STUDY ON TRANSPORTATION SYSTEM PLANNING AIMING TO IMPROVE LABOUR SUPPLY*

Case Study of Vientiane Capital in Laos

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1. Abstract

The purpose of the study is to analyze the affects of transportation improvement on local socio-economic development especially labors' incomes, social welfares, and, local economic growth. The model is developed due to the attempt to find a regional development model for Laos. Vientiane Capital is regarded as the case study. During the simulation process, the model will be hypothesized the assumption that the more traveling hours and traveling cost decrease, the more workers can supply their labors to manufacturing production process, the more they can increase incomes, and the more local economy will be increased. There are four main parts in this paper: abstract, background of the study area, model, and, conclusion.

2. Background of the study area

Vientiane Capital is the capital of Laos located in the central part of the country and has national roads run through the city. The current population are about 669 000 with the population density about 170 inhabitant per square kilometer. Since 2000, the Government has set long term social-economic development goal towards 2020, to release from the poorest condition and become the modernized-industrialization country. With industrialization concept, five industries have targeted to be the main industries: hydro power, wooden and agriculture, manufacturing, construction material, mining, and, tourism industries (in national level). According to the new Master Plan [3], Vientiane Capital has set the new industrial zone with 3000 ha and about 30 km far from city center. It is aimed to attract more industrial investments to the local area. When this industrial zone is in process, many people are expected to gather around this area and as the result it will bring about the urban sprawls, social problems, and environmental issues. Due to those circumstances, working on interaction among transportation system, household, and, manufacturing firms will provide alternative solutions to regional planning. What condition will bring about household satisfaction, optimal firms' output, and, local socio-economic development from improving transportation system while limit the negative impacts from the development.

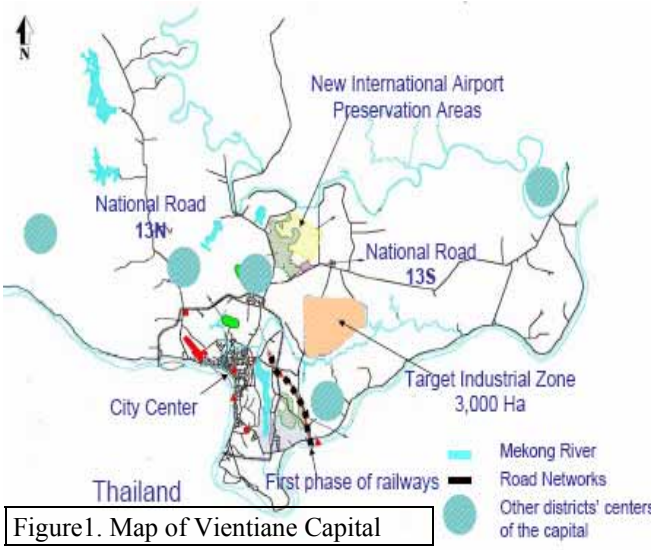

Figure1. Map of Vientiane Capital

3. Model

(1) Introduction to the model

The model is developed due to the attempt to find a regional development model for Lao. The motivation of the model comes from Transportation Infrastructure Development and Local Economic Growth [1], and, the model of Transportation Infrastructure Development and Local Economic Growth [2]. The main concept of those two models is to analyze the impact of improving transportation system on the growth of local economic and the labor-market participation. The first model seems to work well for our concept, but the assumption cases are different. It deals with two types of firm and a household location. Firms are moveable to find the best location for firm while households are fixed. The production and location decision of firms as well as their demand for labor and amount of labors that household will supply are controlled by economics of agglomeration, leisure and work time. In other hand, the second model deals with the affects of accessibility changes on the labor supply. In the analysis, it is tested that if travel time and costs have influences on the labor-market participation, then improvement of accessibility that is aimed to reduce traveling cost

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and time can affect potential labors to enter labor markets. The decision make by potential employees to participate in labor-market is based on three major factors. One is their notional working hours relative to their reservation working hours; the second is their reservation wage rate relative to offered wage rate; and, the last one is the cost of travel to work. However, our case study is assumed to deal with the fixed industrial zone with many industrial firms while households are assumed to be moveable in order to find the optimal satisfied condition aims to increase their incomes and generate the social welfares. The decision make by the potential employees is relied on three factors: wage rate, transportation cost and traveling hours. Transportation system, in other hands, consists of transportation infrastructure accessibility that will play an important role in determining the condition for labor participation, and, transportation infrastructure capacity that will play an important role to determine the condition for firm's growth.

