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Influence of Activity-Travel Participation, Travel Mode Choice, and Multitasking Activities on Subjective Well-Being Using R

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Abstract: Multitasking activities (MTA) are typically thought to enhance general subjective well-being (SWB). However, performing MTA while operating a private vehicle is frequently challenging. Public transportation (PT) can provide an additional option to engage in more pleasurable activities while traveling. Several studies have been conducted on the engagement of different activities while using different transport modes and its influence on physical, social, and mental health. Moreover, numerous studies have been carried out on motorized transport and MTA that resulted in accidents, fatalities, injuries, and even disasters. In addition, several experts studied the influence of health parameters on daily activities. There have, however, only been a few studies on MTA while on PT and its influence on SWB. Therefore, the current study aims to investigate the travel mode choice, the performance of onboard MTA, and its influence on overall SWB. Using random sampling techniques, data on 732 individuals and 191 households—representing 0.029% of the overall population of Bandung, Indonesia—were gathered. Two different models were developed between independent, intermediate, and dependent variables. Statistical Package for Social Sciences (SPSS) was used for descriptive statistics, whereas R software was used for the multilevel linear regression analysis. The model estimation results show that MTA mediates the relationship among socio-demographic and economic variables, built environment, trip and travel parameters, and SWB. A unit increase in PT lines can provide a 1.5% greater opportunity to participate in more onboard MTA; however, a unit increase in MTA can enhance SWB by 5.1% where both the models show satisfactory coefficient of determination (R^2). A unit increase in motorized transport caused a 12.9% negative association with MTA and 10.9% with SWB. A unit increase in NMT and PT are 21.7% and 10.2% positively associated with MTA and 19.2% and 13.1% positively associated with SWB. The current study helps policymakers to develop a policy based on PT which allows the individuals to engage in more MTA that enhance SWB and target sustainable transportation system.

Keywords: subjective well-being; activity-travel participation; multitasking activities; SEM; SPSS

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1. Introduction

Based on the participation or engagement in a diverse set of activities by individuals on a daily basis, activities are categorized as mandatory and discretionary activities, which are further classified as leisure and maintenance activities [1]. In addition, certain activities are carried out at home and are referred to as in-home (IH) activities, and others are out-of-home (OH) activities. Traveling is a natural aspect of practically everyone's life at any age. Travel behavior is influenced by technological advancements, such as the affordability of information and communication technology (ICT) innovations that provide previously unavailable options, such as working remotely or completing activities while traveling [2].

Due to the advancement of ICT, most individuals perform their leisure and sometimes mandatory tasks during travel; therefore, recent and past studies investigated the quality of activity participation performed during travel, which are often called multitasking activities (MTA) [3]. On the other side, more recent growth and development in ICT blurred the boundaries between travel and activity engagement [4,5].

The question arises as to why people must travel and why they use different transport modes for traveling. As it is a well-known fact that not all activities take place in the same places, traveling is required to satisfy needs and desires, as well as to participate in various activities [6]. For instance, on a given day, an individual commutes to work, drops and picks up their kids from school, and visits restaurants, worship places, shopping malls, and relaxing places using several transport modes. On the contrary, travel is a permanent constraint to participation in different activities daily [7]. To travel and engage in activities at different locations, people use different transport modes, as shown in Figure 1. Recent and past researchers studied commuting to work and school using different transport modes and its influence on health parameters (physical, social, and mental health) and the environment [8]. For instance, Ohta et al., 2020, investigated the impact of commuting to work and leisure-time physical activities on mental health and concluded that taking active transportation to work, such as walking or cycling, is connected with better mental health [9]. Schafer et al., 2020, investigated the health indicators associated with daily physical activity and traveling to work via various modes of transportation. They concluded that active commuting offers health benefits comparable to moderate fitness training [10].

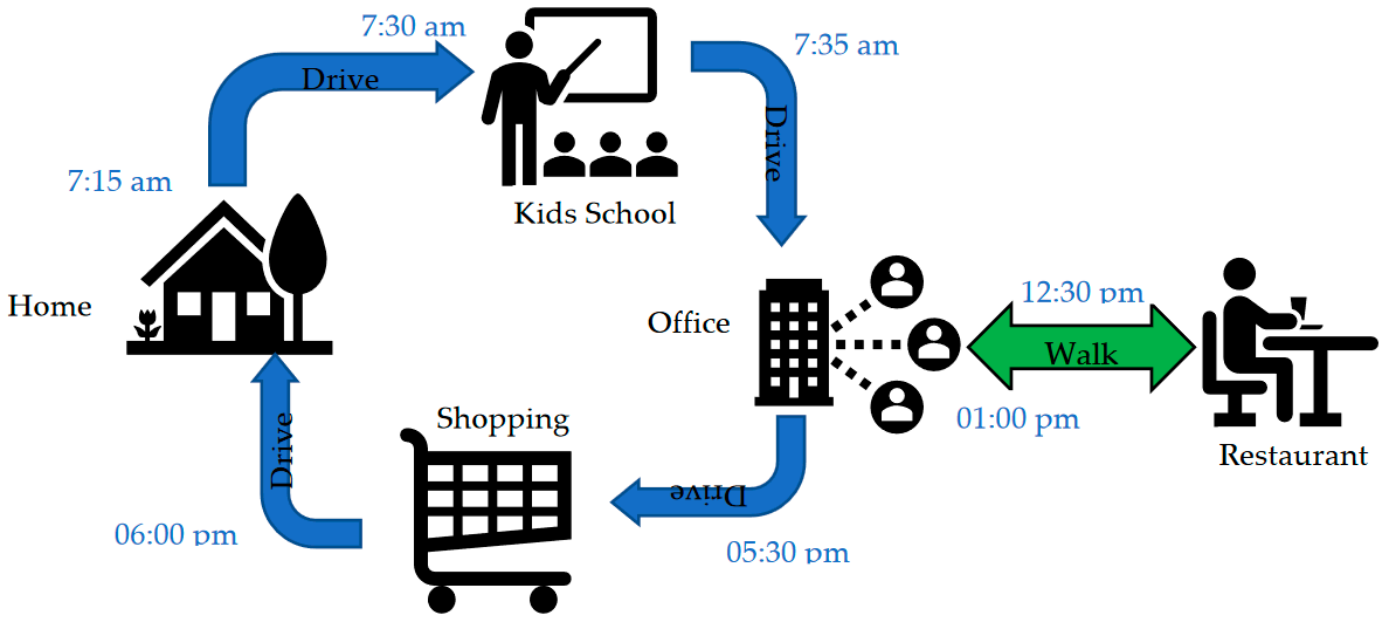

Figure 1. Integration with activity-based model.

The total travel time is subject to the availability of action location, type of action, available travel mode, and individual commitments. It is often assumed that providing a closer activity location to the home site and encouraging MT reduces an individual's trip time [11–13]. Susilo and Dijst investigated the relationship between travel time ratio and activity participation and determined that trip time is affected by activity kind, location, commitment, and mode of transportation available. Furthermore, they concluded that the trip time ratio is influenced by the home trade-off [14]. Some of the action is within walking distance, while others are further away. Meanwhile, some people travel for mandatory reasons, while others go for optional, maintenance, and leisure reasons [11]. These journeys are made for both OH and IH activities. Susilo and Axhausen, 2014, studied the individual activity–travel–mode–location and concluded that the combinations of all these are highly

influenced by the individuals' OH commitments and several activities have different repetition patterns [15].

Positive travel experiences (personal well-being and happiness) and involvement in in-travel activities (travel-based multitasking) are the two main sources of advantages [16]. In 2007, David and Frank studied MTA and automobiles and stated that MTA is typically thought to enhance general SWB. However, MTA while operating a private vehicle is frequently challenging. Unfortunately, performing such multitasking tasks diverts attention away from the essential job of driving because of the intrinsic limitations of human attention [17]. Lemon et al. represented the concurrent activities by dialogue move tree and activity tree models. In the past, drivers have attempted to multitask while operating a vehicle by listening to music, eating, drinking, smoking, and conversing with passengers. However, several new technologies have been created in recent years to encourage drivers to multitask, which is hazardous for drivers and can occasionally result in accidents, fatalities, and disasters [18].

