ANALYSIS ON VALUE OF ACTIVITY TIME BASED ON INDIVIDUAL NEEDS

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Dissertation

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ABSTRACT

Prior to building infrastructure such as roads, or transport facilities to serve the community in general, it is necessary to understand what will be the benefit for the targeted users. The benefit is not only observed from the provider's point of view, but more importantly from the user's or consumer's side. Failing to do so will resulted in the inefficiency, ineffectiveness of the utilization of the infrastructure. There are some cases of infrastructures that have already been built but were not utilized as expected or sometimes even received a lot of complains from the users. This case could stems from several reasons such as: miscalculation and overestimation of user demand or needs, and if it is related to user fee, the fee has been too expensive.

The basic interest of this dissertation is analyzing the benefit of travel time saving. Quantifying travel time saving is a very important issue in determining of the benefit of a transport project. There are many studies on the travel time value, and there have been many recommendations from consultants, and development agencies (e.g. World Bank) about value of time. The value of time (VOT) in the current practice is represented as a proportion of individual income, which is the variable of monetary unit. Despite the many researches on VOT, this current research is still interested in this issue, since there are still many things needs to be explained. Most of the earlier studies in VOT use the trip-based approach (i.e. considering time as a cost), focused more on the approach of economic or the monetary value of time, and regard the travel time value as a loss of productivity time.

In the last decade, a new type of research had emerged, which is called the activity-based research, which is the closest type of classification for this current research. However, most of the previous activity-based researches still did not have strong emphasis on the psychological aspect that shows the attitude of the individual towards time use.

This attitude is presumed as the important aspect in this current research, because such attitudes determine the life style of the individual. This attitude could be different for each individual, population, and life stage. This research also employs activity-based approach but with more emphasis on the psychological aspect that shows attitude of individuals towards a choice of priority lifestyle.

This research would like to contribute firstly a classification method of activities referring to the definition of needs defined by psychologists. Secondly, it would introduce the incorporation of priority of needs in the formulation of individual utility and the value of activity time. Based on the objective, this research proposed a definition of value of activity time. The value of activity time defined in this research is: the quality, scarcity, and meaning of time for certain type of activity *perceived or given* by an individual or group with certain characteristic/culture as the user of time, which can be represented by measurement of monetary (e.g. willingness to pay, proportion of income), and scale or rank. Thirdly, this research would introduce a way combining revealed preference (RP) method and stated preference method (SP), and will show that the combined model can be more representative in obtaining the result of calibration.

The situation in Tokyo and Jakarta, briefly explained below best expresses the interest of this research.

1. In Tokyo, Japan, guidelines state that value of time in weekend is considered more valuable than in weekday. This is to compensate for activities that are difficult to do in weekdays for example recreation with family. Nevertheless, this approach is different with the current practice of transport benefit analysis, and to relate this theoretically with the production time as the conventional method of time value is rather difficult.
2. In Indonesia, the basic assumption of travel time saving of the government is that time lost for travel is a forgone earning. According to a World Bank report, time value in developing countries by default is 30% of the income and considered different between regions in the country according to local evidence. However, Indonesia as an archipelago has many regional and culture disparities that may

determine value of time (i.e., in Jakarta notion that the value of time for family might be more expensive than the value of time of work even in weekday), so it is necessary to have an analysis of culture also instead of only relying only on an empirical analysis.

To explain these two phenomena, this research tries to trace the benefit of time saving from the viewpoint of the service users themselves. As a consequence this resulted in the need to explore the connection between a range of disciplines such as Economics, Psychology, and, Sociology.

The main focus of this research, which has not been emphasized yet in past studies, is the application of individual needs to the consideration of time value or benefit. This will be the contribution of the research to the field of activity-based analysis in transportation.

In the light of these premises, the main objectives of this research are: firstly, to explore time saving impact on time allocation from the consumer's point of view and secondly, to propose a model that could predict time allocation taking into account the needs of the individual. Having these objectives, surveys have been done both in Tokyo and Jakarta. The respondents of the Tokyo survey are individuals using toll road in weekend, because the focus is activity in weekend. In Jakarta, the respondents are household members in the area surrounding the train station, and the focus of this survey is activity in weekday. The survey consisted of RP data, SP data and individual attributes. The RP data shows time allocation implemented by the individual, while the SP data gives the extension choice of individual if a hypothetical one-hour of time saving is obtained. A log-likelihood of time allocation model and probit choice model are produced using the RP and SP data, respectively. The combined RP and SP model then obtained by summing the likelihood functions, maximizing the summation function, and estimating the required parameters. The results show that the parameters estimated using the combined model better represent the data set, than parameters independently obtained from each of the two models.

From the proposed time allocation model and the calibration result, it is observed that, there are two most important variables that determine the meaning of time and consequently the subjective value of time.   These are the individual priority of needs and the weight or the part-worth given to the needs for a certain time span of activity time.

It is shown that the VOT for each type of activity is a function of the allocated time, the level of importance for the related need, and the weight or part-worth allocated. This formulation also means that VOT diminishes over time, and the higher the priority of needs, the higher is the time value. This will be the main difference with the opinion of single time value for each individual.

In Tokyo, the part-worth or the weight of pleasure and family need is very low in weekday but very high in weekend. This explains the discrepancy in temporal values of time.   In Jakarta, the value of time as a resource value for increase in productivity time needs to be re-examined.   The empirical analysis and calculation using the proposed model support the phenomenon of higher value of family activity in Tokyo in weekend and also the higher value of family time in Indonesia in weekday.

The economic benefit of time saving that leads to the increase of production time is related to the probability that the individual extends work activity. The model still has many assumptions, and needs continuous improvement and development these examples have shed some directions on the shape and features that this model will have.

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Chapter 1

INTRODUCTION

1.1 Background

Prior to planning and building infrastructure such as roads, or transport facilities to serve the community in general, it is necessary to understand what will be the benefit for the targeted users. The benefit is not only observed from the provider's point of view, but more importantly from the user's or consumer's side. Failing to do so will resulted in the inefficiency, ineffectiveness of the utilization of the infrastructure. There are some cases of infrastructures that have already been built but were not utilized as it is expected or sometimes received a lot of complains from the users. This case could stems from several reasons such as:

- Miscalculation, misinterpretation or overestimation of user demand or needs
- If it is related to user fee, the fee has been too expensive

In the practice of cost benefit analysis, the main stream of benefit identification of transport projects are in the personal time saving and vehicle operating cost saving (VOC). The personal time saving itself is usually determined using economic approach by the decision maker, while the VOC is quite straight forward although can not be observed directly by the users.

The policy maker or provider could establish a service to reduce a commuting/ travel time to work, with the expectation of increase of productivity. The question is how big is the expectation? Also in other case of providing a transport service to recreational area, how meaningful is this service to the users? Those two services are different in terms of activity type. Is the benefit felt by the user toward that facilities similar or different?

The thesis's interest is basically analyzing the benefit of travel time saving. Quantifying travel time saving indeed is the very important issue in the analysis of the benefit of a transport project. There are hundreds of studies about the travel time value and there have been many recommendations from consultants, and development agencies (e.g. World Bank) about 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 et.al (1990), 40%-60% in U.S.A, by Boardman et.al (2001) and 30% as a default value for developing countries unless there is a local evidence, by Gwilliam (1997). In the a report to the World Bank by Gwilliam, it is stated that there are currently no general guidelines about value of time, and consequently this valuation is often omitted in the economic evaluation of World Bank transport projects.

This research still interested in this issue, since it has still many things needs to be explained. Most of the previous studies in value of time are focused in the approach of economic and concerned on the monetary value of time, and the point of view is taken from the policy maker's side. Quite differently, this research is trying to trace the benefit of time saving from the viewpoint of the service users themselves. As a consequence this resulted in the need to explore the connection between a range of disciplines such as economics, psychology, and, sociology. The economics tries to explain the behavior of individual as an agent of economy, and translate the benefit time saving in the monetary manner, while the psychology covers the analysis individual psychology explaining of why does individual need time for, the sociology study about the shared values that is common in a certain society of time use, and about the difference between social values in certain area with the other that has different characteristics.

Based on the objective, this research proposed a definition of value of activity time. The value of activity time defined in this research is: the quality, scarcity, and meaning of time for certain type of activity *perceived or given* by an individual or group with certain characteristic/culture as the user of time, which can be represented by measurement of monetary (e.g. willingness to pay, proportion of income), and scale or rank.

1.2 Motivation of Research

The motivation of this research is basically driven by the need to explain the phenomena that occur in real situation in life in a certain area or population that has specific characteristic such as in Japan as a developed society and Indonesia as a developing one. The following phenomena in Japan and Indonesia will best explain the motivation.

1.2.1 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 that in weekday. The guideline for value of time for passenger car in weekday is 56 yen/vehicle/minute or 3360 yen/vehicle/hour (31.70 US $), and 84 yen/vehicle/minute or 5040 yen/vehicle/hour (47.55 US $) for weekends. The primary reason for a higher value of weekend time in the Japanese case 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 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, this kind of approach is different with the current practice of transport benefit analysis that stated time value of work is more expensive than any other non-work activity. To explain the phenomena theoretically with the forgone opportunity of production time as the conventional method of time value is rather difficult.

Recently, as in Kitamura (1997), there is a tendency to also explain the benefit in terms of social and psychological benefit using the activity-based approach. This approach is considered able to explain the phenomenon that occurs in Japan.

1.2.2 The Phenomena in Indonesia

The basic assumption of travel time saving of the government of Indonesia is that time lost for travel is a forgone earning. However, Indonesia as an archipelago has many regional and culture disparities that could influence how individuals or population with their culture value their time.

There is a notion that there is a difference in perception of benefit of time saving between the providers and policy makers in Indonesia and the users of transport facilities. One of the indications of this difference in perception is in the tariff determination in Indonesia. Tariff determination is a very sensitive issue, because this has to go through a tedious bureaucratic process, as the final decision must come through a Presidential Decree. During the process, the toll road operators and investors have to discuss it with the People’s Council, and quite often, the negotiation reaches a dead end. This also happens when toll road operators are requesting for a tariff increase or adjustment.

Based on this condition, toll road operators deem it necessary to have a better method that could accommodate the user perception of time saving. A better time saving benefit identification need to be put forward in order to have a better understanding between the road users as a consumer and the investors. 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. The objectives of the research are to obtain the user's perception based on their aspirations, and preferences both stated and revealed, and then proposed a model of time allocation that incorporates their aspirations in order to explain the benefit of time saving.

In achieving those objectives survey has been done in two locations, in Tokyo and Jakarta. The survey in Tokyo has the focus on the weekend activity time, however the average time allocation in weekday is also obtained. The survey in Jakarta is focusing the individual time allocation in weekday only. Analysis and model estimation on both data independently is carried out. However, the time allocation behavior in both locations is also compared in order to obtain the common variables that will influence individual to allocate time to certain activities but only using the weekday data.

Many previous researches on travel benefit have applied trip-based approaches, which concern on the utility/disutility of travel, travel time, psychological or physical discomfort during the trip. However, the trend in current transport researches are the application of activity based approach, as we understand that activity is the reason for travel. The purpose of this research is for time use analysis, which will later be used in the activity based travel analysis. As stated by Bhat and Koppelman (1999). "Broadly, activity based analysis attempts to better understand the behavioral basis for individual. This behavioral basis includes all the factors that influence the how, where and why of performed activities. Among these factors are the needs, preferences, prejudices and habits of individuals".

The related theories in this research are motivational theory, consumer theory with cumulative utility function, and discrete choice. As the first approach, motivational theories was defined by Maslow (1970) which states that "the human being is motivated by number of basic needs which are species wide, apparently unchanging, and genetic of instinctual in origin. They are intrinsic aspects of human nature which culture cannot kill, but only repress". On the average, for individual workers, and so called commuters, their basic physical needs such as food and shelter are assumed to be fulfilled, with stable condition income. The higher needs that they would like to achieve then are the mental achievements, such as love, self esteem, and meaningfulness.

This symptom also has been realized by Solomon and Ben-Akiva, (1983) with their opinion about lifestyle. According to them, lifestyle is basically choice between family formation, participation in labor force, and orientation toward leisure. The lifestyle choice will influence the choice of mobility in terms of employment location, residential location, housing type, and automobile ownership. Consequently, these choices will influence the activity and travel choice (non-work) such as activity type, activity duration, destination, route, and mode.

From the point of economic theory, Becker (1965) is the first to explain about the forgone earning if time is not used for work. This is the emergence of the first concept of value of time as a function of wage rate. He also explained that household is the integration of producing units and utility maximizer and this is not consistent with then-prevailing economic theory of delineating production in firms and consumption in households.

1.3 Research Objectives

Several questions or considerations are raised in this research. When economists consider the double role of households, what would the households think of themselves? Do households consider time an input for production or consumption? It is difficult to observe if someone really likes and enjoys working. While the economists will look at it as producing action, the consumer thinks it is a consuming action with time as an input, to maximize his mental utility. So whether time is considered as an input of production or consumption depends on the households.

For an individual, after the mandatory working hours are finished, he will be offered a choice of consumption, of market goods and services including to extend or continue working. Will it be used for production or for consumption? For working or for leisure (non-working)? Who decides this? The producer or the consumer?

In light of these premises, firstly, this research would like to explore time saving impact on time allocation from the consumer's point of view. The following result of survey in Indonesia will provide a support to the idea of having a method of predicting time allocation based on their intentions and stated preferences. Secondly, this research would like to propose a model that could predict time allocation taking into account the needs of the individual. The procedure of modeling that is implemented in this research is shown in Figure 1.1. Briefly the Figure 1.1 shows the flow of procedure that has been implemented by this research, starting from the process of data collection, modeling effort and evaluation.

1.4 Thesis Contribution

The contribution of this study is in the consideration of psychological aspect of individual needs to the identification of the value of time. The specific contribution is:

- The classification process of type of activities is based on needs defined by Maslow. There have been many classification of activities defined by different basis. For example in the basis of spatial/location (in-home/out-home) and also there are classification based on detail action (window shopping, grocery shopping) based on level of urgency (discretionary, mandatory) and distance, however this new classification will helped the researcher to understand the attitude of population toward some needs and eventually understand its importance or value.

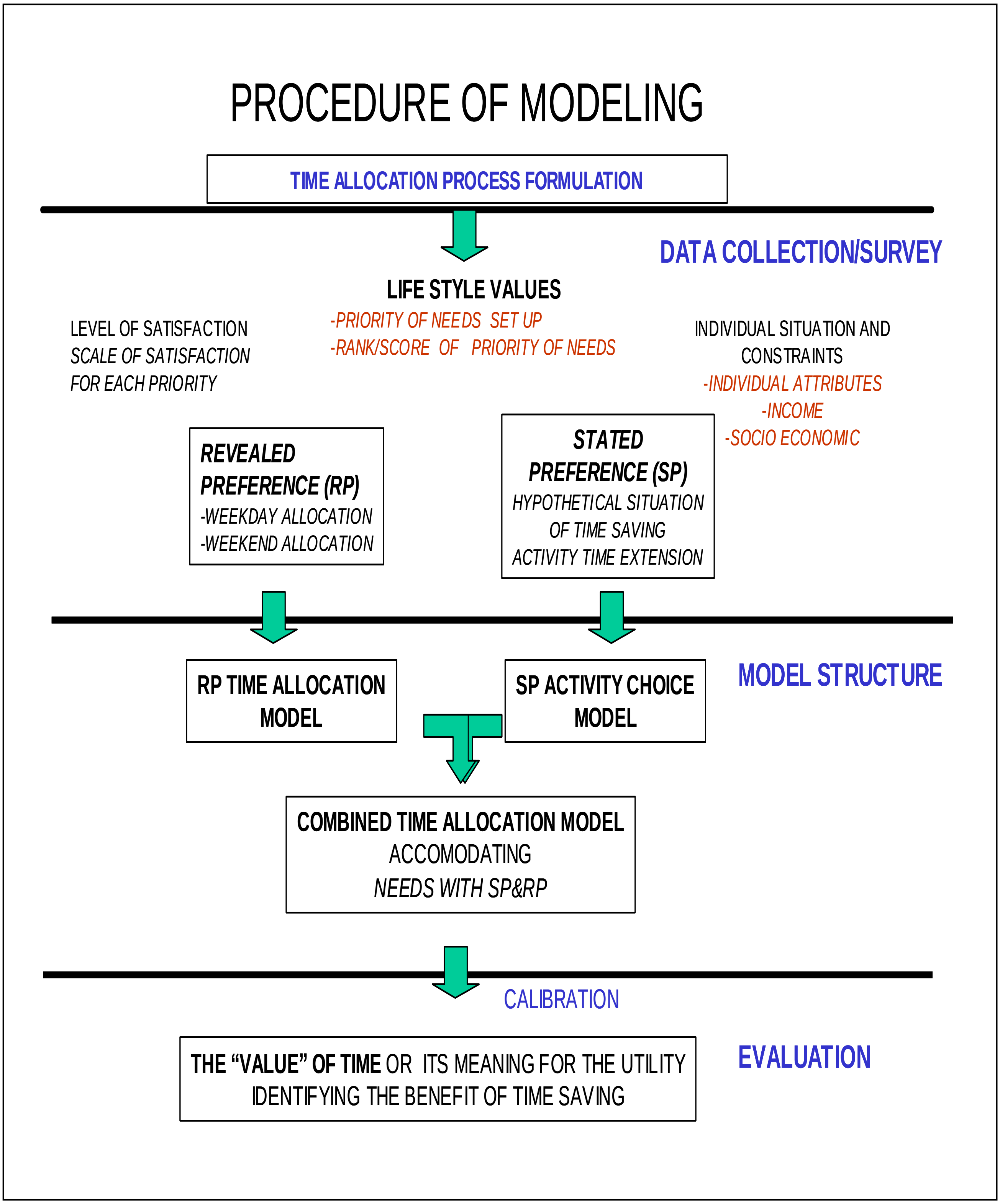


Figure 1.1. The Modeling Procedure of The Research

- The incorporation of priority rank of need that reflect the individual attitude, and lifestyle, is included to the formulation of individual utility, and consequently, to the value of activity time.
- The development of time allocation model using utility maximization principle, with the constraint of time and budget is introduced. The time allocation span can be used in the weekday, and weekend.
- The introduction of new method combining the Revealed Preference Method and Stated Preference. The method combining the time allocation model (using RP data) and activity choice model (using SP data) is by summing up their likelihood functions.
- The introduction of value of time derived from the utility function. The value of time can be differentiated based on type of activity/needs and is a function of individual priority of certain need and allocated weight of needs

1.5 Directions To Improve The Model

The model can be improved for future prospect in several ways:

- The used of simulation is suggested in order to accommodate more number of choices. The number of choice can be expanded to accommodate the spatial aspect such as family activity in-home or out-home.

- The error term and its variance, which will be an important for the calculation of value of time, can be made smaller, by conducting segmentation based on individual types. This may be extended to the possibility to accommodate latent class method.

- The integration of needs as a function of individual attributes can be developed into model system.

1.6 Outline of Thesis

The thesis explanation follows the process that were shown in Figure 1.1, and this thesis, including this chapter contains of six chapters which consists of the following:

Chapter 2. Literature Review

This chapter will cover the literature review of wide range of disciplines starting from economy, psychology, sociology, and trip-based and activity-based transportation researches.

Chapter 3. Survey and Empirical Analysis of Tokyo and Jakarta

The analysis of time allocation classified for by needs (physical care, homemaking, family care, work, socialization, and pleasure) will be explained in this chapter. This will start with the explanation of survey method, for revealed and preference data. The item that is investigated in Tokyo and Jakarta is the individual priority of needs, their time allocation in weekday, their satisfaction level of each activity. Also their stated preference regarding the question if the travel time has been saved for one hour what type of activity they want to extend.

Chapter 4. The Framework of Time Allocation Model

The framework of the model including the procedure of research will be explained in this chapter. The most important aspect in the model is the definition of the utility function. The basic idea of the model is that utility of an individual comes from fulfillment of needs by doing activity and the goods consumed with respective coefficients. The utility that comes from the fulfillment of needs is directly influenced by the time available to do the type of activity. The constraints of the utility maximization are the available time and money. A special emphasis is given to the coefficient of the time of activity.

Chapter 5. The Model Calibration and Result

The parameter estimation of the model is using GAUSS by applying the maximum log-likelihood function for the utility maximization, the choice model and the combination of them. The discussion of the calibration result between weekend and weekday in Tokyo and weekday in Jakarta will be explained here.

The discussion of Value of Time will also be explained here. The formulation and assumption that has been taken, the distribution and the mean value of time for each type of activity will be presented.

