Activity-travel participation, multitasking in travel and daily well-being

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Abstract. Using hierarchical linear regression and multi-dimensional three-week household time-use and activity diary, this study investigated the interaction among spatiotemporal variables on percentage time of engaging multitasking in travel, and how endogenous of percentage time of engaging multitasking in travel interact with other spatiotemporal variables on individuals’ daily subjective well-being. Different from descriptive analysis result, the result in using hierarchical linear regression shows that having tighter time-space constraints tend to positively correlate with performing multitasking activities within travel more often. Moreover, the ones who perform more trips such as the youngest travellers and someone from middle income tend to perform multitasking activities in travel more often. Endogenous of percentage time of engaging multitasking in travel shows positive correlation on improving someone’s daily well-being, as expected. In term of policy implication, undertaking passive leisure within travel can be suggested to improve someone’s daily well-being. The opportunity to undertake passive leisure within travel can be an advantage of using public transport.

1 Introduction

Travel is needed by an individual for undertaking an activity at another/other place/s for fulfilling his/her need and desires. For instance, an individual has to go to the supermarket for groceries shopping. The groceries shopping is considered as the need for the individual and it cannot be done without travelling because the supermarket is located at different location and it requires him/her to travel even by walking. According to [1], travel is a permanent constraint that an individual must do to fulfil their life needs and desire. In consideration of individual’s daily activity-travel pattern, the interaction between individual’s time-space needs and constraints are influenced by their personal and household socio-demographic characteristics and their socio-environmental conditions. The space-time or time-geographical framework is a wide and powerful perspective that analyses human behavior. This framework, originally developed by [1], focuses on the behavioral possibilities of individuals. By recognizing that individuals must operate within very basic spatial and temporal constraints on their behavior, the space-time framework can complement a wide variety of approaches to modelling human behavior in addition to aiding the planning and location of activities and infrastructure [1,2,3].

[1] argued that an individual is subject to three types of constraints which are capability constraints, coupling constraints and authority constraints. The constraints interact with individuals’ needs and desires, and availability resources to shape an individual’s daily time-space prism. The time-space prism shows individuals’ daily activity participation. In participating some activities, individuals may move from one location to another/other location/s in which the time-space prism also demonstrates people’s travel behavior. The framework recognizes that activity participation must be undertaken within spatial and temporal dimensions, for instance activities occur at specific locations for limited time periods. Transportation resources and built environment conditions allow the individuals to trade time for space to travel and participate in activities at different locations. The consideration of multitasking is very significant and have important implications to the activity-travel behavior study. [4] noted that recording multitasking activities in time-use survey can reveal for around 160% of additional time for passive leisure and 50% for household activities. It really shows how people tends to optimize their time to do passive leisure and housework activities within tighter time and space constraints. Multitasking is defined as the simultaneous conduct of two or more activities during a given period of time. This definition embraces both type of multitasking which are natural and time-driven multitasking. Natural multitasking is a normal multitasking that most of the people do in everyday life for instance talking whilst eating or driving whilst listening to the radio whereas time-driven multitasking is usually prompted by time pressure [5].
Multitasking is also defined as the concurrent activities which contained primary and secondary activities [6,7] in order to satisfy different needs and desires at the same time. Multitasking activities act as an influential variable in shaping individual’s activity-travel pattern [8]. Different people have different level of time-space constraints and tend to perform multitasking activities within different activities [6,8,9]. Revealing the impact of multitasking activities on individual’s degree of variability of activity-travel pattern will give another aspect in time-space perspective on how individuals optimize their time and space constraints in order to fulfill their needs and desires. When the secondary activities is taken into consideration, the full picture of how to optimize the tighter space-time prism could be observed. Multitasking study has shown that people with different socio-demographic backgrounds may have different degree on how often he/she participates secondary activities [9]. However, it rarely investigated the influence of people with different time-space constraints or different time-use participation on undertaking multitasking activities within a specific primary activity.

Travel is an activity that can be jointly undertaken with another secondary activity such as passive leisure [6]. Travel is considered to have moderate time and space constraints in comparison with grocery shopping and working [10]. Some research on how multitasking activities are undertaken in public transport has been revealed how public transport can offer another opportunity in undertaking more enjoyable activities such as socializing or working activities during travel with public transport [11,12].

