Travel Behavior Pattern in Yogyakarta Urbanized Area: How Does the Characteristics of Its Trip Pattern Related to Socio-Demographics and Urban Form?

By Mutiasari Kurnia Devi

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Abstract: The development of the region has been carried out expansively causing the urban sprawl phenomenon. This has an impact on increasing people's mobility to meet the needs of their daily movements. This paper focuses on travel survey which identifies the travel behaviour pattern particularly trip characteristics using home-survey data in Yogyakarta Urbanized Area (YUA). The study uses a quantitative approach to identify travel data including socio-economic, spatial aspects, and travel characteristics of the households. The results show that there are 9 (nine) types of daily travel patterns which applicable to the primary activity with work, school, and other purposes. Most of the home-based trips are work trip and other trip. The other trip purpose is carried out jointly in which executed by the needs to drop children to school as there are number of dependent children per household. The results of this study could potentially support the process in arranging urban transport policy in the future.

Keywords: Travel behavior, Travel pattern, Travel characteristics, Yogyakarta Urbanized Area

1. INTRODUCTION

Nowadays, the urban transport patterns have changed dramatically during the last several years. Each individual produces complex travel activity patterns as he/she participates in daily activities in different time and locations. This pattern has formed various of travel behaviours. Many researchers have conceptualized these observed patterns as the outcomes of choices which are made within constraints (Cullen, Godson, and Major, 1972; Kutter, 1973)

Currently, to stimulate economic growth, it is necessary to build an efficient transportation system and its infrastructure. To be able to plan this transport infrastructure efficiently and effectively, planners and engineers have to be able to respond the transportation demands. Travel demand models are used to predict travel characteristics, transport service consumptions, and land-use configurations (Papacostas and Prevedourous, 2005 cited in Kim et al., 2017).

Former studies have clearly demonstrated that individual and household socio-economic characteristics have a strong influence on travel mode choice selection (Miller et al., 2005).

Meanwhile, sociodemographic and spatial characteristics significantly affect travel demand (Tembe *et al.*, 2017) and are somehow related to travel behaviour patterns (Hanson, 1982; Chen and Akar, 2017; Pinjari *et al.* cited in Wongwiriya *et al.*, 2017), specifically travel chain, joint trips, and travel distance. While Ye *et al.* (2007) argue that the flexibility of automobile could provoke individual to undertake additional activities in their trip which yields complex trip chains.

Ho and Mulley (2012) discover that household travel decisions will depend on other household members travel behaviours (intra-household interaction). In similar fashion, Ansusanto *et al* (2011) argue that trip activities are highly influenced by family members. A prominent finding from their study is a family which has elderly member will have at least a single trip to go to health facilities. This pattern also applies in a family which has children. The parents will have a trip to go to school to drop their kids.

Urban transport studies have been done in many metropolitan areas of developing countries, such as in Bangkok (Thailand), Kuala Lumpur (Malaysia), Manila (Philippines) and Jakarta (Indonesia) (Wongwiriya *et al.*, 2017). These studies have been growing rapidly due to high growth of private mode of transportation. In addition to that, there is a new trend. This heavy migration also occurs in rural areas, especially in several cities in Indonesia. One of those cities is Yogyakarta. Yogyakarta is experiencing this fast growth of agglomeration or normally called as Yogyakarta Urbanized Area (YUA).

Yogyakarta is a medium-sized city that faces rapid urbanization and transport problems. The main issue is only a few studies discuss urbanization and travel behaviours in medium-sized cities. The urge and the lack of studies in this area become more important as there are many medium-sized cities are starting to experience these trends. Moreover, investigating the determinants of travel behaviours at the individual levels, which has been done in many metropolitan areas, is still vague. A plausible explanation for this argument is some researchers only focus on the role of sociodemographic and ignore the environmental variables (Hanson, 1982). A study of travel pattern in Jakarta metropolitan area also show that household and individual characteristics are the most significant variables affecting the interactions between activity-travel variables (Dharmowijoyo et al., 2016).

This study will analyse the travel behaviour in Yogyakarta, including its urban area. In YUA, there are number of trips which carried out as joint tours. Therefore, the intra-relationships among family members will have a significant role in determining and shaping travel patterns, travel modes and travel time (Azmi & Irawan, 2018).

The main goal of this paper is to reveal travel patterns based on trip characteristics within the area of study and activities based on travel demand models for YUA. This study extends former studies by considering socio-economic characteristics and its travel patterns. To broaden the research on medium-sized cities analysis, this study also adds the existing dimensions of travel behaviours, specifically socioeconomic and travel characteristics (trip types, trip modes, intra-household interaction, household structures, vehicle ownership, household income). This travel behaviour pattern will be useful to formulate the appropriate policy and regulation for sustainable urban transport system in Asian developing countries. This paper will provide not only some insights towards current theoretical and empirical issues, but also supports for urban transportation policies in the study area.

2. TRAVEL ACTIVITY PATTERN AND ITS INFLUENCE FACTORS

Travel demand modelling is a mathematical relationship between travel demand and travellers characteristics along with their system characteristics (Cascetta, 2009). There are several models, two of them are tour based and activity based model. Tour based approach considers

chain of trips starts and ends at the same location as the individual unit of analysis whereas activity based considers travel as a derived demand to satisfy the need of the individual (Lekshmi et al., 2016).

