



Figure 8. Unified Modeling Framework of Daily Activity-Travel Pattern By Mode And Time Of Day

The probability that the individual chooses activity time use allocation (duration) $x_1^*, x_2^*, \dots, x_Q^*$, activity type, activity time of day, joint tour inter household and activity location (destination).

$$P(x_1^*, x_2^*, \dots, x_Q^*, 0, 0, \dots, 0) = \left[\prod_{k=1}^Q r_k \right] \left[\sum_{k=1}^Q \frac{1}{r_k} \right] \left[\frac{\prod_{k=1}^Q e^{V_k}}{\left(\sum_{h=1}^K e^{V_h} \right)^Q} \right] \quad (4)$$

Where : $r_1 = \left(\frac{1}{x_k^*} \right)$ and $r_k = \left(\frac{1}{x_k^* + \gamma_k} \right) \forall k > 1$ (5)

$$V_1 = \beta' z_1 - \ln(x_1), \quad (6)$$

$$V_2 = \beta' z_2 - \ln\left(\frac{x_2}{\gamma_2} + 1\right), \text{ and} \quad (7)$$

$$V_k = \beta' z_k + \theta_k \ln \sum_{l \in N_k} \left(\frac{\phi' w_{lk}}{\theta_k}\right) - \ln\left(\frac{x_k}{\gamma_k} + 1\right); \forall k > 2 \quad (8)$$

$\beta' z_1$ dan $\beta' z_2$: Basic utility component from *maintenance* and *discretionary* activities in and out of home

ε_1 dan ε_2 : Unobserved components assumed to be independent and identically Gumbel distributed

Conditional probability that mode (m) will be chosen for an activity episode purpose (p), time of day (t), joint tour inter household (j) and activity location (l) or $ptlj$ combination k , given that $x_k^* > 0$, is given by :

$$P(m | x_k^* > 0; m \in N_k) = P[\varphi' w_{mk} + \eta_{mk} > \phi' w_{mk} + \eta_{mk} \quad \forall l' \neq l] \quad (9)$$

η_{mk} : Unobserved components assumed to be independent and identically Gumbel distributed across different activity episode

$\phi' w_{mk}$: Observed components assumed to be independent and identically Gumbel distributed across different activity episode

Unified model framework of activity-travel in Palembang based on:

1. Palembang urban population who mostly work as self-employed (Figure 3) have led to uncertainty to their daily activity schedule, so the choice of generating activity more prioritized alternative combinations of time-duration, not on the agenda of alternative combinations of activities carried out in one day like in hierarchical activity based model.
2. Destination, mode, activity type, activity duration and joint tour choices that is expected to be short-term choices made contemporaneously. Those decisions are made at one time spontaneously and not gradually
3. Although the ownership of cars and motorcycles in Palembang has risen rapidly in recent years, public transit and ojeg still in great demand by the people who do not have private vehicles
4. The numbers of family members are relatively large but the number of vehicle ownership is limited. So it tends to make a joint tour inter household.

The unified activity based model system is formed as a combination of activity type, time of day, and travel mode while the duration of each activity constitutes the continuous dependent variable.

4.3. Comparison of the Unified and the Hierarchical Model Framework

The major objective of this paper is to describe household travel characteristics in Palembang and the general modeling framework of hierarchical and unified model of activity type choice (generation), time of day choice, mode choice, destination choice, and time use allocation (duration). This study is a first step in modeling activity based travel behavior in a city in a developing country. Although the data presented is very limited, but hopefully this study can form the basis for further study of the activity data and a more complete way. The unified and hierarchical activity based models system are based on random utility logit and nested logit models. The calibration and validation of the model need Household Travel Survey (HTS) and Activity Diary Survey (ADS).

Some important things of the data collected, as in section 4.3. can be used as input data for the model to form a hierarchical structure and unity of activity-based travel demand model are :

1. Palembang has a relative great number of household members. Based on household survey, the average number is 6 persons, consist of father, mother and children so that joint tour inter household should be considered in the model structure.
2. According to a survey conducted by BPPS Palembang, 25% population in Palembang has an employment status as entrepreneurs. This means activities undertaken to work less bound by time and this also affects the time of day choice for mandatory, maintenance and discretionary activities.
3. The data, which was collected from 400 residents in the city of Palembang, shows the rich diversity of modes in Palembang. Bus and private motorcycle become major modes in Palembang, so that the competition of the transportation modes should be considered in the random utility model.

The other things that can be analyzed from the comparison between modeling framework of hierarchical and unified model of activity-travel choices are :

1. A hierarchical of activity based travel demand model in Palembang assumes one choice process is nested within another choice process and so on, forming a long chain of inter-connected nests to complete the representation of the behavioral process. Mode and destination for work and school based subtour depend on joint tour inter household. Joint tour inter household depends on time of day choice for doing activities.
2. The unified activity based model system is relatively simpler because the model combines the fifth choice in the maximum utility model framework. (Bhat, 2010) found that the unified activity and tour- based model systems universally strive to mimic and replicate activity-travel choice processes of individuals.
3. The unified approach assumes time allocation, activity type, location and inter-household joint tour choices which influence people for selecting modes.
4. For the hierarchical model, each policy can change activity patterns in a day. It can be seen also how they affect people for selecting location and mode to do their activities.

5. CONCLUSIONS

This paper describes household travel characteristics in Palembang and the general modeling framework of hierarchical and unified model of activity type (generation), time of day, mode, destination and time use allocation (duration) choices. The unified and hierarchical activity based models system are based on random utility logit and nested logit models. The hierarchical activity based model assuming model components with four types of major models, namely,

choices of daily activity-travel patterns, time of day, joint tour inter household, mode and destination in the hierarchy. While the unified activity based model system combines activity type choice, activity time of day choice, mode choice, destination choice and activity duration in a holistic unifying utility-maximization framework.

The modeling system in this study primarily adopts a modified version of the frameworks proposed for Jakarta (Yagi, S. and Mohammadian, A., 2006) and for San Francisco (Bath, 2010). Options-choice of activities and trips are organized within the framework of a model adopted to the conditions activities and travel characteristic in Palembang, such as :

1. Public transit and ojeg still in great demand by the people who do not have private vehicles
2. The numbers of family members are relatively large but the number of vehicle ownership is limited so it tends to make a joint tour inter household.
3. Time of day choice for workers and non workers are more flexible because the distance between the location of the activity is relatively close.
4. Urban population who mostly work as self-employed have led to uncertainty to their daily activity schedule

In this study, the hierarchical model assumes there is a structured alternative to higher levels than other alternatives. Decision making process for the higher level alternatives in the hierarchical has a longer period of time than the decision-making process for alternatives that exist at the bottom level. On the other hand, the unified model is based on the assumption which is expected to be short-term choices made contemporaneously.

Although the data presented in this paper is very limited and the data analysis has not done in-depth, but hopefully this study can form the basis for further study of travel behavior models in Palembang. The unified and hierarchical activity based models system are based on random utility logit and nested logit models. Calibration and validation process of the models need Household Travel Survey (HTS) and Activity Diary Survey (ADS). Once the HTS and DAS data are collected, the next study will continue to test the validity of the unified and hierarchical activity based travel models for the city of Palembang. Based on this study, it is hoped that we can understand the factors better that must be considered from the study area before making travel behavior activity based model. So the models can be used to mimic and replicate activity and travel choices process of individuals in developing countries.

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