[5] and [6] have mentioned that multitasking may be considered as opportunity, but it also can be a burden, which somehow can increase the stress level and decrease wellbeing by ‘contaminating’ primary activities or increasing pressure to participate where participation is undesirable. However, according to [11] and [12], when we have another activities in travel, wellbeing level can be increased. However, the previous study only focuses on investigating the impact of the inclusion of another/other activities during travel on individuals’ travel experience and not in daily well-being. [13] highlighted that when someone has satisfaction in an activity, it will not directly influence daily well-being or daily satisfaction. Daily satisfaction/well-being is a cumulative satisfaction/well-being during a day as a result of undertaking various activity and travel. Improving the travel satisfaction is a thing, but improving daily well-being needs a contribution of various activities and travels. There is a possibility that undertaking multitasking within travel only improves individuals’ travel satisfaction, but not in daily well-being, that is why investigation on the impact of undertaking multitasking activities during travel on daily well-being needs to be done. In investigating the impact on daily well-being, the interaction with participation and time duration of other activities and built environment condition is also included in conjunction with socio-demographic variables.

This paper focus to investigate the nature of multitasking within travel when including spatiotemporal variables such as time-use and activity participation and built environment condition. Moreover, the study also investigates the influence of multitasking within travel in interaction with other spatiotemporal variables on daily well-being. Spatiotemporal variables such as time-use and activity participation, built environment condition and socio demographic variables are assumed to shape either the nature of multitasking activities within travel and daily well-being. Passive leisure such as reading a book, enjoying scenery, socializing and listening to music is the only secondary activities assumed to be undertaken during travel in this study.

2 Bandung metropolitan area dataset 2013

The BMA dataset includes multi-dimensional information such as household, physical activity and lifestyle, individual’s subjective characteristics, time-use and activity diary, and subjective wellbeing data. The dataset raises possibilities to analyze individuals’ behavior in multi-dimensional perspectives.

The study included 732 respondents and 191 households from all over BMA for 21 sequential days. The surveys were conducted in Bahasa Indonesia as the local dialect of individuals in Indonesia. Because of poor enlistment of residents in Indonesia and other creating nations, the survey procedure began with direct interaction between surveyors and potential respondents, intervened by community pioneers in chosen neighborhoods. Accordingly, in the survey procedure, the study did not have any response rate data. After the association, the respondents were requested to sign a dedication letter concurring not to pull back from the survey until the point that it was finished. After signing the agreement, the surveyors started to distribute the questionnaires to the respondents. This process limited the steady loss of respondents in finishing the overview. In this study, none of respondents quit amidst overview time. Further explanation can be found in [14].

The household data section contained household composition, individuals’ perception about how far his/her accommodation was from the city center, public and transportation facilities, and built environment variables. The subjective perception of accessibility was used in this dataset, rather than objective measurements, because the traffic conditions in BMA, like in other developing cities, are rather unpredictable and are frequently highly congested. Thus, a subjective perceived accessibility was considered as a better measurement to capture the accessibility to various activity locations available from individuals’ residential locations. The profile of the samples used in this study is illustrated in Table 1.

Activity diary contained 23 activity participation classified into in-home mandatory, in-home maintenance, in-home leisure, out-of-home mandatory, out-of-home maintenance, out-of-home leisure and travel participation. Activities are categorised as mandatory when a particular activity is defined to be difficult to be re-scheduled [15] with higher temporal and spatial fixity such as working, going to school and pick up/drop activities [16]. Whereas, activities with higher temporal and spatial flexibility which can be easily re-scheduled is classified as discretionary activities such as maintenance and leisure activities [15,16].

[Type here]
Another activity classification included in this study is multitasking activities. In this study, multitasking is considered as undertaking secondary activity participation in conjunction with primary activity [6,7] for satisfying different needs and desires at the same time. Passive leisure such as listening to music, watching TV, checking internet and socializing was the only possible secondary activity accounted in this research. Passive leisure can be found to be combined with all type of activities such as in-home mandatory, in-home maintenance, in-home leisure, out-of-home mandatory, out-of-home maintenance and out-of-home leisure. For this research, adult respondents who have geographical and multitasking activities were included. It means that only around 534 respondents were included.

