

3. Transportation Improvement Plan

As we mention earlier, the main objective is to find the best transportation system choice to encourage labor participation into manufacturing firms through improving transportation infrastructure system; therefore, we will mainly focus on the transportation and labor sectors rather than manufacturing firms. Real data was put to the model above in order to find out a suitable transport plan-new bus route.

(1) Current Transportation Condition

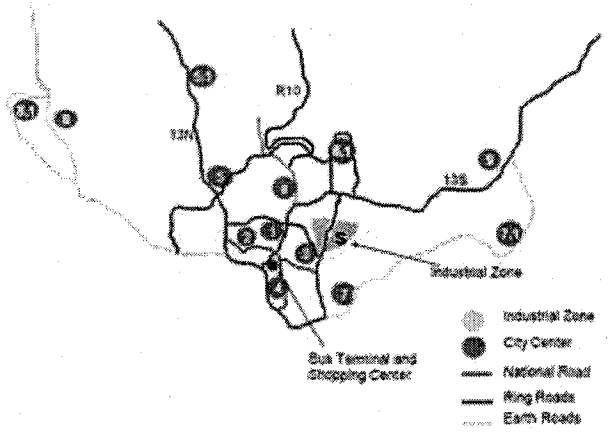

Figure 2. Existing route network, residential and industrial zone

Regarding to the current situation, both bus passengers and motorbike use the same road networks, direct to city center, however, traveling by motorbikes seems to have more traveling routs choices while bus passengers travel towards the city cent due to there is only a bus terminal where there are many shopping and trading places surrounding. In order

to assume labor participation in the industrial zone, the transport infrastructure system plays important par, therefore, good systems need to facilitate workers to access to working place with their satisfaction. Existing bus routes is shown in figure3.

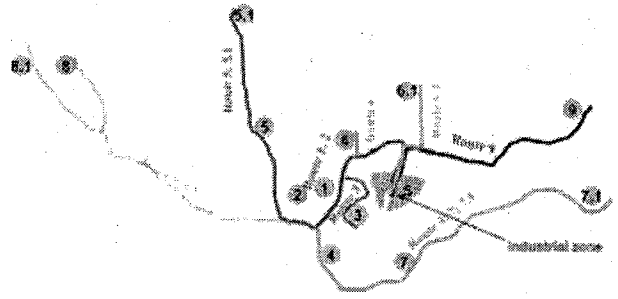

Figure 3. Map of current bus networks

(2) Labor Force Distribution

Since there are thirteen residents where workers are from, we make another assumption that each residents supply equal labors to manufacturing sectors shown in the table below.

Table 1 Labor distribution by residents

Residents	Labor distribution by resident people			
	By 2009	Phase I (2006-2010)	Phase II (2011-2015)	Phase III (2016-2020)
1-0-S	2,037	3134	6395	8277
2-0-S	2,037	3134	6395	8277
3-0-S	2,037	3134	6395	8277
4-0-0	2,037	3134	6395	8277
5-0-S	2,037	3134	6395	8277
5.1-0-S	2,037	3134	6395	8277
6-0-S	2,037	3134	6395	8277
6.1-0-S	2,037	3134	6395	8277
7-0-S	2,037	3134	6395	8277
7.1-0-S	2,037	3134	6395	8277
8-0-S	2,037	3134	6395	8277
8.1-0-S	2,037	3134	6395	8277
9-0-S	2,037	3134	6395	8277
Total	26,488	40,491	83,135	107,610

(3) Transportation Accessibility

The result of data analysis indicates that six residents out total are located more than 40 Km far from the industrial zone. Residents (5-0-S), (5.1-0-S), (7-0-S), (7.1-0-S), (8-0-S), and, (8.1-0-S), where accessibility level is bigger than 20,000 (units of transportation accessibility weighted in time and cost), are with low transportation accessibility, while residents (6-0-S) and (6.1-0-S) are with high accessibility (see figure 5). In order to make sure that those six residents are in low accessibility condition, we will latter compare with the total time that will be available in economy in the labor sector.

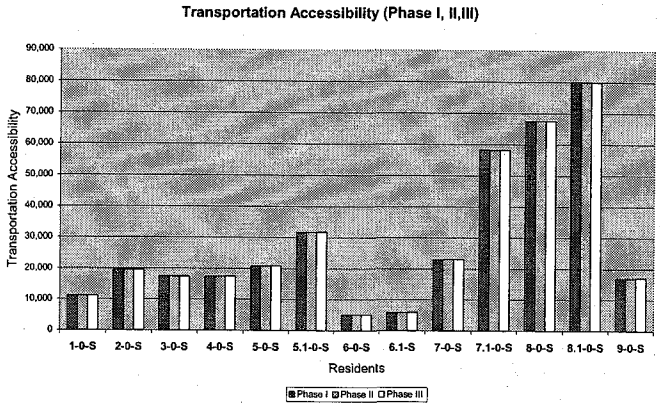

Figure 5. Transportation Accessibility

(4) Proposed Plan of Transport System

According to the analysis of current transport infrastructure system, the results show that workers from third teen residents can not improve their living condition by working in the manufacturing firms due to low incomes and long traveling hours. Transportation accessibility is low for many residents; and, mostly traveling flows head to city center as the result it may cause traffic suggestions in the future. More over, traveling by the existing route networks take many hours with high cost. Hence, alternatives are proposed in order to find the better choice to encourage labor participation in the economy particularly to improve worker's living condition. There are three alternatives are given to the study area as will be presented soon.