Chapter 6. Conclusions and Future Direction

The conclusions of the research regarding benefit of time saving incorporating level and priority of needs will be explained in this chapter. There are still aspects that need to be taken care by the model, such as assumptions of variable, and error terms. More robust method of estimation such as simulation, need to be considered.

Chapter 2.

LITERATURE REVIEW

2.1 Introduction

As it is understood e.g. in Khisty (1990) that transportation engineering has a broad interdisciplinary spectrum, this chapter will explained about the previous and ongoing researches, opinions of scholars from different disciplines. The disciplines and their relation to the research that are going to be discussed in this chapter are:

Microeconomics: To understand the economic point of view of value of time as a resource value.

Psychology: To understand the reason why do people need time, and what is the essence of time to the individual or the people. The psychological aspect will help explain the behavioral value of time.

Sociology: To understand the household or individual activities and the social value of time and it's meaning to the welfare of the society.

Transportation: To discuss the difference between approaches in the transportation field between types of approach of activity based and trip based. Moreover, discussion about revealed preference and stated preference and how to deal with the strength and weakness of them is presented.

2.2 Microeconomic Theory on Value of Time

Becker (1965) is the prominent researcher and among the first that contribute their ideas in the value of time. The motivation of Becker regarding time value is that to show if time is "wasted" or in this case not used for work or production, there will be a forgone opportunity to gain income. "*Time is money*" probably is relevant with his opinion.

The utility function according to Becker has two constraints, income and time, however the income is not exogenous. The time can be converted into money by assigning more time to work (all the available time if possible). Referring Becker's definition, the first concept of a value of time emerged. The value of time was the opportunity cost of assigning time to any activity but work, and this is considered as the wage rate.

It is learned by Mackie, Diaz, and Fowkes (2002) what Becker had overlooked was that time of work could be enjoyable or not enjoyable for someone, regardless on the increase of income. So, as this research's opinion, basically working time could influence individual utility or happiness positively or negatively. If this influence was negative then the value of work would be less than the wage rate and the opposite would happen if work were pleasurable. If someone really enjoys working he will get more happiness and also higher productivity, and the society will obtain both socio-psychology and economic benefit.

2.3 Psychology Point of View and the Motivation Theory

2.3.1 Motivational Theory

It is learned from e.g. Bhat, Koppelman (1999), that the motivational theory has the origins in anthropology and psychology. It is also understood from the study of Freud's statement, that the need of survival could drive and motivate human activity behavior. Freud has the opinion that human are basically motivated by animal instinct however the more humanistic approaches were introduced by other researchers, and one of them comes from Maslow (1973).

The theory of Maslow explained that basically individual have a motivation starting from physical or physiological needs to the psychological growth in the highest level as shown (Figure 2.1). Theoretically someone will fulfill the lower level of needs before pursuing the higher degree.

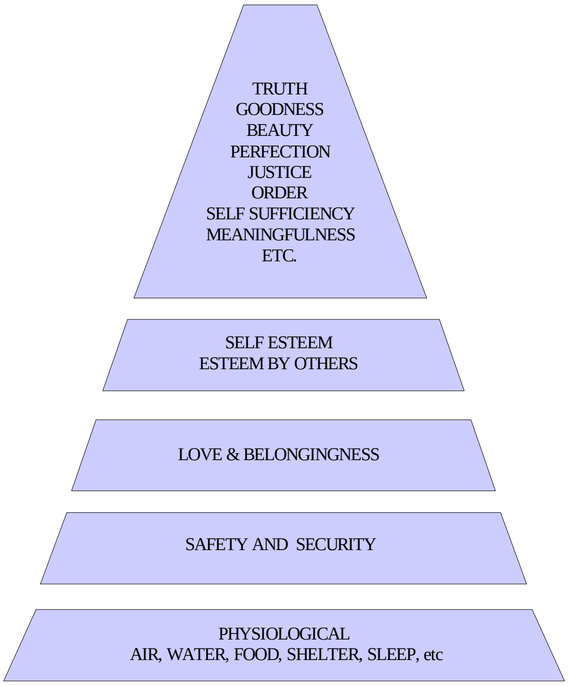


Figure 2.1. Hierarchical Needs

Maslow (1999) stated that: “the human being is motivated by number of basic needs which are species wide, apparently unchanging, and genetic of instinctual in origin. They are intrinsic aspects of human nature which culture cannot kill, but only repress”.

On the average, for individual workers, and so-called commuters in a developed country for instance, their basic physical needs such as food and shelter are assumed to be fulfilled, with stable condition income. The higher needs that they would like to achieve then are the mental achievements, such as love, self esteem, and meaningfulness.

This symptom has been realized by Solomon and Ben-Akiva (1983) and according to them lifestyle is basically choice between family formation, participation in labor force, and orientation toward leisure. The lifestyle choice will influence the choice of mobility in terms of employment locations, residential location, housing types, and vehicle ownership etc. Consequently, these choices will influence the activity and travel choice (non-work) such as activity type, activity duration, destination, route, and mode.

These researches explained the connection between psychology and activity of individual, and provided an idea of relating the psychological aspect to the human daily activity pattern.

2.3.2 Well-Being

The next discussion on well-being is basically trying to relate the economic theory and psychology in explaining human motivation. Antonides (1999) has the opinion of psychological states of life that includes happiness, love, security, freedom, inner harmony, accomplishment and togetherness, which conforms also to the definition given by Maslow (1973). In explaining about individual utility or happiness, there are differences between economic and psychology. In term of psychology, the term of happiness is highly related with the well-being. "Well-being refers to a general sense of happiness or satisfaction with life." It is stated that well-being is a result of experiences, activities, and states of one's life and an aggregate well-being can be considered as the average well-being of a group of individuals i.e. family, the state or the entire country. The new interest in the trend for the economic psychologist is to study the relationship between well-being and the economy. Relating this with the interest of activity pattern of individual is that activities are considered as a tool to attain life values and well-being. Thus doing activities and consuming, arranging the time allocated to it with their constraints of e.g. money budget and time budget will be the instrument to achieve well-being.

In economics happiness is related to the amount goods and services consumed by a person. The more goods and services can be consumed the happier the person will be. Having this assumption, generally it is considered that higher the income the higher the individual utility will always be. However, this general assumption is challenged by research done by Antonides (1999) that relating aggregate measures of well-being to the level of GNP and to socio-economic status. It has been shown that obviously there is a relationship between income and well-being within a country.

It is studied that satisfaction of needs as a variant of theory of well-being explain about happiness. However, there is another competing hypothesis called social comparison and this is related to the rank of income distribution in the country. In this sense of comparison someone is happier when he is in better situation than others, means if everybody is quite equally rich than a person will be less happy. However it is argued that the *satisfaction of needs*, rather than social comparison, is more representative in explaining happiness. It is considered also that economic changes produce more happiness than an abundant but steady economic.

2.4 Trip Based and Activity Based Approach

This literature review will start with the explanation between two approaches in transportation analysis that is the activity based and trip based method, which both are different in the way of conceptualizing time. The trip-based method in conceptualizing time is more focused to the travel time. Hence the time used for travel is generally considered as a cost (Bhat and Koppelmann 1999) or an opportunity lost. The trip-based method still have been used in the empirical practice because of its applicability, however the consequence of the method is that it lacks of having the wider picture of the meaning of time, since it does not consider comprehensively the context of the travel decision and activity participation. To consider trip by purpose (e.g. Thomas 1971) is a starting point of activity based method but still not enough. In the activity-based method (e.g. time allocation and time episode studies) time is not considered as a cost but as a resource to do the activity engagement. Travel is considered as a derived decision of an activity demand that located in the different place. The activity-based method is still having the growing interest starting from the past decade.

2.5 Review of Time Allocation and Value of Time Studies.

2.5.1 The Activity Classification

In the activity-based analysis done by researchers, there are many ways of classifying activity. The reason for classifying is to obtain the discreteness of activity that will be used in the parameter estimation of the model. Several types of classification done by previous researches are shown in Table 2.1 as follows:

Table 2.1 Types of Activity Classification

Researcher	Classification of Activity	
Thompson (1971)	Work, School, Vacation, Personal Business, Social Recreation,	
Chapin (1974)	2 main type Mandatory (obligatory) and discretionary with total 40 sub types	
Kraan (1995)	Discretionary Mandatory	
Kitamura, Yamamoto	In-home/Out-home 1. Paidwork 2. Housework 3. Child Care, 4. Shopping/errands 5. Personal Care 6. Education	7. Social Activities 8. Entertainment 9. Sport Hobbies 10. Reading 11. TV Viewing 12. Meal 13. Sleep
Bhat, Misra (1999)	Weekend/Weekday	
Kockellman (2001)	4 type iso-opportunity	

Every topic of research has its own classification to serve and support their model. This research has its own new type of classification. For example in Thompson (1971), the way the activity has been classified is in the purpose of estimating the empirical value of time for each trip purposes in situation of taking of not taking a toll road. While in Kockelman (2001), the way of classification is in the radius of location of activities that is done by all member of household. This research is also proposing a new type of classification. The reason for this new classification is that to accommodate the relative level importance towards a need of individual. The type of classification that will be used in this research will be explained in Chapter 3.

2.5.2 The Value of Time Studies

Value of Time (VOT) have been studied from nineteen sixties to present by hundreds if not thousand of researches e.g from Becker (1965), DeSerpa (1971), Thomas (1971), Bruzelius (1979) to Hensher (1997), however this still not yet exhaustive. Mackie (2001) has a remarkable statement regarding time value. It is considered that reductions in individual travel time can be beneficial for various reasons. First is the increase of gross domestic production given the time reduction is used for work, which follows Becker's principle. Secondly is the increase in the social welfare, because this change will influence individual utility or happiness directly in such a way. Both of these assumptions are really in accordance with what this research has in mind. In the first assumption of productive resource, the benefit of time saving or the social price of time will be highly related to the value of the individual's marginal product of labor. On the other assumption if working time is not extended as a result of time saving, than the social price is considered zero. However this can be considered as a social welfare regardless of physical product, thus to account the gains is very much depended to the subjective willingness to pay or private willingness to pay. This research are motivated to observe the tendency of individual in choosing the activity that he will do given the extra time, since whether someone will use the time, for example to extend the work or non-work is still probabilistic.

2.6 Discrete Choice Model.

Since the research is involved in the decision making of action choice, then discrete choice model is essential. There are many types of discrete choice model however this research has particular interest in the use of probit model. The model applies the probit model with the consideration of the assumed normal distribution of error. However it is necessary to compare it with other type of choice model to understand each strengths and weaknesses. The other type of choice model to compare is the logit model. The limitation of logit model is the error term or the unobserved components utility are independent and identically distributed. In actual situation, these assumptions will rarely hold. The probit model is relaxing the assumptions of the error terms as explained by Train (1993). These error terms are assumed to be jointly normal, with a general variance- covariance matrix. The crucial change is in the assumption of the joint normal distribution. The more detailed explanation and application of the probit model is explained Chapter 4.

2.7 Stated Preference and Revealed Preference Method

Quite recent development about choice analysis is in combining the revealed preference method and stated preference method. The SP method it self was getting its popularity in the nineties as stated by Zhang (2001). It is stated in Louviere (2000) that “the key role for SP data in combined SP-RP analyses lies in data enrichment; that is providing more robust parameter estimates for particular RP-based choice model, which should increase confidence in predictions as analysts stretch attribute spaces and choice sets of policy interest.” It is considered possible to estimate SP-RP model either jointly or sequentially.

The research will introduce a model combining both Stated Preference (SP) and Revealed Preference to be able to come up with better estimation. As explained by Zhang (2001) the stated preference approach, originating from mathematical psychology, has been widely used in transportation since it can measure how people choose in a not existing situation (e.g. planned project).

Because of the reference of hypothetical situations, the SP approach consequently contains some biases such as reporting bias, which is considered not have been treated properly in conventional travel behavior models. There are two types of SP method (Zhang, 2001) known as compositional approach and decompositional approach. The compositional approach is basically deriving individual preference measuring separately evaluation of attributes. This approach is considered simpler and practical, however it has the problems of ignorance of correlation among attributes and unclearness of individual assumption on the other attributes in the separated evaluation of attribute. The second approach, the decompositional, which more popular called conjoint, measures overall preference of profiles in which consist of several attributes, thus there is a trade-off between attributes in the evaluation of a profile. This type of approach is more often to be applied in the transportation field.

In comparing between SP Method and RP Method, Morikawa (1989) explained that SP has the weaknesses, compared to RP as follows:

- SP is clearly represent preferences but do not replicate actual behavior.
- SP could be governed by decision protocol from that of RP
- SP consequently could have bias and error structures different from RP data.

As it is understood that the RP model represent actual market behavior, while SP model may not capable of predicting behavior but can be useful to help identify the parameters of the RP model by providing additional information preferences. In addition, since RP represent the market behavior, it is not always represent the attitude or the ideal preference of the market. If this is used for projection then there is a concern of underestimation. On the other hand, SP tends to be overestimating the projected situation since the decision makers do not involved in the real situation of constraints.

The application of both approaches simultaneously is what the research also tries to introduce. The detail technique about the combination of RP and SP is explained in Chapter 4.

2.8 Summary

All of this literature review will be useful in the explaining the motivation of the research and the procedure of the modeling. It has been explored that microeconomics that considers that income is a source of utility is the main stream in the time allocation model research. Quite differently, this proposed research of time allocation would incorporate the psychological aspects. The time allocation model will also apply the combination of stated preference method and revealed preference to balance underestimation and overestimation tendency.

Chapter 3

SURVEY AND EMPIRICAL ANALYSIS OF TOKYO AND JAKARTA

3.1 Introduction

As it is mention in the objective that this study would like to explore the psychological aspect of individual value of time, surveys aiming to get the user's perception have been conducted. The surveys have been done in two cities, Tokyo and Jakarta, with several reasons. Firstly, this survey would like to understand the situation and behavior of individual toward time allocation on each of the cities as each region has the character that need to be examined to explain the perception of value of time. Secondly, after analyzing each one of them, comparing them will be useful to emphasize on the difference life style that will cause difference perception or behavior on time use and consequently the difference of value of activity time. The data also will be useful for observing variables that are common both in those population/culture that influence activity time allocation and the value of activity time.

3.2 Survey Questionnaire Design

In the questionnaires both in Tokyo and Jakarta in general, the questions asked were about individual priorities, satisfaction of needs, and travel time along with their social-economic stage information. First, they were made to understand that the activities are classified into six main categories that represent the hierarchical needs based on Maslow as shown in the Table 3.1. The categories are physical care, homemaking, family care, work-oriented, pleasure and socialization. Next, questions pertaining to the respondent's long-term priority of needs, corresponding needs ranking, and the level of satisfaction for each of the needs were asked. After priority ranking, the next step was to obtain their diary-based activities, accept for the main survey in

Indonesia, only average time allocation for each need were asked. This previous information obtain is a revealed preference. By stated preference method, the respondents were asked to imagine that their one-way commuting time is reduced to half an hour (or one hour, two-way). Finally and most importantly, they were asked how they would use or accommodate the hypothetical time saving into their schedule and how much they are willing to pay for this benefit. The activity extension that they preferred were recorded and classified accordingly. The example of design of questionnaire Japanese and Indonesian translated to English is shown in the Appendix B & C.

Table 3.1. Explanation of Needs

NO	TYPE OF NEEDS TERMS	MOTIVATIONAL MASLOW NEEDS TERMS
1	Physical Care	Physiological
2	Comfort/Homemaking	Safety and Security
3	Family Care	Love and Belongingness
4	Socialization	Self Esteem by Others
5	Work Performing	Self Sufficiency, Meaningfulness
6	Pleasure	Truth, Beauty, Perfection

3.3 Survey Implementation in Tokyo

A survey in Tokyo was conducted in Coastal line of Narashino tollgate, Aqua-Line Toll Bridge/Tunnel Road that connects two sides of the Tokyo Bay last November, 2000. With the support of facilities, this survey is more thorough than the survey in Jakarta. In this survey the weekday average time allocation also asked, and the type of activities is described in more detail.

The distribution of questionnaire is for 7000 respondents in Tokyo. The questionnaires were distributed during weekend at the two ends of the bridge and respondents were asked to mail them back. The survey is done as a part of Mitsubishi Research Institute survey, with the expected response rate of 14.2% (1000 samples). However the returned questionnaire for the total questionnaire is 819, only or 11.7% response rate. From this data, since the interest is for the working person then the first screened and completely filled out data are only for 413 respondents. All of them are working in Tokyo (88% are male). These workers are the focus of the analysis because they are considered as the most typical individuals that use transportation service regularly. They are also the ones who have the most typical pattern of weekday activity and are the most exposed to repeated travel activity (which is considered in this research as a disutility). However it is determined that the segment of this research is a working person that has and living with family with children. The reason to choose this segment is to observe the psychological needs of family importance in their weekly time allocation. In order to have homogenous population and to reduce sample bias, the individual who is not living in the family with children environment is excluded.

The number of person who satisfied these criteria is only 266 persons. Since the main interest of this research is related with time allocation of family activity and need for family care, the 266 samples are considered relevant for the analysis. The profile of respondents is shown in Figure 3.1.

Moreover for the calibration purposes, which required precise, doubtless and correct data, from these data the second screening was implemented. The incorrectness occurs probably due to the complicated form of questionnaire, especially in the schedule and time allocation section. Eventually, the most reliable data especially in the calibration is only for 169 persons.

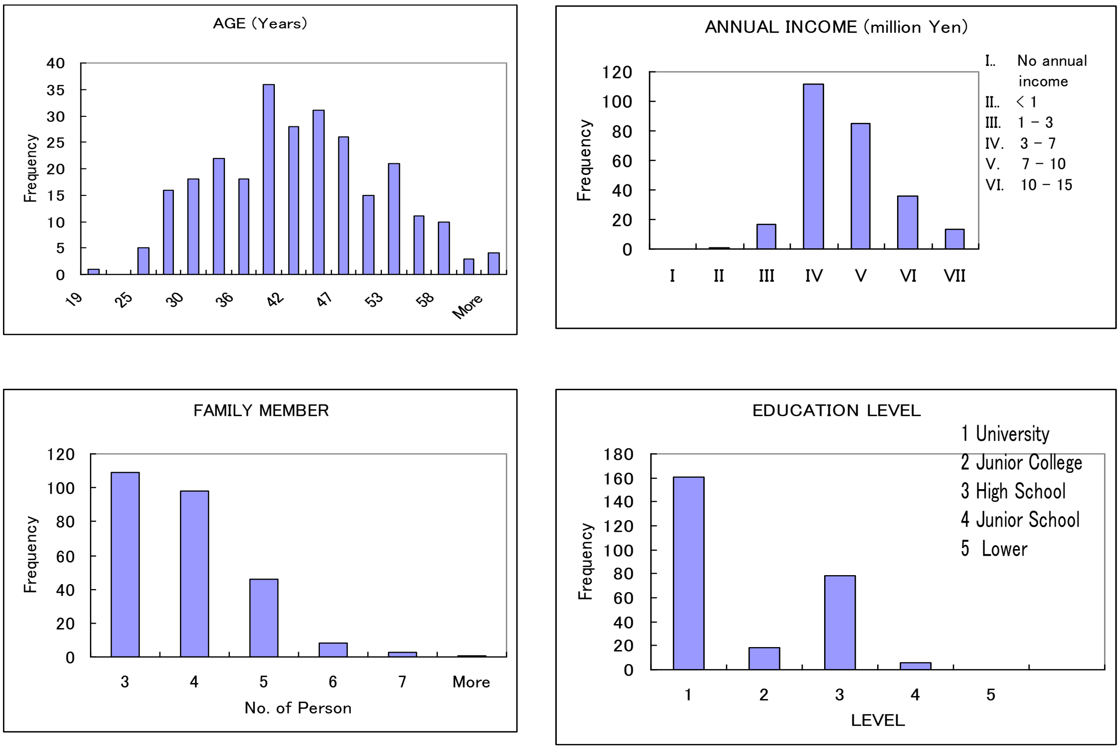


Figure 3.1. Tokyo Respondent Data

3.4 Compilation and Analysis of Tokyo Data

The result of the survey is explained in this section. Figure 3.2 shows that the highest priority rank among samples are the long term priority need for family care (35.0%), followed by physical care (30.1%), and then pleasure (17.3%), working (12.0%), homemaking (3.0%) and lastly socialization (2.6%). Figure 3.3 shows the Proportion of Time Consumption for Each Need Grouped By Top Priority. For the analysis on level of satisfaction of needs in their time allocation, the results are given in Figures 3.4 A,B,C,D. The respondents were grouped according to their top need (according to their priority)