(2) Measure of economic growth

There are some criteria to measure the effects of transportation improvement on labor supply and local economic development. The measurements will be weighted in money and time terms. (a) For firm's growth refers to changes in output-to-input ratio (economics return to scale), and changes in the amount of input factors: employees (labors), and, capitals. (b) labor growth refers to the changes in incomes of labors, changes in the amount of time allocated to leisure activities, and change of level of social welfares will be measure in the level of population' utility. (c) The measure for transportation system is the change in level of transportation accessibility to support population labor supply, and the change in level of transportation infrastructure capacity to support firm's production respectively. (d) The measure for the market growth is the level of equilibrium employment in local economy, and the number of new firms coming into the market.

(3) Structure of the Model

In general speaking, we assume that there are three sectors, household, industrial, and transportation, who will play the important role in our model.

(a) Household sector

Workers are representatives to household sector who will provide labors input to manufacturing firms. Workers are to supply labor unit for production purposes, consume leisure times, consume goods, and use transportation infrastructure to access to industrial zone from their residential areas. It is assumed that there are many residential areas in different locations and they are freely to move to find jobs but under the condition of their satisfaction: wage rate, rational traveling cost, and short traveling hours.

(b) Production Sector

Manufacturing firms are representative of production sector in our industrial zone. They are assumed to produce non-homogeneous outputs for external markets, and they use labors, capital, a piece of land, and technology as their main input. Each firm is assumed to maximize their profits subject to production functions.

(c) The transportation infrastructure sector

It is represented by the transportation accessibility from residential areas to industrial zones and the capacity of transportation to ship manufacturing products to the markets. Both are aimed to provide the short traveling times and cheap traveling cost to population and manufacturing firms.

(4) Model in detail

As we have mentioned above, three main sectors will play the important role in our economy: households, production, and transportation sectors. The figure 2 shows the phenomenon and relationship of three sectors in local economic framework, however, our study will consider only on three sectors that are in the red line.

(a) Household Sector

As we have mentioned earlier, workers are representatives of household sector who will supply labors to manufacturing firms, generate incomes and increase social welfares. We will begin talking how labors generate income. We assume that labors are living in different locations denoted by ***r (r=1,…,m)***. We further assume that labors will get the curtain incomes from working in firms. Firms will pay for labors through the wage rate which will calculate based on working hours. We assume that labors have to maximize their incomes under three main conditions: type of jobs that is based on skill or education level, extra working hours, and saving from traveling cost. Since we assumed earlier that education value will influence to labor's wage rate, therefore, the more labors have higher education, the more they can get higher wage rate; hence, labors have opportunity to gain higher education value by utilizing leisure times to enroll the evening course (the leisure time will be explained later on). It is supposed workers will supply their labor for firms in time unit denoted by (l_{rs}^{w}). For the same sense, they will travel from their residents to working places and they will consume time unit as traveling hours (l_{rs}^{t}) to arrive their working places. Finally labors are assumed to consume the leisure time (l_{rs}^{e}) that will be spent for non-working activities. Therefore, the total times available in the economy is denoted by (l_{rs})which is:

$$l_{rs} = (l_{rs}^{w}) + (l_{rs}^{t}) + (l_{rs}^{e}) \quad (1)$$

Hence to respond to the second factor, extra working hours can also be substituted by leisure times. Saving from traveling expenditure will be third factor for labor to increase their incomes. We further make an assumption that labor will take these factors are as their criteria to decide to take labor-market participation. Each labor is assumed

to maximize the utility through utility function over leisure time (l_{rs}^{e}) , incomes (I_{rs}^{H}), and consumption (C_r^{H}). Here, we have:

Max $$U_r(l_r^e, C_r^H, I_r^H) = (l_{rs}^e)^{\mu 1}.(C_r^H)^{\mu 2}.(I_r^H)^{\mu 3} \quad (2)$$