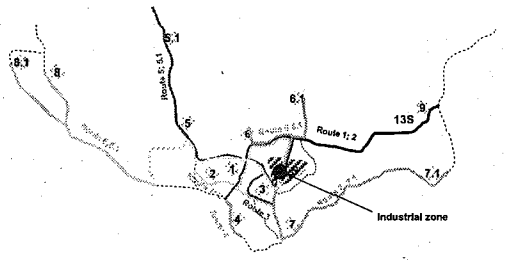

Figure 6. Alternative route network 1

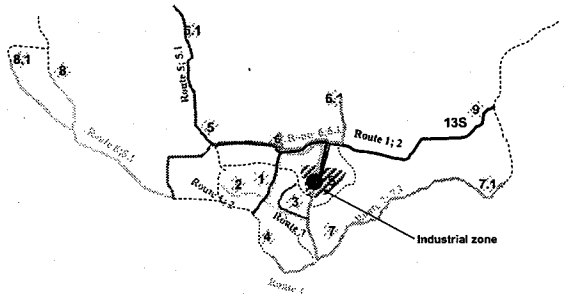

Figure 7. Alternative route network 2

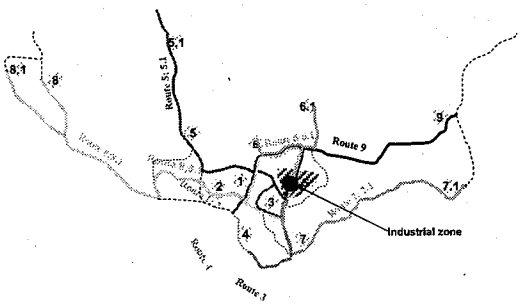

Figure 8. Alternative route network 3

Three alternatives will be simulated as the first system and saving level and total time available in economy will be tested. In the next step, the results will be compared; however, we will focus only on bus-using workers due to motorbike-using workers have lower living condition than bus-users as the result of traveling expenses and daily consumption. In addition, we want also to promote public transportation and prevent future traffic problems. At first stage, they will be tested with the existing condition. When the conditions are not satisfied, then improving condition will be proposed and check for the satisfaction again. Then after, the best alternative will be selected in order to make future planning.

(5) Selective Transportation Infrastructure System

Since there are three alternatives, we must select the first priority for future planning analysis. The criteria of the selective system is the residents with better transport infrastructure system, however, there are about four residents, residents (5-0-S), (7.1-0-S), (8.-0-S), and, (8.1-0-S), are needed to focus. The selected alternative is subtracted from alternative I, II, and III. Table 2 shows the distances and traveling hours in the current condition. Figure 9 shows the prioritized alternative.

Table 2: Distance and traveling hours of selective choice

Resident	Distance	Traveling Hours
1-0-S	27.00	1.35
2-0-S	36.00	1.80
3-0-S	19.00	1.09
4-0-S	32.50	1.63
5-0-S	31.00	1.55
5.1-0-S	45.00	2.25
6-0-S	17.00	0.85
6.1-S	18.00	0.90
7-0-S	15.00	0.86
7.1-0-S	51.50	2.94
8-0-S	77.00	4.40
8.1-0-S	89.00	5.09
9-0-S	42.00	2.1

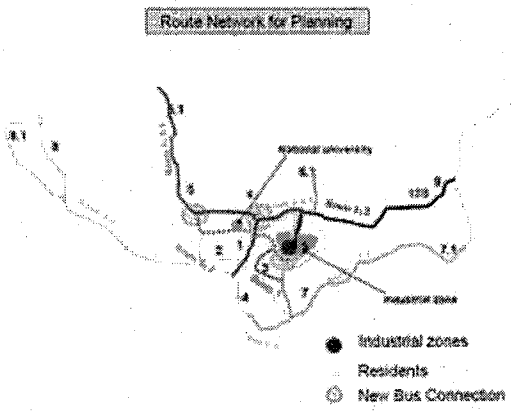

Figure 9. Selective network for future planning

4. Conclusion

To sum up the result of this study indicates a choice of transportation planning. This plan may much affect to transportation efficiency in the future. It could provide another satisfactory transport network.

Reference

*1)*Banister, D. and M. Berechman, J. (2000): Transportation Investment and Economic Development, UCL Press;
*2)*Berechman, J. (1994). Urban and Regional Economic Impacts of Transportation Investment: A Critical Assessment and Proposed Methodology. *Transportation Research A 28.*