A developed nation is one where fifty people utilize PT instead of fifty private automobiles, which provides substantial health and environment benefits, reduces road congestion and greenhouse gas emissions (CO_2), and also offers the opportunity for MT [19]. A sort of concurrent execution of numerous tasks over a certain amount of time is known as MTA. This term includes both natural multitasking and time-driven multitasking. Natural multitasking is the type of multitasking that most people naturally engage in, such as conversing while eating or listening to music while driving. Time-driven multitasking, on the other hand, is typically motivated by time constraints [20].

A secondary activity like passive leisure can be combined with travel as a primary activity [21,22]. PT can provide an additional option to engage in more pleasurable activities while traveling, such as working or socializing, according to some studies on how MTA are carried out on PT [23]. Sending and receiving emails, messaging friends and family, and even watching television and the news while driving are just a few examples. Multiple researchers have noted that while multitasking may be seen as a benefit, it may also be a burden that, in some way, raises stress levels and lowers well-being by 'contaminating' core activities or raising pressure to engage in situations where it is not desired [24]. Numerous studies have been carried out on motorized forms of transportation and MTA that resulted in accidents, fatalities, injuries, and even disasters [25,26]. In 2014, Rosouli and Timmermans studied the contribution of MTA to travel for the next generation and concluded that it has a positive impact on travel experience and can be included in travel. On the other hand, they concluded that MTA may affect (i) the duration of the other activities, (ii) fragmentation and time, and (iii) transport mode choice decision [27]. Therefore, there are sufficient studies on MTA and its effect on safety, disaster, accidents, time framework, affect on the primary activities, and challenges while using private vehicles; however, there has been limited research on TMC, MTA, and its influence on SWB and other health parameters. It is vital to study travel mode choice, MTA, and its influence on SWB. Therefore, the current study aims to prompt activity on PT to provide more opportunities to participate in onboard MTA that will not only enhance health parameters, such as social, mental, and physical health, but will also promote a sustainable transportation system. As concluded by Tiwari et al., poor quality of PT and NMT lead to traffic congestion, energy consumption, road crushes, and push the individuals to shift travel mode to private vehicles [28]. Therefore, the current study is targeting sustainable transportation systems such as NMT and PT to reduce environmental impacts from the transport sector, fuel consumption, traffic congestion, perform MTA, and enhance health parameters and traffic safety. Based on recent and past studies, the current study develops a conceptual framework, as shown in Figure 2.

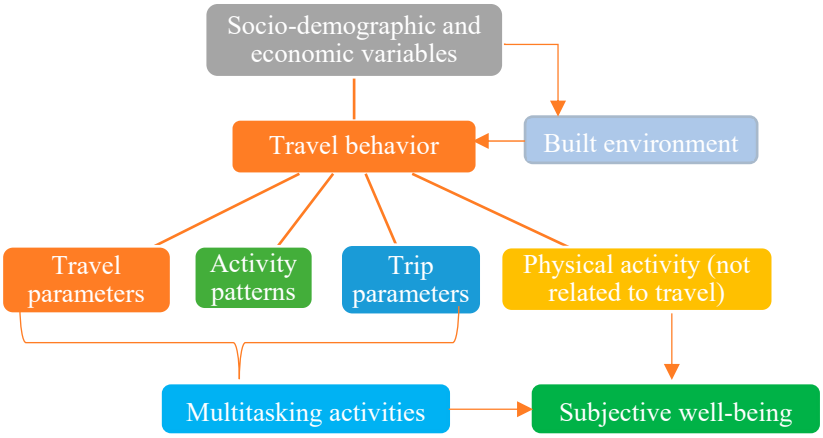

Figure 2. Conceptual framework for the association among multidimensional variables, MTA, and SWB.

1.1. Research Questions

Based on recent and past studies, the current research will be able to answer the following questions:

1. Do MTA mediate the relationship between time-use and activity-travel participation (ATP) and SWB?
2. Do PT options offer opportunity to engage in onboard MTA and enhance SWB?
3. What percentage of SWB will be enhanced by engaging in onboard MTA while using active transport and PT?

1.2. Research Objectives

The main objectives of the current study are:

1. To study the travel mode choice, performance of onboard MTA, and its influence on overall SWB.
2. To investigate the correlation between time-use and activity-travel participation, MTA, and SWB.
3. To study the endogeneity of MTA among travel mode choice and SWB.

Therefore, the current paper studies (1) time-use and activity-travel participation, (2) different transport modes used for a daily set of activities, (3) MTA while using PT mode, and (4) its influence on SWB. It is believed that spatial–temporal factors such as time utilization, activity participation, built environment quality, and socio-demographic factors influence both the types of MTA found in travel and everyday well-being. Only passive leisure activities—like reading a book, taking in the view, chatting with others, and listening to music—are considered to be secondary activities carried out while traveling for this study. Recent and past studies claimed that traveling by PT is negatively allied with individuals' well-being. However, it has been discovered that engaging in secondary activities (especially offline socializing) when traveling improves individuals' overall well-being and everyday travel experiences. Moreover, PT is a free-space transportation platform that helps people go where they need to go while also allowing them to see to other things to fulfill their needs and demands under more constrained time and space limits.

2. Bandung Metropolitan Area (BMA) Dataset

2.1. History and Background

Southeast Asia's Indonesian archipelago is a thriving and diversified region. It is the largest island nation in the world, with more than 17,000 islands, around 6000 of which are inhabited. Indonesia experienced substantial economic expansion and industrialization in the late 20th century. Bandung, Indonesia, has a long and varied history that ranges from its pre-colonial beginnings to its significance as a cultural, economic, and political hub in contemporary Indonesia. To meet the demands of both inhabitants and visitors, the

transportation system includes a variety of forms of transit. To reduce traffic congestion and support more environmentally friendly means of transportation, the city has been attempting to upgrade its transportation infrastructure. Small public vans known as "angkot", which is short for "angkutan kota" or city transportation, travel along predetermined routes around the city. They can be congested, but they are a common and inexpensive means of transportation. For many locals, public buses run by several firms are their main form of mobility. The majority of people utilize private vehicles for everyday commuting; however, car rental services let tourists rent cars at their convenience. Additionally, in Bandung, motorcycles and ojek (motorcycle taxi) services are frequently used to avoid the city's traffic. For quick travels, a lot of locals use ojek, especially when traffic is a concern. The government is working to enhance the city's inadequate walking and cycling paths to encourage environmentally friendly and healthy means of transportation.

2.2. Dataset

Based on the transportation system and available travel mode, the questionnaire has been prepared to gather data from the inhabitants about their daily time-use and ATP, travel mode, built environment, and health parameters. The questionnaire was prepared based on the conceptual model constructed from the study's hypothesis and objective. The survey was intended to collect multidimensional data that are related to travel mode choice, MTA, and health-related QoL indicators. The dataset contains multidimensional data; however, the current study mainly focuses on the variables related to travel mode, daily activity, MTA, and SWB, to be concise towards the aim of the study. Several methodologies are available to gather the data using various sampling techniques. However, for the current study, the survey was taken by a face-to-face questionnaire, utilizing the most effective and efficient methods—random sampling techniques. The surveyors and respondents signed an agreement stating that no respondents would leave the survey throughout the survey time because the goal was to collect data for 21 consecutive days. Due to the respondents' low educational backgrounds, the poll was conducted in the local tongue, such as Bahasa Indonesia.

According to the author's view and recent studies, it was the first survey that collected multidimensional data at a household level. It is crucial to check the validity and reliability of the questionnaire survey to ensure that the variables we are trying to measure are accurately represented. For this purpose, several steps were considered: (1) Pilot study: a pilot study was conducted in which 40 respondents were selected to undertake the survey. (2) Content validity: before collecting the data, the survey was discussed between the student and supervisor and with the experts in the field to review and validate the questionnaire's content. (3) Statistical methods: several statistical methods such as factor analysis, correlations, and reliability coefficients (e.g., Cronbach's alpha) are used to assess the validity and reliability using different software like SPSS V23 and R 4.3.1. (4) Revisions: based on the pilot survey and the results of validity and reliability assessments, necessary revisions were performed to improve the overall quality of the questionnaire survey. For 21 consecutive days, 730 respondents and 191 households responded to the survey, representing 0.029% of the population of the Bandung Metropolitan Area (BMA) inner area in 2013. To make sure that survey data are reliable, consistent, and ready for analysis, cleaning is an essential step in the data analysis process. Since it is common and well known that most data have missing values, handling them during analysis might be challenging. Therefore, after data cleaning, the current study includes 508 respondents, or 0.020% of the inner region's population in 2013, after relying on young children (under seven years old). There has not been any discovery of new legislation that could significantly alter the dataset collected over the intervals after survey collection. However, there are some minor changes in the transport mode and infrastructure which does not deeply affect the current survey. For the purposes of this inquiry, the BMA dataset was still enough. For further information about BMA and the data collection, refer to Dharmowijoyo et al. and Ali et al.'s articles [6]. Table 1 depicts the description of the respondents.