Subject to $$w_{r,s}.(l_{rs} - l_{rs}^e - l_{rs}^t) > P_c.C_r^H \quad (3)$$

$$l_{rs} = l_{rs}^w + l_{rs}^e + l_{rs}^t \quad (4)$$

Where $w_{rs}.(l_{rs}-l_{rs}^{e}-l_{rs}^{t})$ is labors' earning (incomes) from industrial firms, and $P_c.C_r^H$ is their spending on consumption. The test coefficients **μ1, μ2, μ3** are assumed to be constant proportion of utility function. The demand function for leisure time is:

$$l_{rs}^e = \mu 1 \frac{U_0}{(\lambda.w_{rs} + \varphi)} \quad (5)$$

Where ***μ1*** is test coefficient to leisure time, U_o is the current utility, **λ** and **φ** are shadow price of the budget and time constant, respectively, and finally (w_{rs}) is wage rate that labor will get from industrial firm through working hours. Finally the consumption function for labor is:

$$C_r^H = \mu 2 \frac{U_0}{(\lambda.P_c)} \quad (6)$$

Where P_c is price of consumption goods, U_o is present utility Level, ***μ2*** is test coefficient for consumption, and ***λ*** shadow price of the budget.

(b) Industrial Sector

We assume the index ***s (s=1,…,n)*** as the types of manufacturing firm that will be located in one industrial zone. We assumed that each manufacturing firm produce non-homogenous products that will sold out in the outside markets. To produce the out put requires the use of three inputs: labor ***(l)*** supplied by households, private capital ***(k)***, and land ***(x)***. Given the prices and level of output demanded, the real wage rate and the capital cost, and the land rent (of each firm), the firms decide on their level of output and the use of labor and capital inputs. Manufacturing firm's objective function is to maximize profit subject to their production technology. Therefore, the value of educated labors is important for manufacturing output which has been described in the previous part. To make simple analysis, we assume land rent and lot's size is constant and independent of firm's location. Therefore in the simulation we assume the land price for each land lot (p_x) is fixed. The production function for each firm is :

$$y_s(A_s, l_s, k_s, x_s) = A_s.(l_s)^{\alpha}.(k_s)^{\beta}.(x_s)^{\sigma} \quad (7)$$

Where y_s is the production function output of firm ***s*** weighted in money term, and (l_s, k_s, x_s) are labors, capital, and used in firm ***s*** respectively. Where α, β, σ are labor, capital, and land elasticity parameters respectively. Each firm is aimed to maximize profit function subject to production function. The profit function is :

$$\pi_s = p_s y_s - w_s.l_s - p_k.k_s - p_x.x_s \quad (8)$$

Where $p_s.y_s$ is the value of firm's production, $w_s.l_s$ is the expending on employment, $p_k.k_s$ is the total investment of each firm, and $p_x.x_s$ is expending on land rent for each firm ***r***. When we maximize profit function with the respect to the amount of labor input employed and subject to the production function. The labor demand function

$$l_s^d = \alpha_s.(\frac{p_s.y_s}{w_s}) \quad (9)$$

Where α_s is labor labor elastic parameter, p_s, y_s, w_s are price of production produced by firm ***r***, production output, and wage rate used to produce an output of firm ***s*** respectively. From this equation, as we expected, more labor demanded is associated with greater output $\delta l_s^d/\delta_y^s >= 0$. Similarity to labor demand function, the capital demand function, k_s^d, is a function of the output level which is equal :

$$k_s^d = \beta_s.(\frac{p_s.y_s}{p_k}) \quad (10)$$

Where β_s, p_s, y_s, p_k are capital elastic parameter, output price, production output, and price of the capital respectively.

(c) Transportation infrastructure.

As we have mentioned earlier, there are two types of transportation infrastructure will support production in our economy. One is transportation infrastructure accessibility that will support the labor movement from their residential ***r*** to industrial zones ***s***. We measure accessibility as a combination of travel time and monetary cost, known as generalized travel cost, adjusted for the type of model used. The accessibility is denoted by T_{rs}.

