Analysis of Travel Time Saving Benefit by Understanding Individual Needs and Value of Activity Time (Case Study: Tokyo and Jakarta)

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ABSTRACT

This paper presents a method of analyzing the benefit of travel time savings. It is argued that the benefit should not only be derived from the provider's point of view, but also from the consumer's side as well. Quantifying value of time saving (VOT) is a very important issue for benefit of a transport project. In Japan, VOT is considered higher during weekends than on weekdays. The reason for this is that people have limited time in the weekend to allocate for activities that are not normally done on a weekday, in particular, family recreational activities. In Indonesia as a country with diverse cultures, it seems that there is perception difference of VOT between providers and users. However this has not been proven theoretically. A research has been conducted for Tokyo and Jakarta, with objectives to propose an activity-based method that incorporates individual psychological needs, develop a time allocation model using revealed preference and stated preference method and to propose a concept of value of activity time. The underpinning theories are the Maslow's theory of needs, consumer theory, and discrete choice models. The resulting model is a combination of two approaches: the utility maximization and activity choice model. The model shows that individual priority of need influences his time allocation tendency. The calibration result shows that in Tokyo, the value of family time in weekend is the highest among other types of activity, and in Indonesia, the value of family time is higher than work time even in weekday.

BACKGROUND

It is explicitly recognized that prior to building transport infrastructure, it is important to understand the benefit for the users. The benefit is not only observed from the provider's point of view, but more importantly from the user's side. Failing to do so would result to inefficient utilization of any infrastructure development.

The research's interest is basically analyzing the travel time saving benefit. Quantifying travel time saving indeed is the very important issue in the analysis of a transport project benefit. There are many studies and recommendations related to the issue of value of time. The travel time value for non-working activity has been represented by proportion of income, and according to previous researchers is ranging from 27%-43% of hourly income in England, by Ortuzar and Willumsen (1), 40%-60% in U.S.A, by Boardman et al. (2), and it is considered by Gwilliam (3) that there are currently no general guidelines about value of time.

This research is still interested in this issue, since it has many things to be explained. Most of the previous studies in value of time are focused on the approach of economic and concerned about the monetary value of time, and the point of view is mostly taken from the provider's side. Quite differently, this research is trying to trace the benefit of time saving from the viewpoint of the users themselves. Hence, it is necessary to explore the connection between a range of disciplines such as economics, psychology, and, sociology.

In the last decade, a new type of research had emerged e.g. Yamamoto and Kitamura (4) and Kraan (5), which is called the activity-based research. However, most of the previous activity-based researches still did not have strong emphasis on the individual psychological aspect that shows the attitude towards time use. This attitude is presumed as the important aspect in this current activity-based research, because such attitudes determine the life style of the individual. This attitude could be different for each individual, population, and life stage.

The motivation of this research is basically driven by the need to explain the phenomena that occur in real situation in an area that has specific characteristics. The following phenomena in Japan and Indonesia will explain our motivation the best.

The Phenomena in Japan

The phenomena that occurs in Japan is that there is a notion given by the current guideline stating that the value of time in weekend is more expensive than in weekday. The guideline for value of time for passenger car in weekday is 56 yen/vehicle/minute, and 84 yen/vehicle/minute for weekends. The primary reason for a higher value of weekend time is that people have limited time in the weekend to spend for activities that are difficult to do on a weekday, in particular recreational activities with family. The budgeting system in Japan also helps explain this situation because weekend holiday wages for employees are 35%~50% higher than weekday wages, and charges for accommodations are 20~30% higher on holidays. Nevertheless, the phenomena is different from the current practice of transport benefit analysis that stated time value of work is more expensive than any other non-work activity. It is rather difficult to explain the phenomena theoretically with the conventional method of time value.

The Phenomena in Indonesia

The basic assumption of travel time saving by Indonesian government is that time lost for travel is proportional to forgone earning. However, Indonesia as an archipelago has many culture diversities that could influence individual behavior on time use. It seems that there is a perception difference of time saving benefit between providers and users. One of the indicators for this is in the transport project feasibility study. Project feasibility is a very sensitive issue because this should be decided through a tedious bureaucratic process and the final decision must come through a presidential decree. During the process, the providers and investors have to discuss about it with the people's council, and quite often the negotiation reach a dead end. Having this situation, providers deem it necessary to have a better method that could accommodate the user perception of time saving. A better identification for time saving benefit needs to be put forward in order to make a consensus between users and providers.

Research Objectives

When economists consider the double role of households as producer and consumer e.g. Becker(6); DeSerpa (7), the following questions can be raised, like: What would the household think of itself? Do households consider time an input for production or consumption? Based on this condition, there is a need to understand the perception of time saving from the user's point of view in order to have more theoretical justification on the subjective value of time. In light of these premises, this research would like to add to the large body of activity-based researches with the following intention; to contribute a classification method of human needs activities, introduce the priority of needs in formulating individual utility and the value of activity time, and present the advantage of combining revealed preference (RP) method and stated preference (SP) method in estimating time allocation behavior of individual.

SURVEYS IN TOKYO AND JAKARTA

The survey in Tokyo has the focus on the weekend activity time, although it asked the average time allocation in weekday. On the other hand, the survey in Jakarta is focusing on the individual time allocation in weekday only. The weekday time allocation behavior in both surveys is explored in order to obtain the common variables that may influence individual allocation of time to certain activities.

Introduction of Survey Method

Questionnaire is designed to capture individual revealed and stated preference. The questions were about individual priority rank, satisfaction of needs, time use, and travel time along with their social-economic stage information. The activities are classified into six main categories corresponding to hierarchical needs proposed by Maslow (8). They are:

TYPE OF ACTIVITY BY NEEDS	CORRESPONDING MASLOW NEEDS TERMS
1. Physical Care	Physiological Need
2. Homemaking	Safety and Security
3. Family Care	Love and Belongingness
4. Socialization	Self Esteem by Others
5. Working	Self Sufficiency, Meaningfulness
6. Pleasure	Truth, Beauty, Perfection

Finally and most importantly, respondents were asked to imagine that their one-way commuting time is reduced to half an hour (or one hour, two-way) and were asked how they would accommodate the hypothetical time saving into their schedule and how much they are willing to pay for the benefit. The activity extension choice were recorded and classified.