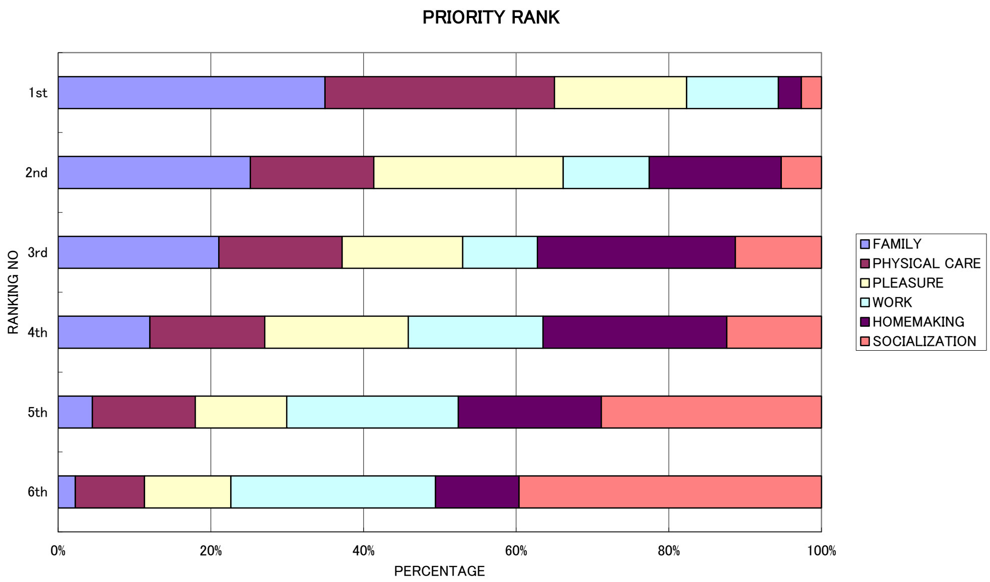
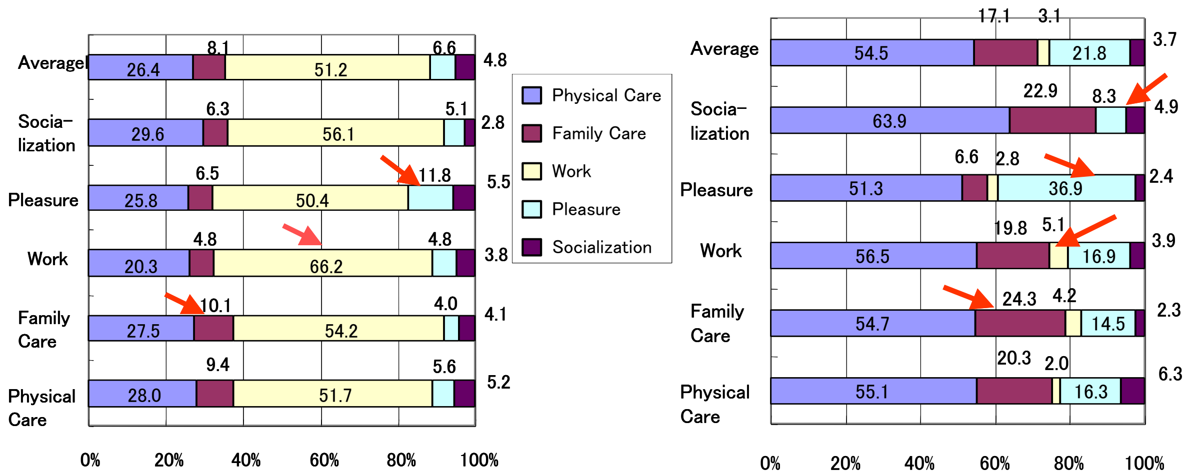


Figure 3.2. The Rank of Priority for Each Need



A. Weekday B. Weekday

Figure 3.3. The Proportion of Time Consumption for Each Need Grouped By Top Priority in Weekday and Weekend

Observing Figure 3.3 A&B as indicated by arrows, it can be seen that an individual's priority of a certain need is revealed by the tendency of having higher time allocation for that 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. This phenomena might seems quite obvious, however this will be a very important variable of the modeling of time allocation.

Figures 3.4 A,B,C,D show the example of level of need satisfaction. Respondents are grouped by individual rank. For example, for the satisfaction level of Family Care

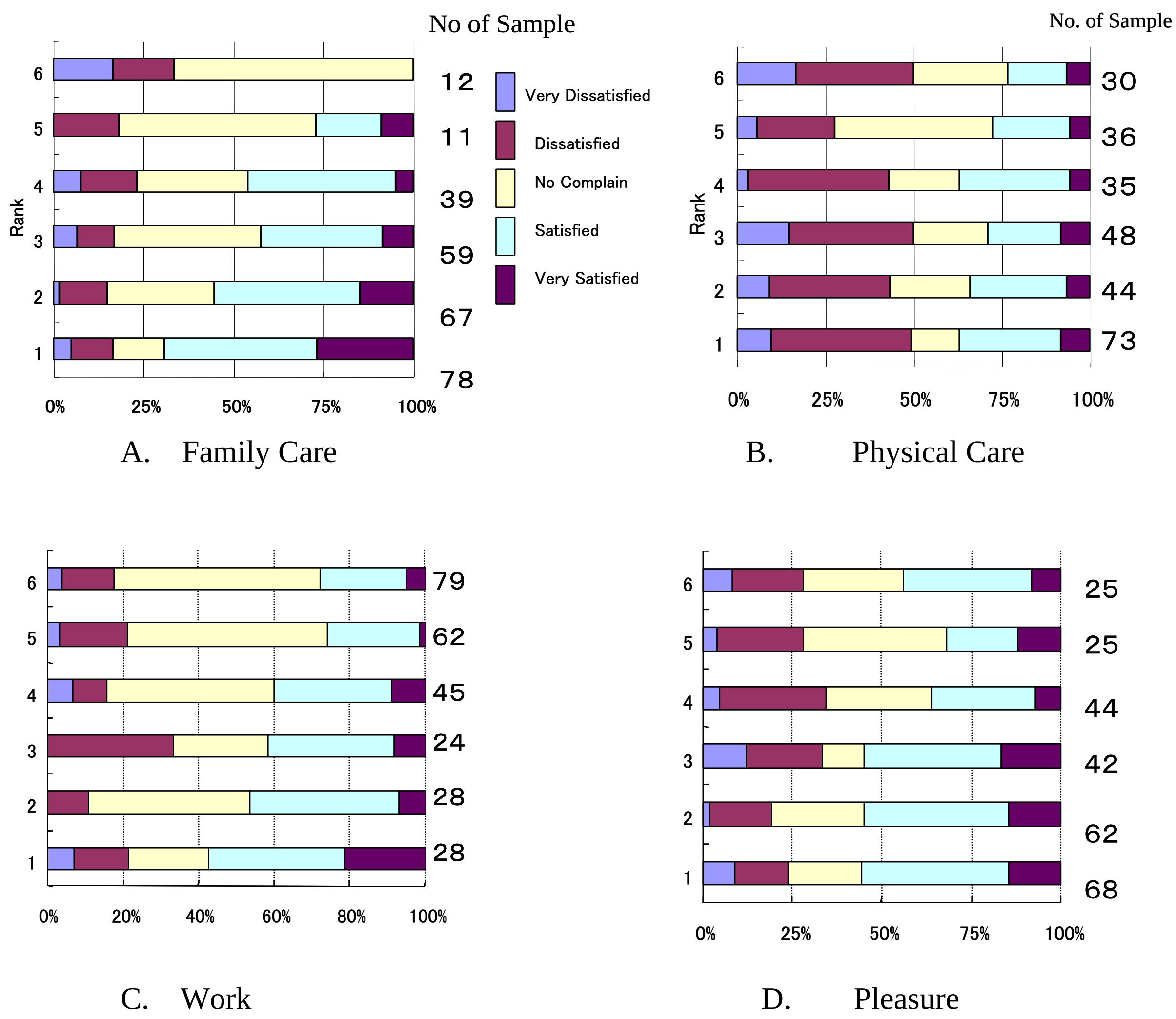


Figure 3.4 Level of Satisfaction of Needs

(Figure 3.4A) there are 78 individuals who prioritize "family care" as the first rank, and less than 25% of them are dissatisfied with the time availability. Following the same analysis for all types of needs, results revealed that for "Work", "Family Care", and "Socialization", it seems only around 25% are dissatisfied, while for the need on "Pleasure" and "Physical Care", the dissatisfaction is relatively higher at more than 25%, and 50%, respectively. This level of satisfaction will be also an important variable in time allocation model.

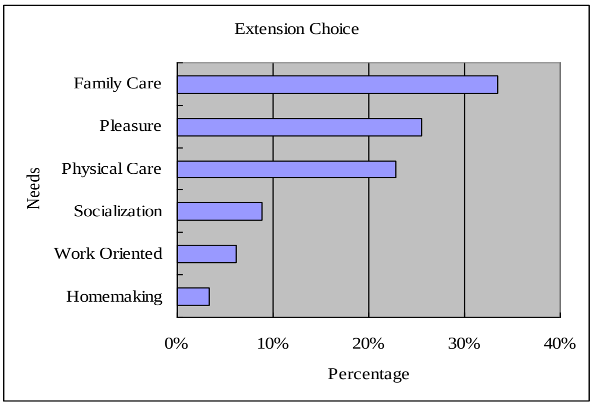


Figure 3.5. Extension Choice

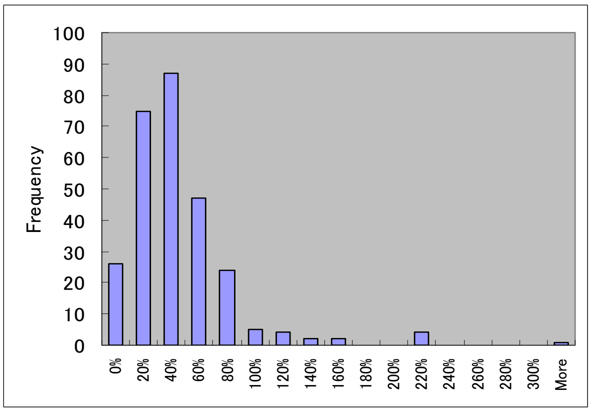


Figure 3.6. WTP/Hourly Income

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 3.5. The figure shows that around 33.4% of the respondents chose to engage in or extend family care activities with the extra time, while 25.5% chose pleasure, and another 22.8% for physical care, reflecting the need of individual well being. If it is compared with the general priority of needs rank, there is some inconsistencies with the rank of pleasure in the extension choice that is getting higher over the physical care, and also priority of work have a lower rank in the extension choice under the socialization. The hypothesis is that if time allocation is performing well, the extension choice will be the same with priority rank. Since there are inconsistencies it assumed that there is an unobservable aspect that causing this. This phenomenon will be accommodated also in the time allocation model, especially in the part of choice model.

Willingness-to-pay (WTP), the measure that could show how much the individuals value the time saving for doing activity is shown in Figure 3.6. In terms of proportion of income, on the average, respondents are willing to pay for about 30% of their hourly income to buy a service of time saving. In actual currency, WTP is around 890 yen per minute. WTP in currency is broken down for each type of activity, and shown in Figure 3.7.

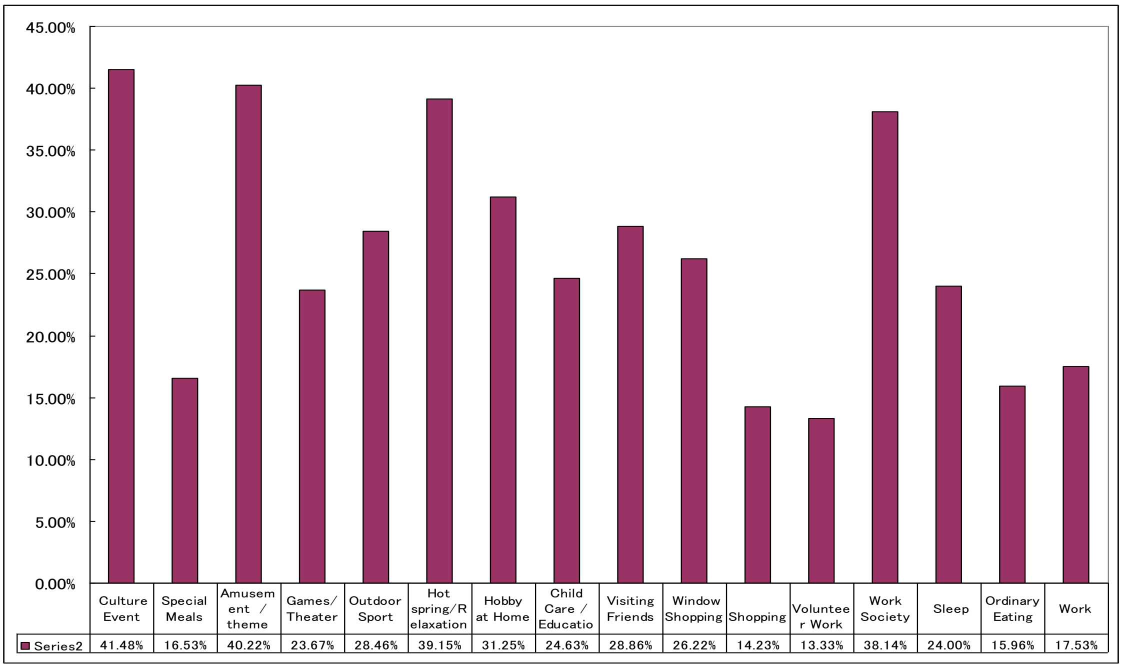


Figure 3.7. WTP/ Hourly Income for Type of Activity

In Figure 3.7 (WTP-Income ratio for type of activity), it is observed that the most prominent value of activities are: the activity of going to cultural events (both in terms of proportion to income and monetary value), followed by going to amusement/ theme park activity, and going to hot spring/relaxation. Most of these activities were done with family. These seem to reflect the combined need for family care, pleasure and physical care. The non-work activity related to work societies is also significantly high. The value of time for work for the individuals who prioritize work and works on Saturdays (and also has the intention to extend it) is not significantly high.

3.5 Summary of Empirical Analysis of Tokyo

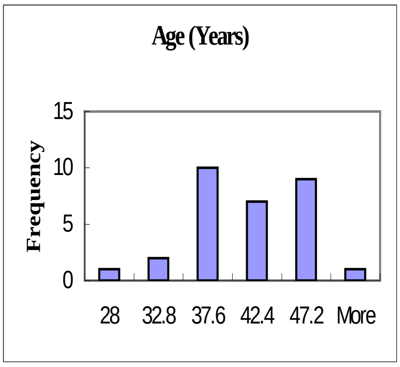
Observing the data from the survey, it is clear that most of the individual in Tokyo wants to extend the time for family, pleasure and physical care in the weekend. This need is related to the reason that their time allocation for types of activity especially pleasure, physical care are not all satisfied in their weekly time allocation.

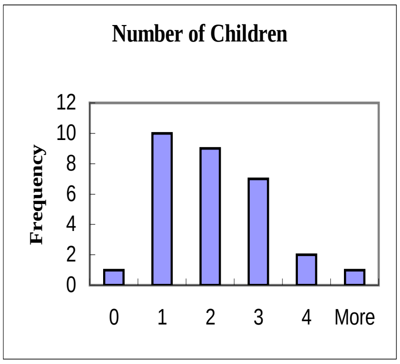
3.6 Survey Implementation in Jakarta

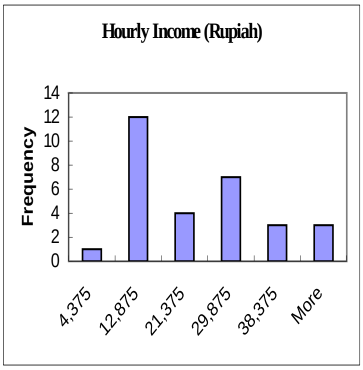
Two type of survey with different groups have been done in Indonesia. The first survey has been conducted for the middle high-income-worker commuters and this is considered also as the pilot survey. The survey is done with detailed interview and greater detail on daily schedule and attributes. The respondents residence is allocated in the outskirt are of Jakarta and most of the respondents are the private vehicle users. The second one is done for railways users with more general information interviewed due to time and operational constraint, however the sample size is much larger. Most of the respondents are in the middle low class. Both of the surveys will be analyze independently.

3.6.1 The First Survey in Jakarta

The first survey was done in Jakarta for the commuters living in the outskirts of Southern Jakarta, this survey although is done only for 30 respondents but the information obtained is quite detail especially about their time allocation. Most of the respondents among 30 samples in Jakarta are married with children. They belong to the high-middle income level, with regular work hours. The other attributes of the respondent are shown in Figure 3.8 including the lifecycle of the respondents. The average of the respondents are the person with the life cycle stage of D (family with young children).







Group	Description of Group	Features
A	Younger (married) adults without children	Young person under 35 and no children
B	Families with pre-school children	All children under 5
C	Families with pre-school children and young children	Youngest children under 5 and another child is 5 or over
D	Families with young children	Youngest children 5 or over but under 12
E	Families with older children	Youngest child 12 or over but under 16
F	Families of adults, all of working age	Youngest 'child' 16 or over
G	Older Adults, no children in the house hold	Youngest person 35 or over

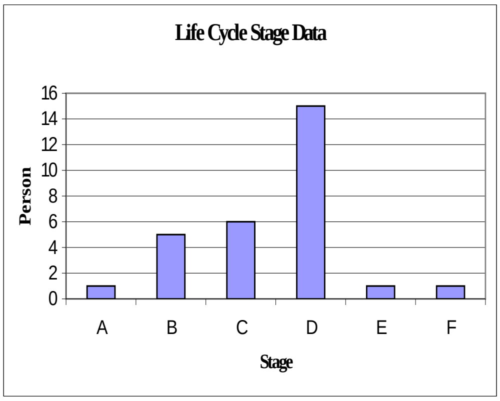
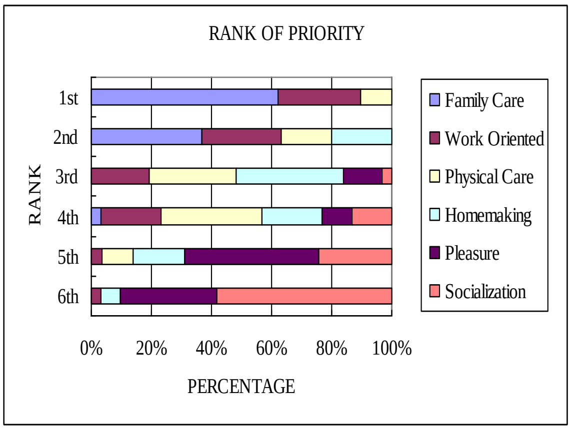


Figure 3.8. Jakarta 1st Survey Respondent Data

3.6.2 Compilation and Analysis of The First Survey

The result of the data compilation is as follows. Regarding the general priority of needs that reflect their life style values is shown in Figure 3.9. The result shows that there are 63.3% of individuals that prioritize family care, and some 26.7% who are prioritizing work, both in the working day. The latter group is for persons who are work oriented, enjoy work and not binded by regular working hours. Analyzing the satisfaction of



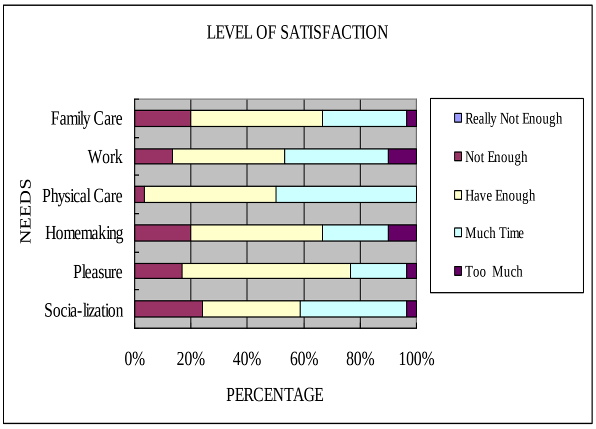


Figure 3.9. Rank of Priority for Each Need   Figure 3.10 Level of Satisfaction of Need

time availability for each need, Figure 3.10. shows that respondents feel that they do not have enough time for socialization (23%), family care (20%) and also homemaking (20%). There are some who feel that they have too much working time (10%) and too much homemaking/household activity (10%).