Table 1. Profile of the samples used in the study

| Variables | Percentage or Mean |
|-----------|--------------------|
| Socio-demographic characteristics at individual level: | |
| Male | 52.10% |
| Worker and non-worker | 43.64% and 31.05% |
| Is a dependent children (<= 14 years old) | 12.73% |
| Age (continuous) (years old) | 38.6 |
| Part of low income (< IDR 3 million/month) and medium income households (IDR 3-6 million/month) | 75.20% and 15.80% |
| Household characteristics: | |
| Number of household members | 4.52 |
| Number of dependent children per household | 0.83 |
| Number of motorised vehicles per household | 1.77 |
| Reside within the inner city boundary of BMA and within Greater BMA | 44.90% and 37.90% |
| Trips engagements and travel time spent on weekdays (weekends): | |
| Number of trips | 2.64 (2.29) |
| Number of trip chains | 1.26 (1.08) |
| Percentage of using motorised mode | 39.19% (36.77%) |
| Percentage of using public transport | 14.88% (9.55%) |
| Percentage of using non-motorised mode | 34.49% (32.08%) |
| Total travel time spent from Monday-Friday (minutes) | 74.87(69.35) |

Table 2. Model classification for activities criteria

| Code | Activities Criteria | Classification |
|------|---------------------|----------------|
| A    | Sleeping at home    | MANDI          |
| B    | Personal care at home | MANDI         |
| C    | Eating and drinking at home | MANDI |
| D    | Relaxing activities at home | LEISI |
| E    | Social and family activities at home | LEISI |
| F    | Household activities at home | MAINTI |
| G    | Babysitting activities at home | MAINTI |
| H    | Indoor working activities | MANDO |
| I    | Out-of-home social activities | LEISO |
| J    | Outdoor working activities | MANDO |
| K    | Sales activities from door to door, delivery something, purchasing activities | MAINTO |
| L    | Indoor school activities | MANDO |
| M    | Outdoor school activities | LEISO |
| N    | Eating and drinking outside home | MANDO |
| O    | Shopping activities | MAINTO |
| P    | Organization/ Volunteer/ Political activities | LEISO |
| R    | Sport activities | LEISO |
| S    | Maintenance activities (out-of-home) | MAINTO |
3 Day-to-day individuals’ multitasking activity participation

Each individual has his/her own travel behavior and each of them is different. The time-space prism can analyzes the human travel behavior where it can display the interaction between individual’s time-space needs and constraints. The time-space needs and constraints are basically influenced by their personal and household socio-demographic characteristics and their socio-environmental conditions. Moreover, Figure 1 shows the distribution of day-to-day individual’s percentage of undertaking multitasking activities for different socio-demographic variables. From Figure 1, it can be shown that individuals’ participation on multitasking activities within travel is different from day to day. Participation of multitasking activities within travel is drop on Sunday and raising up again on Monday.

From the graph, individuals that have high income had the highest percentage of doing multitasking in travel. Besides, female also have high percentage of doing multitasking in travel right after the individuals that have high income. Surprisingly, workers and students does not have much difference of percentages in doing multitasking in travel. Perhaps because they both need to multitask due to time and space constraints.

From the survey, the data is analyzed by plotting the graph of time used of activities against the multitasking activities in travel. Figure 2 shows the time used for out of home mandatory activities and time used for in home mandatory activities of individual with high and low percentage of doing multitasking. Out of home mandatory activities consist of activities like working, going to school or study place and dropping off children while the example of in home mandatory activity is personal care. Based on the Figure 2, the ones who do high percentage of multitasking activities within travel are the ones who undertake longer time for in-home mandatory and out-of-home mandatory activities. It shows that the ones who have tighter time and space constraints for undertaking longer working/school time tends to do higher percentage of multitasking in travel.

Next, Figure 3 show the line graph of time used for out of home maintenance activity with high and low percentage of undertaking multitasking in travel. The example of out of home maintenance activity are going for grocery shopping or doing out of home personal care. The line graph shows that time used for out of home maintenance activities of individual that do multitasking for in home maintenance activity is the highest. This shows that the ones who undertake multitasking in travel is the ones who undertake longer time for in-home maintenance activities and grocery shopping.