Travel pattern is defined as sequence of activities which done by individual within a day. According to its presence of both spatial and temporal constraints towards mandatory activities, travel pattern is distinguished into mandatory travel pattern and non-mandatory travel pattern (Paleti et al., 2015). Meanwhile, Dharmowijoyo et al. (2016) categorized the activity based on the time duration to mandatory activities and discretionary activities. Mandatory activities are related with activities that have a high level of temporal and spatial order (Shwanen cited in Dharmowijoyo et al., 2016), which includes priority activities such as work or school. While the discretionary activities include maintenance and leisure activities.

Bowman and Ben-Akiva (2000) define tour as a travel which originally from home to one or more activity locations and back to home again. Normally, daily activity patterns have a list of activities that an individual does in a day. Activity pattern comprises of important decisions that provide overall structure for the day's activities and travel. Each activity consists of primary and secondary tour, in which the primary tour is the most important activity in a day.

Tour type also can be defined as a number, purpose and/or sequence of activity stops on the tour. Table 1 presents primary activity and primary tour activity patterns from Bowman and Ben-Akiya (2000) study in Boston.

Table 1. Activity pattern alternatives in the Boston prototype

Decision	Choice alternative	Description
Primary activity	Home	At home all day
	Work	The activity pattern includes at least 1 work activity
	School	The activity pattern includes no work activities and at least 1 school activity
	Other	The activity pattern includes no work or school activities
Primary tour type	HWH	Simple tour from home to work and back
	HWH+	Work tour with at least 1 additional stop for another activity
	HW+WH	Work tour with a work-based sub-tour, and any number of additional stops
	HWHWH	Work tour with an intermediate stop at home
	HWHWH+	Work tour with an intermediate stop at home, plus 1 or more additional stops
	HSH	Simple tour from home to school and back
	HSH+	School tour with at least 1 additional stop for another activity
	HOH	Simple tour with purpose other than work or school
	HOH+	Tour with purpose other than work or school, with at least 1 additional stop for another activity

Source: Bowman and Ben-Akiva (2000)

Joint travel study has emerged since an individual travel decision is not restricted but affected by other household members (Ho and Mulley, 2013). Chandrasekharan and Goulias

(1999) also support this statement by arguing that the number of vehicle ownership as well as the presence of children in the family will influence the joint travel. In addition to that, Chen & Akar (201) say that joint travel captures intra-household interactions (Chen & Akar, 2017). As the example presented by Ansusanto et al. (2011), in families with elderly family members, there will be a shuttle activity for parents to health facilities, as well as families with school-age children who are not independent yet, there will be activities to escort children for school or day care. In connection with school transfer activities, Irawan and Sumi (2012) revealed that joint trips can also 35 m different patterns of travel and departure hours. In school-age adolescents, they prefer to arrive at school earlier than school entry. If delivered by family members and escorts back home, the child tends to arrive at school very early while if the delivery person travels to the workplace at the same time, the child will arrive at school when approaching the designated entry hour.

Moreover, urban for 5 is also reported as a potential effect on joint travel decisions because people, who are living in urban areas, have a 5 igher tendency to travel together (Vovsha *et al*. cited in Chen & Akar, 2017). However, since travel is a derived demand of 5 ndertaking activities (Kitamura, cited in Chen & Akar, 2017), so the decisions for traveling with other household members will depend on the activities that they do. Thus, trip chaining can influence joint travel involvement.

3. DATA AND METHODOLOGY

To study the travel patterns, this research focused on travel behaviour dimensions, such as trip distribution, trip types, trip modes, household income, household structures, vehicle ownership and driving license ownership. These factors can represent socio-economic and travel characteristics accordingly. In order to obtain this information, a comprehensive household survey was conducted by distributing questionnaires in YUA. This survey was done in August 2018.

The questionnaire has three sections. The first section is the information about respondent household characteristics, such as household structure, vehicle ownership, driving license ownership, and household income. The next section contains activity and residential location characteristics, such as public transport accessibility, residential location decisions, and public facilities in surrounding area. The last section gather travel behaviour information, specifically travel modes and travel chain information.

Respondents were chosen by using multistage proportional sampling method. In order to control spatial factors which can alter travel behaviour, it is very important to classify the study area based on urban form characteristics. The categorization of urban typologies is measured by density, diversity and accessibility within the area of the study. The values of these variables were averaged and used to divide the urban forms into three domains (high compact, middle compact and low compact). High compact has high value of density, diversity and accessibility, whilst medium compact and low compact have medium and low value of these three factors accordingly