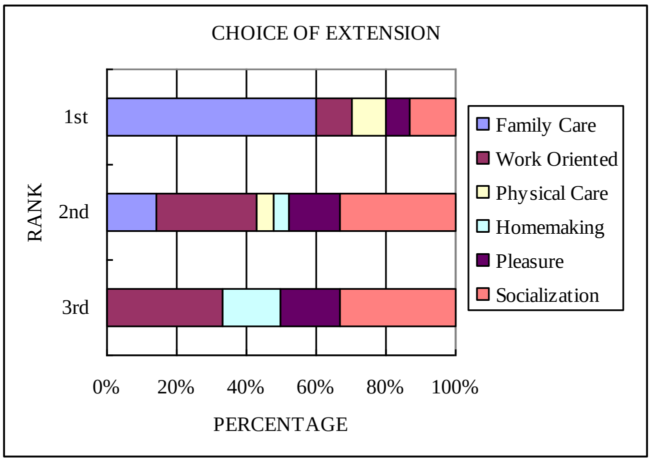


Figure 3.11 Activity Choice Extension

After observing the priority and the level of satisfaction, the activity extension choice is observed. For the activity extension if the time saving could be obtained, Figure 3.11. shows that there are about 60% of the respondents who choose to extend the family oriented activities. The next probable choice is socialization, followed by working oriented, physical care, pleasure and homemaking ranked accordingly. Except for the first priority and the first choice of extension of family care, it is seen that priority rank and the choice of extension did not always match. Work Oriented is chosen as the second priority, but not chosen as the second to be extended. This inconsistency shows that level of satisfaction could have influenced the decision and there is an indication of marginality where, for example, the working need is not chosen to be extended anymore, because of the diminishing marginal utility.

The next stage, with better understanding of the benefit, monetary value of time saving was obtained by asking them how much they are willing to pay for the benefit. The results of the survey show several conditions. In terms of nominal value, the willingness to pay (WTP) varies widely from 4.000 Rupiah to 20.000 Rupiah with an unclear distribution (Figure 3.12) and with the median value of 5.000 Rupiah. Although if the WTP is compared with their income as a ratio between WTP and Hourly Income then a skewed distribution with the mean of 26.47 % is obtained. This indicates that at the average an individual is willing to pay around 26% of his/her

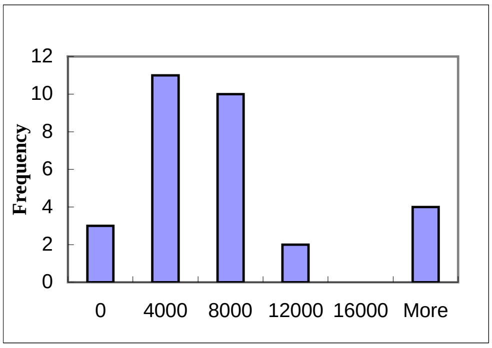


Figure 3.12. WTP In Rupiah

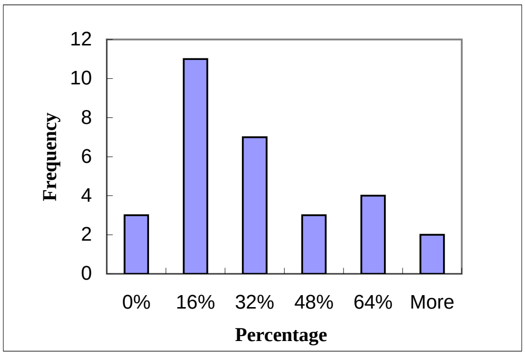


Figure 3.13.WTP Proportion to Hourly Income

hourly income to buy the service of one hour time saving (Figure. 3.13). Distinction also has been made for people of working oriented and people who are family oriented. This is related whether a person is producer oriented or consumer oriented.

It is seen in Figure. 3.14 and Figure. 3.15, that a work oriented person for this group of sample will have a higher proportion willingness to pay for a productive activity with average of 40% of his income, rather than a family oriented one which has average of WTP of 20% of income.

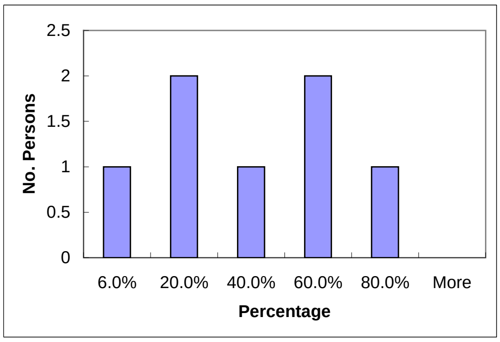


Figure 3.14. WTP/Income of Work Oriented

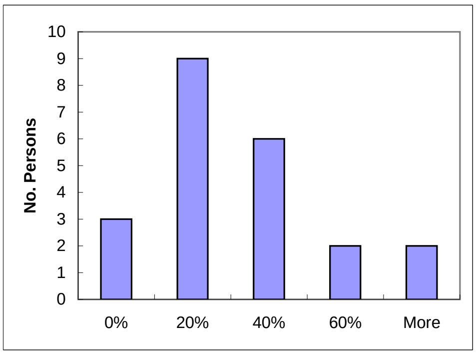


Figure 3.15. WTP/Income of Family Oriented

The compilation on the time allocation of female and male workers data is shown in Figure 3.16. From Figure 3.16, it can be seen that working female has a longer time allocation for physical care, family care, homemaking, pleasure, and as a consequence, has a shorter working time than male. The average working hour for male is nine hours and eight hours for female.

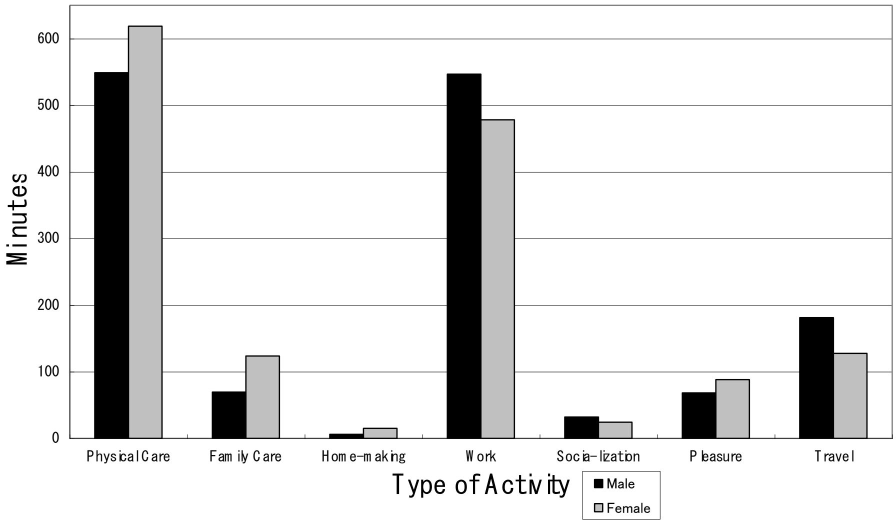


Figure 3.16. Time Allocation (Male-Female) in Jakarta

The compilation on the time allocation proportion is shown in Figure 3.17. In this figure, the respondents were grouped according to their top need (according to their priority of ranking of needs) and the bars show the time consumption proportion of each group. (There are only three top needs in this sample). Observing the figure as indicated by the arrows, same situation with the Tokyo data that an individual's priority of certain need is revealed by the tendency of having higher time allocation of that particular need. Thus the statement that priority of individual influence on how they arrange their time allocation is also valid in Jakarta.

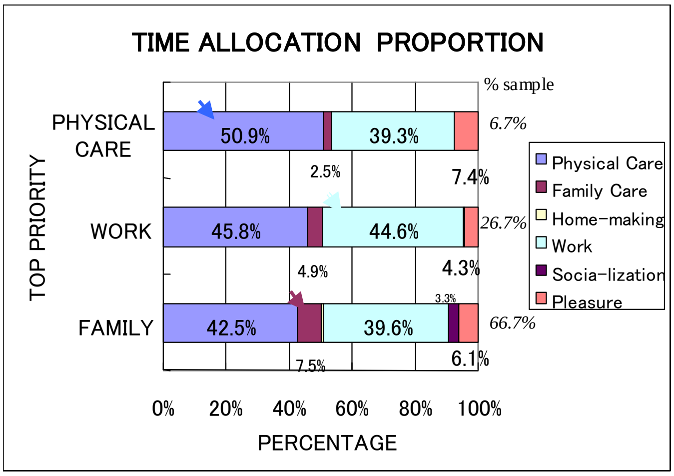


Figure 3.17. Time Allocation Proportion in Jakarta

The relationship between the working-time allocation with hourly income is shown in Figure 3.18. The figure shows that hourly income could influence the prioritizing of work activity. This means that for workers, the higher the income, the higher is the propensity to allocate time to the working time. There seems to be a particular working time allocation in typical life cycle as shown in Figure 3.19. The figure shows that in life cycle C, the time allocation for work is the least among other cycles.

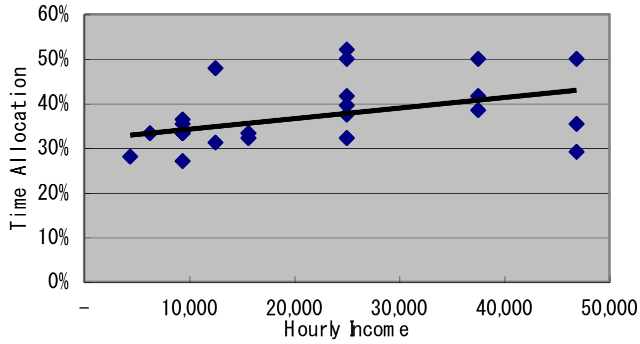


Figure 3.18. Work Time Allocation to Hourly Income (Rupiah)

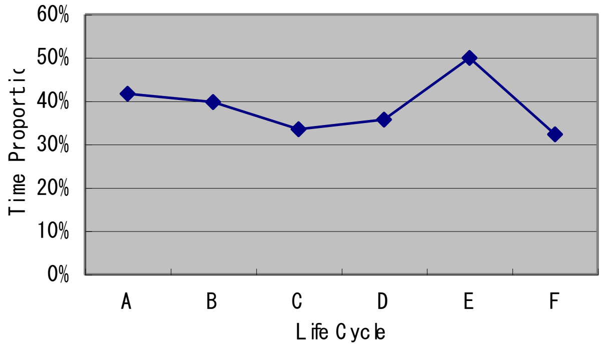


Figure 3.19. Working Time Allocation to Life Cycle

3.6.3 The Second Survey in Jakarta

This second survey is much larger than the first one and it is expected it will have much better statistical property. The Jakarta questionnaire is distributed from house to house in the area surrounding a train station. The persons who would like to cooperate then are given the questionnaire. The number of respondent obtained is 1179 respondents. However, similar with data of Tokyo, to have the homogenous population, we focus on the segment of working commuters which resulted the sample is reduced to 433 persons. Then the data is screen again for person in family with children, which is resulted in the sample of 323 persons. The orientation of this survey is for the railway users. The data about the attribute of the respondents is as shown in the figure 3.20. The data shows that the segment of this current group is relatively different the first survey's respondent. The second survey segment is in middle to low income, with the median bracket is in 1000-2000 Rupiah per hour, while in the first survey is in 12.000 Rupiah per hour.

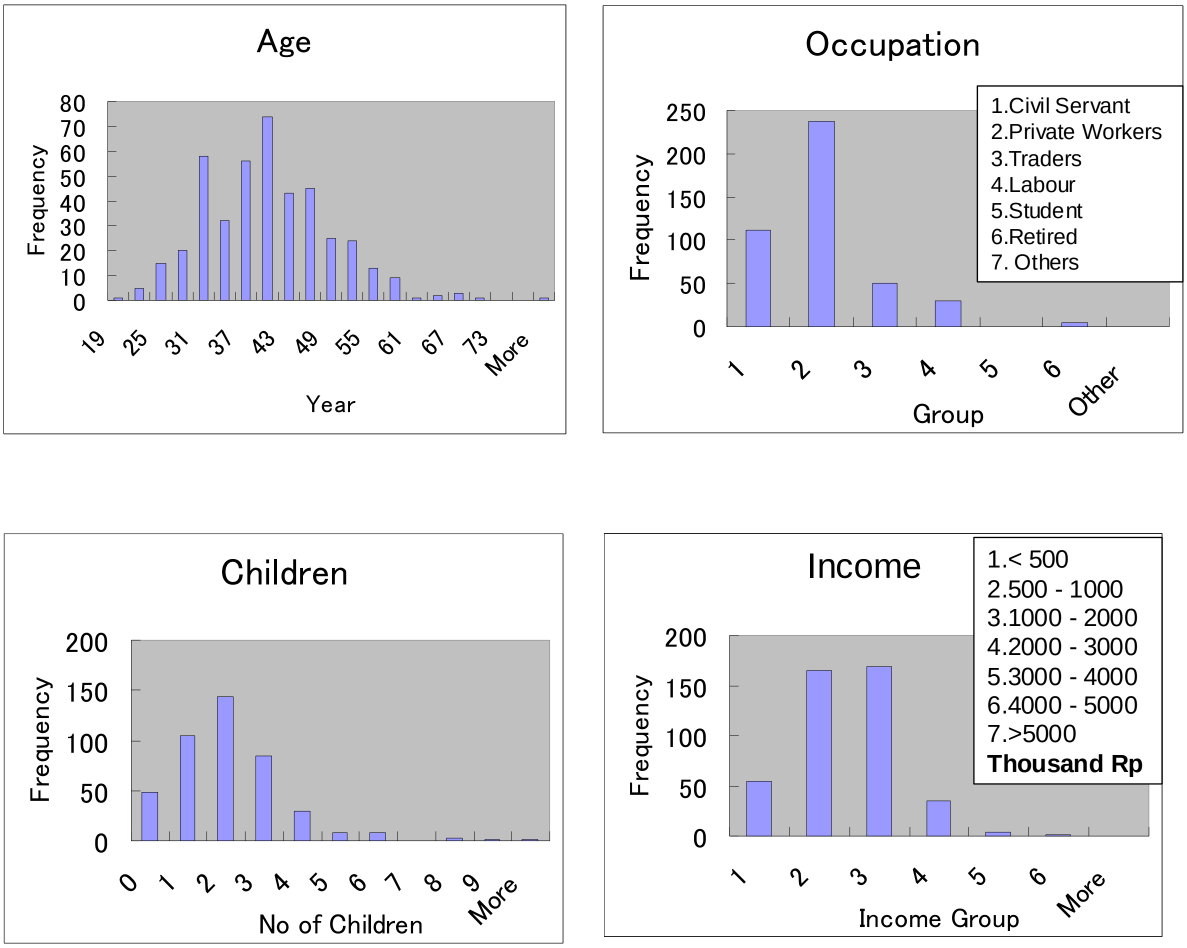
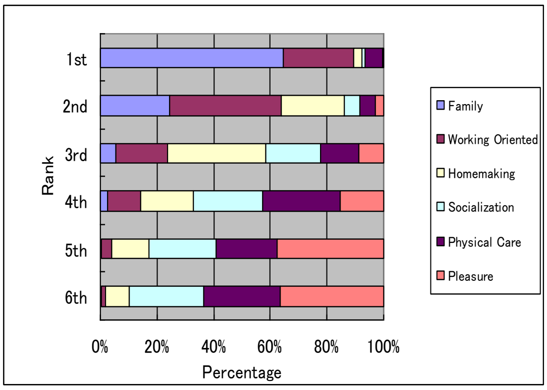


Figure 3.20 Jakarta 2nd Survey Respondent Data



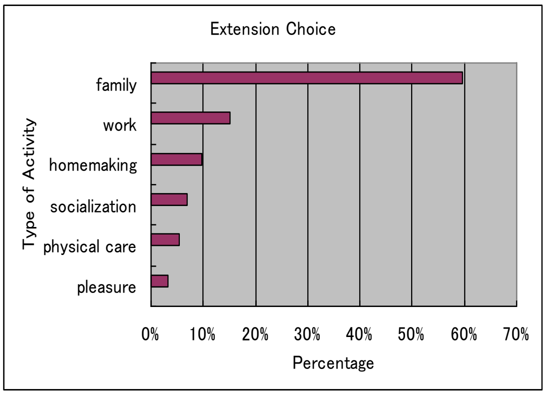


Fig 3.21. Priority Rank 2nd Survey

Fig 3.22. Extension Choice

The priority rank in Figure 3.21, shows that the population aggregately put priority in the order of Family, Working, Homemaking, Physical care, Socialization and Pleasure respectively. It shown from comparison of Figure 3.21 and Figure 3.9 that the middle low income have a different set of priorities compare to the first survey of middle high income as the middle low income put homemaking in higher rank, and pleasure as the last priority. This difference show that the low-income group have a less inclination towards pleasure, and more homemaking oriented that the higher income group. For the activity extension if the time saving could be obtained, Figure 3.22 interestingly shows that the aggregate rank of activity type extension is the relatively the same with the priority rank. The first choice is prominently goes to family care 59.58 %, followed by work 15.16 %, Homemaking 9.68 %, Socialization 6.95 %, Physical Care 5.47 %, and Pleasure 3.16 %. Also shown by the Figure 3.22 that this group (the middle low income) choose family time to be extended much more prominent than the group in the first survey. While for the satisfaction of needs in their time allocation is shown in Figure 3.23. The figure shows that this sample group is relatively satisfied with their time allocation, since only around 20% of the sample is not satisfied with a certain need.

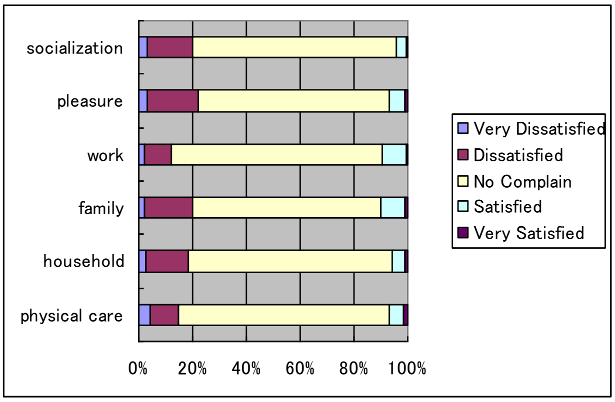
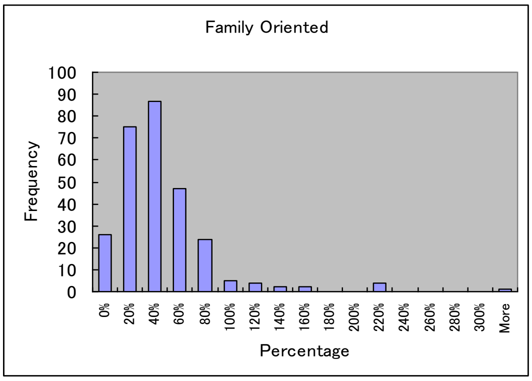


Figure 3.23. Level of Needs Satisfaction

The figure 3.24 and figure 3.25 shows the WTP/Income of Family Oriented person and Working Oriented person. In this group of sample the WTP/Income of Family Oriented person is higher than the Working Oriented person. Interestingly this situation



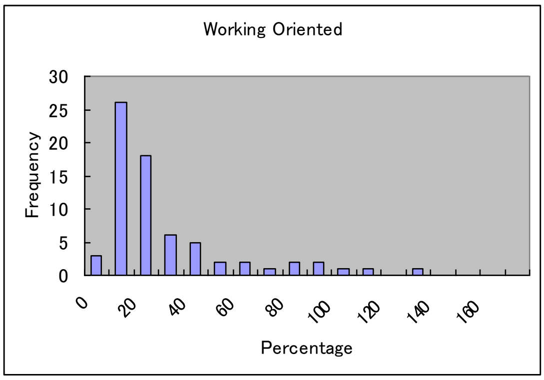


Figure 3.24 WTP/Income (Family) Figure 3.25 WTP/Income (Work)

is different with the group in the first survey that shows on the contrary. The WTP analysis indicates that at the average an individual is willing to pay around 36% of his/her hourly income to buy the service of ‘transferring’ one hour time saving. Distinction also has been made for the WTP of working oriented people (32.55 %) and family oriented people (36.63%). This means that the family time is more valuable than the working for this group of middle-low income individual. This is quite different with the situation of middle-high income group in the first survey. However the middle-low income has the largest proportion in representing the population of Jakarta.

