

Travel Behavior Towards Transit-Oriented Development in Dukuh Atas, DKI Jakarta

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Abstract— Increasing resident activity in Jabodetabek has highlighted that increased traffic flow and transportation needs could cause congestion and environmental problems. To address these possible transportation problems, a transit-oriented development (TOD) policy is soon to be implemented in Dukuh Atas, Jakarta. Therefore, the research objective was to examine resident travel behavior based on socioeconomic characteristics and land use based on the TOD policy in Dukuh Atas. A model was developed to more closely examine the travel behavior influencing factors in the Dukuh Atas TOD area. Questionnaires were distributed to 300 respondents (150 inhabitants near the transit station and 150 commuters), and the data analyzed using structural equation modeling (SEM). It was found that the travel behavior in Dukuh Atas TOD was more influenced by socioeconomic status (0.431) than land use in the TOD area (0.251). In general, the income, transportation costs, and educational background variables were found to be the most influential socioeconomic variables. Moreover, respondent travel behavior was not found to be unduly influenced by transit area facilities.

Keywords—travel behavior, transit-oriented development, structural equation modeling

I. INTRODUCTION

As cities drive economic growth and development, urbanization has been seen as a policy tool to drive city development and improve the quality of life of the residents. According to the World Bank (2007), by 2025, approximately 67.5% of Indonesia's population are expected to be living in urban areas. In recent years, due to an increase in infrastructure facilities and qualified jobs, Jakarta has been growing rapidly, with an estimated increase in population of 269 people a day. Until 2017, the population density in Jakarta was 15,234 people / km². According to Statistics Indonesia, the average population growth rate in Jakarta was 1.09 since 2000. However, after 2010, the number of migrants to Jakarta city started to decline, with many migrants preferring to move to the Jakarta hinterland to Bogor, Depok, Tangerang, and Bekasi possibly because the land prices were lower than in Jakarta. However, the hinterland migrants conduct most of their daily and commercial activities in Jakarta. A 2014 Jabodetabek commuter survey found that out of the 28 million Jabodetabek residents, 13% or ± 3.5 million people were commuter residents; however, 20% of residents from Depok, 20% from Bekasi population, and 18% from South Tangerang were commuter residents, with the lowest commuter population being from Tangerang Regency at

only 6%. Data from the Jabodetabek Transportation Management Agency (BPTJ) also found that the volume of vehicles per day in Jakarta was 940,000; the toll road load per day for four-wheeled vehicles heading to Jakarta was 31% or 423,000 vehicles per day from Tangerang and South Tangerang, 31% or 426,000 vehicles per day from Depok and Bogor, and 38% or 571,000 vehicles per day from Bekasi. The tendency that affects urban problems is, amongst others, the farther the average human movement every day, the more women who work, the more students and students, and the more tourists (Tamin, 2000) It has been found that 74% of the commuters from Jabodetabek are in the productive age group of 15–44 years; 68% male and 32% female.

The increase in population density has begun to affect the urban transportation facilities in Jakarta. Because of the urban sprawl, the government is expected to implement technical instruments and planning regulations, especially for the transportation sector. Jakarta's urban problems are a government concern as it is the government's responsibility to provide quality urban infrastructure facilities that are capable of accommodating large numbers of commuters. With the rising commuter loads from Bodetabek, multimodal transport systems and networks and convenient public transport services are needed. Therefore, the government needs to "force" people to switch to public transportation rather than using private transport. Transit-oriented development (TOD) is a concept that supports smart growth, increases economic growth, is able to change market demand and lifestyle preferences (Cervero, 2004), and minimizes human and vehicle movements. Therefore, the TOD concept could be the answer to ensuring sustainable economic, social and environmental urban development. TOD concentrates urban activities in one transit point through mixed land use (mixed-use) and compact development (Calthrope et al., 2004), which means placing commercial centers, housing, offices, parks and public facilities within walking distance of transit stops. To support the transportation system development, the government through the Minister of ATR / BPN is responsible for developing policies for TOD in Indonesia. Basically, the regulation reviews the basis and purpose for TOD areas to support urban transportation systems that are pro-commuter and are aligned with the socioeconomic carrying capacity of the community in the TOD area as well as the residents living in the transit area vicinity.