Data of Tokyo

The survey was conducted in Aqua-Line toll road that connects two sides of the Tokyo Bay in December 2000. The questionnaires were distributed during weekend at both ends of the road and respondents were asked to mail them back. Among the total number of respondents, 413 are working in Tokyo. These workers will be the focus of the analysis because they will use the transportation service regularly. They are also the ones who have the most typical pattern of weekly activity in the population. Since the main interest of this research is related with time allocation of family activity and need for family care, the data of 266 samples of worker having children are used for the subsequent analysis.

Figure 1 shows that the highest priority rank among samples is the priority need for family care (35.0%), and the least prioritized is socialization (2.6%). For the analysis on their time allocation for each type of activity, the results are given in Figures 2. The respondents were grouped by their priority ranking of needs and the bars show the time consumption proportion for each group. No individual ranked homemaking as their top need and thus homemaking does not appear in the figures. Observing Figure 2 as indicated by arrows, it can be seen that an individual's priority for certain needs is revealed by the tendency of having higher time allocation for the particular need. He revealed it in his time allocation showing that the top priority need allocation is relatively higher than other type of individual's. Thus, the priority of individuals seems to influence on how they arrange their time allocation as stated by Prasetyo et.al (9).

Figure 3 shows the example of level of need satisfaction. Respondents are grouped by individual ranking. For example, for the satisfaction level of physical care there are 73 individuals who prioritize it best, and almost 50% of them are dissatisfied with the time availability. Following the same analysis for all types of needs, our results showed that it seems only around 25% are dissatisfied for work, family care and socialization while the dissatisfaction is relatively higher at more than 25% for pleasure.

The compilation of data that corresponds to the question on what type of activity individuals will most likely engage in or extend given one hour extra time, is shown in Figure 4. In terms of willingness-to-pay to income (WTP-Income) ratio, respondents are willing to pay for about 30% of their hourly income on the average in order to obtain time saving. Figure 5 shows WTP-Income ratio in more detail for each activity. The most prominent value of activities are: the activity of going to cultural events, followed by going to amusement / theme park activity, and going to hot spring / relaxation with the range of 39%-40%. Most of these activities were done with family. These seem to reflect the combined need for family care, pleasure and physical care. The value of time for work, volunteer work, meal, and shopping have lowest WTP-Income ratio ranging from 13% to 18%.

Data of Jakarta

In June 2001, a household survey with result of 433 commuter respondents was conducted in southern and eastern of Jakarta in Indonesia. The data is also screened for person in family with children. Finally, the 323 persons were sampled and categorized into the same segment as in Tokyo.

The priority rank in Figure 6 shows that the ranking order of the population for their priority are family, working, homemaking, socialization, physical care, and pleasure respectively. Figure 7 shows that the rank of activity type to be extended is the same with the priority rank. The first choice is family care (59.6 %), and the least prioritized is pleasure (3.2 %). To see the intention if, hypothetically, the 1-hour travel time is saved, Figure 8 shows that for home-office trip, more than 60% of respondents want to postpone the departure time from home, and 35 % want to leave home as usual to work. For the office-home trip, there are almost 70% of them want to go straight home at the usual time and only less than 25% want to postpone the departure from office. This situation is not in accordance with the expectation of Becker's theory that the time saving should be transferred to work.

The WTP-Income ratio analysis indicates that each individual is willing to pay around 36% of his/her hourly income on the average in order to obtain one-hour time saving. Distinction also has been made for the WTP-Income ratio of working oriented and family oriented people, which is 32.6 % and 36.6 % respectively. Hence, family-oriented people basically have a higher WTP-Income ratio than working-oriented people.

Apart from this survey, a more detailed pilot-survey was conducted by Prasetyo et.al. (10) about a diary schedule for only 30 respondents. Although from this, there is a finding similar with the situation in Tokyo, that the priority of individual seems to influence on how they arrange their time allocation.

Relating Priority of Need with Individual Attributes

An ordinary least square method has been carried out using LISREL result with the linear equation of

$$\alpha_{nj} = \omega_j X_n + \delta \tag{1}$$

Where α_{nj} = level of importance of need (made observable), ω_j = parameters for need j, X_n = attributes of individual n, and δ = error term.

The purpose of this calculation is to observe the influence of the attributes of income, age of the youngest child, sex, age, and number of family to the priority of individual both in Tokyo and Japan. With the parameters is significant in alpha 0.25, the common characteristic for individual in Tokyo and Jakarta for each priority needs is as follows:

- Family Care: Highly significantly influenced by the age of the youngest children. The younger the children, the higher is the family priority need. Income has a negative effect on family care, the higher the income the less priority given to family.
- Work: Work priority is influenced by income, the higher the income then the higher priority of work. Male have more orientation towards work.
- Pleasure: Male are more pleasure oriented than female.

FRAMEWORK OF TIME ALLOCATION MODEL

The model consists of two types of approaches: the utility maximization and the activity choice model. These approaches use the same form of utility of activity, which is defined as follows.