In order to be able to represent each typology in YUA, this study applied Slovin Sampling Theory with significance level 95% and sampling error 0,5. As the total population of YUA is 1.053.711 people (BPS, 2016), the minimum total number of sample in each area is 400 respondents. In this research, there are 5 sub-districts of low and middle compact and 4 sub-districts of high compact. The number of household sample in each sub-district was obtained by calculating the proportional number of population in each sub-district. Figure 1 and Table 2 show the number of sample distribution in every district.
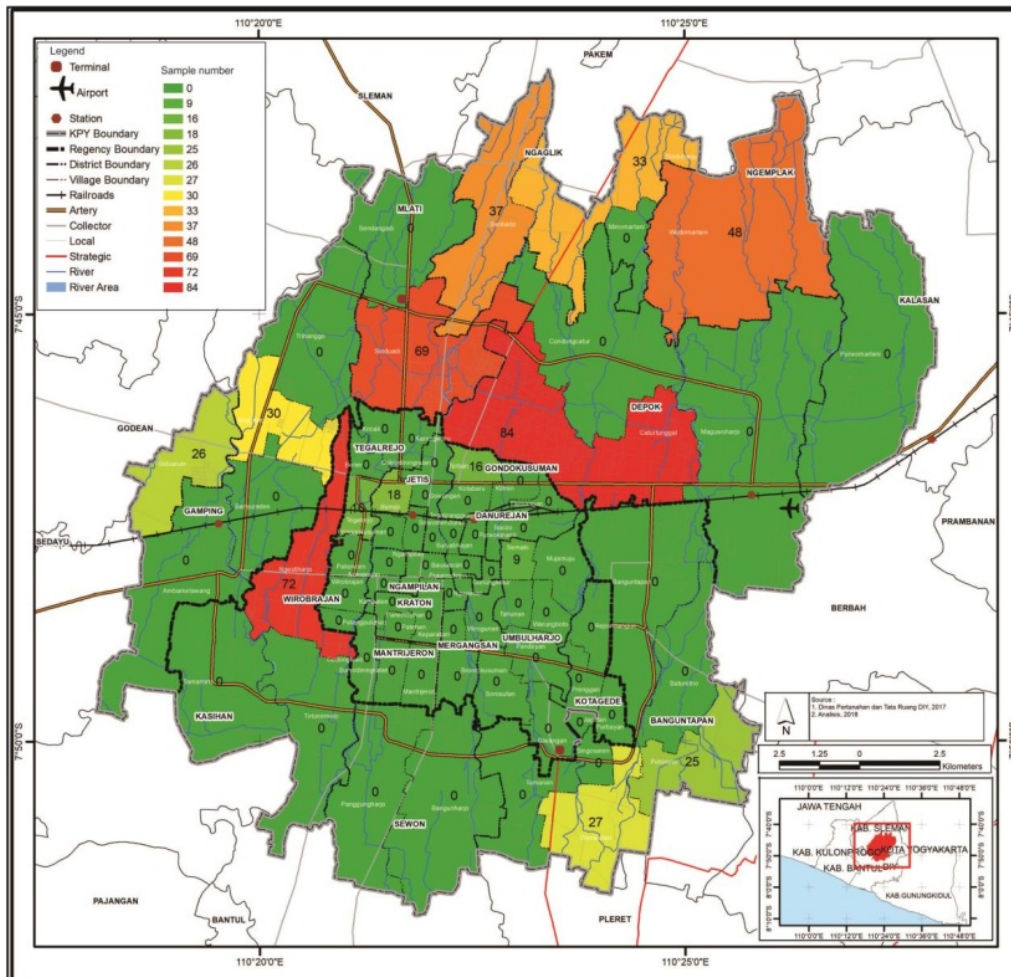
Figure 1. The distribution of sample within YUA area

Table 2. Sample number distribution based on study area

District		Sub-district	Number of Household Sample	TOTAL
LOW	Banguntapan	Wirokerten	27	159
		Potorono	25	
	Ngaglik	Sinduharjo	33	
	Ngemplak	Wedomartani	48	
	Godean	Sidoarum	26	
MIDDLE	Tegalrejo	Tegalrejo	16	164
	Umbulharjo	Semaki	9	
	Kasihan	Ngestiharjo	72	
	Ngaglik	Sariharjo	37	
	Gamping	Nogotirto	30	

	District	Sub-district	Number of Household Sample	TOTAL
HIGH	Jetis	Bumijo	18	187
	Gondokusuman	Terban	16	
	Depok	Caturtunggal	84	
	Mlati	Sinduadi	69	

The focus of this paper is confined to the relationship between travel and the attributes of individuals as well as the impact of spatial constraint. Socio-economic status is found to affect travel particularly mode choice, travel frequency, and distances travelled. Socio-economic status in this study is described through income, automobile availability, and household structures. Travel pattern is very complicated. Therefore, it is very crucial to collect spatial and temporal data for some period of time with the entire out-of-home activities, (i.e. day, week or month) (Hanson, 1982). U 37 analysis of this paper is a home-based tour. In other words, this tour can be identified as a sequence of trips starts and ends from home (Shiftan, 1998 cited in Ho and Mulley, 2012; Primerano *et al.* cited in Chen & Akar, 2017).

Joint travel can be defined 30 household trips which involves two or more household members. It has two types. First, a pure joint tour, the members of joint parties travel together throughout the tour. On the other hands, a mixed tour means one or more trips are made independently by one or more of the joint member activities. In other words, the trip is made independently by the household members. Table 3 describes the variables and their definitions.

Table 3. Variable used in this study

Variable name	Variable
Travel pattern	
TRIPACT	Trip activities
INTRAINT	Intra-household interaction
MODE	Travel mode
Socio-economic	34
HSIZE	Number of people in the household
CHLD	Number of dependent children per household
HINCOME	Household average income in month
AUTO	Motorized vehicle availability: number of vehicles owned by household
DLICENSE	Driving license ownership both for type A (car driving license) and type C (motorcycle driving license)

4. RESULTS AND DISCUSSIONS

4.1 Yogyakarta Urbanized Area (YUA) Characteristics

Yogyakarta Urbanized Area (YUA) is an area that is formed from physical development of Yogyakarta. Following the regulation of Special Region of Yogyakarta no. 20 2010, YUA only covers several areas such as the city centre, a part of Sleman Regency and a part of Bantul Regency. However, Yogyakarta Urban Agglomeration Area is growing denser year-by-year. The density of residential areas in YUA increased from 27,06 in 2004 to 351,81 in 2015 (Fitria, 2018). One of the main causes is its urban development is highly influenced

by the travel patterns of its population.