Table 1. Description of the respondents (N = 508).

Variables	Percentage or Mean	Total
Socio-demographic characteristics at an individual level		*2.4 million*
Man	52.60%	67.5%
Woman	48.40%	32.5%
Worker	39.0%	42.18%
Non-worker	25.55%	32.09%
Student	33.45%	25.79%
Dependent children (<15 years)	14.54%	13.20%
Age 15–22	22.46%	20.90%
Age 23–44	43.60%	45.65%
Age 45–55	10.60%	12.10%
Age over 55 years old	9.50%	8.09%
Medium household income (3–6 IDR)	92.05%	76.80%
High household income (>6 million)	7.95%	23.20%
Trip involvement and travel time spent on weekdays (weekends)		
Daily trips	2.64 (2.30)	-
Trip chains	1.08 (1.10)	-
Travel time by a motorized mode (%)	46.60%	-
Travel time by active mode (%)	28.30%	-
Travel time by PT (%)	25.10%	-
Total travel time (minutes)	98.29	-
Perceived accessibility variables (travel time)		
PT lanes passing through respondents' location (number)	2.470	-
Time to CBD (minutes)	28.70	-
Time to a government office (minutes)	16.88	-
Time to shopping centers (minutes)	14.55	-
Time to grocery shop (minutes)	9.45	-
Time to park (minutes)	18.92	-
Time to bus stop (minutes)	13.14	-

The dataset contains time-use daily activity participation and travel mode used for the specific activities. The activity was divided into 15 min sections, which makes 96 slices in total for a complete day (24 h). The respondents were asked to complete a questionnaire survey detailing their daily activities for the previous 24 h as well as the form of transportation they used. Although the authors collected data for 24 h a day, they evaluated the daylight from early morning (4:45 a.m.) until late night (22:00) for the analysis. Figure 3 shows the daily transportation mode employed for their daily activities with a 15-min gap. As discussed earlier, the activities were categorized as leisure, mandatory, and maintenance activities, and further, they were divided into IH and OH activities. Each motion diary recorded 23 different forms of activity involvement, which were divided into IH and OH pursuits, as predicted in Table 2 and Appendix B. Due to the congested conditions in BMA, subjective awareness was employed in the dataset in lieu of objective measurement. In addition, metrics of perceived and objective accessibility were employed to assess the effects of residential sites. The density of different land-use types in every area was measured using digital land data. The subjective well-being is measured from the

travel experience and satisfaction and health-related quality of life questions, whereas the MTA are measured through a questionnaire in which we asked the respondents about their daily activities per 15 min and the transport mode used. All the IH and OH activities were recorded per 15 min throughout the day, along with transport mode use, which contains mandatory, leisure, maintenance, and MTA. The most popular period to utilize all types of TM is between 5:45 and 7:45 in the morning, with MT transport showing the highest usage, followed by AT and PT. This indicates that the majority of people use TMs in the morning for daily obligatory, leisure, and maintenance activities. A similar scenario, which depicts people returning from their jobs or other activities, may be observed in the early evening from 14:45 until 18:15.

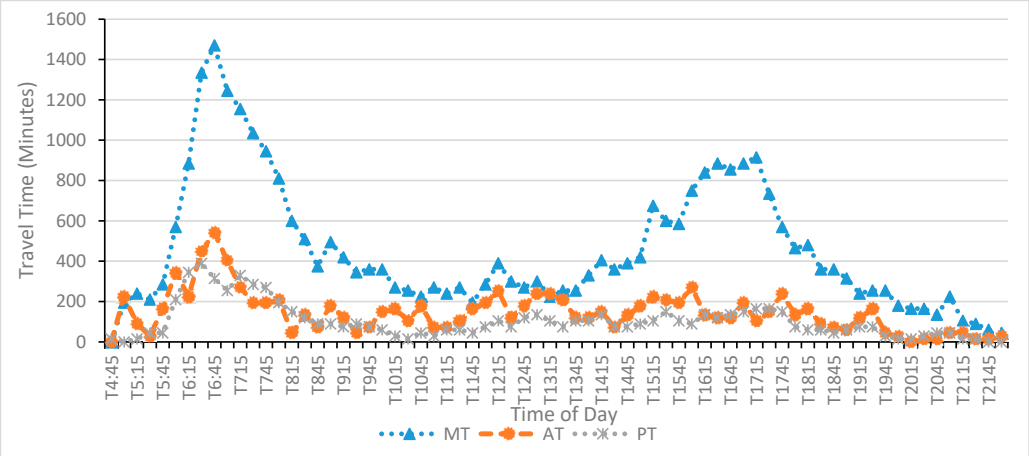

Figure 3. Transport mode used for daily activities throughout the day.

Table 2. Classification of daily activities.

Activity Criteria	Mandatory		Maintenance		Leisure	
	IH	OH	IH	OH	IH	OH
	Sleeping Personal care Eating and drinking at home	Indoor working activities Outdoor working activities Indoor school activities Eating and drinking Dropping/Pick up children or others OH sleeping	Household activities Babysitting activities	Sales activities Shopping activities OH maintenance Waiting for public transport	Relaxing activities Social, family activities	OH social Outdoor school Organization/ Volunteer/ Political activities Sports activities Holiday Other OH

In addition, other parts of the questionnaire survey contained household data including information on household composition, socio-demographic and economic variables, transport mode use for daily activities, and built environment characteristics. The socio-demographic data contain gender, age, marital status, occupation, and education, whereas the economic characteristics data related to monthly income and expenses of an individual and household. However, the transport mode was mainly categorized to motorized transport, PT, and active transport such as walking and cycling. The socio-demographic characteristics were categorized based on gender, as shown in Figure 4. Males always surplus the female despite the non-workers and divorced rate. On the other hand, the travel mode was also categorized based on socio-demographic characteristics, as shown in Figure 5. Observing gender, males used a high number of transport modes due to their involvement in out-of-home mandatory activities. In addition, those who are from low-income states use the highest all three modes of transport for their daily mandatory, leisure, and maintenance activities. Regarding occupation, those who are workers used the highest number of all three transport modes compared to the non-workers and students. In

addition, those who are married and educated to a senior high school level used the most transport modes compared to the rest of the martial statuses and education levels.

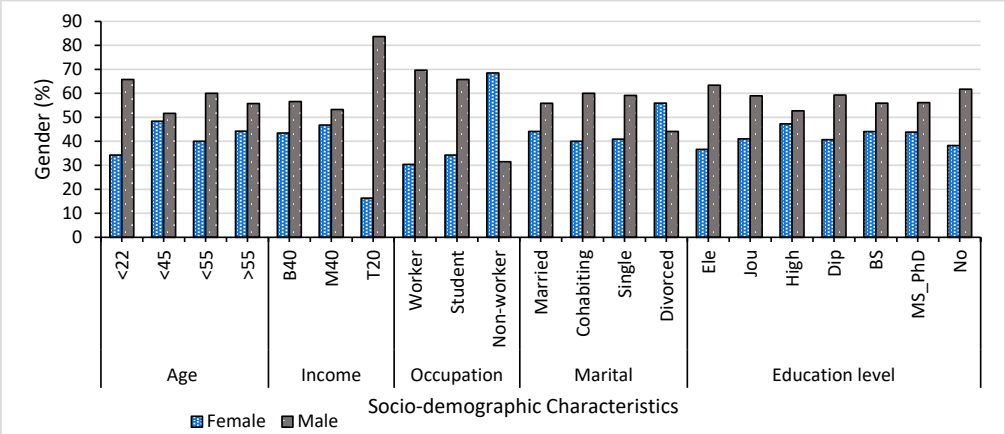

Figure 4. Socio-demographic classification based on gender. Notes: B40 = below 40%, M40 = middle 40%, T20 = top 20%, Ele = elementary, Jou = junior, High = higher, Dip = diploma, BS = bachelor, MS_PhD = master and doctor, No = no education.