Utility of Activity

The researches of (4) and (5) that dealt with modeling the utility of activity as a function of time are highly useful and served as a starting point for this research. The focus of this research is to work in more detail on the coefficients of the utility function. The proposed utility function is as follows:

$$\underset{t_{ni},q_n,z_n}{Max}\ U_n = \sum_i \gamma_{ni} \ln\left(t_{ni}+1\right) + \mu_n \ln\left(q_n\right) + \xi_n \ln\left(z_n\right) \tag{2}$$

Subject to

$$c_{zn} z_n + \sum_i c_{ui} t_{ni} + C_{nm} \le R_n \tag{3}$$

$$q_n + \sum_i t_{ni} + T_n \le H_n \tag{4}$$

As shown in Eq. (2), the total utility (U_n) of individual n is a function of time spent on activity i (t_{ni}), the time spent for mandatory activities (q_n) and amount of composite goods consumed (z_n). The corresponding parameters are γ_{ni}, μ_n, and ξ_n respectively. The activities are classified into six categories i =1 to 6 according to the definition of needs by Maslow (1970). The categories are (1) physical care, (2) homemaking/comfort, (3) family care, (4) work, (5) socialization, and (6) pleasure. The constraints for maximizing U_n are income or maximum budget (R_n) and total available time (H_n). These constraints are defined in Eq. (2) where c_z is the unit price of composite goods consumed, c_{ui} is the unit cost for doing activity i (market price), G_n is total cost of travel and T_n is total travel time. Having defined the utility function, the first approach in the model is explained in the following section.

Utility Maximization Using RP Data

The main concept of the approach is that the individual will try to maximize his utility by allocating time for each types of activity. Using the Lagrange method to find the solution of maximization of Eq. (1), with the constraints of Eq. (2) we got:

$$\begin{aligned} l_n &= \sum_i \gamma_{ni} \ln(t_{ni}+1) + \mu_n \ln(q_n) + \xi_n \ln(z_n) \\ &+ \lambda_{nB}\left(R_n - c_{zn} z_n - \sum_i c_{ui} t_{ni} - G_n\right) + \lambda_{nT}\left(H_n - q_n - \sum_i t_{ni} - T_n\right) \end{aligned} \tag{5}$$

The first-order condition will be:

$$\frac{\gamma_{ni}}{t_{ni}+1} = \frac{\mu_n}{q_n} + \frac{c_{ui}\xi_n}{c_z z_n} \qquad if\ t_{ni} > 0 \tag{6}$$

$$\frac{\gamma_{ni}}{t_{ni}+1} \le \frac{\mu_n}{q_n} + \frac{c_{ui}\xi_n}{c_z z_n} \qquad if\ t_{ni} = 0 \tag{7}$$

Since the coefficient γ_{ni}, μ_n, and ξ_n should be non-negative, they are formulated as follows:

$$\gamma_{ni} = \exp(\beta_i \alpha_{ni} + \varepsilon_{ni}) \tag{8}$$

$$\mu_n = \exp(\mathbf{B}\mathbf{Y}_n) \tag{9}$$

$$\xi_n = \exp(\mathbf{C}\mathbf{Y}_n) \tag{10}$$

The simplification of number of activity i is equal to the number of need j for the $\boldsymbol{\alpha}$ is imposed, α_{ni} is the level of priority/importance of needs of an individual, β_i is the part worth of needs i (this coefficient is situational, different for each i e.g. weekend, weekday). **B** and **C** are unknown parameter vectors. $\mathbf{Y}_n$ is an individual attribute vector and ε_{ni} is the error term. Substituting the Eq.(8) – (10) into Eq.(6) - (7), we can derive the following equations.

$$\varepsilon_{ni} = \ln(t_{ni}+1) + \ln\left(\frac{\exp(\mathbf{B}\mathbf{Y}_n - \beta_i\alpha_{ni})}{q_n} + \frac{c_{ui}\exp(\mathbf{C}\mathbf{Y}_n - \beta_i\alpha_{ni})}{c_z z_n}\right) \qquad if\ t_{ni} > 0 \tag{11}$$

$$\varepsilon_{ni} \le \ln(t_{ni}+1) + \ln\left(\frac{\exp(\mathbf{B}\mathbf{Y}_n - \beta_i\alpha_{ni})}{q_n} + \frac{c_{ui}\exp(\mathbf{C}\mathbf{Y}_n - \beta_i\alpha_{ni})}{c_z z_n}\right) \qquad if\ t_{ni} = 0 \tag{12}$$

Assuming the error term ε_{ni} follows the normal distribution with an average of zero and distributed with variance σ^2, then function of log likelihood can be represented using a Tobit Censored Regression model as in Eq. (13). L_{Tn} is the likelihood of individual n, ϕ is standard normal probability density function and Φ is standard cumulative normal distribution function. For the estimation purpose, the log likelihood function LL_T, which is the sum all the individual log likelihood, with parameter β_i, **B**, **C** and σ which are assumed to maximize the log likelihood, is described in Eq. (15).

$$L_{T_{ni}} = \begin{cases} \frac{1}{\sigma}\phi\left[\frac{\ln(t_{ni}+1)+\ln(D_{ni})}{\sigma}\right] & if \;\; t_{ni} > 0 \\ \Phi\left(\frac{\ln(D_{ni})}{\sigma}\right) & if \;\; t_{ni} = 0 \end{cases} \tag{13}$$

$$D_{ni} \equiv \frac{\exp(\mathbf{BY}_n - \beta_i \alpha_{ni})}{q_n} + \frac{c_{ui}\exp(\mathbf{CY}_n - \beta_i \alpha_{ni})}{c_z z_n} \tag{14}$$

$$LL_T = \sum_{n=1}^{N}\sum_{i=1}^{m} \ln\left(L_{T_{ni}}\right) \tag{15}$$

The ideal situation of utility maximization is that individual with time constraint could allocate time for all activities with equal satisfaction, which means that the marginal utility of all activities are equal. However, in reality there are significant constraints like budget. Because of this individual might be forced to reduce the time allocation for some activities, and this means that marginal utility for some activities might still not be equalized to reach the maximum utility.