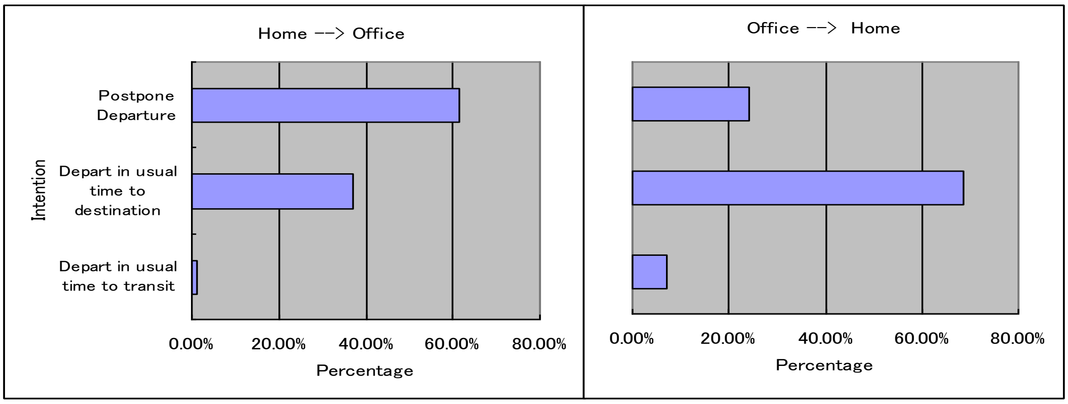


Figure 3.26 Individual Action if Commuting Time is Saved for One Hour

To see the intention if, hypothetically, the 1 hour travel time is saved, Figure 3.26 shows that for home to office trip, more than 60% wants to postpone the departure time from home, and 35 % wants to leave home as usual to work. For the office to home trip there are almost 70% wants to go straight home at the usual time and only less than 25% wants to postpone the departure from office. This situation did not fulfilled the requirement of Becker's theory that the time saving will be transferred for work.

3.6.4 Sampling Bias

The sample bias occurs consequently as a result of choosing the segment of type of family with children because this will become a subpopulation. However this segmentation is unavoidable since the segment is the main interest and central focus of this time allocation model. This segment will incorporate the variable of family needs especially in the time allocation for family care activity. The other purpose of segmentation is also in the objective of comparing the segment between Tokyo and Jakarta. The purpose of comparison is to obtain which variables that can be significant for both populations even in different life-pattern and different culture of persons with family. Comparing the same segment between Tokyo and Jakarta also could reduce the sample bias. It is also important to note that the proportion of person in family with children in the sample to total number of sample is 64.4% in Tokyo and 74.6% in Jakarta.

3.6.5 Estimation using Structural Equation Model

The purpose of working in a structural equation model using LISREL is basically to relate individual characteristic or individual attitude toward a need with his personal attributes. The focus of this specific model is to work on more detail on the coefficients of the utility function. The form of utility of one activity *i* is for example

$$U_i = U_i(\gamma_i, t_i)$$

where γ is a positive coefficient of activity *i*, and *t* is time allocated for activity *i*, then coefficient γ will be explained in more detail as:

$$\gamma_i = \sum_j^k \beta_i \alpha_j \qquad \text{with} \qquad \alpha_j = \alpha_j(\omega, X) = \omega X \qquad 3.1$$

where α_j is a vector of value to show individual priority score toward needs *j*, while β is parameters. It is assumed that α_j means value of need is independent and exogenous of time allocation with ω is the parameters and X is a vector of individual attributes, that show conditions, and situation of individuals.

Related to Eq. 3.1, an approach is needed to separate and obtain α that is the positive vector value given to importance or priority of a certain need. It is also assumed that α is a function of X , where X is an individual attribute such as income, age of the youngest child, sex, age, number of family member and education. The approach is by using individual scoring and applying linear regression with the observed variables. Data for individual 1 to *n* were obtained, and also their score with scale 5 to 10 for their priority score for needs (work, family, pleasure etc). Utilizing this data from Tokyo and Jakarta and relating it to the *k* individual attributes with linear regression, the ω matrix is obtained as shown in table 3.2 and 3.3.

Table 3.2. Parameter of ω for the Value of α Tokyo

IMPORTANCE OF NEEDS	PARAMETER OF THE VARIABLES						MEAN OF SCORE
	INCOME	AGE-Y CHILD	SEX	AGE	MEMBER FAMILY	EDUCA-TION	
HOMEMAKING	-0.10 *(-0.90)*	-0.01 *(-0.91)*	0. 25 *(0.73)*	0. 02 *(1.21)*	0.18 *(1.51)*	0. 11 *(1.01)*	6.21
PLEASURE	-0.14 *(-1.13)*	0. 01 *(0.94)*	-0.36 *(-0.91)*	-0.02 *(-1.02)*	0. 12 *(0.88)*		6.91
PHYSICAL CARE	0. 34 *(2.76)*	0. 01 *(0.87)*	0. 87 *(2.17)*	-0.02 *(-1.33)*			7.02
SOCIALIZATION	-0.19 *(-1.93)*	0. 03 *(2.68)*	-0.65 *(-1.85)*		-0.13 *(-1.10)*		5.28
FAMILY	-0.16 *(-2.20)*	-0.06 *(-6.18)*			-0.10 *(-1.03)*		7.74
WORK	0. 22 *(1.84)*		-0.39 *(-1.00)*	0. 03 *(1.82)*			5.80

χ^2 with 26 df = 576.17, GFI=0.86 RMR= 0.25 , t-statistic in bracket, Blank=not significant in alpha=0.25
No. Sample 169 individual in Japan in family with children

Basically, the table 3.2 and 3.3 shows the result of ω that related the attributes of individual to their priorities or score that one gives to a certain need and will be used for estimating the value of α. In the analysis of Tokyo data, it is shown that level of life cycle influence positively to the priority of family, and homemaking, but negatively to work and pleasure. Income has a positive influence to the priority of work but negatively to family, physical care, and homemaking. The older the age the less priority is given to family. The younger the youngest child is then the more priority given to family, the less given to pleasure, and physical care. Male are more work oriented than female and also more pleasure oriented. Number of child influence positively to socialization priority.

Table 3.3. Parameter of ω for the Value of α Jakarta

IMPORTANCE OF NEEDS	PARAMETERS OF THE VARIABLES					MEAN OF SCORE
	INCOME	AGE Y-CHILD	SEX	AGE	CHILD	
HOMEMAKING	-0.39 *(-4.66)*		0.68 *(3.81)*		0.09 *(1.64)*	6.63
PLEASURE	0.19 *(2.70)*	0.01 *(0.99)*	-0.38 *(-2.41)*		0.12 *(2.70)*	5.07
PHYSICAL CARE		-0.02 *(-1.36)*	0.26 *(1.29)*	0.02 *(3.08)*	0.04 *(1.45)*	5.60
SOCIAL	0.19 *(2.36)*		-0.62 *(-3.51)*		-0.10 *(2.44)*	5.63
FAMILY	-0.08 *(-1.59)*	-0.02 *(-2.43)*		-0.01 *(-1.45)*		8.58
WORK	0.16 *(1.99)*		-0.22 *(-1.30)*		-0.14 *(3.15)*	7.65
χ^2 with 25 df = 438.82, GFI=0.85 RMR= 0.19 , t-statistic in bracket						
No. Sample 323 individual in family with children						

In the analysis of Jakarta data, it is concluded from the estimation that for Physical Care, women have more priority than men, for Homemaking women obviously have more concern than man, the more children one has, the more concern is given to it. For Family Care the older the person the higher concern given to the family, the higher the income the less priority given to it, and the more children, the more attention given to the family care, and the older the youngest children is the less priority given to the family. For Work, men have more priority than women, the higher one's income than the higher priority given to it, the more number of children, the less priority given to work.

There are common characteristics of individual in Tokyo and Jakarta, those are:
Family care need is most influenced by the age of the youngest children. The younger

the children, then the higher is the priority of need. Income has a negative effect on family care, the higher the income the less priority is given to family. Work priority is influenced by income, the higher the income then the higher priority of work and male are pleasure oriented than female.

3.7 Summary

To summarize all of the survey done both in Tokyo and Jakarta, several point needs to be put forward:

The result shows that, in Jakarta in weekday, most of the respondents would not use all the time saving for the time of production or work. Rather, they would use it also for family oriented and other activity which is a type of consumption activity. There is a notion that this proportion of WTP to income may relatively be small because the orientation of activity does not encourage most of individuals to have strategic behavior about the value of time. For example, they do not see that time could be used for productive activity that could generate economic benefit. For them the time is used for fulfilling social welfare or psychological needs, which will later be beneficial by encouraging them to reach the higher level of need such as self-esteem or actualization. Moreover, as it is shown from the data, the WTP to pay for family activity is higher then the WTP for work. On the time allocation satisfaction most of the individuals are somewhat have no complain about their weekday time allocation.

According to the survey conducted 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. It is shown by the data that their time allocation for types of activity is not all satisfied in their weekly time allocation e.g. pleasure, physical care.

In relation with WTP for time saving for each type of activity or need, it is regarded that the higher the level of need is, the higher the WTP. As seen from the data, WTP for travel time saving for Culture Event, and Going to Amusement Park with family are prominently high because the needs for “family care” and “pleasure” are fulfilled. So the model could explain that value of time for a non-productive activity such family activity, physical care and pleasure could be much higher when it is highly demanded or needed.

As general conclusion it could be noticed that individual priority of needs influence how someone allocate time for each type of activity and individual in Tokyo and Jakarta have relatively different set of priority of needs. For example in Jakarta individual put pleasure, physical care in lower tier while in Tokyo these needs are in the higher tier.

All of these findings supported the proposal that there is a need to understand or predict what kind of activity that the users will be involved in if the time saving is obtained using their stated preferences or intentions. This will result in better approximation of the benefit of time saving not only in a matter of monetary value but also in social-welfare or psychological value.

Chapter 4

THE FRAMEWORK OF TIME ALLOCATION MODEL

4.1 Introduction

In this research, efforts have been made to explore two types of model. The main difference of these models, are in defining the shape of the utility functions. The first model defined it as a logarithmic function and the second one depended on the exponential parameter θ that will influence the concavity or convexity of the function. Eventually the research will use the first model for the calibration because of its higher possibility of estimation, however it is worthy to explore the second model through simulation in order to have a clearer picture on the mechanism of time allocation having determined the variables and attributes involved. Both models basically consist of two approaches that are revealed preference for time allocation and stated preference for extension choice. These approaches are then to be combined in order to have better estimation.

The conceptual difference of this research of activity-based analysis in travel demand analysis with others such as Kockelmann (2001), and Kraan (1995) is in the focus object of individual. The object here that will be examined is an individual with life pattern, life-style and character (e.g. hardworking, family-caring etc). These life pattern and character is treated as variables in the model and this idea is considered new concept to be introduced. The explanation of the framework will start from the time allocation Model I.

4.2 The Time Allocation Model I

4.2.1 Functional Form of Utility of Time Allocation Model I

The functional form of utility of time allocation is as follows

$$U_n(t_{n1},.....t_{ni},q_n,z_n)=\sum_i U_{ni}(t_{ni})+U_{nq}(q_n)+U_{nz}(z_n)$$

t_{ni} : Time to spend on discretionary activity type *i* of individual *n*

q_n : Total minimum time to spend on physiological activities

z_n : Amount of composite goods of individual *n* in the day

In this definition, utility or happiness comes from doing activity *i* with time t_{ni} as the resource, and also comes from the minimum fulfillment of activity that he must do, and lastly from the amount of goods he can consume.

4.2.2 Proposed Form of Utility of Activity Model I

The researches of Kraan (1995), Kitamura and Supernak (1997), Yamamoto and Kitamura (1999) 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.

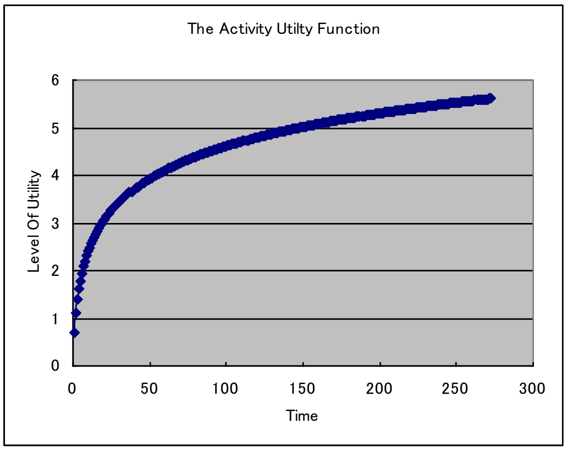


Fig 4.1. The Utility Function as Logarithmic Function

As shown in Fig 4.1., the utility of activity as a logarithmic function has been used by the most of the previous researchers, because of its general assumption that utility is diminishing over and this shape is also considered quite practical and has high possibility in parameter estimation. Based on the assumption, the proposed form of activity which also related to the previous Eq. 3.1 is :

$$U_{ni} = \gamma_i \ln(t_{ni} + 1) \tag{4.1}$$

4.2.3 Time Allocation Model Using Revealed Preference (RP) Data I

Having the definition of utility of activity, the proposed form of utility of time allocation which it is also include the utility of activity is written as follows:

$$Max\ U_n = \sum_i \gamma_i \ln(t_{ni} + 1) + \mu \ln(q_n) + \xi \ln(z_n) \tag{4.2}$$

Subject to:

$$c_z z_n + \sum_i c_{ui} t_{ni} + G_n \le R_n \tag{4.3}$$

$$q_n + \sum_i t_{ni} + T_n \le H_n \tag{4.4}$$

Where U_n is the total sum of utility of individual n doing activity type i, and γ_i is a parameter of specific activity type i, that consists of element of particular main need, t_{ni} is time to spend on activity i of individual n. The μ and ξ are parameters, q_n is the time consumption mandatory (physical and formal) activity, z_n is amount of composite goods of individual n. The c_{ui} is unit cost for doing activity i (market price), c_z is composite goods unit price , and R_n is the individual income (maximum budget), H_n is individual total time available, G_n is individual total cost of travel and T_n is individual total travel time. The activities are classified into six categories i =1 to 6, based on needs. The categories are (1) physical care, (2) homemaking/comfort, (3) family care, (4) work, (5) socialization, and (6) pleasure, based on Maslow's psychological theory applied to a daily context.

The assumption of the model specifically in the income constraint is that income is exogenous and given. Even that money can be borrowed, he still needs to considered how to pay it back. So it is assumed that individual knows and understands his limit of his funding.

Moreover this formulation of budget constraint is not related to how much time he spent for work. For instance the income per month is fixed, regardless he work over the working hours or not. If he works overtime it is not always he has to be paid by his hourly income. This model does not assume that individuals are free to choose the number of working hours they want to do, to obtain more income as stated in Blayac (2001).

The target of population in this research is the ordinary average person without any extreme differences (e.g. very rich person having a helicopter etc.) Related to the budget constraint or variable constraint, this model is not dynamic. Dynamic usually consider the interest of the borrowing. The budget constraint is the average budget constraint in a time span.

As an illustration figure 4.2 shows how someone will maximize his total utility based on how he allocated time between two activities, with the constraint of time availability

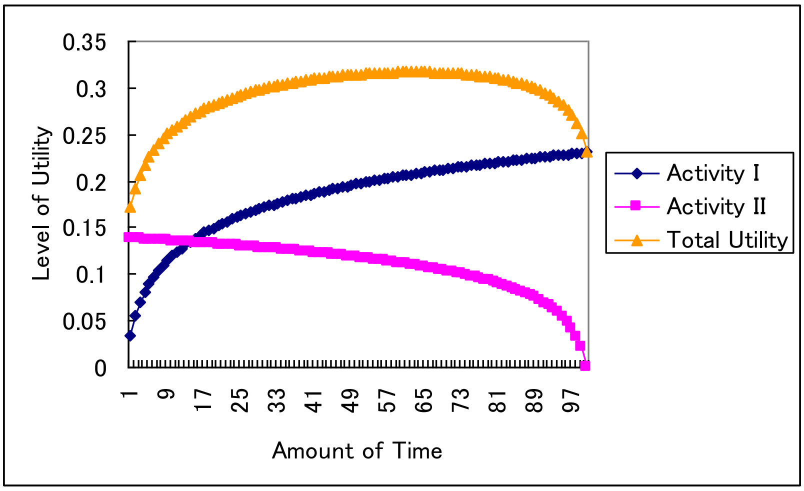


Figure 4.2 Illustration of Time Allocation Utility

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. (4.2), with the constraints of Eq. (4.3 and 4.4) we got:

$$
\begin{aligned}
l_n &= \sum_i \gamma_i \ln(t_{ni}+1) + \mu \ln(q_n) + \xi \ln(z_n) \\
&+ \lambda_{nB}\left(R_n - c_z z_n - \sum_i c_{ui} t_{ni} - G_n\right) + \lambda_{nT}\left(H_n - q_n - \sum_i t_{ni} - T_n\right)
\end{aligned}
\qquad 4.5
$$

The first derivative of the Lagrange function is:

$$\frac{\partial l_n}{\partial t_{ni}} = \frac{\partial U_{ni}}{\partial t_{ni}} - c_{ui}\lambda_{nB} - \lambda_{nT} = \frac{\gamma_i}{t_{ni}+1} - c_{ui}\lambda_{nB} - \lambda_{nT} = 0$$

$$\frac{\partial l_n}{\partial t_{ni}} = \frac{\partial U_{ni}}{\partial t_{ni}} - c_{ui}\lambda_{nB} - \lambda_{nT} = \frac{\gamma_i}{t_{ni}+1} - c_{ui}\lambda_{nB} - \lambda_{nT} \leq 0$$

$$\frac{\partial l_n}{\partial q_n} = \frac{\partial U_{nq}}{\partial q_n} - \lambda_{nT} = \frac{\mu}{q_n} - \lambda_{nT} = 0$$

$$\frac{\partial l_n}{\partial z_n} = \frac{\partial U_{qn}}{\partial z_n} - \lambda_{nB} = \frac{\xi}{z_n} - \lambda_{nB} = 0$$

And the solution will be:

$$\frac{\gamma_i}{t_{ni}+1} = \frac{\mu}{q_n} + \frac{c_{ui}\xi}{c_z z_n} \qquad 4.6$$

If $t_{ni}>0$

$$\frac{\gamma_i}{t_{ni}+1} \leq \frac{\mu}{q_n} + \frac{c_{ui}\xi}{c_z z_n} \qquad 4.7$$

if $t_{ni}=0$

4.2.4 The Classification of Activity

About the classification of activity, the assumption that has been made is that the activities are mutually exclusive. (Means there is no activity that could belong more than one classification). However, in reality if the classification is to be made really exclusive then the number of types will be very large. This reality will resulted in difficulties in the model calibration, so simplification is surely needed. In reality, the idea of an activity that could contain several need fulfillment with time resource constraint can be analogue with having certain resource input (24 hours time budget) and produce more than one product (joint production). However this will make the model more complicated so simplification is also needed here. Indeed the classification of activity has still oversimplified the real situation, since it is more common that activities can contains several needs or purposes to be fulfilled.

The following equation shows the ideal and more robust assumption:

$$\gamma_i = \exp(\sum \beta_{ij}\alpha_{nj} + \varepsilon_{ni})$$

or

$$\gamma_i = \exp(\beta_{i1}\alpha_{n1} + \beta_{i2}\alpha_{n2} + \beta_{i3}\alpha_{n2} + ...+ \beta_{ij}\alpha_{nj} + \varepsilon_{ni})$$

with:

β_{ij} = the coefficient/part worth of needs *j* in activity *i* (this coefficient is situational, different for each *i* e.g weekend, weekday.

α_{nj} = the level of priority/importance of needs of an individual. This level of priority is long term, consistent independent of *i*

This means that the coefficient for activity *i* consists of several element of needs, and the type of activity *i* is need not to be classified into certain group.

However it is understood that since the model is using probit model, it will be very cumbersome if the number of choice is more than four. So the limitation of number of choice is unavoidable at this time, and moreover, the model needed to make simpler activity classification in order to compare time allocation between individuals.

So basically it is determined to have the simplification by Classification of type of activity which is based on the main need. This simplification is in the form of that one activity will fulfilled only one main type of needs or formulated as:

$$i = j$$

The process of classification is basically a respondent-defined classification for e.g.