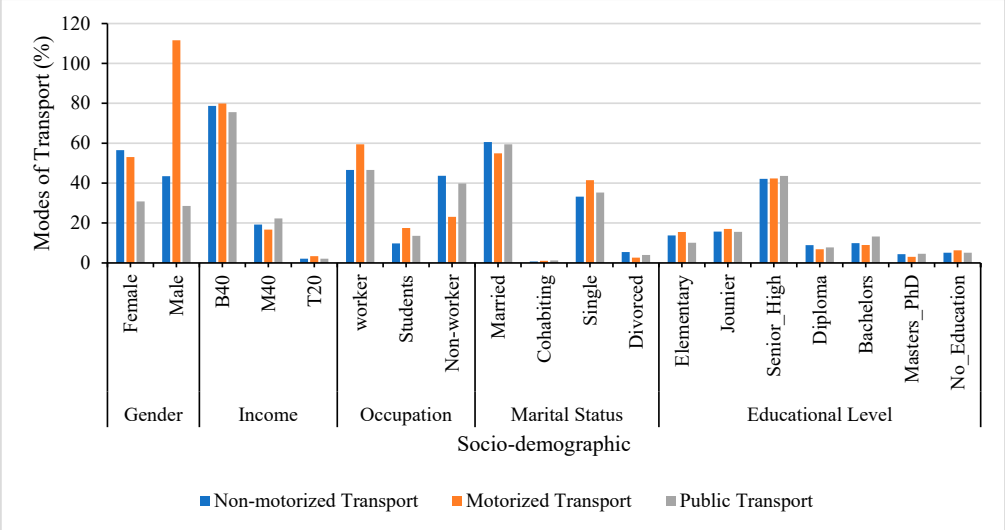

Figure 5. Socio-demographic classification based on modes of transport.

2.3. Travel Mode Choice for Daily Activities and Multitasking Activities

The individual was asked about their daily IH and OH mandatory, leisure, and maintenance activities and about the TM that they used to participate in these activities. Figure 6 depicts the time-use and ATP for several sets of daily IH and OHM, OHL, and OHMA activities in a week, while Figure 7 illustrates the percentage of TM used for daily numerous sets of activities in a week. On weekends, OHM activities decline, although IHM, IHL, and IHMA activities rise, indicating that most people work and study on weekdays. Additionally, there was a small increase in IHMA and OHL activity, demonstrating that people engage in weekend leisure activities outside the home, such as traveling to the park for entertainment, playing sports, and going shopping. The current study reflects the findings of Lockwood et al., who concluded that weekend activity travel is primarily leisure-focused and is carried out in the middle of the day [29].

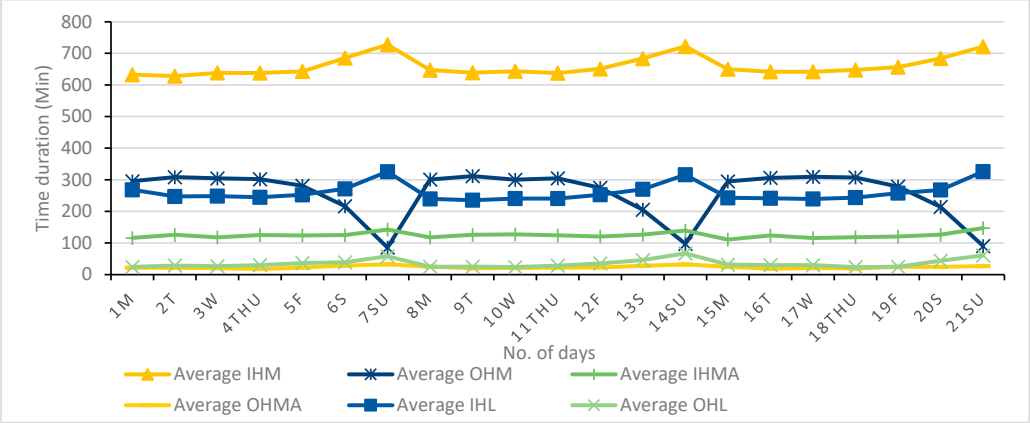

Figure 6. Time used for diverse set of activities on a specified day in a week.

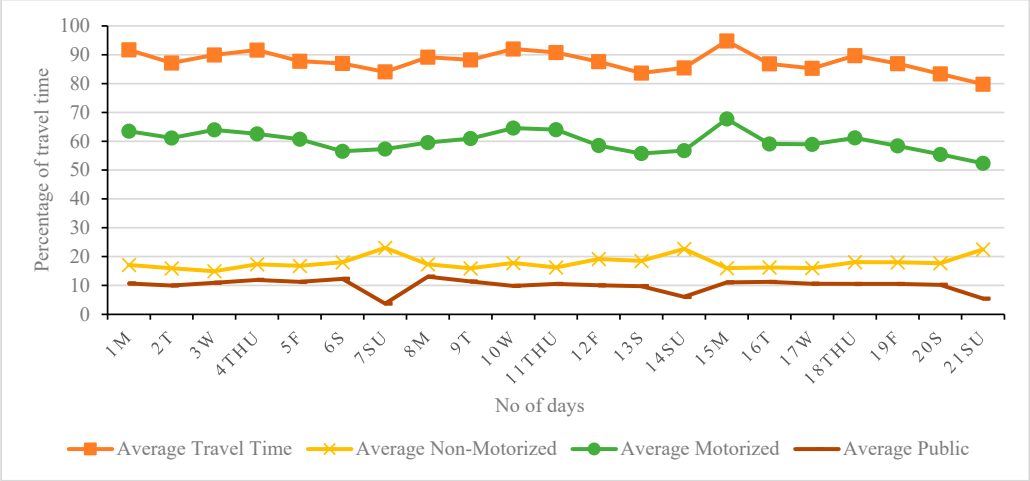

Figure 7. Time use on diverse transport modes on a specified day in a week.

Individuals used several TMs while participating in activities on both weekends and weekdays. As depicted in Figure 7, there is a slight decrease in MT mode on weekends, which shows that, mostly, the MT mode is used for the office, pick-up and drop off of kids to school, and other mandatory activities, whereas it is the opposite on weekends. In addition, there is a gradual increase in AT modes while a gradual decrease in PT modes on weekends shows that most individuals walk and cycle on weekends for OHL and OHMA activities. The current study, in line with the study that was conducted by Lindsey et al., concluded that by place, day of the week (weekday vs. weekend), infrastructure category, and season or month, bicycle and pedestrian traffic numbers vary widely [30]. In addition, individuals spend more than 20% of their travel time on AT on weekends, which promotes sustainable mobility and enhances the environment. As concluded by P Rietveld, walking and bicycling are inexpensive, quick, and ecologically beneficial alternatives to driving for excursions up to around 3.5 km [31]. Therefore, promoting AT will not only provide health benefits but will also be cheap, reduce traffic congestion, and be environmentally friendly. Among all three transport modes, PT was the lowest, which shows that BMA does not have a proper PT system, a limited transport line, and minimal access to PT. In an overview of the development of PT policy in South Africa, Jackie Walters concluded that there are several factors that contribute to the growth of PT, including a lack of funding for the implementation of PT policies, organized labor opposition to a tender for contracts in the commuter bus industry, lengthy and complex public engagement procedures, a lack of expertise to carry out policy initiatives, and difficulties involving three levels of government in PT [32].

The transport modes that are used in BMA are classified into 21 different types, as shown in Appendix A, which are further grouped into three main transport modes: active transport, public transport, and motorized transport, as depicted in Figure 8. In total, MT shows the highest percentage, which is 65%, whereas 21% of the individuals who participated in the survey travel using AT and 14% of the people used PT. The questionnaire survey was developed based on the available mode in BMA; therefore, the AT was categorized as walking and cycling and MT was categorized as motorcycle and Jeep/car. In addition, PT was categorized as railway (economy and executive class), bus (with and without air conditioning), angkot, ojek, and school/company bus.