The Activity Choice Model using SP Data

To support the situation of difference in marginal utility, a second approach is to use an additional model, that takes into account the situation whether an individual has reached equal marginal utility for each type of activity or not. This situation can be captured by asking them directly whether they are satisfied or not with the time allocation of the particular activity engagement. If he is not satisfied with the time provided, then it means that the existing time allocation is not fully satisfactory to the individual. If extra time can be obtained, hypothetically an individual will choose an activity expansion/engagement that has the highest marginal utility. The marginal utility of the time of Activity *i* is represented in equation as a function of t_i as follows.

$$\frac{\partial U_n}{\partial t_{ni}} = \frac{\gamma_{ni}}{t_{ni}+1} = \frac{1}{t_{ni}+1}\exp(\beta_i \alpha_{ni} + \varepsilon_{ni}) \tag{16}$$

Using natural logarithm, the previous equation becomes:

$$\ln\left(\frac{\partial U_n}{\partial t_{ni}}\right) = \beta_i \alpha_{ni} - \ln(t_{ni}+1) + \varepsilon_{ni} \equiv \; V_{ni} + \varepsilon_{ni} \tag{17}$$

Where V_i is the observable part of marginal utility of activity *i*.

Since error term ε_i is assumed to follow the normal distribution with average equal to 0 and distributed with variance σ^2, (same as stated in the utility maximization approach), then the multinominal probit model is formulated as follows:

$$P_{ni} = \int_{\rho_{ni1}=-\infty}^{V_{ni}-V_{n1}} \int_{\rho_{ni2}=-\infty}^{V_{ni}-V_{n2}} \cdots \int_{\rho_{nim}=-\infty}^{V_{ni}-V_{nm}} \phi\left(\rho_n^i\right) d\rho_{nim} \cdots d\rho_{ni2} d\rho_{ni1} \tag{18}$$

$$\phi\left(\rho_n^i\right) \equiv \frac{1}{\left(\sqrt{2\pi}\right)^{m-1}\left|\Omega\right|^{1/2}} \exp\left[-\frac{1}{2}\rho_n^i{}'(\Omega)^{-1}\rho_n^i\right] \tag{19}$$

Where P_{ni} is the Probability that individual *n* will spend the extended time for the activity type, $\rho_{nmi} = \varepsilon_{nm}$-$\varepsilon_{ni}$ (difference between error terms of alternative *j* and *i*), Ω is the variance-covariance matrix of ρ and *m* is the number of activities. The log likelihood function for the model is as follows.

$$LL_p = \sum_{n=1}^{N}\sum_{i=1}^{m} \delta_{ni} \ln\left(P_{ni}\right) \tag{20}$$

Where δ_{ni} is dummy variable when the alternative *i* has been chosen. The β_i and σ are unknown parameters that makes the log likelihood function reach maximum.

The activity choice model uses data obtained from the SP method. The SP Method is used in describing and predicting individual preference and choice for not-yet-existing (hypothetical) situation and there is no consideration of constraints. The SP approach is known to contain more biases then RP data. Using the SP based prediction model alone tends to overestimate the projection of the result, so it is deemed necessary to propose some alternative method that could reduce this bias.

Combining The Utility Maximization and Activity Choice Model

As previously explained, the activity choice approach tends to overestimate the individual's behavior of time allocation of needs. To correct this, the idea is to combine both the utility maximization and the activity choice model and use them simultaneously. The way of combining is to define a new log likelihood function, which is basically the sum of log likelihood functions from each model since they share the same error term, and parameters. The new combined equation is written in Eq. (21).

$$LL=LL_T+LL_P \tag{21}$$

LL is the total log likelihood and is the sum of the log likelihood from utility maximization model and activity choice model. This combined modeling process is that constitutes the time allocation model proposed in this research.

The Estimation Results

In this calibration of the model the choices will be the four types of classification taking into account the most prominent needs in the weekend that is Family Activity, and Personal Pleasure Activity, Work Activity while the rest is classified as Other Activity. The estimation is using the GAUSS environment with the application of three types of methods of multinomial probit and tobit censored regression, and combination of probit and tobit. The result of the estimation is shown in the Table 1. As shown by the table, in terms of likelihood ratio, variance of error the combination of SP and RP has a better performance. The combination has also increased the significance of *t* statistics of three variables of needs compare to the RP alone. This means the priority of certain need has been proven more significantly to have large influence to utility of the respective type of activity and accommodating the difference in marginal utility by combining it with the activity choice model is proven useful.

Calibration is also done for the inter-regional and inter-temporal comparison, as shown in table 2. The result shows that for Tokyo in weekday it shown that the part-worth or the weight given for family activity and pleasure are the lowest among other needs, and even lower than part-worth of income. Income and Satisfaction of Physical Care (SPC) does not significantly influence the utility. The highest part worth comes significantly from work and physical care respectively. For the comparison with weekend, the family care and pleasure have significantly the highest weights among other needs. Income and SPC has the highest contribution to the utility of weekend.

To compare with the Indonesian situation in weekday, it is shown that the highest part worth comes from physical care, work and lastly family care, while income and SPC contribute the lowest. Quite different with Tokyo case, in Jakarta family care still contributes significantly to the utility of the weekday.