Furthermore, Figure 4 shows the line graph of time used for in home and out-of-home leisure activities of individuals with high and low multitasking activities. The example of in home leisure activities are watching television, listening to radio and socializing with family members while the example for out-of-home leisure activities are participating in any other social activities
outside home and doing sports activities as well. Figure 4 shows that the ones with longer in-home leisure and out-of-home socializing time are the ones who have higher percentage of multitasking activities.

This chapter can show how individuals tend to have different day-to-day activity participation on different activities. Individuals tend to do longer mandatory activities time on weekdays and shorter on weekends, but the pattern is on other way around out-of-home discretionary activities such as socializing activities, sport, grocery shopping and other maintenance activities. It seems that the ones who undertake longer in-home activities either mandatory or discretionary tend to have higher percentage of undertaking multitasking within travel. It may mean that the ones who undertake higher percentage of multitasking within travel is not necessary the ones who have tighter time-space constraints such as longer working/school time and out-of-home discretionary activities. The ones who undertake longer in-home activities as most housewives always do could do higher percentage of undertaking multitasking within travel.

Fig. 4. Day-to-day individual’s time use for undertaking leisure activities of the ones who undertake low and high percentage time of engaging multitasking within travel

**4 The proposed model**

The purpose of the proposed model structure is to better understand the relationships between spatiotemporal variables and the nature of undertaking multitasking in travel. Moreover, the endogenous multitasking activities within travel is assumed to interact with spatiotemporal discretionary activities such as socializing activities, sport, grocery shopping and other maintenance activities. It seems that the ones who undertake longer in-home activities either mandatory or discretionary tend to have higher percentage of undertaking multitasking within travel. It may mean that the ones who undertake higher percentage of multitasking within travel is not necessary the ones who have tighter time-space constraints such as longer working/school time and out-of-home discretionary activities. The ones who undertake longer in-home activities as most housewives always do could do higher percentage of undertaking multitasking within travel.

![Figure 5. Proposed Model Structure](image)

Hierarchical linear regression was used in this research. It means that for this research, the day-to-day variability of individuals’ activity participation was ignored. However, the different daily variability of individuals’ activity-travel participation can be acknowledged in different average time of a particular activity or travel participation. The idea of this research is just to show whether the endogeneity problem can be solved with the proposed model without including day-to-day variability. Without this method, the influence of day-to-day percentage of time engaging with multitasking activities within travel on daily well-being may not be seen due to correlation with other independent variables.

To more clearly show the model in Figure 5, with mathematical forms, Equations 1 to 2 were written as follow:

\[
\text{Multi}T_i = \beta_1 W_i + \beta_2 R_i + \beta_3 \text{Time-Act}_i + \beta_4 \text{Travel}_i + \varepsilon_1, \quad (1)
\]

\[
\text{DW}B_i = \beta_5 W_{hi} + \beta_6 R_i + \beta_7 \text{Time-Act}_i + \beta_8 \text{Travel}_i + \gamma_i \text{Multi}T_i + \varepsilon_2, \quad (2)
\]

**5 Model estimation result**

### 5.1 Multitasking in travel

Table 3 shows the variables that are significance to multitasking in travel. This means that these variable positively or negatively correlate with the tendency of individual to do multitasking in travel.

From the results, it shows that the workers tend to do more multitasking in travel compared to non-workers and students. Workers tend to have tighter time and space constraints than non-workers and students hence they need to do multitasking in travel to ease their work loads [1,2,3,18,19,20,21]. Moreover, the individuals with middle income have higher tendency to do multitasking in travel than the individual with high income. It is presumably because middle tends to do more trips [18,19,20]).