The city development of Yogyakarta occurs horizontally, which is more centred in the northern side of the area. This is quite reasonable since the development follows the road network, so people will have higher accessibility and transportation services are needed to accommodate those who do not live in the city centre (Strategic Area Spatial Planning Document, 2016). In contrast, the development of YUA residential areas is more focused on the southern part of the city, specifically in Bantul Regency. Fitria (2018) reports that the sub-districts that had risen sharply in Bantul Regency from 2004 until 2015 were Sewon, Banguntapan and Kasihan.
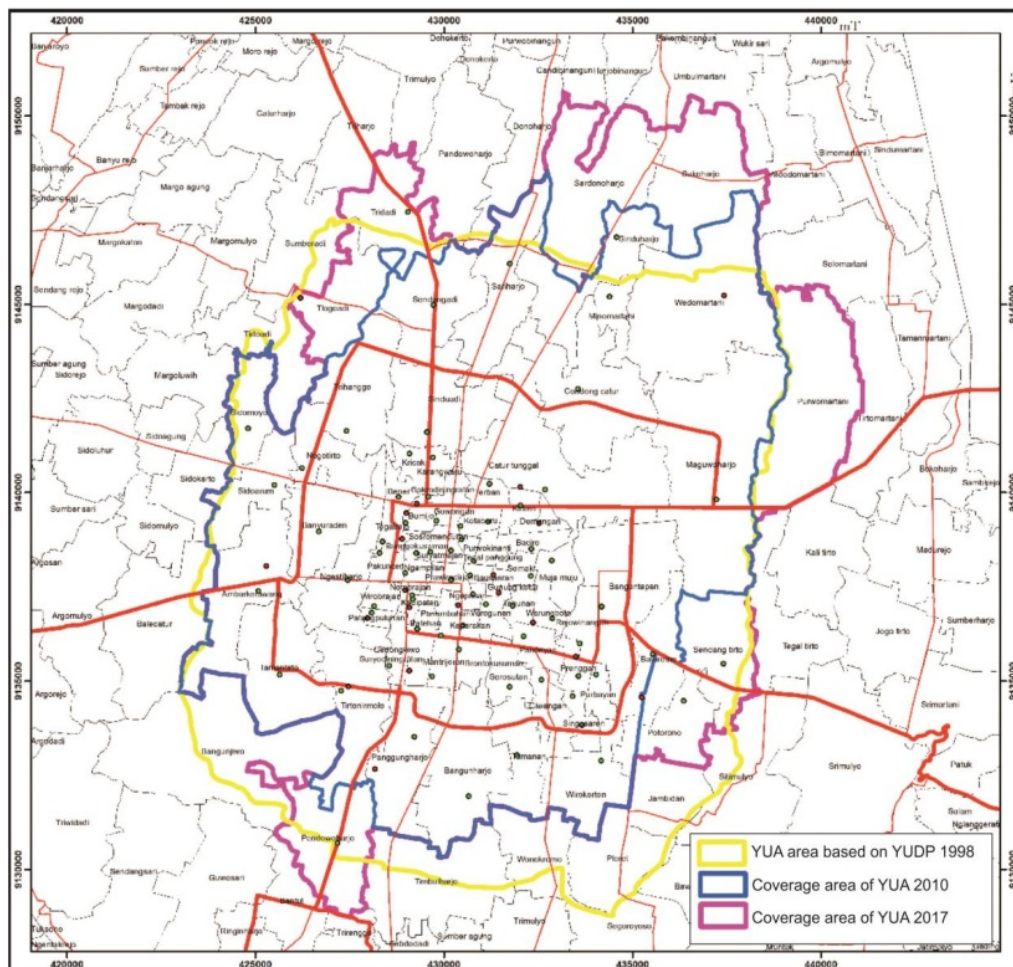

Figure 2. The development pattern of Yogyakarta agglomeration in 1998-2017

Figure 2 presents the growth of urban characteristics in YUA from 1998 to 2017. It exhibits that the development in the northern area is greater and denser than the development in the southern part. Commercial and newly residential areas are the main factors that significantly affect this development. Furthermore, high intensity of activities, which changed rapidly in very short-time, creates activity concentration in several areas, mainly in Depok District. This produces leap frog development. In other words, several villages experience

heavy migration and high urbanization.

4.2 Descriptive Analysis

The measures of travel activity pattern obtained in this study were generated from the information of the respondent towards their trip experience which they mostly done during the week. Table 4 summarizes the descriptive data of YUA. Majority respondents live in greater area of Yogyakarta (57.25%), followed by those who live in sub-urban (31.2%) and only 11,57% of the total respondents live in the city centre of Yogyakarta.