Proposed Concept of Value of Activity Time

The value of activity time defined in this research is: the worth or desirability of time for certain type of activity *perceived or given* by an individual with certain characteristic/culture as the user of time, which can be represented by measurement of scale, rank or monetary value (e.g. in this case amount spent on composite goods). The concept of value of activity is derived as the ratio of marginal utility of activity time and the marginal utility of expense. Especially for the weekend activity in Tokyo, there are other predetermined variable of t_{ni}^{WD} (time for activity *i* in weekday) and Z_n^{WD} (composite goods consumption in weekday) that were added to t_{ni} and Z_n in weekend correspondingly in the utility function. The purpose is to relate individual weekday allocation to the utility of the weekend. The result of the estimation will be applied in the calculation of value of activity time.Having this formulized then the expected value of activity time is as follows:

$$VOT_{ni}=\frac{\gamma_{ni}}{\xi_n}\frac{z_n+z_n^{WD}}{t_{ni}+t_{ni}^{WD}+1}=\frac{z_n+z_n^{WD}}{t_{ni}+t_{ni}^{WD}+1}\exp\left(\beta_i\alpha_{ni}-\mathbf{CY}_n+\varepsilon_{ni}\right) \tag{22}$$

Having the E [$\exp(\varepsilon_{ni})$] as follows:

$$E[\exp(e_{ni})] = \int_{-\infty}^{+\infty} e^{x} \frac{1}{\sqrt{2\pi}\sigma} e^{-x^2/2\sigma^2} dx = \exp\left(\frac{\sigma^2}{2}\right) \equiv a \tag{23}$$

Then the expected value of activity time is:

$$\overline{VOT_{ni}} = \frac{z_n + z_n^{WD}}{t_{ni} + t_{ni}^{WD} + 1} \exp\left(\hat{\beta}_i \alpha_{ni} - \hat{\mathbf{C}}\mathbf{Y}_n + \sigma^2/2\right) = a \times \frac{z_n + z_n^{WD}}{t_{ni} + t_{ni}^{WD} + 1} \exp\left(\hat{\beta}_i \alpha_{ni} - \hat{\mathbf{C}}\mathbf{Y}_n\right) \tag{24}$$

It is shown that $\overline{VOT_{ni}}$ is a function allocated time, level of importance of activity *i*. This explain the value of activity time of individual depends on:

1. How he allocates time for type of activity *i*
2. How he prioritizes that type of activity *i* (as a general attitude, orientation of needs *i*)

This formulation also means that $\overline{VOT_{ni}}$ is a decreasing function of t_{ni}, and is an increasing function of the priority of needs. The calculation of $\overline{VOT_{ni}}$ as a unit of aZ_n is shown in Table 3.

CONCLUSION

For Tokyo

- Most of the respondents in Tokyo have higher need for family care, physical care and pleasure in the weekend as shown by the way they allocate time. These needs are to be fulfilled within limited time on weekends and as a consequence, the time for doing this activity is valuable for them.
- The part-worths of priorities of family and pleasure with respect to the total utility in weekend is significantly high, this shows that extending the activity time for family activity and pleasure is very significant in maximizing total utility. Consequently this also influences the value of activity time especially for family care that is much higher than any activity in weekday.

For Jakarta

- Most of the respondents would not use all the time saving for the time of production or work. Rather, they would use it mostly for family-oriented and other activity. Time in this case, is used for fulfilling psychological needs.
- The part-worth and priority of family care in weekday are the highest and this consequently makes the value of activity time for family also high. This is reflected in the calculation by the model and their WTP-Income ratio that shows that the value of activity for family is more expensive than the value for work.

For the Model

- The proposed model is able to relate the characteristic of individuals or population with activities they will do given extra time. The variable α that represent individual level of importance for each need will determine time allocation.
- Using this time allocation model, given the parameters and individual attributes, the individual time allocation can be predicted. The change of time allocation as a result of time saving can also be calculated.
- The combination of two approaches (RP and SP) is proven to increase the estimation performance.
- Income and satisfaction of physical care generally will increase the utility of all activities.
- Further effort is still required to improve the model. The estimation of parameters involved must still be verified. Some assumptions, considerations, and definition of errors need to be dealt with. The model still need continuing improvement and development, but examples shown in this paper has shed some directions on the features that this model will have.

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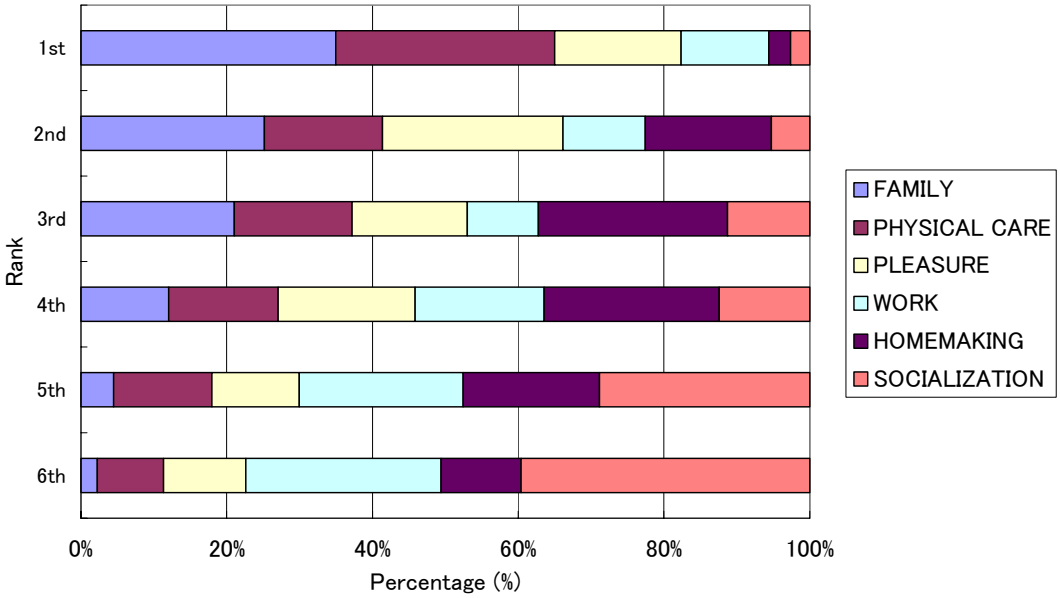
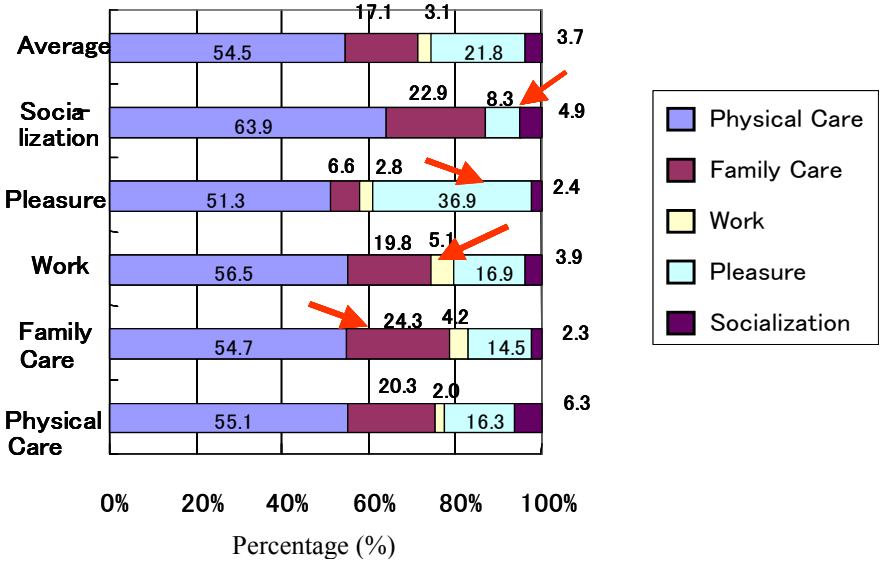