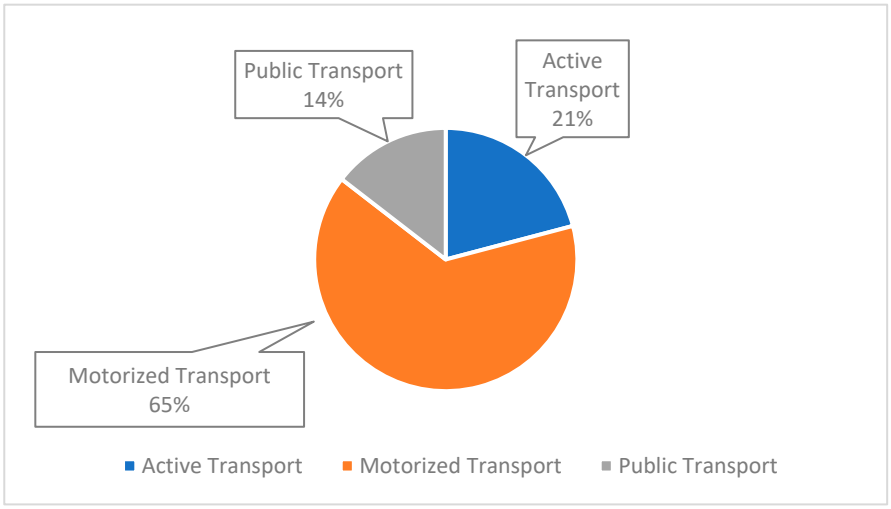

Figure 8. Percentage use of several transport modes for daily activities.

Walking accounts for 94% of daily activities in terms of AT, but cycling accounts for 5%, which indicates a shortage of bicycle routes in BMA and low-income households. Additionally, as shown in Figure 9, walking to and from bus or train stops only contributes 1%, further supporting the lower use of PT in BMA. However, AT only contributed 21% total, which was three times less than the utilization of MT, which demonstrates how the majority of people in BMA are more reliant on MT.

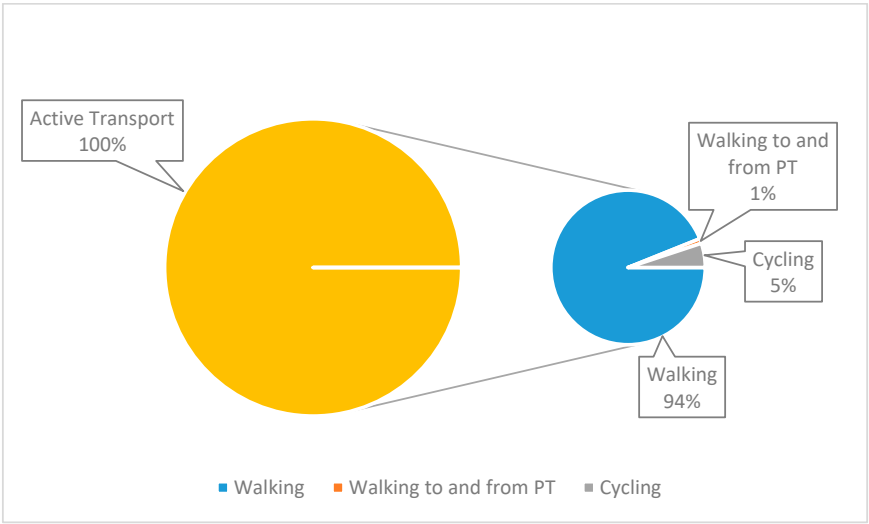

Figure 9. Categorization of percentage of average travel by AT per day per person.

On the other hand, the MTs were categorized as Jeep/car and motorcycle. Due to the number of low-income households, most of the individuals used motorcycles for their

daily commutes, which contribute to 88% of the MT; however, 12% of the individuals were dependent on private vehicles, as depicted in Figure 10. Of all TMs, MT contributes 65%, of which 88% is contributed by motorcyclists. Due to the poor infrastructure, number of low-income households, and low vehicle ownership, motorcycle was the main TM for their daily mandatory, leisure, and maintenance activities.

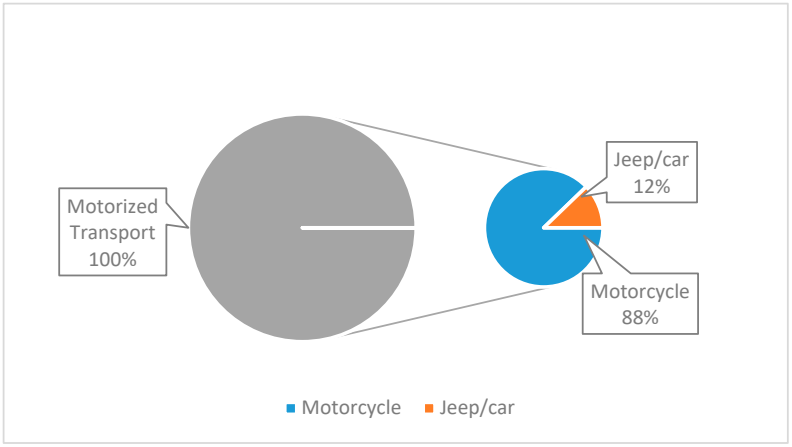

Figure 10. Categorization of the percentage of average travel by motorized transport per day per person.

In terms of public transport, it was categorized as railway (economy and executive class), bus (with and without air conditioning), angkot, ojek, and school/company bus. Angkot is a common PT mode that is used in BMA as a PT system due to their poor policy, infrastructure, and low income. As illustrated in Figure 11, angkots make up more than half (56%) of the total PT system in BMA, which confirms that they are the basic PT mode in BMA and inhabitants are dependent on them. However, the railway with executive class is the second highest mode of PT used for daily commuting, contributing 30% of the total share of PT, showing that those from middle-income or high-income households use executive class railway for their daily activities. In addition, there were public bus systems without air conditioning which contributed 9%, and the economy class railway made up 2% of the total PT. This study confirms that most of the BMA inhabitants are willing to use PT due to their low income; however, the government has to provide adequate infrastructure.

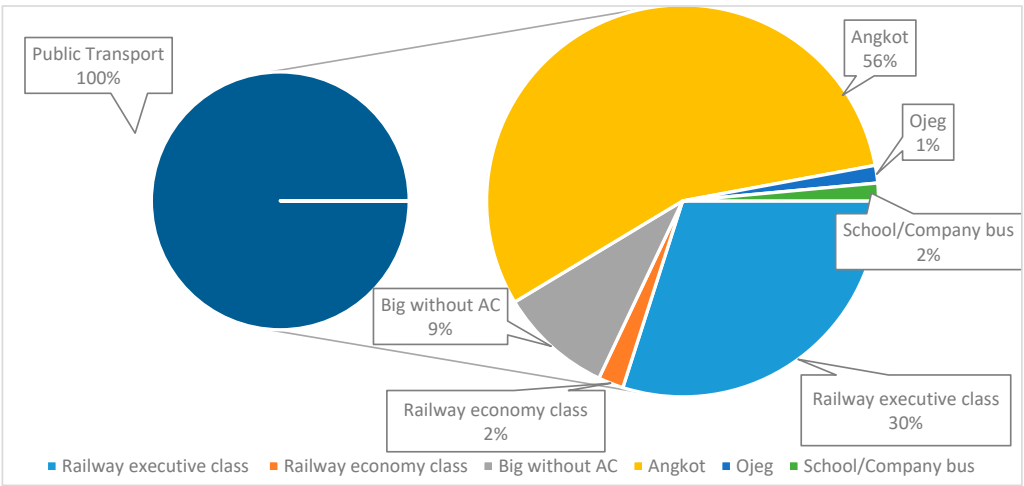

Figure 11. Categorization of percentage of average travel by public transport per day per person.

While performing OH and IHM, IHL, and IHMA activities using different TMs, individuals also perform MTA, as shown in Figure 12. The IHM activities are high due to containing sleeping hours, which last for approximately eight hours; therefore, the in-home

MTA is also high. The IHM and IHL activities increase on weekends, which increases MTA. For instance, an individual cooks a meal or food while listening to music or the news, washing clothes, or cleaning the house. The out-of-home MTA on weekends decreases because the individual is not driving to the office while listening to music or replying to texts or reading emails and newspapers.