Among these respondents, 31.8% of them have type A driving license, a license that is needed to be able to drive a car. Meanwhile, 92,3% of the total respondents have type C driving license, a license that allows the respondent to drive a motorcycle. These two subjects choose motorcycle or car as their daily travel mode to reach their regular destinations. As it can be seen in Figure 3, 85% of respondents ride motorcycle (MC) as their main travel mode. In average, the number of motorcycle owned by household is 2,08/household. Meanwhile, the other respondents reported that they normally use Non-Motorized Transport (NMT) and/or drive a car to reach their destination (10% and 5% respectively). Surprisingly, although 25,54% of respondents have cars, it does not mean that this travel mode (car mode) share nearly as high percentage as other travel mode (bicycle mode). Speaking of monthly income, majority residents in YUA are classified as medium income group (around 73.47%). The percentage of low income group is approximately 18% and only 8.51% of total respondents are high income.

Table 4. Descriptive analysis of the variables

| Variables	Percentage/mean (SD)
Number of household members per household	3.72 (1.18)
Number of dependent children per household	0.59 (0.77)
Car ownership	25.54
Number of motorcycle ownership	2.08 (1.06)
Bicycle ownership	44.55
Driving license ownership (type A)	31.8
Driving license ownership (type C)	92.3
Low income	18.02
Medium income	73.47
High income	8.51
Residing in the Yogyakarta city area	11.57
Residing in the greater Yogyakarta area	57.25
Residing in Yogyakarta sub urban area	31.2
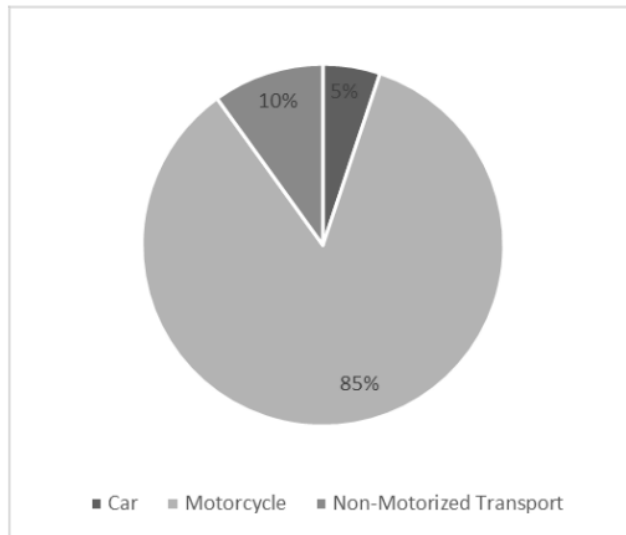
Figure 3. Mode share of residents in YUA

Drawing insight from how travel patterns shape the structures of city, low density areas tend to generate fewer trips of non-motorized transport than high density areas do (21,5%). The plausible reason is, high density areas are caused by the concentration of workplace and other service functions in their surroundings. Figure 4 indicates that even though non-motorized transport in high compact are greater than in other areas, car and motorcycle are still the most popular travel mode for those who live not only in high compact area, but also middle compact area.

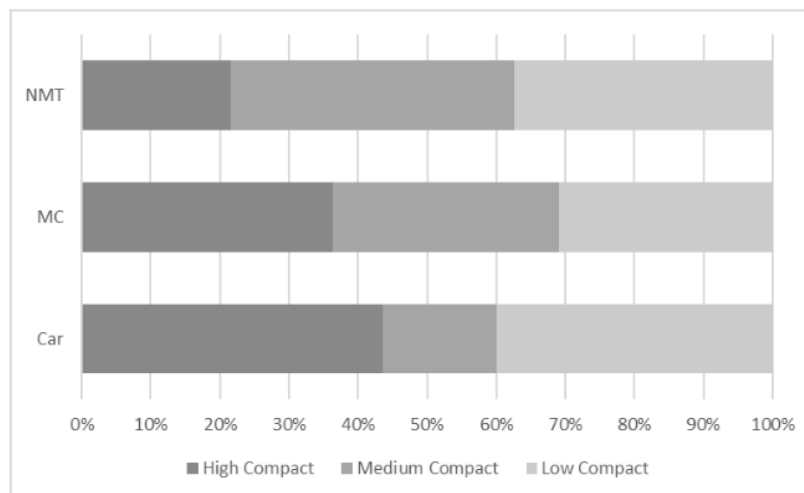Figure 4. Distribution of travel mode based on residential location

Figure 5 points the consideration to select certain mode for daily trips. Possibility to save the cost and flexibility to reach the destination are the most dominant reason in opting daily travel mode. This is followed by time efficiency. Nearly 43,5% of respondents stated that they prefer to use travel mode which can save their time or which can reach the

destination faster. Indeed, both car and motorcycle are more convenient than NMT, and can meet almost all the demands of selecting the daily travel mode. Therefore, the two modes definitely contribute as the biggest travel modes in YUA.
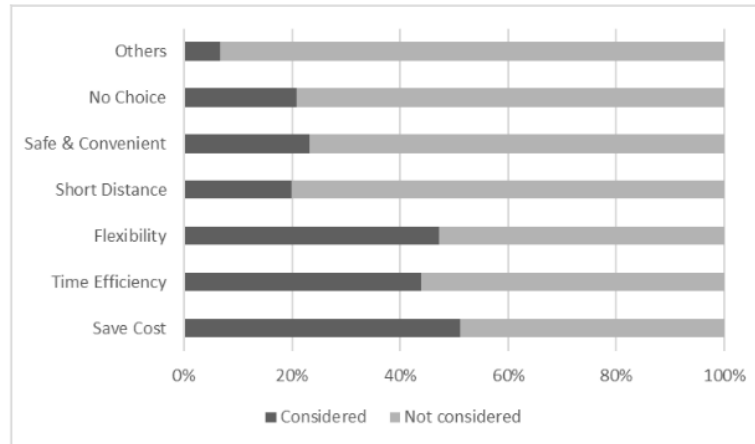