The result from occupation and income variables is inline with result from activity participation variables. The ones who have commitment to undertake longer out-of-home activities tend to perform high percentage time of engaging multitasking in travel. However, the result is opposite when someone has commitment to undertake
longer time for maintenance activities. As expected, when more advanced model is applied, people with tighter time-space constraints tend to do multitasking in travel more often than the ones with higher commitment to undertake in-home maintenance activities such as housewives [1,2,3,18,19,20,21]. The magnitude is higher when someone has commitment to undertake out-of-home maintenance activities. Undertaking a planned discretionary activities such as out-of-home maintenance activities is not routine and might be considered as a planned discretionary activities whereas out-of-home leisure activities are considered as impulsive activities in Asia/Indonesia context [15,21]. It means that performing a planned discretionary activities tend to make travellers to have tighter time and space constraints. Therefore, it seems logic when undertaking a planned discretionary activity has a higher magnitude in undertaking multitasking more often than a routine out-of-home activities such as working and studying time at school, and an impulsive activity such as a leisure activity. Furthermore, the results also showing the individuals that are using public transport are more likely to do multitasking in travel. This is the advantage of taking public transport than motorised mode. Undertaking public transport provide opportunities to undertake passive leisure while riding [10,12]. From perceived accessibility variables, it shows that having longer travel time to achieve basic amenities such as CBD, shopping centre and government office tends to make someone to take higher percentage time of engaging multitasking activities within travel. However, residing in an area farther from grocery store tend to make travellers to undertake less percentage time of engaging multitasking within travel.

| Variables | Multitasking in Travel | Daily subjective well-being |
|-----------|------------------------|-----------------------------|
|           | Coeff | T-stat | Coeff | T-stat |
| Intercept | -30.394 | 12.591 | 6.120 | 11.972 |
| Male (vs. female) | 9.494 | 2.832 | 0.291 | 3.367 |
| Workers | -12.452 | 6.075 | 0.380 | 2.519 |
| Non-workers | Ref | Ref | Ref | Ref |
| Aged < 22 | 9.796 | 5.617 | | |
| Aged 23-45 | -8.454 | 5.579 | | |
| Age 55+ | Ref | Ref | Ref | Ref |
| From low income household | 14.133 | 2.687 | | |
| From middle income household | Ref | Ref | Ref | Ref |
| Number of household members | Ref | Ref | Ref | Ref |
| Number of dependent child/children within household | Ref | Ref | Ref | Ref |
| Access to motorised mode | Ref | Ref | Ref | Ref |

Table 3. Model estimation result

| Variables | Multitasking in Travel | Daily subjective well-being |
|-----------|------------------------|-----------------------------|
| Resident of Greater BMA area (vs. central city) | 0.457 | 2.403 |
| Number of trips | -0.045 | -2.202 |
| Number of trip chains | 0.066 | 1.942 |
| Total daily travel time (minutes) | 0.195 | 0.042 |
| Percentage of using motorised mode | -0.005 | -4.349 |
| Percentage of using public transport mode | -0.001 | -3.253 |
| Time spent for in-home mandatory | -0.010 | -2.669 |
| Time spent for in-home maintenance | 0.031 | 10.974 |
| Time spent for in-home leisure | 0.010 | 2.543 |
| Time spent for out-of-home mandatory | 0.069 | 7.889 |
| Time spent for out-of-home social activities | 0.100 | 9.899 |
| Time spent for grocery shopping | 0.035 | 1.782 |
| Time spent for other out-of-home maintenance | 0.087 | 2.479 |
| Time spent for out-of-home sport activities | 0.132 | 4.714 |
| Percentage of time engaging with multitasking activities within travel | 0.150 | 9.166 |
| Percentage of time engaging with multitasking activities within in-home mandatory | 0.047 | 3.262 |
| Percentage of time engaging with multitasking activities within in-home discretionary | Endogenous of percentage of time engaging with multitasking activities within travel (MultIT) | |
| Percentage of time engaging with multitasking activities within working and studying activities | |
| Percentage of time engaging with multitasking activities within grocery shopping | |
| Km-length of road/km² within the respondents' residential location | -0.500 | -2.323 |
5.2 Daily subjective well-being

Table 3 shows the variables that are significance to individual’s daily subjective wellbeing. This shows that these variables positively or negatively correlate with the individual’s daily subjective wellbeing.

From the results, it shows that as expected the endogenous of percentage time of engaging multitasking in travel shows positive correlation on improving individuals’ daily well-being. It also shows that when endogeneity problem has not been tackled, only few multitasking variables shows a significance result in improving individuals’ daily well-being. Moreover, longer time spent for obligation activities such as in-home maintenance and working/studying at school tend to decrease individuals’ well-being, whereas undertaking out-of-home discretionary activities such as grocery shopping and sport activities tend to improve individuals’ subjective well-being.