Because the policy has now been drafted, it is expected that there will be several TOD area announced for Jakarta. These areas need to be able to accommodate at least two modes of public transportation, one of which should be rail-based and located downtown; therefore, the Jakarta TOD is to be centralized in the Dukuh Atas area. Several rules for the Jakarta TOD have been made to comply with Governor Regulation No. 44 of 2017 concerning the Development of Oriented Development Areas. The existing conditions in Dukuh Atas are basically in accordance with the requirements for TOD areas. Data from the PT MRT Jakarta (2018) show that Dukuh Atas is already an intermodal mass transportation area with connections to Sudirman KRL Station, the Airport Train Station, Jakarta MRT Station, Dukuh Atas LRT Station and the Transjakarta Bus Stop. Dukuh Atas also has many commercial and residential activities such as offices, retail stores, hotels, and apartments. Therefore, developing this area as the key transportation node and the center of economic development in Jakarta has many challenges because of the current inadequate environmental, social and economic quality, flood risks, urban congestion problems, and poorly functioning pedestrian (pedestrian) and bicycle road network. For this reason, this development requires the implementation of regional principles that are focused on land use with mixed functions that allow for high density development and ensure increased connectivity, an improved quality of life, social justice, environmental sustainability, infrastructure resilience, and economic regeneration.

As well as the aim to streamline public transport services in TOD areas, the TOD can also increase social capital by improving the kinship between the local communities or neighbors (Nallari, Griffith, & Yusuf, 2012), which could overcome the main problems associated with urbanization; the lack of strong social bonds. However, TOD have been found to increase the social capital for people living closer to the station. TOD research in China in Beijing and Shenzhen, found that accommodating the development of multimodal transportation was able to improve ecological, economic and social sustainability in these rapidly growing cities (Xie, 2017). Although TOD implementation development indicators have shown that it can be successfully applied, each city has varying development needs. Therefore, this paper examines travel behavior around the Transit-Oriented Development in Dukuh Atas in terms of the socioeconomic characteristics and land use development policy, and develops a model that explains the influencing factors for travel behavior in the Dukuh Atas TOD area.

II. METHODS

This research was conducted in the transit-oriented area Dukuh Atas located on Jalan Juana, Jalan Kendal, to Jalan Blora, Kelurahan Menteng, Kecamatan Menteng, City of Central Jakarta. In the DKI Jakarta Provincial Spatial Plan for 2012 - 2030 and the DKI Jakarta Province Spatial Detail Plan for 2014 -2019, the Dukuh Atas area was identified as a priority area for the primary TOD activity. Dukuh Atas is a large scale, high density residential, commercial and business area in the Sudirman-Thamrin area and has significant potential as a central transit-oriented area. The focus of the research was the TOD area and the surrounding areas that would be affected by the TOD. The buffer Map (Figure 1) shows the 800 meter transit point area that is to be affected by the TOD.

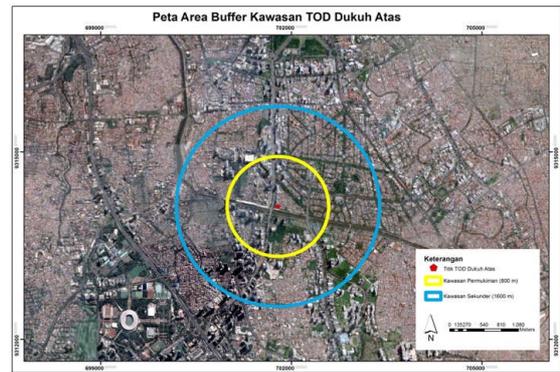


Fig. 1 Buffer Area for the Dukuh Atas TOD

The research took a stratified random sampling approach, which is considered suitable for proportional and heterogeneous populations (Margono, 2004; Sugiyono, 2001; Meng, 2013). Stratified random sampling was also used because the sampling could be done in all survey locations and because the estimates have been found to be more accurate for each section of the population. Sample collection was conducted on people in the area around the TOD Dukuh Atas. The determination of the number of respondents to be approached in this study was according to Joreskog & Sorbom (1996) based on the number of research variables. In this research, as there were 22 variables, the sample was determined based on the following formula:

$$\text{Sample minimum} = \frac{\kappa(\kappa + 1)}{2}$$

k = number of variables

The estimation of the minimum study population using the Joreskog & Sorbom's (1996) formula was 210 local residents and commuters; because of a possible sampling error of 5%, the research sample was rounded to 300 respondents; 150 resident respondents and 150 commuter respondents. The commuters were identified as people who were travelling across districts and cities to carry out their daily activities and the residents were people who had been living within a radius of ±800 meters around the Dukuh Atas TOD area transit point for at least 6 months or not up to 6 months but with the intention to stay. The occupant data was obtained using a questionnaire that required the respondent to systematically answer the study questions. The household questionnaire was designed to capture the characteristics of the housing environment and socioeconomic characteristics of the household (e.g., car ownership and household income) (Van Acker, Witlox, & Van Wee, 2007).

The resident and commuter travel behavior model in the TOD area was developed using the structural equation modeling (SEM) approach, which is a multivariate analysis technique used to build and test a statistical model and develop a causal model (Golob, 2001; Hairulsyah, 2013). SEM is a hybrid statistical modeling technique that includes confirmatory aspects from the factor, path, and regression analyses, and has cross-sectional, linear and general properties. The SEM analysis in this study was processed using SmartPLS software, which is used for structural equation modeling and includes formative indicators to make predictions through relationship testing between each variable construct (Soo, 2016).