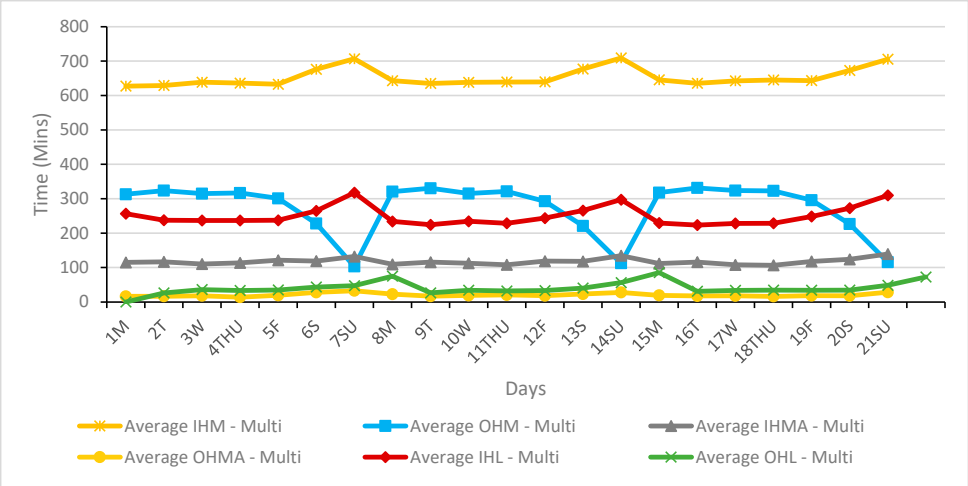

Figure 12. Time spent on multitasking activities on a given day in a week.

On the other hand, transport mode has a great effect on MTA. It is widely believed that those who use PT or non-motorized transport modes are more exposed to or have more time to perform MTA than those who use private vehicles [33]. For example, an individual using PT or non-motorized transport can talk on call, reply to emails, chat with family and friends, read the newspaper, and talk to other people, while those who are driving can only listen to music or just talk with those who are next to him/her because he/she needs to focus on driving.

All the activities were divided in 23 separate categories and alphabetically coded, as seen in Appendix B. Individuals chose code CD, which combines IHM and IHL, as illustrated in Figure 13, because they execute IHMs like eating and engage in IHLs like viewing, scrolling, or speaking with friends. The majority of MTAs involved indoor activities like working at an office desk, conducting indoor research or experiments in a lab, seeing clients over the phone, and social and familial activities like conversing with loved ones who were coded as HE. The majority of people engage in more IHM, IHL, and IHMA activities than OH activities.

On the other hand, the activity was categorized based on the IH and OH participations such as IHM and IHL, IHM and IHMA, IHL and IHMA, OHM and OHL, OHM and OHMA, and OHL and OHMA. As shown in Figure 14, the majority of MTA were IHM with IHL, including eating while listening to music, watching television, reading the newspaper, chatting with loved ones, responding to emails, cooking, cleaning the house, praying, ironing clothes, surfing the internet, and relaxing. In contrast to OHMA activities, people engage in more OHM and OHL activities, which indicates that most people use MT and listen to music or talk to their friends. However, OHL and OHMA activities outnumber OHM and OHMA, indicating that most people use NMT to participate in OHL and OHMA activities on the weekends. The current study highlights that individuals engaged in more OH MTA on weekends than weekdays.

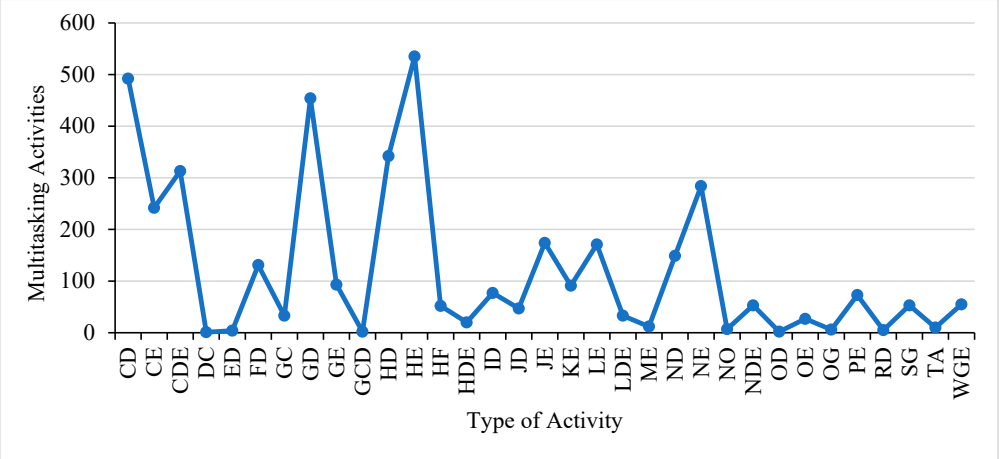

Figure 13. Time engaged in MTA on a daily basis.

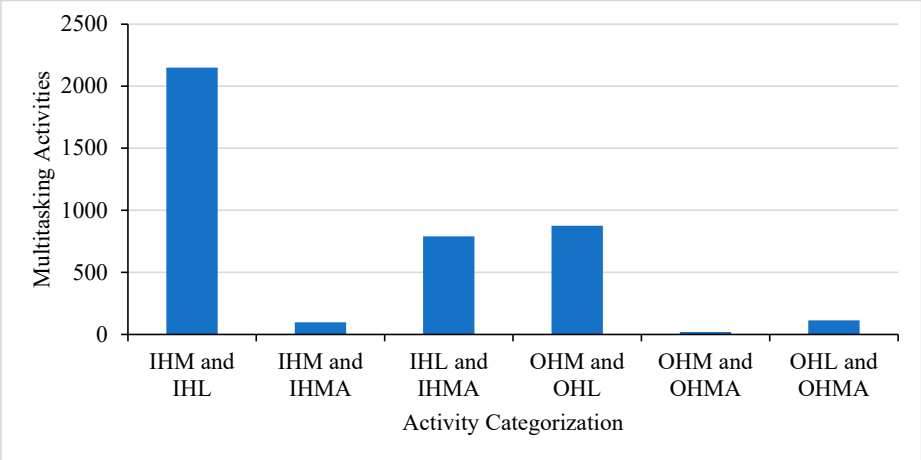

Figure 14. Combination of several MTA activities.

3. Model Estimation Results

The suggested theoretical model shown in Figure 15 examines the causal links between socio-demographic and economic variables, the built environment, time usage and activity-travel participation, trips, daily travel parameters, the MTA, and its impact on SWB. Table 3 displays the results of the model estimation with significant values of the *p*-value less than 0.05 as a consequence of the 95% confidence level.

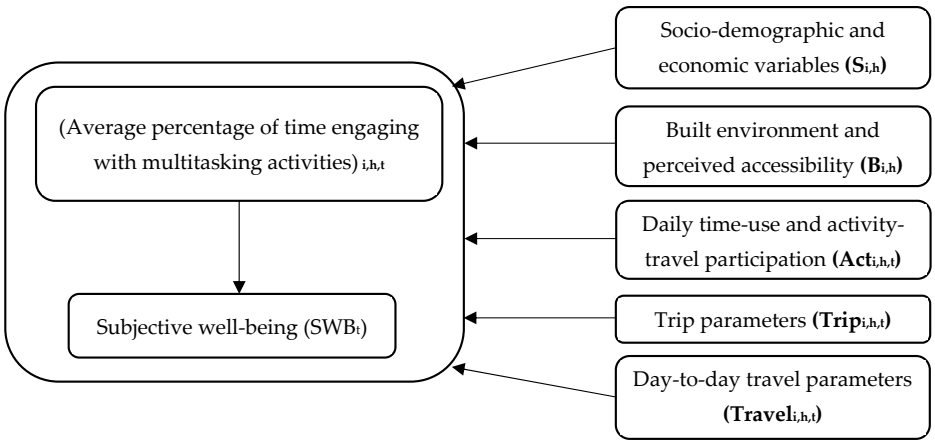

Figure 15. The proposed model.

All the variables on the right side of the model—socio-demographic, economic, built environment, daily time-use and ATP, trip parameters, and day-to-day travel parameters—are used as independent variables, whereas the percentage of time spent using the MTA is used as a dependent variable in the first model and as a mediation variable in the second model for the dependent variable of subjective well-being. Equations (1) and (2) illustrate how mathematical equations were created using multilevel linear regression analysis with exogenous and endogenous variables in SPSS. Additionally, the causal link between the exogenous and endogenous variables is determined using the t-stat values and the unstandardized coefficient B value.

Table 3. Model estimation results (only significant values with a *p*-value of less than 0.05 are shown).

