

An analysis of day-to-day variability of discretionary activities behaviour and how they influence day-to-day variability of Activity Space Indices: Case study in Jakarta Metropolitan Area

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Activities are widely known as individual's efforts to fulfil his/her needs and desires. In organizing activities, individual is a subject to their constraints such as capability, coupling and authority constraints (Hägerstrand, 1970), and opportunities that offered by space, time, and other resources within physical, economic, social, institutional and cultural context (Miller, 2007). In practice, those constraints and available resources will interrelate each other to create degree of prioritization or discretion in certain activities (Neutens et al, 2011). Activities that have highest degree of prioritization and commitment to do in fixed-place and -time will be called fixed activities (e.g working, school, dropping children). On the other hand, activities that can be conducted in other space or time with various degrees of prioritization and commitment will be defined as flexible activities such as discretionary activities.

Fixed activities will mark as anchor points, whilst discretionary activities will conducted between those anchor points. It is largely unknown how the discretionary activities were planned and decided between those anchor points. Recent studies (e.g. Yamamoto and Kitamura, 1999; Bhat and Misra, 1999; Meloni et al, 2004, 2007) argued that individual's trade-off mechanism between in-home and out-home discretionary activities are exist to maximize his/her utility. At the same time, Lee et al (2007, 2009) highlight the presence of interactions between different out-home activities purposes such as subsistence, maintenance and leisure, but they did not further investigate how these interactions interact with individual's in-home activities.

In reality, given the time-space constraints that an individual have, he/she will select and execute certain purpose of discretionary activities and abandon/reschedule others. This decision will depend on his/her degree of prioritization or discretion in the given space (whether it is in-home and/or out-home). Different individual have a different trade-off mechanism or to chain different purpose of discretionary activities. Ignoring either purpose of discretionary activities or where activities will and can be conducted can over/under estimate of the individual ability to engage in a certain activity on the given day. This study will investigate what mechanism occurred between different purposes of discretionary activities and how this will influence the distribution of individual activity locations over urban space in the given day.

Using a 4 consecutive days of activity diary of SITRAMP dataset (household travel diary that was collected at the Jakarta Metropolitan Area, Indonesia), this study used Simultaneous Equation Model (SEM) with 3SLS estimator to examine complex interaction of day-to-day individual's discretionary activities behaviour and how they influence the individual's day-to-day activity space. In measuring the size and the distribution of individual's activity location over urban space, two activity space indices, lc and lh , are applied. lc is equal to the total squared distance of individual out-of-home activity locations to the centroid of individual's activity locations on the given day. Whereas, lh is the total squared distance of the centroid of individual out-of-home activity locations to home.

SEM is powerful method to investigate complex decision making process (Lu and Pas, 1999; Golob, 2003; Susilo and Waygood, 2013). It could also solve reciprocal effect (Kang and Scott, 2010; Gujarati, 2003) between endogenous variables to correlate their error term and causal reasoning effect (Pearl, 2009). The 3SLS estimator is a full information method that produces asymptotically consistent and more efficient estimator than limited-information (Zellner, 1962; Myung, 2003). Each day observations from Thursday to Sunday was modelled for workers-student and non-workers to explore day-to day variability of individual's discretionary activities behaviour. Each day model is better fit model than pool weekly model (Kang and Scott, 2010). This model also takes into account other household members' duration activities to capture any joint activities with other household members. Equation 1 exhibits mathematical model applied in this study.

$$Y_{i,m} = \alpha_m + BY_{i,m} + \Gamma X_{i,m} + U_m \quad (1)$$

Assuming:

$Y_{i,m}$ is $T \times m$ matrix of endogenous variables, $X_{i,m}$ contains $T \times k$ matrix of exogenous variables and $U_{i,m}$ is $T \times m$ matrix of error term and would be independent and identically distributed (i.i.d) for different i of different individual and m for different equation.

The SEM with full information estimator has been successfully estimated and the model structure developed has been managed to capture the complex interaction between discretionary activities within the given individual's space and time. Trade-off mechanism is occurred between leisure and maintenance activities rather than in- and out-home activities. A higher participation of workers/students' out-home leisure activities positively influences the amount of their in-home leisure activities on the given day, whilst, for non-workers, such relationships happened between maintenance activities and in-home leisure activities. Presumably this is due to individual needs to relax after spends energy in engaging with out-home and/or maintenance activities. Furthermore, a higher fixed activities duration, and the number trips that associated with it, will make workers/students to reduce their in-home activities. The model also show that workers/students will start to substitute their out- and in-home leisure activities if they have a longer duration/more participations of more prioritized activities such as maintenance ones.

The findings so far also in-line with previous findings, e.g. the non-workers models have more un-stable relation between each of endogenous variables and between endogenous and exogenous variables (Susilo and Kitamura, 2005; Susilo and Avinieri, 2014) than workers-students model. Among workers and students, the maintenance activities duration time is highly influenced by other household members' in-home activities. Whilst for non-workers, the out-home maintenance activities is highly influenced by other household member's discretionary activities. Workers' and students' distances to their out-home activity locations are negatively influenced by the amount of their discretionary trips, whilst the spread of the locations is positively affected by the amount of out-home activities their participated.

Keywords: discretionary activities behaviour, degree of prioritization or discretion, activity space indices, SEM, 3SLS

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