- shopping for baby food is classified for family care
- window shopping is classified for pleasure
- eating in restaurant with family is classified for family care

Related to the formulation, since coefficient γ_i, μ and ξ are non-negative, then the coefficient can be expressed and simplified as follows:

$$\gamma_i = \exp(\beta_i \alpha_{ni} + \varepsilon_{ni}) \qquad \mu = \exp(BY_n) \qquad \xi = \exp(CY_n) \tag{4.8}$$

$\beta_{i,}$ is vector of alternative specific parameters, and the *B*, *C* are parameter vectors. *Xi* is an activity attribute vectors of priority of needs (scale 1-6) and other individual attributes, Y is individual attribute vectors and ε_i is the error term. Substituting the Eq.(4.8) to Eq.(4.7) and solving ε_i as the dependent variable then function for ε_i becomes:

$$\varepsilon_{ni} = \ln(t_{ni}+1) + \ln\left(\frac{\exp(BY_n - \beta_i\alpha_{ni})}{q_n} + \frac{c_{ui}\exp(CY_n - \beta_i\alpha_{ni})}{c_z z_n}\right) \quad \text{for} \quad t_{ni}>0$$

4.9

$$\varepsilon_{ni} \le \ln(t_{ni}+1) + \ln\left(\frac{\exp(BY_n - \beta_i\alpha_{ni})}{q_n} + \frac{c_{ui}\exp(CY_n - \beta_i\alpha_{ni})}{c_z z_n}\right) \quad \text{for} \quad t_{ni}=0$$

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. (4.9). L_{Tn} is individual's *n* likelihood function, 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 will be 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. (4.10 and 4.11).

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.

$$L_{Tni} = \begin{cases} \dfrac{1}{\sigma}\phi\left[\dfrac{\ln(t_{ni}+1)+\ln\left(\dfrac{\exp(BY_n-\beta_i\alpha_{ni})}{q_n}+\dfrac{c_{ui}\exp(CY_n-\beta_i\alpha_{ni})}{c_z z_n}\right)}{\sigma}\right] & \text{for } t_{ni}>0 \\ \Phi\left[\dfrac{\ln\left(\dfrac{\exp(BY_n-\beta_i\alpha_{ni})}{q_n}+\dfrac{c_{ui}\exp(CY_n-\beta_i\alpha_{ni})}{c_z z_n}\right)}{\sigma}\right] & \text{for } t_{ni}=0 \end{cases} \qquad 4.10$$

$$LL_T = \sum_n \sum_i \ln\left(L_{T_{ni}}\right) \qquad 4.11$$

4.2.5 The Activity Choice Model using Stated Preference (SP) Data I

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.

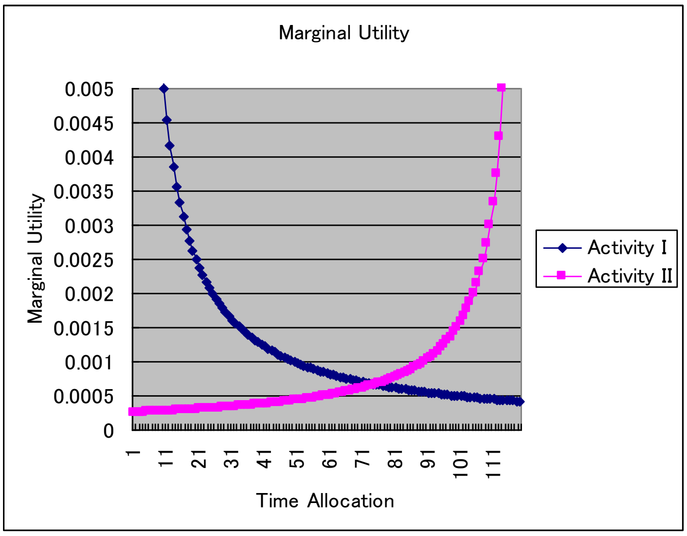


Fig. 4.3. Illustration of Marginal Utility

To illustrate the marginal utility of activity Figure 4.3 shows that the optimal allocation will the point where both activity marginal utility intercept which also means equal.

The marginal utility of the time of Activity i is represented in equation as a function of t_i as follows.

$$\frac{\partial U_n}{\partial t_{ni}} = \frac{\gamma_i}{t_{ni}+1} = \frac{1}{t_{ni}+1}\exp(\beta_i \alpha_{ni} + \varepsilon_{ni}) \qquad 4.12$$

Using natural logarithm, the previous equation becomes:

$$\ln\left[\frac{\partial U_n}{\partial t_{ni}}\right] = \beta_i \alpha_{ni} - \ln(t_{ni}+1) + \varepsilon_{ni} = V_{ni} + \varepsilon_{ni} \qquad 4.13$$

With V_i as the observable part of marginal utility of Activity i.

Since error term ε_i follows 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 formulized as follows:

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

$$\phi\left(\rho_n^i\right) = \frac{1}{\left(\sqrt{2\pi}\right)^{m-1} \left|\Omega^i\right|^{1/2}} \exp\left[-\frac{1}{2}\rho_n^{i}{}'\left(\Omega^i\right)^{-1}\rho_n^i\right] \qquad 4.14$$

where

P_{ni} : Probability of individual n extending activity type i=1..m

ρ_{nmi} : $\rho_{nmi} = \varepsilon_{nm} - \varepsilon_{ni}$ (difference between error terms of alternative m and i)

Ω : the matrix of covariance of ρ

m : The number of choices

The log likelihood function for the probit model is explained by LL_P as:

$$LL_P = \sum_{n=1}^{N} \sum_{i=1}^{m} \delta_{mn} \ln\left(P_{nm}\right) \qquad 4.15$$

δ_{mn} = 1 when the alternative has been chosen and δ_{mn} = 0 when it has not

The β_i and σ are the unknown parameters that makes the log likelihood *(LL_p)* function reach maximum and the LL_p is basically the sum of all the individual log likelihood function.

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.

4.2.6 Combining The RP Time Allocation and Activity Choice Model I

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. (4.16).

$$LL = LL_T + LL_P \tag{4.16}$$

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. This model is possible to be estimated with some predetermined value. The result and discussion will be explained in the following Chapter 5.

4.3 The Time Allocation Model II

In this model the utility of each activity has a different shape and this is depend on the paramater θ. As a result of this assumption the estimation gets more complicated and difficult. Nevertheless to explore this model through simulation is useful and challenging for future direction.

4.3.1 Proposed Form of Utility of Activity Model II

The utility of activity, which will be the medium to fulfill the needs, is formulated as follows:

$$U_i = U_i(\gamma_i, t_i, \theta_i) = \gamma_i t_i^{\theta_i} \tag{4.17}$$

with $t_i > 0$ otherwise $U_i = 0$

where
θ_i = parameter that will also determine the shape of the utility curve

In the effort of validating the utility model and obtaining the parameters of the model, two approaches or methods are also proposed in this model. These two approaches are already known as utility maximization in time allocation and the choice of activity time extension and also both of these approaches are to be combined.

4.3.2 **Time Allocation Model using RP Data II**

The sum of utilities for activities *i* to *R* will maximize the total utility in the time span, for example in this case, one day or one week, and is formulated as follows:

$$\max U_{total} = \max \sum_{i}^{R} U_i \qquad 4.18$$

s.t.

$T = \sum_i t_i$ the total available time for doing activities 4.19a

$C = \sum p_i t_i$ the total budget allocation for pursuing activity 4.19b

where

t_i = time of each activity

p_i = price of activity/service time.

In this model composite good and minimum time for mandatory activities is not included in the utility.

Using Lagrange method, the following equations are obtained:

$$L = \sum_i \gamma_i t_i^{\theta_i} + \lambda_T (T - \sum t_i) + \lambda_C (C - \sum_i p_i t_i)$$

$$L = \sum_i U_i - \lambda_T \left(\sum_i t_i - T \right) - \lambda_C \left(\sum p_i t_i - C \right)$$

$$L = \sum_i \gamma_i t_i^{\theta_i} - \lambda_T \sum_i t_i + \lambda_T T - \lambda_C \sum p_i t_i + \lambda_C C$$

$$\frac{\partial L}{\partial t_i} = \gamma_i \theta_i t_i^{\theta_i - 1} - \lambda_T - \lambda_C p_i = 0 \qquad 4.20$$

$$\frac{\partial L}{\partial t_i} = 0 \,, \frac{\partial L}{\partial \lambda_T} = 0 \,, \frac{\partial L}{\partial \lambda_C} = 0$$

Lagrange multiplier is the derivative of the objective function on the restriction functions:

$$\lambda_T = \frac{\partial U}{\partial T} \,, \quad \lambda_C = \frac{\partial U}{\partial C} \quad \text{thus} \quad \lambda_C = \frac{\partial T}{\partial C} \lambda_T \qquad 4.21$$

and using (4.20) and (4.21) we obtain,

$$\lambda_T = \frac{\gamma_i \theta_i t_i^{\theta_i - 1}}{1 + \frac{\partial T}{\partial C} p_i} \qquad 4.22$$

because λ_T is fixed implying that the marginal utility of every activity is considered equal, thus:

$$\frac{\gamma_1 \theta_1 t_1^{\theta_1 - 1}}{1 + \frac{\partial T}{\partial C} p_1} = \frac{\gamma_2 \theta_2 t_2^{\theta_2 - 1}}{1 + \frac{\partial T}{\partial C} p_2} = \ldots\ldots = \frac{\gamma_i \theta_i t_i^{\theta_i - 1}}{1 + \frac{\partial T}{\partial C} p_i} \qquad 4.23$$

In order to come up with a solution we need one more equation, that is :

$$\sum_i \gamma_i = A \qquad \text{Which is an arbitrary constant} \qquad 4.24$$

Using equations (4.23) and (4.24) given θ_i, t_i, p_i and $\partial T / \partial C$, λ_T and each γ_i (although still using the arbitrary constant A) can be obtained.

4.3.3 The Activity Choice Model using SP Data II

The second approach is to obtain a parameter using a choice model for activity extension. This latter method will be used for verification and refinement of the parameter estimation. To explain this, it is assumed that there is a marginality to maximize total utility *U* taking advantage of ΔT as time saved, represented by:

$$\max U^{'} \big| \Delta T \tag{4.25}$$

Then for a type of activity (*i*) that is chosen to be extended by Δt_i, the utility will be:

$$U_i^{\prime} = U_i + \frac{\partial U_i}{\partial t_i}\Delta t_i + \varepsilon_i \quad = \gamma_i (t_i^{\theta_i} + \theta t_i^{\theta_i - 1}\Delta t_i) + \varepsilon_i \tag{4.26}$$

with ΔU_i for each activity calculated as:

$$\begin{aligned}\Delta U_i &= \gamma_i (\theta t_i^{\theta_i - 1}\Delta t_i + \mu_i) + \eta_i \\ &= \gamma_i \theta_i t_i^{\theta_i - 1}\Delta t_i \quad + \gamma_i \mu_i + \eta_i \\ &= \gamma_i \theta_i t_i^{\theta_i - 1}\Delta t_i \qquad + \varepsilon_i^{\prime} \\ &= \Delta V_i + \varepsilon_i^{\prime}\end{aligned}$$

Hence:

$$\Delta V_i = \gamma_i \theta_i t_i^{\theta_i - 1}\Delta t_i \tag{4.27}$$

where $\varepsilon_i, \mu_i, \eta_i, \varepsilon_i^{'} =$ error terms caused by social, culture and other unobserved heterogeneities.

To which activity the Δt will be reallocated to, is presumed the extension of activity that will give the highest change of ΔU. Then the probability that a type of activity (*i*) is chosen to be extended by individual *n* is:

$$P_{in} = \Pr(\Delta U_{in} \geq \Delta U_{kn}, \ \forall j \in C_n, k \neq i)$$

$$P(i|\Delta T) = \Pr(\Delta U_i \geq \Delta U_j) = \Pr(\Delta V_i + \varepsilon_i^{'} \leq \Delta V_j + \varepsilon_j^{'}) = \Pr(\varepsilon_j^{'} - \varepsilon_i^{'} \leq \Delta V_i - \Delta V_j) \quad 4.28$$

4.3.4 Combining Time Allocation Model and Activity Choice Model II

These two models will be used for estimating the parameters of the utility model by comparing both of them and refining the result. Both of the methods are supportive in finding the parameters. The main idea is that time saving will be allocated to the type of activity according to the probability of the activity being extended as a result of having the highest marginal utility. The formulation of new time allocation is written as:

$$T + \Delta T = \sum_i t_i + \Delta TP_i \qquad \text{and then,}$$
$$\Delta T = \sum_i \Delta t_i = \sum_i \Delta TP_i \, . \quad 4.29$$

Using the equation (4.17) and (4.22) we get:

$$V_i = \sum_i \left\{ \frac{\lambda_T \left(1 + \frac{\partial T}{\partial C} p_i \right) t_i}{\theta_i} \right\} \quad 4.30$$

The new time allocation with the additional time saving will reach another state of equal marginal utility with the equation:

$$\lambda'_T = \frac{\gamma_i \theta_i (t_i + \Delta TP_i)^{\theta_i - 1}}{1 + \frac{\partial T}{\partial C} p_i} \quad 4.31$$

The change in the utility of activity will thus be:

$$V_i + \Delta V_i = \left\{ \frac{\lambda_T \left(1 + \frac{\partial T}{\partial C} p_i\right)(t_i + \Delta T p_i)}{\theta_i} \right\} = \frac{\gamma_i \theta_i (t_i + \Delta T p_i)^{\theta_i - 1}}{\left(1 + \frac{\partial T}{\partial C} p_i\right)} \times \frac{\left(1 + \frac{\partial T}{\partial C} p_i\right)(t_i + \Delta T p_i)}{\theta_i}$$

$$= \gamma_i (t_i + \Delta T P_i)^{\theta_i} \qquad 4.32$$

Hence,

$$\Delta V_i = \gamma_i (t_i + \Delta T P_i)^{\theta_i} - \gamma_i t_i^{\theta_i} \qquad 4.33$$

Referring to the equation from the Time Allocation Model (4.21), (4.22) and Choice Model (4.29), (4.33), the basic intention is to have:

$$\lambda_T = \frac{\partial V_i}{\partial t_i} \cong \frac{\Delta V_i}{\Delta t_i} \qquad 4.34$$

The right- and left-hand side terms can be checked for closeness of value. Otherwise, iterations will be done changing the value of γ_i and the arbitrary constant A of the equation (4.24) for each iteration until the difference between two values narrows down. This process is considered as proposed method to estimate each γ_i.

4.3.5 The Simulation of Combined Time Allocation Model II

Having the attributes of the individual and the parameters, the model intends to predict the time use for each individual's type of activity and the most possible activity time extension. This model is expected to feature an understanding of the intension for which activity time they are going to extend. The results can then be used to predict the possible time-saving utilization of individuals. In order to verify the validity of the model, the basic characteristics of the model are examined. The change in individual time allocation obtained from the model is calibrated to the actual intended change by changing each of the parameters. As an illustration, several cases that consider three needs and three activities were performed. First let us explore the example of three types of activity, those are Rest in Home as a type of Physical Care, Hobby in Home as Pleasure, and go out with family as the Family Care activity. Table 4.1. represents the changed and assumed parameter values. In this case, α_j is the importance level of need j, and θ_i is the parameter of activity i, and this is simplified that one need is fulfilled by one type of activity ($i = j$).

Table.4.1. Assumption of Parameters

Activity	p_i	θ_i
Rest in home (i =1)	100	0.20
Hobby in home (i =2)	200	0.25
Go out with family (i =3)	400	0.30

$$\text{(Matrix Form)} \quad \beta = \begin{pmatrix} 10 & 1 & 1 \\ 1 & 10 & 1 \\ 1 & 1 & 10 \end{pmatrix} \qquad \alpha = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix} \quad \text{(Initial)}$$

Initialization was set to have total time T =100 and total disposable income C = 20.000. Some result of simulation is explained as the following, with the changing parameters α, and T, for Case 1 and Case 2 respectively.

Case 1 : α_3 changes

Increasing α_3 implies increasing importance of family care needs. For instance, the changing of life stage, and the number and increasing age of children can influence the level of importance of family care. This will result in time allocation change as shown in Figure 4.4. Based on the calculation of the model, we can see that the time for family activity out of home increases while the time for other activities decreases. The sudden decrease of “rest at home” of Physical Care occurs around α_3 =1.125. To compare and illustrate with real condition, Figure 4.5 shows average time allocation of respondents from the Tokyo survey. People who worked five days a week were divided into two types by satisfaction/dissatisfaction of the family care needs on weekdays. Based on this figure, we can see more clearly the difference between those two types, that is, the time allocation proportion of "go out with family" or Family Care of the "not sufficient" group is more than the proportion of the "sufficient" one. This situation of real condition is conform to the result of the model in a way since for the group of individual who have always allocated time for family care larger, they have the higher tendency to feel not having enough time and has more inclination to extend it.

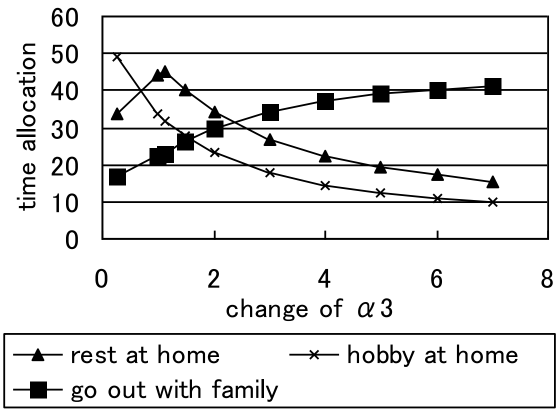


Figure 4.4. α_3 Vs Time Allocation

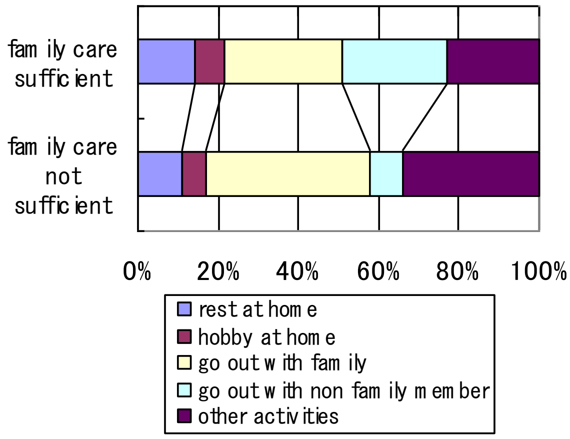


Figure 4.5. Time Allocation for Individual Types in Family Care

Case 2 : Total Time Changes

The change in total time T reflects expansion of available time, though still without change of the total budget. Figure 4.6 shows time allocation variation with the change in total time T. For this case the time of two activities were expanded with relatively same constant cost. For T values up to 70, the total cost did not reach the budget constraint. After this point, the budget constraint has been reached and the proportion of time allocation of "go out with family " or Family Care starts to decrease. Comparing with real conditions (Figure 4.7), this figure shows that for some individual who have a limited time or less free time, he would have a larger proportion of family care time than other. But when the time availability is continuously increasing and makes the individual have more time, it does not always guarantee that the family care time is increasing, if the budget remain constant and become a constraint.   So in this case even the first tendency is increasing the family care time but to certain extent it still limited to the budget constraint.

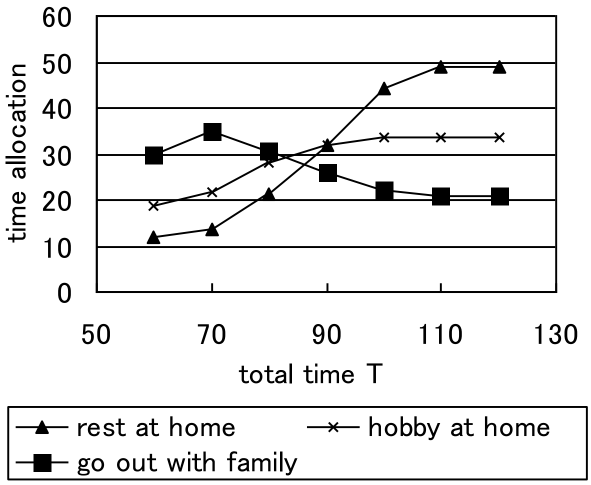


Figure 4.6. T vs Time Allocation

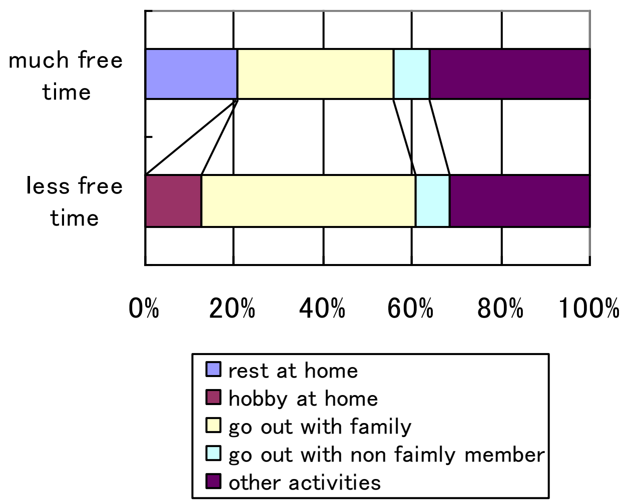


Figure 4.7. Time Allocation for Individual Types in Free Time Availability

All of this simulation of Model II is based on predetermined value of parameters, however this model shows some interesting mechanism that has closer resemblance to the actual situation compare to model I.