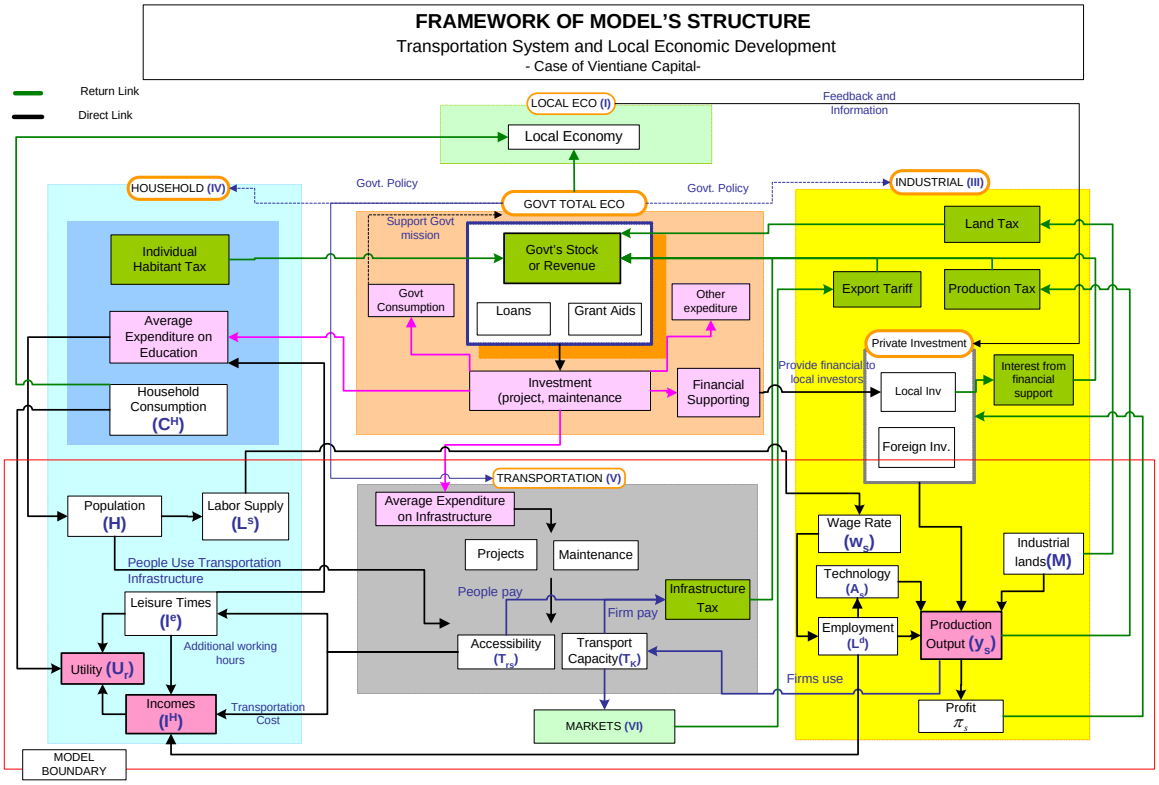

Figure2. The Model Structure in Detail

$$T_{rs} = \eta_0 + \sum_m \eta_1^m (w_{rs}^m c_{rs}^m) + \sum_m \eta_2^m (w_{rs}^m t_{rs}^m) + \eta_3 d_{rs} + \eta_4 c_r^H + \eta_5 \ln I_r^H + \varepsilon \quad (11)$$

Where η_0 is reduction in accessibility cost between place of resident and place of working; η_1^m is reduction of traveling cost mode, w_r^{sm} is proportion of people using transport mode between residential and industrial zones, c_{rs}^m is monetary costs of travel by mode; η_2^m is reduction traveling time by modes, t_{rs}^m is travel time by mode; η_3^m is reduction in time of departure, d_{rs} is time of departure; η_4^m is car ownership parameter, c_r^H bike ownership by household; η_5 is parameter of income level, I_r^H household incomes level; ε is an error term. For the industrial firms, we will assume the capacity of transportation infrastructure to ship the output of manufacturing firms from industrial zone to outside markets by

$$T_{ss'} = f(T^m, V^m, C^m) \quad (12)$$

Where $T_{ss'}$ is capacity of transport to ship production the outputs from industrial zone s to outside market s' measured in unit of time and cost; T^m is the capacity in time spending for each flight; V^m is capacity to carry for a flight; and, C^m is the cost of the flight.

5. Conclusion

So far since we have not gotten enough data for our analysis, the background of the study area, the model development are presented in this paper. Our next step is to apply the real data to our model, and latter we will hypothesize the affects of transportation improvement on local socio-economic development especially household incomes, social welfares, job opportunities, and, manufacturing firm's output. Latter, we will propose alternative regional planning model to case study (Vientiane Capital) through controlling and planning variables.

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