FIGURE 1 The rank of priority for each need in Tokyo.



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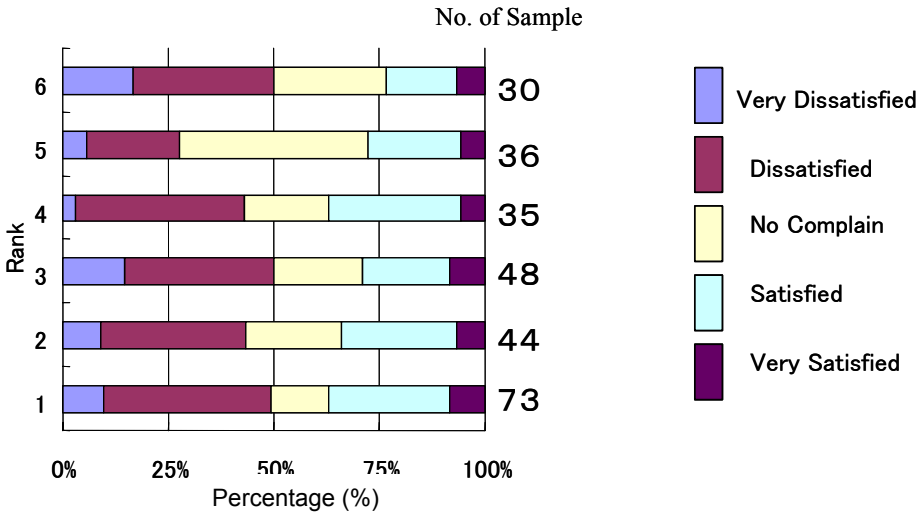

FIGURE 3 Level of satisfaction of needs for physical care in Tokyo.

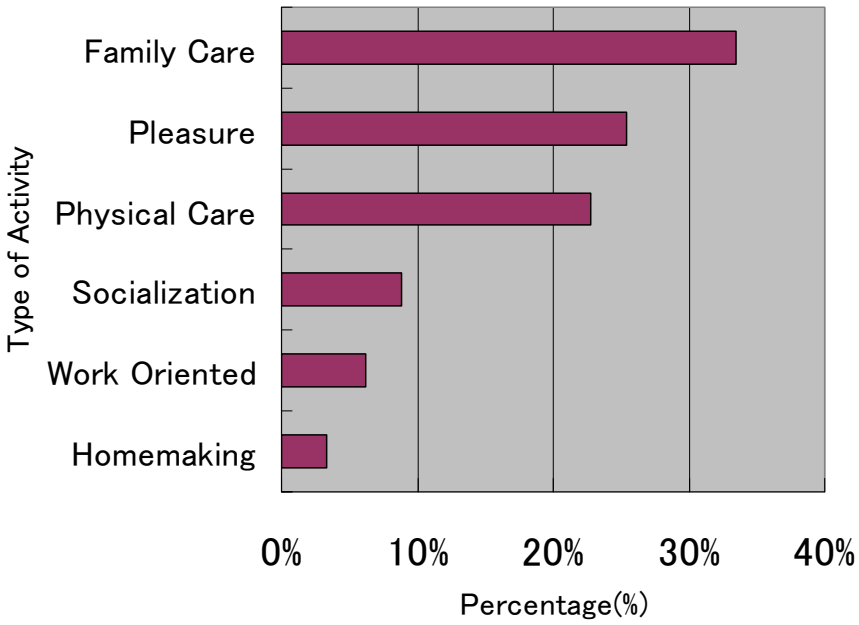

FIGURE 4 The choice of activity extension classified by needs in Tokyo on weekend.