The ones who take more trips and trip chains tend to have different result on deteriorating or improving individuals’ daily well-being. Undertaking more trips within a separate trip chain tend to improve individuals’ daily well-being whereas taking more trips within a trip chain tends to show opposite result. It is presumably because the second and next trip chain tend to be utilized to perform more meaningful stops such as undertaking out-of-home discretionary activities [22].

Residing in an area that farther from city centre tends to reduce individuals’ daily well-being. Residing within an area with a dense plantation and settlement areas tends to be located farther from city centre [8,23,24,21]. Therefore, residing in those areas negatively correlate with improving daily well-being of individuals.

| Variables | Multitasking in Travel | Daily subjective well-being |
|-----------|------------------------|-----------------------------|
|           | Coeff                  | T-stat                      | Coef  | T-stat |
| the respondents’ residential location | -2.901 | -3.215 | -0.987 | -2.161 |
| Density of settlement area/ km² within the respondents’ residential location | -71.521 | 19.284 | -2.941 | -4.693 |
| Density of trade centre area/ km² within the respondents’ residential location | -1.332 | 0.379 | -0.762 | -2.189 |
| Density of industrial area/ km² within the respondents’ residential location | 2.094 | 31.614 | 0.136 | 1.614 |
| Perceived travel time to CBD (minutes) | 0.136 | 1.614 | -0.016 | -0.095 |
| Perceived travel time to government office areas (minutes) | 2.094 | 31.614 | 0.136 | 1.614 |
| Perceived travel time to shopping centre (minutes) | 1.332 | 0.379 | -0.762 | -2.189 |
| Perceived travel time to grocery store (minutes) | 0.136 | 1.614 | -0.016 | -0.095 |
| Perceived travel time to park (minutes) | 2.094 | 31.614 | 0.136 | 1.614 |
| Mean of the dependent variables | 3.790 | 4.910 | 17.412 | 0.833 |
| SD | 17.412 | 0.833 | 21.222 | 5.982 |
| Error term | -54300.75 | -18458.35 | -95697.49 | -37012.70 |
| AIC | -95050.68 | -37365.89 | -95697.49 | -37012.70 |
| BIC | -95697.49 | -37012.70 | -95050.68 | -37365.89 |
| Log likelihood | -54300.75 | -18458.35 | -95697.49 | -37012.70 |

6 Conclusion

Using hierarchical linear regression and multi-dimensional three-week household time-use and activity diary, this study investigated the interaction among spatiotemporal variables on percentage time of engaging multitasking in travel, and how endogenous of percentage time of engaging multitasking in travel interact with other spatiotemporal variables on individuals’ daily subjective well-being. The study excluded the day-to-day variability of activity and participation available in the dataset. However, the variability can be represented by average time amount for undertaking a particular activities. Different from descriptive analysis result, the result in using hierarchical linear regression shows that having tighter time-space constraints tend to positively correlate with performing multitasking activities within travel more often. Moreover, the ones who perform more trips such as the youngest travellers and someone from middle income tend to perform multitasking activities in travel more often. When travellers’ residence farther from their some basic amenities such as CBD, shopping centre and government offices, travellers tend to undertake multitasking within travel more often.

Endogenous of percentage time of engaging multitasking in travel shows positive correlation on improving someone’s daily well-being, as expected. Applying hierarchical linear regression tend to solve endogeneity problems that may appear between multitasking in travel variable and other spatiotemporal variables. Having commitment to perform longer obligation activity time such as working/studying at school time and in-home maintenance time tends to deteriorating individuals’ daily well-being. However, any commitments to undertake out-of-home discretionary activities tend to improve daily well-being. In Bandung or Indonesia context, different trip management tends to provide different result on daily well-being. People in Bandung tends to undertake out-of-home discretionary visit or more meaningful visit on the second or next trip chain, whereas in first trip chain tend to have less meaningful impact in regards of daily well-being.

In term of policy implication, travel is considered as the least enjoyable activities [25,26]. Therefore, undertaking passive leisure within travel can be suggested to improve someone’s daily well-being. The opportunity to undertake passive leisure within travel can be an
advantage of using public transport. The opportunity of having passive leisure more often during travel can be framed to attract more people using public transport in order to improve someone’s daily well-being rather than taking private motorised mode.

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