Figure 5. Reason on mode choice decision among households in YUA

4.3 Trip Pattern in YUA

Table 5. Travel Activity Pattern in YUA

Primary Activity	Choice Alternative	Frequency (%)
Work	HWH	46,11
	HWH+	6,06
	HW+WH	1.21
	HWHWH	0,87
	HWHWH+	1,47
School	HSH	15,40
	HSH+	1,12
Other	HOH	26,21
	HOH+	1,56

In total, there were 1156 tours collected which then classified based on its primary activity. According to Bowman and Ben-Akiva (2000), primary activity is the most important activity in a day. There are three type of activities to be classified as primary activity in this study which are work, school, and other trip. As this classification is somewhat quite limited, it is suggested more appropriate classification in which distinguish subsistence (work or school), maintenance (household or personal business activities), and leisure (activities engaged for pleasure, recreation or refreshment). For this study purposes, the sample included 642 work tours and 514 non-work tours. Non-work tours are trip with the purpose for school and other trip.

Trip pattern in this study is modified from the concept patterns of Bowman and Ben-Akiva (2000). Tour type is defined by the number, purpose, and sequence of activity stops on the tour. The prototype partitions the observed work tour types into five categories. The three predominant categories are (a) the tour from home to work and back again with no additional stops (HWH), (b) the tour with at least 1 additional stop for another activity (HWH+), and (c) the tour involving work activities in more than one different locations as well as any number (including zero) of additional stops for other activities (HW + WH). Two

additional work tour categories involve mid-tour returns home, one with no additional activity stops (HWHWH) and another with one or more additional stops for another activity (HWHWH+). While for the school and other tour types divided into two categories for each type. School and other tours received a similar categorization involving only the first two work tour types. Travel or chain with one stop or activity outside the home is defined as a simple tour, while a tour with a number of stops more than one is defined as a complex tour (Ye, Pendyala, and Gottardi, 2007).

By evaluating the respondent primary activity, in Table 5, it can be concluded that HWH patterns dominate the alternative activity patterns (46,11%). HOH patterns earn second place with 26,21% and HSH patterns is slightly below HOH patterns (15,40%). This outcome reveals that the majority of trips which were done by residents in YUA are direct trip patterns. As this study applied a home-base trip approach, people will start their journey from home and go directly to desired destination of their primary activities, then end their tour at home without stopping in any location in between this round-trip.

The results shown in Table 5 also highlight that the most home-based trip is work trip. It can be seen that primary activity, in particularly work trip, creates various of alternative travel patterns compared to other primary activities (School and other primary activity). This study expands Azmi and Irawan (2018) study which also analysed travel behaviour in YUA. In their study, the largest activity patterns are HW+WH, HWH, and HWH+ respectively. The main reason for this difference is data collection method. This paper used household survey that recorded all household travel reported by one of the household member. This condition can cause the household trips were not reported in detail, especially trips from other household members.

Ho and Mulley (2012) reveal that intra-household interactions means that the travel decisions of household members will be depend on the travel behaviour of the other members. In order to analyse the intra-household interaction toward travel decision, we divided the trip into two types which according to what Ho and Mulley (2013) discussed in their study. Basically, the trip is categorized based on how travel is carried out, whether by traveling alone or delivering other family members. Single tour is defined as a trip which done by the travellers alone, while joint trip is a trip involving the activity of delivering family members.
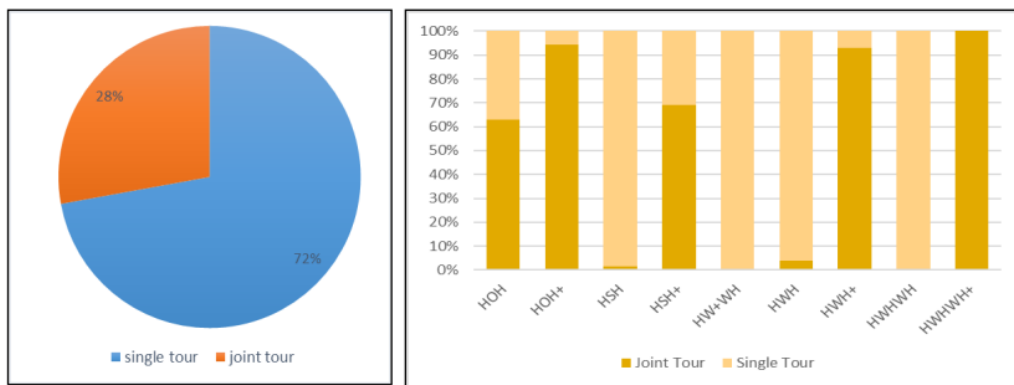

Figure 6. Home-based trip types in YUA and choice alternatives

The pie chart in Figure 6 explains that only 28% of the trips are made jointly. Majority respondents do a single tour. In addition to that, the table in Figure 6 shows HWHWH+ patterns almost 100% are made jointly. The urge and the need of other household member activities influence HWHWH+ patterns.