Variables	Multitasking Activities		Subjective Well-Being	
	Coeff	**T-Stat**	**Coeff**	**T-Stat**
Constant	−1.490	−13.76	0.748	5.714
Female	Ref	Ref	Ref	Ref
Male	−0.029	−3.802	0.049	4.690
Worker	Ref	Ref	Ref	Ref
Non-worker	-	-	0.129	8.342
Student	−0.092	−5.970	0.278	4.720
Dependent children (<15 years)	−0.12	−4.134	−0.10	−2.66
Age 15–22 (Years old)	-	-	0.332	7.093
Age 23–44 (Years old)	0.261	4.662	0.299	7.602
Age 45–55 (Years old)	-	-	0.303	7.130
Older than 55 years	Ref	Ref	Ref	Ref
Medium household income (3–6 IDR)	0.0198	2.186	−0.052	−3.932
Low household income (<3 IDR)	Ref	Ref	Ref	Ref
High household income (>6 million)	−0.081	−3.301	−0.210	−6.884
Number of household members	0.009	2.980	−0.029	−9.98
Number of trips	-	-	−0.021	−2.018
Number of trip chains	0.201	10.825	0.040	3.189
Number of public transport lines	0.019	3.852	−0.032	−4.492
MT	−0.129	−2.331	−0.109	−2.996
NMT	0.217	3.733	0.192	3.201
PT	0.102	2.331	0.131	2.891
IHM activities	0.001	8.21	-	-
IHMA activities	0.001	9.83	−0.001	−2.512
IHL activities	0.001	10.22	0.001	2.821
OHM activities	0.001	11.32	0.001	2.411
OHMA activities	0.002	12.010	−0.001	−6.901
OHL activities	0.001	11.082	−0.001	−5.201
Endogenous of multitasking	-	-	0.051	3.981

Table 3. *Cont.*

Variables	Multitasking Activities		Subjective Well-Being	
	Coeff	T-Stat	Coeff	T-Stat
Error term	0.298		0.401	
F	61.871		29.98	
R-Square	0.150		0.081	
SD	30		31	

Notes: Coeff = coefficient, T-stat = t-statistics, IHM = in-home mandatory, IHMA = in-home maintenance, IHL = in-home leisure, OHM = out-of-home mandatory, OHMA = out-of-home maintenance, OHL = out-of-home leisure, SD = standard deviation, PT = public transport, NMT = non-motorized transport, MT = motorized transport, IDR = Indonesian Rupiah.

The theoretical model's model summary, shown in Table 4, includes the R^2 and adjusted R-square for both models. Additionally, a significance value of 0.01 was used to determine the model's significance, and the coefficient of determination (R^2) was used to determine how exogenous variables affected endogenous variables. The R^2 of 0.01 (10%) is considered good for quantitative research, but in the current study, the R^2 for the first model was 0.150 (15%) and 0.081, or circa 8%, for the second model. Table 5 displays the ANOVA of the model estimation findings.

$$(\text{Multitasking})_{i,h,t} = (\alpha_{i,h} + u_i + u_h) + \beta_1 S_{i,h} + \beta_2 B_{i,h} + \beta_3 \text{Act}_{i,h,t} + \beta_4 \text{Trip}_{i,h,t} + \beta_5 \text{Travel}_{i,h,t,} + \varepsilon_{i,h,t} \quad (1)$$

$$(\text{SWB})_{i,h,t} = (\alpha_{i,h} + u_i + u_h) + \beta_6 S_{i,h} + \beta_7 B_{i,h} + \beta_8 \text{Act}_{i,h,t} + \beta_9 \text{Trip}_{i,h,t} + \beta_{10} \text{Travel}_{i,h,t,} + \beta_{12} (\text{Multitasking})_{i,h,t} + \varepsilon_{i,h,t} \quad (2)$$

Table 4. Model estimation summary.

Model Summary				
Model Number	**R**	**R-Square**	**Adjusted R-Square**	**Std. Error of Estimate**
1 [a]	0.381	0.150	0.098	0.298
2 [b]	0.269	0.081	0.077	0.401

[a]—multitasking dependent variable, [b]—subjective well-being dependent variable.

Table 5. ANOVA of the model.

ANOVA					
Model 1	**Sum of Square**	**df**	**Mean Square**	**F**	**Sig**
Regression	258.091	30	10.051	60.029	0.000 [a]
Residual	1598.281	10,637	0.148		
Total	1856.372	10,666			
Model 2					
Regression	198.092	31	7.201	31.143	0.000 [b]
Residual	2433.050	10,636	0.1989		
Total	2631.0592	10,666			

[a]—multitasking dependent variable, [b]—subjective well-being dependent variable.

Males have an adverse association with MTA as they are more engaged in OHM activities using MT modes; therefore, they have limited access to participate in MTA, which negatively influences them. However, males positively associated with SWB. A unit increase in the MTA of males will cause a 4.9% increase in daily SWB. The current study is in line with previous studies conducted by Hamadneh and Esztergár-Kiss, in which

they concluded that females engage in more onboard MTA than males [2]. Regarding occupations, both the non-workers and students have positive SWB, whereas those who have dependent children in their household are negatively associated with subjective SWB due to tighter time–space constraints and limited time to participate in MTA.

Those who are from ages 23 to 45 had a positive correlation with MTA and with daily SWB, which means that if they tend to participate in MTA on a daily basis, they will improve their daily SWB. A unit increase in the age group from 23 to 45 years causes a 26.1% increase in MTA and 29.9% in daily SWB. Moreover, those who are from medium-income households are participating in more MTA, which shows a positive correlation; however, it is opposite with the daily SWB. This may be due to the high stress and pressure from handling several activities on a given day, which negatively influences their SWB. However, in the cross-cultural study by Diener and Oishi, poorer countries had a slightly larger association between income and SWB [34]. On the other side, being from a high-income households had a negative impact on MTA and daily SWB due to the use of MT modes for daily participation in OHM activities, which restricts participation in MTA, as well as negatively affecting the individual's daily SWB. As concluded by Luhmann et al., in the low-income range, the relationship between income and SWB is stronger, whereas in the high-income range, the relationship is weaker [35]. In addition, instead of onboard MTA, working at an office and performing MTA has a negative impact on well-being, which is in line with the study of Silva et al., who concluded that MTA at telework and well-being have a negative association [36].

Regarding the trip chains and number of trips, those who have a high number of trips have negative daily SWB while those having trip chains (from place to place to complete a circle, as shown in Figure 1) have positive daily SWB. This is due to the involvement of MTA in a trip chain and participating in several sets of OH activities at different locations. The number of PT lines has a positive correlation with MTA, which shows that PT provides more opportunities to participate in more MTA while traveling. A unit increase in PT lines can provide a 1.9% increased opportunity to participate in more MTA while traveling. As concluded by Hamadneh and Esztergár-Kiss, most people in urban areas are more likely to use PT than shared and autonomous vehicles because they want to engage in more MTA and reduce travel time and cost [37].

On the other hand, those who use MT for their daily activities are unable to engage in more MTA, which negatively influences MTA as well as SWB. However, those who tend to use NMT and PT are more involved in MTA and are positively associated with SWB. A unit increase in MT caused a 12.9% negative association with MTA and 10.9% with SWB. However, Sun et al. concluded that commuting by e-mopeds is found to be associated with the most increase in SWB but has a substitution effect on the city buses [38]. Moreover, a unit increase in NMT and PT are 21.7% and 10.2% positively associated with MTA and 19.2% and 13.1% positively associated with SWB. Ettema et al. concluded that those who shifted from private vehicles towards PT and active travel had higher levels of satisfaction [39].

Regarding OH and IHM, IHL, and IHMA activities, those participating in all activities are positively associated with MTA, whereas there are some variations in the association of SWB and daily OH and IHM, IHL, and IHMA activities. Those who are participating in IHL and OHM activities while performing MTA have a positive correlation with daily SWB, whereas others are the opposite. The current study shows that MTA can be used as an intermediate variable between the socio-demographic, built environment, and travel and trip parameter variables, and daily SWB. As concluded by Bachmann et al. in 2019, onboard multitasking activities have a higher positive impact than monotasking [40]. A unit increase in MTA can enhance SWB by 5.1% and mediate the relationship between transport mode choice, daily activities, and SWB.

4. Discussion

The current study aims to use the MTA as an intermediate variable to study the association among socio-demographic and economic variables, activity-travel participation, transport mode, built environment, and SWT. Two linear regression models were developed in which (1) socio-demographic and economic variables, activity-travel participation, transport mode, and built environment were used as independent variables and MTA as a dependent variable; however, in the (2) model, the MTA was treated as an intermediate variable and SWB was a dependent variable. Based on the model estimation results, it was concluded that MTA shows a significant correlation and can mediate the relationship among socio-demographic and economic variables, activity-travel participation, transport mode, and SWB. A unit increase in MTA can enhance SWB by 5.1% and mediate the relationship between transport mode choice, daily activities, and SWB. Bachmann et al. also concluded in their studies that 41% of students traveling to school perform MTA, which have a higher positive impact than monotasking activities [40].