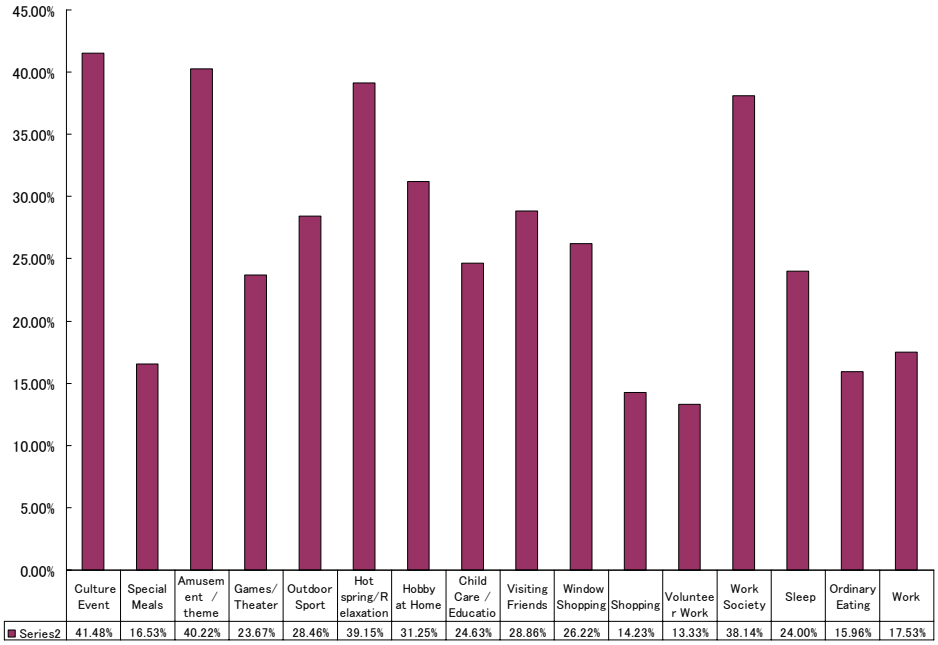

FIGURE 5 Willingness-to-pay/income for travel time saving for type of detail activity in Tokyo on weekend.

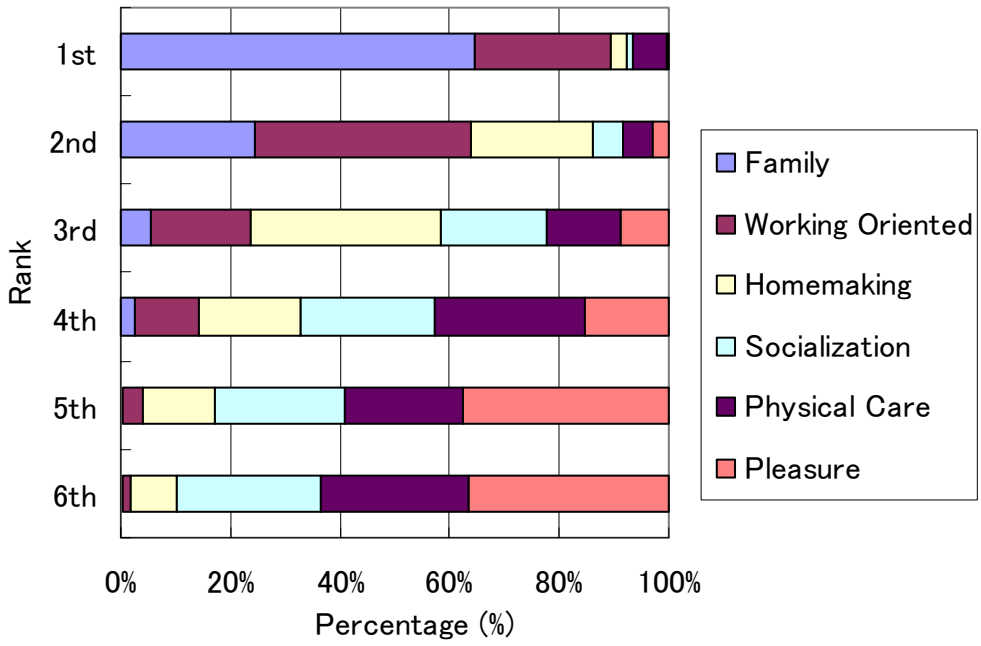

FIGURE 6 The rank of priority for each need in Jakarta.

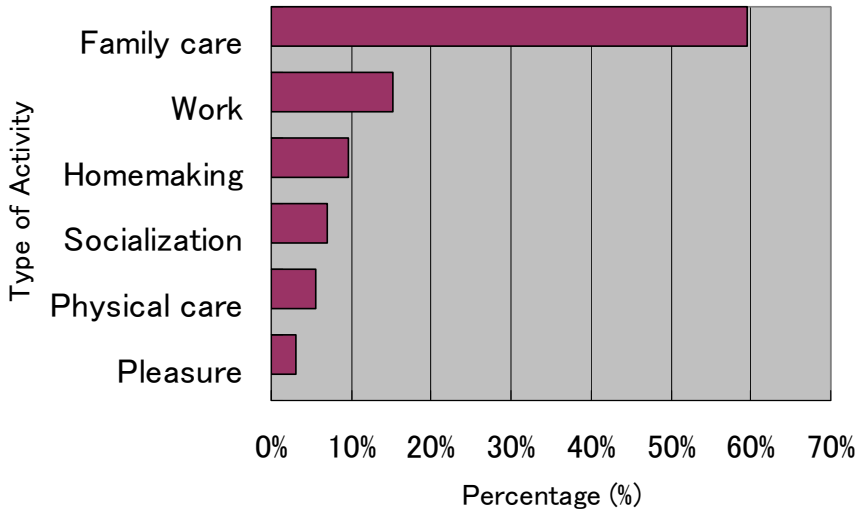

FIGURE 7 The Choice of activity extension classified by needs in Jakarta on weekdays.