4.4 The Combined Time Allocation Model I Accommodating the Weekday Time Allocation in the Utility Function

Because of its estimation possibility more focus is given to Model I.   In Model I, the utility function of time allocation is applied to only a certain time span e.g. weekday or weekend.   In the utility of weekday allocation only, its marginal utility is diminishing toward the end, and supposedly when it moves or shift to the utility of weekend allocation, at the beginning, the function is sharply increasing (the marginal utility is very high as shown in Figure 4.8).   If one wants to estimate the time allocation model of weekend only (independent from weekday) it will resulted in a too step difference between parameter of weekend and weekday, and this is considered not representative. To accommodate this situation, the suggested solution is by incorporating the weekday allocation into the utility of weekend thus will result in a more moderate change from weekday to weekend.

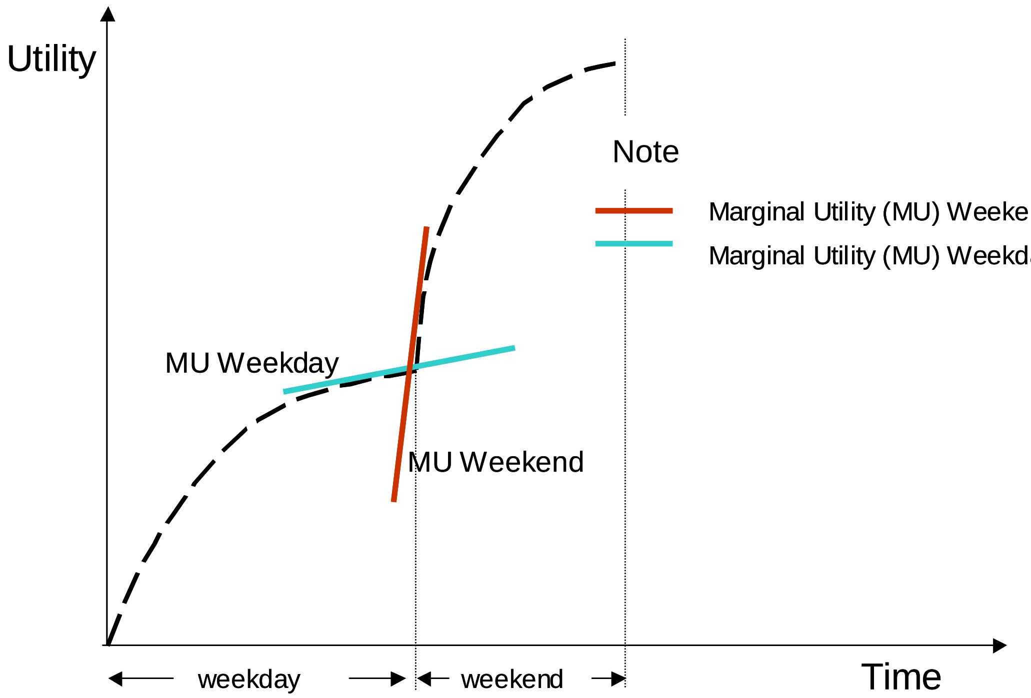


Figure 4.8. Illustration of Utility in Weekday and Weekend

To have the relationship of the utility of weekend with the time of activity in weekday, the individual average weekday activity time is included in the utility function as follows:

$$Max\ U_n = \sum_i \gamma_i \ln\left(t_{ni} + t_{ni}^{WD} + 1\right) + \mu \ln\left(q_n + q_n^{WD}\right) + \xi \ln\left(z_n + z_n^{WD}\right) \quad 4.35$$

subject to:

$$q_n + q_n^{WD} + \sum_i t_{ni} + \sum_i t_{ni}^{WD} + T_n + T_W \leq H_n \quad 4.36$$

$$c_z z_n + \sum_i c_{ui} t_{ni} + \sum_i c_{ui} t_{ni}^{WD} + G_n \leq R_n \quad 4.37$$

The solution of the Lagrange Method is:

$$\frac{\gamma_i}{t_{ni} + t_{ni}^{WD} + 1} = \frac{\mu}{q_n + q_n^{WD}} + \frac{c_{ui}\xi}{c_z\left(z_n + z_n^{WD}\right)} \quad for\ t_{ni} \geq 0$$

4.38

$$\frac{\gamma_i}{t_{ni} + t_{ni}^{WD} + 1} \leq \frac{\mu}{q_n + q_n^{WD}} + \frac{c_{ui}\xi}{c_z\left(z_n + z_n^{WD}\right)} \quad for\ t_{ni} = 0$$

with

$$\gamma_i = \exp(\beta_i\alpha_{ni} + \varepsilon_{ni}) \qquad \mu = \exp(BY_n) \qquad \xi = \exp(CY_n)$$

4.39

solving for error term the function of ε_i is formulated as:

$$\varepsilon_i = \ln(t_{ni} + t_{ni}^{WD} + 1) + \ln\left(\frac{\exp\left(BY_n - \beta_i\alpha_{ni}\right)}{q_n + q_n^{WD}} + \frac{c_{ui}\exp\left(CY_n - \beta_i\alpha_{ni}\right)}{c_z\left(z_n + z_n^{WD}\right)}\right) \quad for\ t \geq 0$$

4.40

$$\varepsilon_i \leq \ln(t_{ni} + t_{ni}^{WD} + 1) + \ln\left(\frac{\exp\left(BY_n - \beta_i\alpha_{ni}\right)}{q_n + q_n^{WD}} + \frac{c_{ui}\exp\left(CY_n - \beta_i\alpha_{ni}\right)}{c_z\left(z_n + z_n^{WD}\right)}\right) \quad for\ t = 0$$

Then the individual n's likelihood function is:

$$L_{Tn} = \begin{cases} \dfrac{1}{\sigma}\phi\left[\dfrac{\ln(t_{ni} + t_{ni}^{WD} + 1) + \ln\left(\dfrac{\exp\left(BY_n - \beta_i\alpha_{ni}\right)}{q_n + q_n^{WD}} + \dfrac{c_{ui}\exp\left(CY_n - \beta_i\alpha_{ni}\right)}{c_z\left(z_n + z_n^{WD}\right)}\right)}{\sigma}\right] & for\ t \geq 0 \\[2em] \Phi\left[\dfrac{\ln\left(\dfrac{\exp\left(BY_n - \beta_i\alpha_{ni}\right)}{q_n + q_n^{WD}} + \dfrac{c_{ui}\exp\left(CY_n - \beta_i\alpha_{ni}\right)}{c_z\left(z_n + z_n^{WD}\right)}\right)}{\sigma}\right] & for\ t = 0 \end{cases}$$

4.41

Having the likelihood defined then the parameter estimation process is the same as done previously in sub chapters 4.2.4, 4.2.5, and 4.2.6.

4.5 Value of Time Formulation

The value of activity is derived as the following:

With $\frac{\partial U_n}{\partial t_{ni}} = \frac{\partial U_{ni}}{\partial t_{ni}}$ and also $\frac{\partial U_n}{\partial z_n} = \frac{\partial U_{nz}}{\partial z_n}$ 4.42

Thus,
the Marginal Utility of Time $= \frac{\partial U_{ni}}{\partial t_{ni}}$ 4.43

Marginal Utility of Money $= \frac{\partial U_n}{\partial c_{ni}} = \frac{\partial U_n}{\partial z_n} \frac{\partial z_n}{\partial c_{ni}} = -\frac{\partial U_{nz}}{\partial z_n}$ 4.44

with $z + \sum_i c_{ni} + C = 0$ $\frac{\partial z}{\partial c_{ni}} = -1$ 4.45

The value of Activity Time (VOT) is basically the ratio of marginal utility of time over the marginal utility of money, which will be:

$$VOT_{ni} = -\frac{\frac{\partial U_n}{\partial t_{ni}}}{\frac{\partial U_n}{\partial c_{ni}}} = \frac{\frac{\partial U_{ni}}{\partial t_{ni}}}{\frac{\partial U_{nz}}{\partial z_n}} = \frac{\gamma_i}{\xi} \frac{z_n}{t_{ni}+1} \qquad 4.46$$

Having these parameters and the data, for the Value of time of activity *i* in the weekend the following formula 4.47 is used (c_z=1)

$$VOT_{ni} = \frac{\gamma_i}{\xi}\frac{z_n + z_n^{WD}}{t_{ni} + t_{ni}^{WD} + 1} = \exp(\beta_i \alpha_{ni} - CY + \varepsilon_i)\frac{z_n + z_n^{WD}}{t_{ni} + t_{ni}^{WD} + 1} \tag{4.47}$$

It is shown that the VOT_{ni} is a function, specifically of, t_{ni}= allocated time and α_{ni}= level of importance, where i is type of activity by need. 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 VOT_{ni} is a decreasing function of t_{ni}, and increasing function of the priority of needs then the higher is the time value. This formulation is considered different with the conventional single time value for any activity for each individual.

$$VOT_{ni} = \frac{\gamma_i}{\xi}\frac{z_n + z_n^{WD}}{t_{ni} + t_{ni}^{WD} + 1} = \exp(\beta_i \alpha_{ni} - CY)\frac{z_n + z_n^{WD}}{t_{ni} + t_{ni}^{WD} + 1} \times \exp(\varepsilon_i) \tag{4.48}$$

$$\overline{VOT_{ni}} = \exp(\beta_i \alpha_{ni} - CY)\frac{z_n + z_n^{WD}}{t_{ni} + t_{ni}^{WD} + 1} \times a \tag{4.49}$$

with $\varepsilon_i \sim N(0, \sigma^2)$

$g(\varepsilon_i, \sigma) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\varepsilon^2/2\sigma^2}$ $\quad \sigma > 0$ normal distribution function of error term 4.50

general formula for the expected value of is $E(X) = \int_{-\infty}^{\infty} x f(x) dx$ 4.51

with

$$f(\varepsilon_i) = e^{\varepsilon_i}$$

and the result of expected exponential error term is:

$$a \equiv E(\exp \varepsilon) = \int_{-\infty}^{\infty} e^{\varepsilon} \times \frac{1}{\sigma\sqrt{2\pi}} e^{-\varepsilon^2/2\sigma^2} d\varepsilon = \exp\left(\frac{\sigma^2}{2}\right) \tag{4.52}$$

All of these formulations are to be used in the calculation of value of activity time that will be explained in Chapter 5.

4.6 Summary

The Time Allocation Model I is considered more feasible to be estimated with the assumption that the basic shape of utility function of each activity is similar. The shape of the function is logarithmic which means that the utility is a decreasing function of time. The Model II is can be considered more ideal in explaining the reality, although it is not feasible to be estimated at this time. The consideration of this model can be taken into account for the future research. For the calibration to obtain the parameter of the variables, the model I will be implemented and the result will be explained in the following chapter 5. The value of time can be calculated as unit of (a * Z_n). The smaller and closer variance between the weekend and weekday data is better for the validity of the value of activity time and comparison between weekend and weekday value of activity time.

Chapter 5

THE MODEL CALIBRATION AND RESULTS

5.1. Introduction

The calibration result shown in this chapter is based on the formulation explained in Chapter 4. The model that is used for the calibration is Model I. The reason of choosing Model I is because of its higher possibility to be estimated compare to Model II. The following sub-chapters will explain several cases of calibration. The calibration is shown by several method, that is probit model (choice model), tobit model (regression), and combination of probit and tobit for combination model. The calibration is done using Tokyo data for situation in a weekend and in a weekday. To accommodate the interaction between weekend and weekday, the time allocation model is adjusted to using equation of weekend accommodating weekday allocation as described in Chapter 4. Data of Jakarta is done only for the weekday allocation. The more detailed explanation will be described in the following sub-chapters.

5.2. The Calibration Results

5.2.1 Calibration for 3 types of Choice including the Attribute of Individual.

Specific for this case, the individual attribute will directly influence or be treated as a variable in the utility of activity, and also the priority of individual priority is independent of individual attribute. In this estimation exercise the choices will be the three types of classification taking into account the most prominent needs in the weekend that is Family Activity, and Personal Pleasure Activity, while the rest is classified as Other Activity. While the individual attribute that taken into consideration are: *the age of the youngest child* specific for Family Activity, *individual sex* specific for the Personal Pleasure Activity, and lastly *the satisfaction level of physical care* of Other Activity. The estimation is using the GAUSS Programming with the application of three types of method of Multinominal Probit (SP) and Tobit Censored Regression (RP), and Combination of Probit and Tobit (Combined Method).

The result of the estimation is shown in the Table 5.1.

As shown by Table 5.1, the influence of *the age of the youngest child* is very significant for the coefficient γ of Family Activity and this relevant with the result of LISREL in Chapter 3 stating that *the age of the youngest child* is a significant variable for the priority of family. *Individual Sex* and *Age* seems does not have a significant influence in the γ of Pleasure and Other Activity respectively.

Table 5.1. The Calibration Result of 3 Choices using method of SP,RP and Combined Method with Individual Attributes

		SP METHOD	RP METHOD	COMBINED METHOD
	3 Choices of Extension: A. Family Activity (FA) B. Pleasure Activity (PA) C. Other Activity (OA)	Multi - nominal Probit (MNP)	Tobit Censored Regression	MNP and Tobit Censored Regression
			Estimates of A_i	
1	X_1=Priority of Family (specific for FA)	1.7489 *(7.27)*	0.8101 *(6.06)*	1.3573 *(7.11)*
2	X_2=Age of Youngest Child (specific for FA)	-0.3717 *(-6.40)*	-0.1821 *(-5.02)*	-0.3320 *(-6.67)*
3	X_1=Priority of Pleasure (specific for PA)	0.9637 *(3.59)*	0.4515 *(2.57)*	0.7150 *(3.08)*
4	X_2=Sex (specific for PA)	-0.5086 *(-0.47)*	-0.2123 *(-0.34)*	-0.7596 *(-0.891)*
5	X_1=Priority of Physical Care (specific for OA)	-0.2212 *(-0.77)*	-0.0903 *(-0.48)*	-0.2205 *(-0.91)*
6	X_2=Age (specific for OA)	0.0413 *(1.10)*	0.0158 *(0.71)*	0.0196 *(0.66)*
			Estimates of B_i, C_i	
7	Y_2=Satisfaction Level of Physical Care (for *BY*)		1.1555 *(3.789)*	1.6088 *(4.73)*
8	Y_1=Income level [1-7] (for *CY*)		0.1020 *(0.79)*	0.3659 *(1.89)*
9	σ of error	4.0140 (assumed)	4.0140 *(21.15)*	6.1869 *(19.92)*
	Initial Likelihood with σ=4.0140	-416.18	-954.78	-1370.96
	Final Likelihood	-345.90	-917.10	-1226.73
	Likelihood ratio	0.17	0.03	0.11
	Number of Samples		169	

t statistics in italic bracket. Assumption: c_{ui} / $c_z z_n$ for PA=0.06, FA=0.04, OA=0.05 respectively.

With respect to the variance of error it seem that Tobit Censored Method (RP) has relatively smaller variance. The table shows that the values of parameter A_i in RP Method and Combined Method for priorities of family and pleasure have large and significant positive influence to the utility of respective type of activity. Also the *t*-statistics and the likelihood ratio for the Combined Method are higher than RP Method alone reflecting better model performance for the Combined Method. This means that accommodating the difference in marginal utility as demonstrated in the Combined Method is proven useful for parameter estimation

5.2.2 Calibration for 4 Types of Activity Choice without the Individual Attributes.

The incorporation of individual attributes seems impractical since it only can be alternative specific. To know which individual attribute that best explain the coefficient of activity is still empirical. In view of this situation, the next calibration is done only incorporating priority of needs, and the number of choice now is increased including the Working Activity, with the incorporation of priority of work.

The purpose of calibration as shown in Table 5.2, is to compare the part-worth of each type of activity that represent the needs allocation in that particular day situation, in this case in weekend. The same performance shown by the combined model that *t*-statistics and likelihood ratio of the combined model is better than the RP alone. It is shown by the parameters that the priority of work has the smallest contribution to the total utility in weekend and the parameter of family has the highest part-worth followed by Pleasure and Physical Care. However the variance of the combined method is relatively larger than the RP method, this seems due to the data situation that has more variation taken from the choice model.

5.2.3 Calibration for Comparing between part-worth of Needs in weekend and weekday in Tokyo and weekday in Jakarta

Two situations have been taken into consideration in this case, especially related to the time allocation in the weekday. Since this calibration taken into consideration the

Table 5.2. The Calibration Result of 4 Choices using method of SP, RP and Combined Method without Individual Attributes

		STATED PREFERENCE METHOD (SP)	REVEALED PREFER-ENCE (RP)	COMBINED METHOD
	4 Choices: 1. Family Activity 2. Personal Pleasure Activity 3. Work Activity 4. Other Non Work Activity	Multi Nominal Probit	Tobit Censored Regression	MNP and Tobit Censored Regression
	Variables	Estimates of β_j		
1	α_1= 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	-1690.41
	Final log-likelihood	-330.70		
	Final log-likelihood of Tobit and Combination Tobit and Probit		-1097.21	-1408.49
	Log-Likelihood ratio	0.23	0.12	0.17
	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. (*) assumed as a scale parameter.

working hours in weekday, then the issue of working activity becomes more significant. In the first situation as shown in Table 5.3 the time allocation for work both official or (regular) and overtime is considered directly contribute to the utility of individual and not considered as such a mandatory activity where it should not be considered to contribute the mental utility. However this assumption is quite weak, since it is difficult to prove or to analyze that someone enjoy their work or not.

The model has also considered that income is exogenous and independent of additional working time. The second case considered that only unofficial (overtime) working hour that contribute to the utility with assumption that he is not paid to do this, and he is considered to do overtime in his own discretionary. However, still this is weak assumption also because it is difficult to trace from the data whether that individual is being paid or being forced to do this. Focusing on Table 5.3 first, for Tokyo in weekday, and compared vertically, it shown that in the weekday allocation the part-worth or the weight given for pleasure and family activity is very low and the highest part-worth comes significantly from work and physical care respectively. For the comparison with weekend, to compare directly it is not theoretically correct since one need to consider the variance of error. However this can show at least the relative part-worth or weight between activity time allocation between weekend and weekday.

To compare with the Indonesian situation in weekday, it is shown that the highest part-worth is for physical care, work and lastly family, however the difference between them is not as large as the result of Tokyo's estimation.

The Table 5.4 shows the calibration of weekday allocation with different assumption that only overtime work in weekday contribute to the utility. This resulted in the change of working activity part-worth to become second highest in the calibration result for Tokyo, and raised the rank of part-worth of family activity to the second highest after the physical care for Jakarta. This result seems quite resemble the real situation, thus the result will be referred in the calculation of value of time that will be discussed in the next sub-chapter 5.2.5.

5.2.4 Calibration for Comparing between With and Without Incorporating the Weekday Time Allocation

It shown by the Table 5.5 that as expected by the modification of the model, the marginal utility will be moderate and will be more representative in explaining the situation because of the variance of error is relatively smaller. These parameters will be used in the calculation of value of time.

Table 5.3 Calibration for Weekday and Weekend in Tokyo (Inter-temporal) And between Weekday in Jakarta (Inter-regional) with total Working Time contributes to Utility.

		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

Table 5.4. Calibration for Weekday and Weekend in Tokyo (Inter-temporal) And between Weekday in Jakarta (Inter-regional) with only Unoffical Working Time contributes to the Utility.