In average, approximately 63% of the HOH pattern are joint trips. Most of the trips happens because of the desire to take their children to school. Although, the average number of dependent children is only 0,59/household, amazingly, it gives great impacts on the intra-household interaction. HOH pattern become the second largest pattern made by YUA residents. However, about 63% of the trips were made jointly. Most of those trips are derived from the needs to take their children to school. Though the average number of dependent children per household is 0.59, it still gives greatly effects on the intra-household interaction in which can be seen through the joint trip involvement.

A: single tour, trip from home to work and back to home

B: single tour, trip from home to work with one stop

C: Joint tour, trip from home to work with stop for dropping off family members

D: Joint tour, trip from home to work with stop for picking up family members

E: Joint tour, trip from home to work with stop for dropping off and picking up family members

F: Single tour, trip from home to work with or without stop, involving work activities in more than one location

G: Joint tour, trip that happened only for dropping off and picking up family members

H: Single tour, trip from home to work, back to home, and repetition occurs

I: Joint tour, trip from home to work, back to home and repetition occurs with additional stops for dropping off and picking up
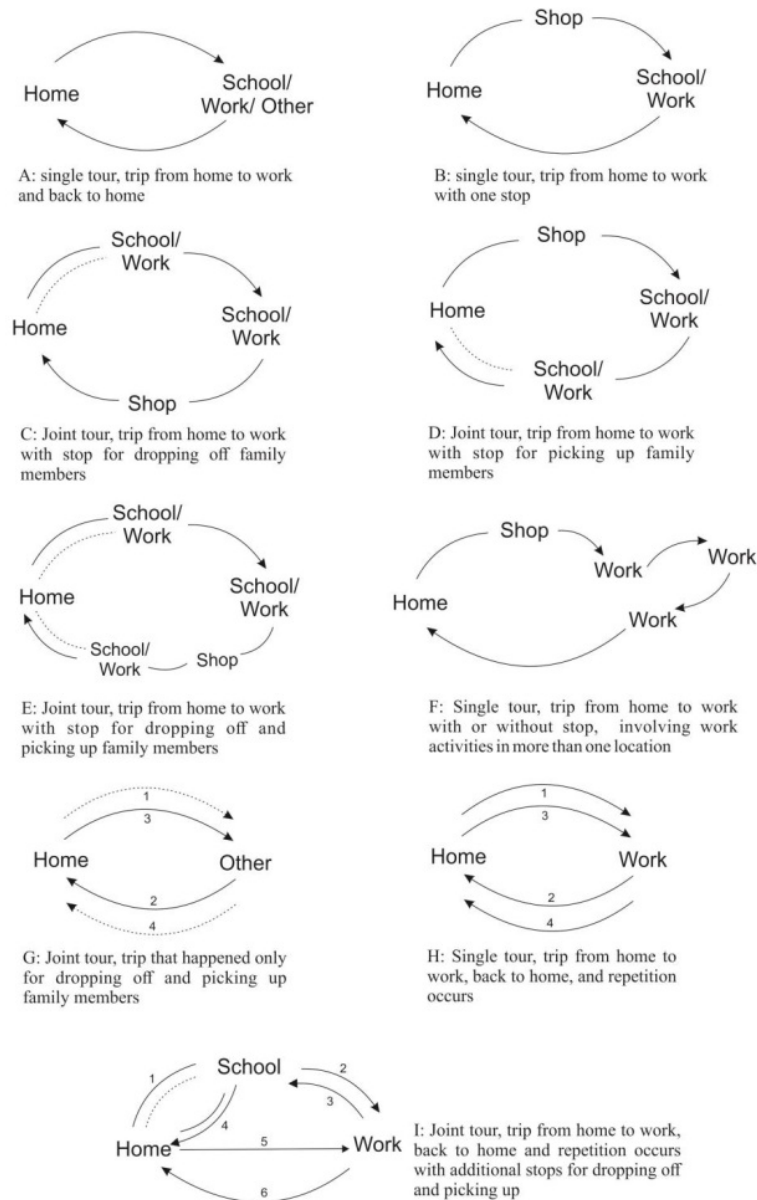
Figure 7. Type of trip patterns in YUA (modified from Azmi & Irawan, 2018)

Furthermore, the results of analysis show that there are 9 (nine) types of trip patterns in YUA as illustrated in the Figure 7. The dashed lines indicate that the trip is a joint tour. According to the typology that was formed in Figure 7, it is known that five types of the trips made in YUA are a joint tour trip (C, D, E, G, and I) while the rest of the trips are made as a single tour trip (A, B, F, and H). Moreover, regarding its complexity, only 2 types of trips are simple tour, which are trip type A and type G. It is interesting by the fact that based on its travel activity pattern which shown in Table 5, most of the trips are a direct trip pattern which can be also considered as simple tour. However, the complex tours in YUA can be drawn into 7 types of trip pattern as represented in Figure 7.