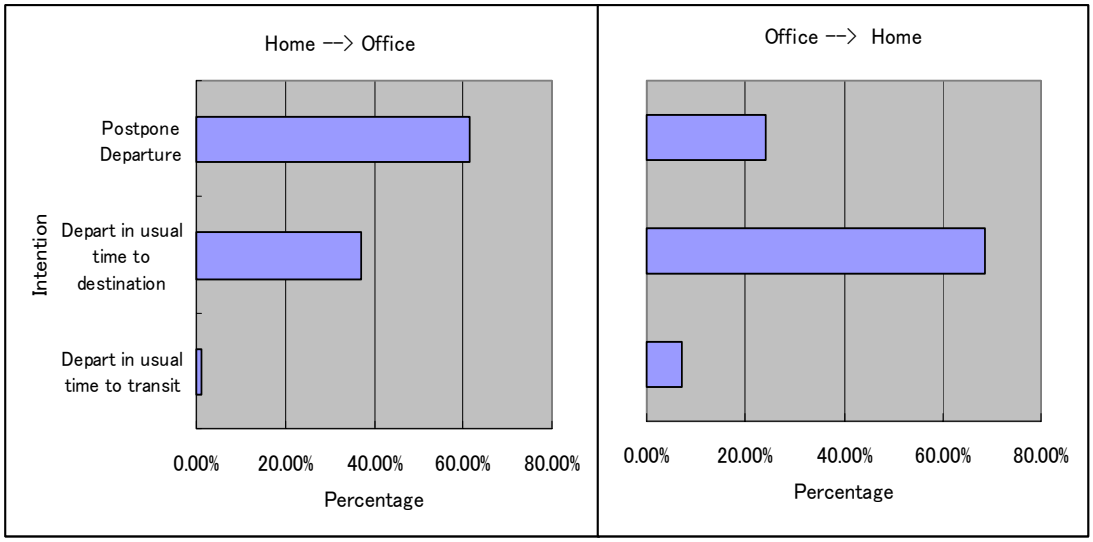

FIGURE 8 Intention if travel time saving obtained in Jakarta on weekdays.

TABLE 1 The Calibration Result of 4 Choices using method of SP, RP and Combination SP and RP

		STATED PREFERENCE METHOD (SP)	REVEALED PREFER-ENCE (RP)	COMBI-NATION SP AND RP
	4 Choices: 1. Family Activity (FA) 2. Personal Pleasure Activity (PA) 3. Work Activity 4. Other Non Work Activity	Multi Nominal Probit	Tobit Censored Regression	MNP and Tobit Censored Regression
	Variables	Estimates		
1	α1 = Priority of Family (specific for Family Activity)	1.887 *(8.93)*	0.803 *(5.57)*	1.495 *(8.32)*
2	α_2 = Priority of Personal Pleasure (specific for Pleasure Activity)	1.715 *(7.03)*	0.721 *(4.38)*	1.279 *(6.29)*
3	α_3 = Priority of Work (specific for Work Activity)	-0.499 *(-1.53)*	-0.670 *(-2.79)*	-0.976 *(-3.39)*
4	α_4 = Priority of Physical Care (specific for Other-Nonwork Activities)	0.915 *(3.34)*	0.255 *(1.54)*	0.505 *(2.39)*
5	Y_1 =Income		1.045 *(7.76)*	1.702 *(9.28)*
6	Y_2 =Satisfaction of Physical Care		1.841 *(8.64)*	2.620 *(8.91)*
7	σ of error	5.491 (*)	5.491 *(19.82)*	8.032 *(19.02)*
	Initial log-likelihood	-434.46	-1255.95	-1685.90
	Final log-likelihood	-330.70		
	Final log-likelihood of Tobit and Combination Tobit and Probit		-1097.21	-1407.96
	Log-Likelihood ratio	0.23	0.12	0.16
	Number of samples	169		

t statistics in italic bracket. Assumption: $c_{ui} / c_z z_n$ for PA=0.06, FA=0.05, WO=0.04, NW=0.03 respectively.
(*) is assumed to be a scale parameter.

TABLE 2 The Calibration for Weekday and Weekend in Tokyo (Inter-temporal) And Between Weekday in Jakarta (Inter-regional)

		REVEALED PREFERENCE (RP)		
		JAKARTA	TOKYO	
	4 Type of Activity: 1. Family Activity 2. Personal Pleasure Activity 3. Work Activity 4. Other Non Work Activity	Parameter/ Part Worth β_j in Weekday	Parameter/ Part Worth β_j in Weekday	Parameter/ Part Worth β_j in Weekend
1	$\alpha 1$= Priority of Family (specific for Family Activity)	0.202 *(8.52)*	-0.445 *(-8.72)*	0.803 *(5.57)*
2	α_2 = Priority of Personal Pleasure (specific for Pleasure Activity)		-0.254 *(-4.44)*	0.721 *(4.38)*
3	α_3 = Priority of Work (specific for Work Activity)	0.378 *(14.14)*	0.612 *(8.42)*	-0.670 *(-2.79)*
4	α_4 = Priority of Physical Care (specific for Other-Nonwork Activities)	0.524 *(9.66)*	0.365 *(6.57)*	0.255 *(1.54)*
5	Y_1 =Income	-0.548 *(-12.42)*	-0.215 *(-5.23)*	1.045 *(7.76)*
6	Y_2 =Satisfaction of Physical Care	-6.827 *(-4.62)*	-9.00 *(-0.08)*	1.841 *(8.64)*
7	σ of error	1.510 *(44.46)*	2.19 *(30.59)*	5.491 *(19.82)*
	Initial log-likelihood	-3532.84	-1602.83	-1255.95
	Final log-likelihood of Tobit and Combination Tobit and Probit	-1947.84	-1328.59	-1097.21
	Log-Likelihood ratio	0.45	0.17	0.12

t statistics in italic bracket. Assumption: $c_{ui} / c_z z_n$ for PA=0.06, FA=0.05, WO=0.04, NW=0.03 respectively.
(*) is assumed to be a scale parameter.

TABLE 3 The Value of Activity Time as a Unit of aZ_n

Activity Type	Jakarta in Weekday	Tokyo in Weekday	Tokyo In Weekend
Family-Care	0.12	0.15	1.88
Pleasure	*n.a.*	0.27	0.18
Work	0.04	0.38	0.05
Others	0.09	0.02	0.03

n.a. = not applicable because only 3 choices involved