In contrast to the results of the descriptive study, the results of the hierarchical linear regression demonstrate that more frequent onboard MTA is positively correlated with different transport modes. Additionally, those who travel more frequently, such as those with middle-class incomes and those who have a high number of trip chains, frequently engage in more MTA, which positively influences their SWB. According to Luhmann et al., there is a higher correlation between income and SWB in the low-income range and a smaller correlation in the high-income level [35]. Travelers tend to multitask more frequently when they live further from some of their fundamental facilities, such as the CBD, shopping malls, and government buildings.

In addition, the current study confirms that those who are exposed to PT and tend to use NMT modes for daily activities have more opportunities to participate in MTA such as listening to the radio, reading emails and newspapers, and chatting with friends and family members, making them more positively associated with daily SWB than those who use a private vehicle. In terms of engaging in more MTA, the majority of people in metropolitan areas are more likely to use PT than shared and autonomous vehicles, as determined by Hamadneh and Esztergár-Kiss [37]. Furthermore, Ettema et al. found that people who switched from using private cars to active transportation and PT experienced higher levels of satisfaction [39]. As might be predicted, the endogenous proportion of time spent multitasking while traveling has a favorable link with an individual's daily SWB. Endogeneity issues between the multitasking in travel variables and other spatiotemporal factors can be resolved by using hierarchical linear regression. Any commitment to engage in OHL and OHMA activities, however, seems to enhance everyday well-being.

5. Conclusions

The current study aims to research different transport modes used for daily activities, the performance of MTA while traveling, and their influence on daily SWB. This study looked at the association between spatio-temporal variables on the percentage of time spent multitasking while traveling and how the endogenous percentage of time spent multitasking while traveling interacts with other spatio-temporal variables on people's daily subjective well-being. It used hierarchical linear regression and a multidimensional three-week household time-use and activity diary. Based on the model estimation results, the following conclusions can be drawn:

- Those who use MT for their daily activities are unable to engage in more MTA, which negatively influences MTA as well as SWB. A unit increase in MT caused 12.9% negative association with MTA and 10.9% with SWB. In addition, those who tend to use NMT and PT are more involved in MTA and are positively associated with SWB. A unit increase in NMT and PT are 21.7% and 10.2% positively associated with MTA and are 19.2% and 13.1% positively associated with SWB.
- The number of PT lines has a positive correlation with MTA, which shows that PT provides more opportunities to participate in more MTA while traveling. A unit

increase in PT lines can provide a 1.9% greater opportunity to participate in more MTA while traveling.

- Those who are from the ages of 23–45 have a positive correlation with MTA and with daily SWB, which means that if they participate in MTA daily, they will improve their daily SWB. A unit increase in the age group from 23 to 45 years causes a 26.1% increase in MTA and 29.9% in daily SWB.
- The relationship between income and SWB is strong, except in the high-income range where the relationship is weaker. The current study concluded that those who are from low- and medium-income households positively correlate with MTA; however, those from high-income households have a negative impact on MTA and daily SWB. This may be because of the MT mode used for daily participation in OHM activities, which restricts them from participating in MTA, as well as negatively affecting their daily SWB.
- The current study helps the policymakers to develop their policy based on the needs of the individuals, to develop the infrastructure, and to provide facilities to encourage people to perform MTA and to use PT and active modes of transport for their daily short car trips, which will not only reduce traffic congestion but will also enhance their SWB and provide a green and sustainable environment.

6. Research Contribution

Past studies used travel diary data, whereas the current study gathered and used time-use and activity data which provided richer and insightful information about daily activity participation, travel mode selection, and its influence on SWB. Moreover, the current study was based on both individual and household data, thus gathering multidimensional data at a household level. In addition, previous studies gathered the data for a specific day or week, whereas the current study used a three-week (consecutive) household dataset that studies the activities and transport modes used both on weekdays and weekends. Moreover, the current study proposed conceptual and theoretical models for daily time-use and activity-travel participation, which provide a visual background of how daily activities influence health outcomes. Previous studies investigate the direct correlation among the variables; however, the current study introduces mediation variables to study the endogeneity issue between independent and dependent variables. Moreover, the current study targets sustainable transportation systems by shifting the urban dependency on private vehicles towards AT and PT to not only enhance health parameters but also provide more opportunity to engage in onboard MTA that will improve SWB and lower emissions from the transportation sector, reduce traffic congestion and fuel consumption, and enhance traffic safety.

7. Future Recommendation

The current research gathered the data from the city of Bandung, Indonesia, which is not the capital city of Indonesia and may not contain all transport modes and/or has different road infrastructure and transport modes. Therefore, for future research, it is recommended to gather the data from Jakarta (the capital city of Indonesia) and make a comparison between the two cities. As the behaviors, infrastructure, income status, and transport modes are changing, it is therefore strongly recommended that a recent and up-to-date dataset is gathered and the current situation and traveler behaviors are compared with the past to provide an overview. There are some other variables such as lifestyle habits, etc., that are excluded from this study which also affect travel behaviors, transport mode, and MTA that can be considered in future studies.

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Institutional Review Board Statement: In Indonesia, taking an activity diary does not need any details of ethical approval. In addition, approval for the study was not required in accordance with local/national legislation.

Informed Consent Statement: Respondents declared their consent to inclusion in the survey and completed the survey while supervised by the community leaders and surveyors.

Data Availability Statement: Data are available on special request from the corresponding author.

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Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

ATP	Activity-travel participation
IH	In-home
OH	Out-of-home
MTA	Multitasking activities
SWB	Subjective well being
PT	Public transport
NMT	Non-motorized transport
AT	Active transport
MT	Motorized transport
TM	Transport modes
IHM	In-home mandatory
IHL	In-home leisure
IHMA	In-home maintenance
OHM	Out-of-home mandatory
OHL	Out-of-home leisure
OHMA	Out-of-home maintenance

Appendix A

Transport Mode Categorization

1 : Walking
2 : Walking from/to station/bus stop and other public transport transfer
3 : Bicycle
4 : Motorcycle
5 : Sedan, Jeep, Kijang, and related vehicles
6 : *Station wagon* like a Suzuki Carry, MPV, and related vehicles
7 : *Pick up*
8 : Truck
9 : Railway executive class
10 : Railway economy class
11 : Big bus and medium bus with AC
12 : Big bus and medium bus without AC
13 : Small bus/Angkot
14 : Taxi
15 : Ojek/Paratransit
16 : Becak
17 : Omprengan
18 : Bajaj
19 : School/Company bus
20 : Delman
21 : Lainnya

Appendix B

Classification of Daily Activities

A : Sleeping

B : Personal care: taking a bath, brushing teeth, titivating, and so on

C : Eating and drinking at house

D : Relaxing activities such as:

- Watching TV
- Listening to radio
- Listening to music
- Reading newspaper/magazine/comic, and so on
- Browsing internet
- Relaxing
- Other

E : Social and family activities:

- Chatting with other family members/friends
- Chatting with other family members/friends on the phone
- Walking/biking with other family members/friends
- Visiting relatives/friends
- Praying

F : Household activities:

- Cleaning the house
- Cooking
- Baking a cake
- Washing a cloth/clothes or a dish/dishes
- Ironing
- Preparing a drink
- Other related activities

G : Babysitting activities

- Babysitting
- Playing together
- Feeding your children

H : Indoor working activities:

- Working at office desk
- Conducting indoor research or experiments in laboratory
- Meeting with clients over the phone

I : Driving vehicle to other places

J : Outdoor working activities: operating machinery or heavy vehicles outdoors, for outdoor inspection or outdoor engineering inspection, and other related activities

K : Sales activities from door to door, delivering something, purchasing activities

L : Indoor school activities

M : Outdoor school activities: visiting zoo/museum/park, camping, and other related activities

N : Eating and drinking outside the home

O : Shopping activities:

- Grocery shopping
- Shopping at the shopping centre/mall

P : Organization/volunteer/political activities: boyscouts, youth/political/religious meeting activities

R : Sport activities

S : Maintenance activities: going to hospital/health centre/medical doctor, visiting bank/post office

T : Dropping/picking up children/other family members/friends/business partners/others

U : Holiday

V : Waiting for public transport

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