Table 6. Cross Tabulation of mode choice and tour type in YUA

Mode Choice	Tour Type		Grand Total
	Complex	Simple	
NMT	3,52%	9,86%	9,08%
Car	6,34%	5,13%	5,28%
MC	90,14%	85,01%	85,64%
Grand Total	**100,00%**	**100,00%**	**100,00%**

Table 6 show simple cross-tabulations of tour complexity against mode choice. It is indicated that almost 10% of simple tours involve the use of NMT as the primary mode of transportation. This value is considerably lower at 3,5% for complex tours. It also happens on automobile use, as the proportion of car and motorcycle use for complex tour (96,5%) is higher than the simple one (90%). This phenomenon can be indicated as there is at least small correlation between the mode choice and tour complexity. In this case, it can be concluded that people with simple tour will tend to use NMT mode as it involves only one stop. Conversely, they who have complex tour will choose automobile for their travel mode.
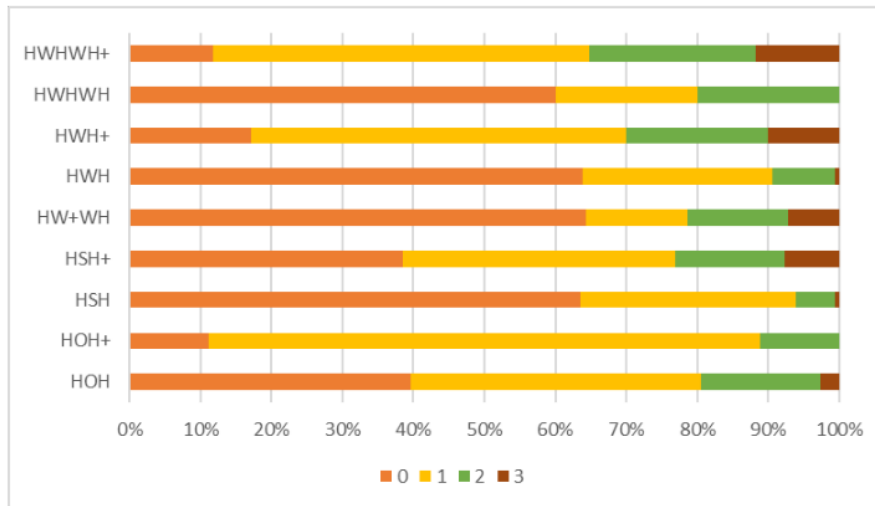

Figure 8. Trip patterns and number of children to be escorted in YUA

Previous study found that characteristics of the parents will influence travel mode of school trip in which non full-time workers are more likely to transport their children to school (Yarlagadda and Srinivasan, 2008). In this study, it is explained through the HOH pattern

which mostly appear as the urge of parents to escort their children to school. From Figure 8 above, it can be seen that more than 60% of HOH pattern have children who need to be escorted. Meanwhile, HWH and HSH pattern which considered as single tour were comprised mostly by household who have no children to be escorted (63,8% and 63,5% respectively).

Table 7. Cross tabulation of urban form typology and tour type in YUA

Urban Form	Tour Type		Grand Total
	Complex	Simple	
Frequency			
HIGH	47	367	414
MIDDLE	41	336	377
LOW	54	311	365
Total	142	1014	1156
Column percentage			
HIGH	33,10%	36,19%	35,81%
MIDDLE	28,87%	33,14%	32,61%
LOW	38,03%	30,67%	31,57%
Total	100%	100%	100%

Table 7 represents the cross-tabulation between urban form typology and tour complexity. Regarding its urban form typology, there are no major differences on the tour type occurrences whether complex tour or simple tour. However, middle compact area has the lowest proportion of complex tour than two other typologies. Low compact typology has high complex tour involvement. In other words, people, who live in this area, have higher tendencies to produce trips with multiple stops. In contrast, simple tour is more likely to occur in high compact area. These outcomes have confirmed that urban form typologies can influence travel behavior, specifically tour complexity.

5. CONCLUSIONS

This paper focuses on revealing the travel behaviour patterns particularly trip characteristics using home-survey data in Yogyakarta Urbanized Area (YUA). There are 9 types of daily activity travel patterns in YUA. HWH patterns have the biggest proportion, followed by HOH patterns and HSH patterns respectively. Mostly, those trips are a single tour for all the primary activities (work, school and other destinations). Both HWH pattern and HSH pattern are individual trip, while HOH patterns mostly are joint trip. This outcome explains that the need to deliver their children at school influences the intra-household interaction.

Regarding socio-demographic aspect, results from this study show that number of dependent children can be related to trip patterns. Households with number of children who need to be escorted are more likely to carry out joint tour. Spatial aspect is also found to be related with tour complexity. Higher compact area will lead to simpler tour rather than area with low compact.

Findings from this study can be supported to transport policy strategy formulation, particularly for medium-sized city in developing country. Creating more compact area will indirectly decrease the involvement of joint trip as well as complex tour within daily activity pattern. Intra-household interactions which explained in this study through joint tour is triggered by the household structure condition where there are dependent children who need

to be dropped to school. School location and residential environmental condition might be considered as the main reason for parents not to let their children go to school by their own. Therefore, it is suggested to implement regulation for school location which should be within residential area as well as create environmental condition which support the use of NMT mode.

It should be emphasized that the analysis in this paper does not attempt to explore the causality between variables in statistical inferential model approach. It is explained by using cross-tabulation tools to show the possible relationship of the variables. Further researches are suggested to develop the estimated model of travel behaviour by exploring its link towards socio-demographics and urban form typology.

ACKNOWLEDGEMENTS

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