		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
1	$\alpha 1$= Priority of Family (specific for Family Activity)	0.303 *(5.70)*	-0.320 *(-5.02)*
2	α_2 = Priority of Personal Pleasure (specific for Pleasure Activity)		-0.095 *(-1.34)*
3	α_3 = Priority of Work (specific for Work Activity)	-0.901 *(-14.42)*	0.063 *(0.69)*
4	α_4 = Priority of Physical Care (specific for Other-Nonwork Activities)	0.630 *(5.24)*	0.554 *(7.80)*
5	Y_1 =Income	-0.309 *(-3.184)*	-0.027 *(-0.49)*
6	Y_2 =Satisfaction of Physical Care	-10.97 *(-0.37)*	-0.424 *(-0.21)*
7	of error σ	3.38 (37.30)	2.674 *(8.62)*
	Initial log-likelihood	-3013.22	-1519.15
	Final log-likelihood of Tobit and Combination Tobit and Probit	-2373.21	-1363.75
	Log-Likelihood ratio	0.21	0.10

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

Table 5.5 Comparison between Calibration without and with incorporating Weekday Time Allocation

		Combined Method	
	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 Weekend only	Parameter/ Part Worth β_j in Weekend with Weekday consideration
1	$\alpha 1$ = Priority of Family (specific for Family Activity)	1.495 *(8.32)*	0.796 *(7.53)*
2	α_2 = Priority of Personal Pleasure (specific for Pleasure Activity)	1.279 *(6.29)*	0.689 *(5.68)*
3	α_3 = Priority of Work (specific for Work Activity)	-0.976 *(-3.39)*	0.152 *(1.02)*
4	α_4 = Priority of Physical Care (specific for Other-Nonwork Activities)	0.505 *(2.39)*	-0.210 *(-1.62)*
5	Y_1 =Income	1.702 *(9.28)*	0.599 *(5.97)*
6	Y_2 =Satisfaction of Physical Care	2.620 *(8.91)*	1.326 *(7.31)*
7	σ of error	8.032 *(19.02)*	5.303 *(25.49)*
	Initial log-likelihood	-6751.75	-5074.83
	Final log-likelihood Combination Tobit and Probit	-1407.96	-1804.14
	Log-Likelihood ratio	0.79	0.64

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

5.2.5 The Calculation Result of Value of Activity Time

Using the formula in Chapter 4, the result of calculation is shown in the following figure of histogram. The calculation is done for activity in weekday and weekend. The unit of the value of time is in $a_{WD} * Z_n$.

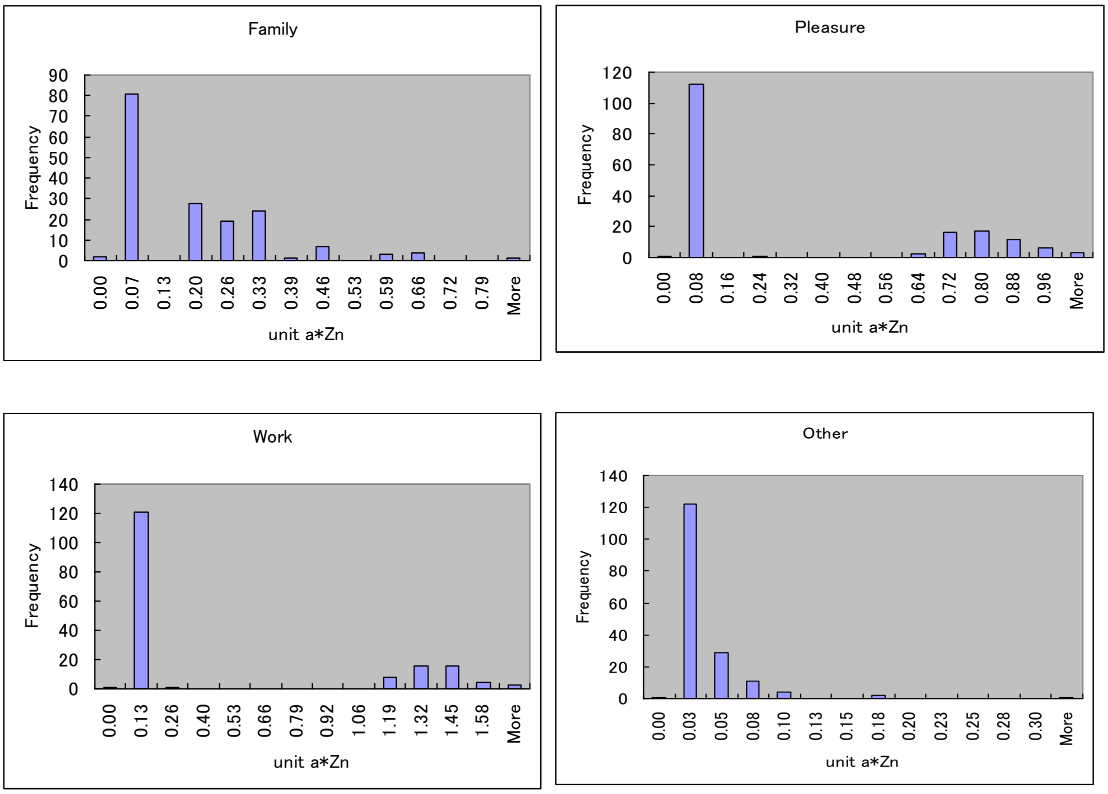


Figure 5.1. Distribution Of Value of Activity Time in Weekday in Tokyo

For the time value in the weekday in Tokyo it is shown in Figure 5.1, that most of the values of activity time are log-normally distributed. This conforms to the several studies stating that the distribution value of time follows a log-normal distribution. The highest mean value of activity time in weekday in Tokyo is obviously for the working activity.

The Figure 5.2 shows the distribution of value of activity time in weekend. It is shown by the figure that the distribution also in the log-normal distribution. The result of value of activity time in weekday and weekday in Tokyo is shown in Table 5.6 as a unit of $(a * Z_n)$. It shown by the table that compare to other value of time in the same time span of weekday, the highest value of time is for work oriented activity and the second is pleasure, while the family care activity gets the smallest value. On the contraty, in the weekend the family time becomes the highest value of time compare to others and the work activity becomes the lowest one. This conforms and resembles to the assumption given by the current guideline of benefit analysis in Japan.

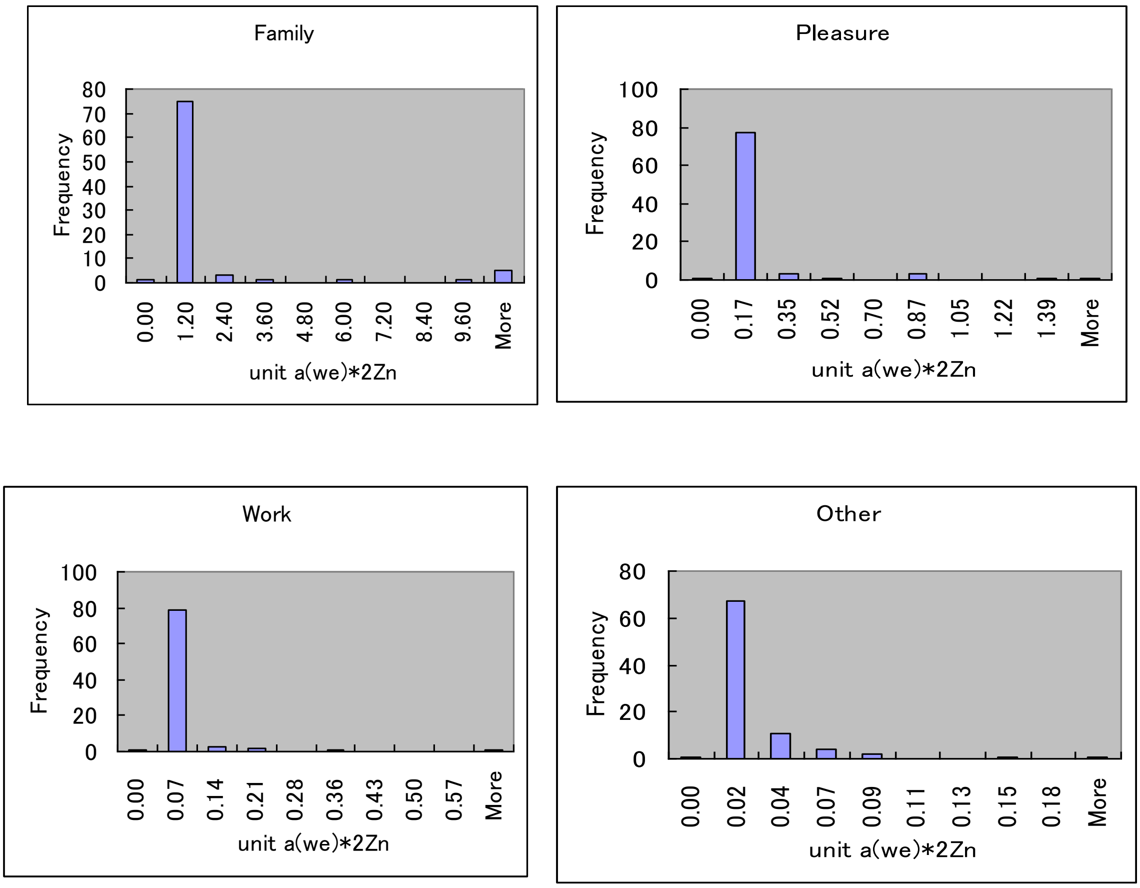
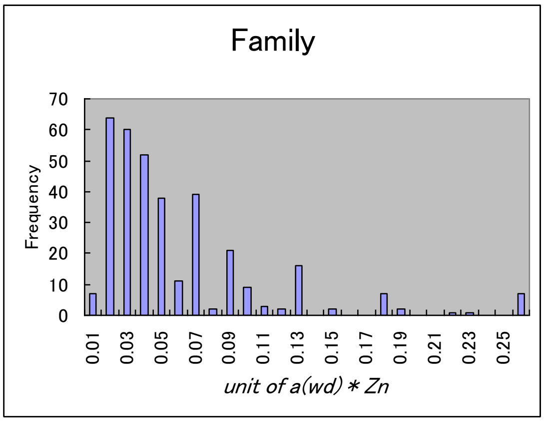


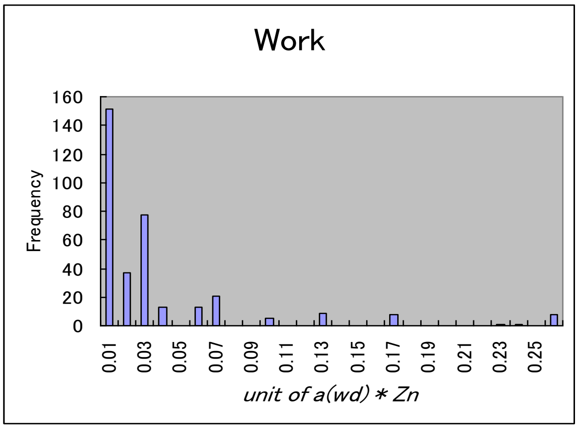
Figure 5.2 Distribution Of Value of Activity Time in Weekend in Tokyo

Table 5.6. The Individual Value of Time in Tokyo

Value of Time	Weekday a(wd)*Zn	Weekend a(we*Zn)
Family	0.15	1.88
Pleasure	0.27	0.18
Work	0.38	0.05
Others	0.02	0.03

For the value of activity in Jakarta, this research obtained the result as shown in Figure 5.3. It is indeed shown that the value of family care time is much higher compare to the value of work time, and this is also in accordance with the hypothesis of the common values that were shared by average individuals in Jakarta.





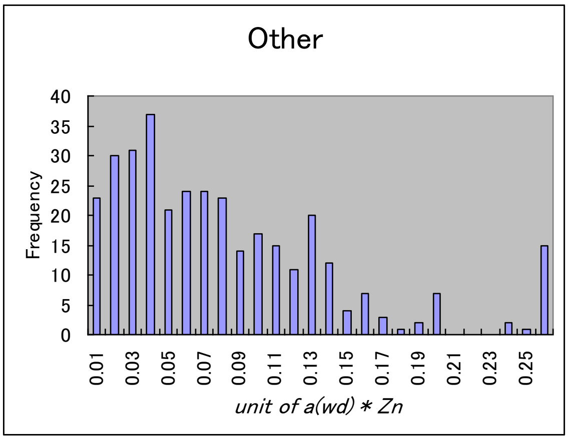


Table 5.7. The Individual Value of Time in Jakarta (Unit of a_{wd}*Z_n)

Value of Time	Weekday
Family	0.116
Work	0.039
Others	0.085

Figure 5.3. The Distribution of Value of Time in Weekday in Jakarta (Unit of a_{wd}*Z_n)

5.2.6 The Sensitivity Analysis of The Model

The sensitivity of the model is implemented in terms of:

1. How sensitive is individual priority to the time allocation of a type of individual
2. How sensitive is the price or cost of activity time to time allocation of a type of individual

Figure 5.4. shows the time allocation proportion of three group of individual. Each group have a different top priority, that is Family Oriented Group, Pleasure Oriented Group and Work Oriented Group, and it is shown that individual time allocation is significantly sensitive to the individual priority. This is conforms to the real situation from the data.

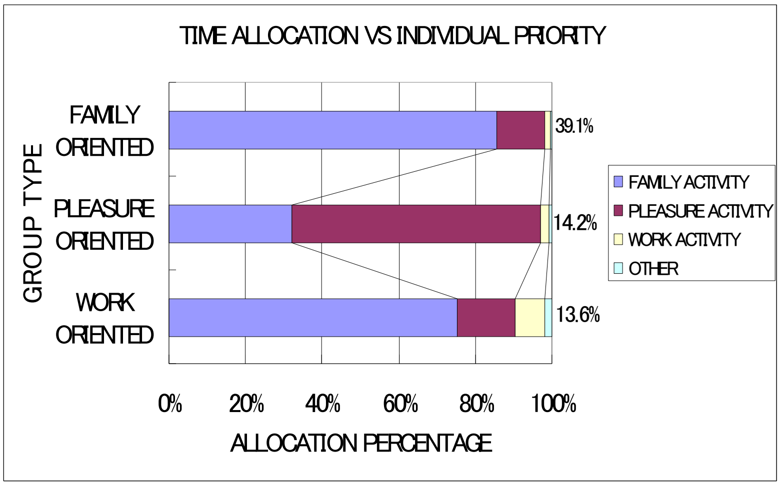


Figure 5.4. Time Allocation Vs. Individual Priority Calculated by The Model

Figure 5.5. shows a certain family oriented individual's time allocation, when the price of family activity time is changing. It is shown when the unit price or unit cost of family activity increasing, this will reduce the proportion of time allocation given to the family time. Until a certain level this could cause the individual have a higher proportion time of personal pleasure, and also to work and other activity. So the price of activity is quite sensitive between family activity and personal pleasure activity for this certain individual, but not significantly sensitive for work and other type of activity in the weekend. It is concluded from this analysis that price or unit cost of activity do influence significantly the time allocation for that particular type of activity.

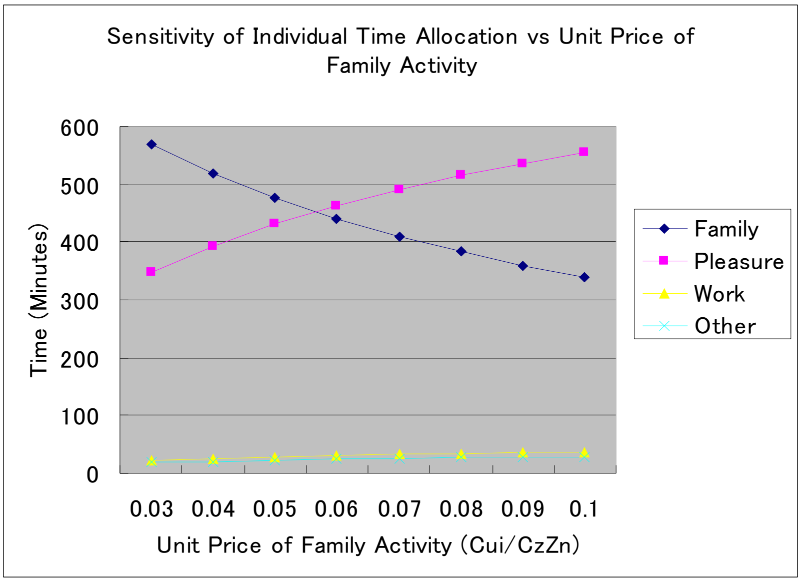


Figure 5.5. Time Vs. Unit Price of Family Activity

5.3.Summary

In this chapter the result of calibrations of several cases has been implemented. And almost all of the result shows significant *t* statistics. From the result of calibration, value of activity time can be performed with assumption of unit of (a * Z_n) and, the result quite resembles the explanation of current guideline of Tokyo and the situation in Jakarta. The sensitivity analysis has been conducted on individual priority and unit price of activity and shows a reasonable result.

Chapter 6

CONCLUSION AND FUTURE DIRECTION

6.1 Conclusion

As it is captured by the time allocation both in Tokyo population and Jakarta population, there are two most important variables that determine the meaning of time and consequently the subjective value of time. The variables are the individual priority of needs and the weight or the part-worth given to the needs in a certain time span of activity time. Priority and allocation of needs will influence the time allocation, and the "value" of time for activity.

In Tokyo, as shown by the calibration result, the part-worth or the weight of pleasure and family need are relatively very low in weekday. These needs are supposed to be fulfilled within limited time on weekends. 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 will influence the value of activity time especially for family care that is much higher than any activity in weekday. This explains the discrepancy in temporal values of activity time between weekend and weekday .

In Jakarta, most individuals in the Jakarta sample do not prioritize work for time allocation or time extension choice in weekdays and most of them choose to extend family oriented activities. The high part worth and priority of family care, consequently will make the value of activity time for family is relatively higher. This is reflected in the calculation of the model and their WTP that shows that value of activity for family is more expensive than value for work. The value of time as a resource value for increase in productivity time, need to be re-examined. The economic benefit of time saving that leads to the increase of production time is related to the probability that the individual extends work activity.

Furthermore, from this research, it is possible to understand the behavior of an individual or community toward needs. It is also possible to understand what kind of activity individuals may feel lacking based on their stated intentions and preferences. Time saving as an impact of a project, can be explained comprehensively by this model. It could be noted that the economic benefit may come indirectly from the increase in work efficiency or effectiveness as a result of properly fulfilling other needs such as family care and pleasure.

Regarding the proposed model the result of the research has shown that:

- The model is able to relate the characteristic of individuals or population with activities they will do given extra time.
- 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, revealed preference and stated preference, is proven to increase the estimation performance.
- Level of priority of need as shown by result of estimation has a significant part-worth in the respective type of utility of activity, so basically individual priority (represented by variable α) influences how he or she allocates time for each activity.
- 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 research has shed some directions on the features that this model will have in the future.

6.2 Possible Application

The possible way of application of this method will be discussed in the following section. In calculating the benefit of transport facilities usually it required the traffic data that consist of the O-D and purpose of travel of the survey sample. In order to obtain the data needed for this method, the purpose of travel in weekday or weekend will be made to follow the classification of needs. For this current model, the type of classification is defined by the respondent himself by asking the main one need that is involved in the activity engagement. Having these activity all classified, the total time allocated to it and individual attributes obtained then the parameters of each need can be estimated.

Using the parameters of the model, it is possible to understand the probability of each activity to be extended for total population. For example in Jakarta there are 30% of respondent wants to extend their working time if their commuting time is reduced for one hour. So basically if someone wants to extend their working time, it means that they are satisfying their mental utility, in addition to increase of productivity to the society. This mean that there is an extension around one hour for productivity and this also mean the direct benefit of same worth with their hourly income. Having this kind of characteristic of individual, a population will benefit a lot from travel time saving for weekday activity. However in Jakarta for example, since it is only around 30% of individuals want to extend the production activity for an hour, consequently the economic benefit will only be considered of 30% of the total amount of income/per hour.

In Japan for the weekend case, the value of family care time which is considered twice more expensive per passenger car, can be justified because the individual need is significantly higher in weekend and this is reflected in the market prices to follow the demand. So the value of activity time in the weekend theoretically can be distinguished with the activity in the weekday.

Other application also could be in the decision-making on the infrastructures that will serve several different types of land uses, for example in the analysis of comparing the benefit of roads serving to recreational area or to central business district. The policy maker will have more detail approach by incorporating the needs or behavior of the community, and have a better measurement of value of time based on types of activity. The value of time for serving pleasure activity will be differentiated with the value of time for serving business activity in weekend or weekday for instance.

6.3 Future Direction

The idea of integrating the needs as a function of individual attributes, directly in the time allocation model, is interesting and challenging. However, obviously this will result in difficulties and tremendous effort in estimating the parameters of individual attributes. The proposed idea might be to simplify or to provide a linear function of γ (coefficient of activity time) with α (priority of need) as the independent variable.

The other future consideration is, in maintaining the combination of the RP method with the SP method of choice model, it is usually have limitation of the number choice that can be accommodated. In accommodating the extension of number of choice, the use of simulation method is proposed. The simulation method is more robust in handling the numerous number choice e.g. Train (2001). Given the chance to accommodate more choices of the type of activities, this model can then be extended to accommodate the classification of in-home or out-home activity which will make this model more comprehensive concerning the travel activity.