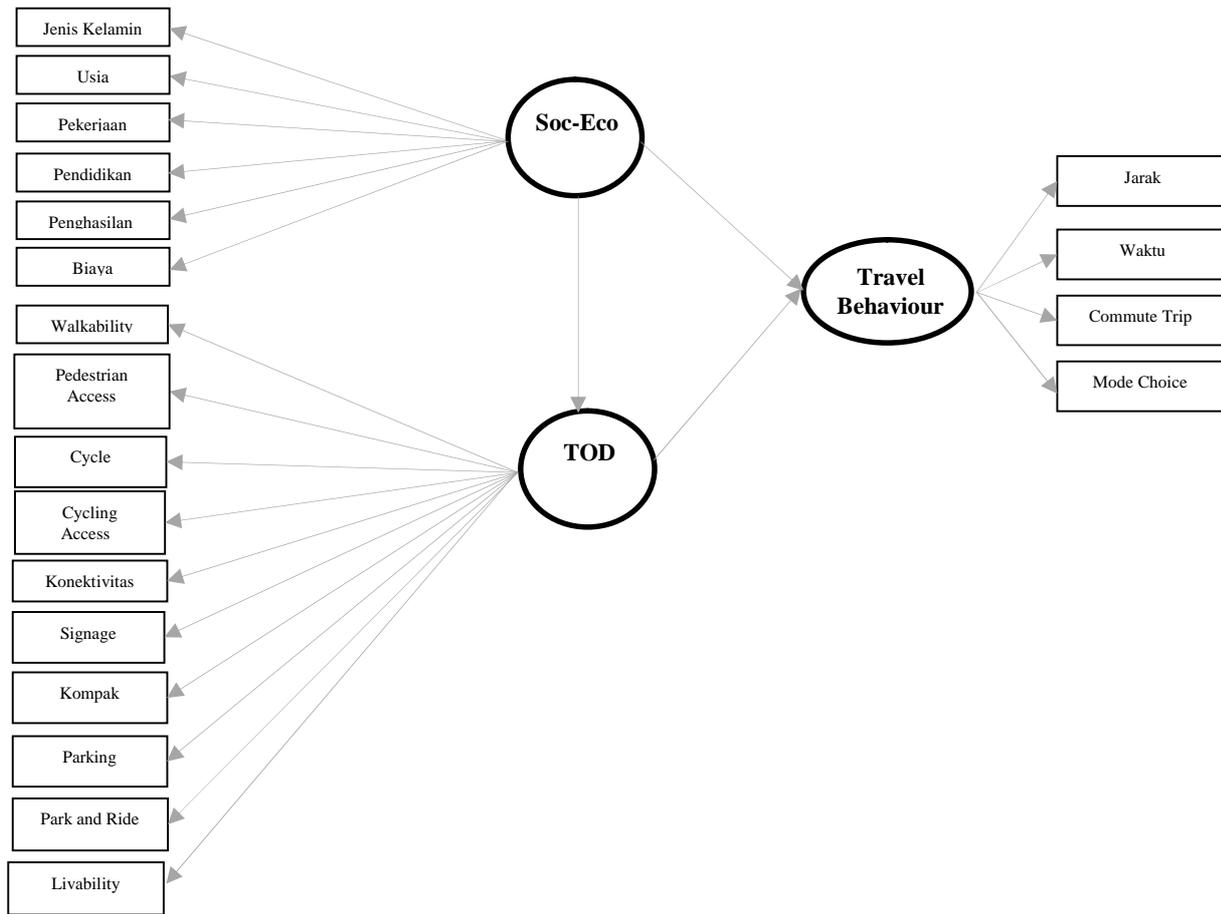


Fig. 2 Model Construct

This research examined government policies on the development of the TOD area regarding the behavior of public transportation users in the Dukuh Atas TOD area and the population around Dukuh Atas.

The analysis included three latent variables. The latent construct predictor variable was socioeconomic (X1), the observation variables were gender (X11), age (X12), occupation (X13), education (X14), income (X15), and transportation costs (X16), and the mediator variables were the TOD (X2) simultaneous variables; walkability predictor variables (X21), walking distance (X22), walking time (X23), alternative mode (X24), cycle (X25), cycling access (X26), connect (X27), signage (X28), pedestrian access (X29), one-stop center (X210), parking (X211), park and ride (X212), and livability (X213). The latent travel behavior construct (Y) was explained using the following observation variables; distance (Y1), choice of public transportation mode (Y2), trip (Y3), and time (Y4). The results of the model are shown in Figure 2.

The SEM model analysis in Figure 3 revealed that the model fit was in accordance with previous research. The model test obtained a Chi-Square of 586.122.

III. RESULTS AND DISCUSSION

To identify the characteristics of each of the inhabitant and commuter respondents, a questionnaire was distributed to 150 residents in the vicinity of the Dukuh Atas TOD area

and 150 commuter respondents. The respondents' socioeconomic quantitative data is shown in Table 1.

The Jakarta urban sprawl has had an impact on the many daily commuters to Jakarta. As shown in Table I, the majority of people commute for employment purposes, with the others attending school or involved in activities around the Dukuh Atas transit area. The survey revealed that 60.7% of commuters came to Jakarta for work, and 39.3% of local residents were either housewives or students. Around 40% of commuters had graduated from college (40%), but the majority of local residents had only graduated from high school (59.3%). In terms of income, however, 41.3% of residents earned 3.51–5 million and 36% earned up to 3.5 million, whereas 34% of commuters earned below 3.5 million, 34% earned between 3.51 to 5 million, and 32% earned more than 5.1 million, which means that one-third of commuters were in the upper middle category based on the World Bank calculations. Previous studies have found that populations around transit areas are generally low-income households without cars (Cervero, 2004), which was also found in this study.

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In terms of the land use in the TOD area, the rail and non-rail mass public transportation and the pedestrian and bicycle lane transit functions are very important. Moreover, to reduce the use of personal vehicles, walking or cycling provisions are needed. Table 2 shows the resident and commuter travel behavior, from which it can be seen that most residents (70%) and commuters (76.7%) travelled 00 - 0.4 km from the transit point from their place of residence to the place of their activities. More local residents (26.75) walked 0.41 - 1 km to their place of activity than commuters (13.3%), but more commuters (9.3%) walked 1- 4 kms to their place of activity than local residents (2.7%). However, very few commuters or residents walked 4.1 - 7 km (0.7%).

To improve the quality of Jakarta’s development, the government plans to operate sustainable transportation; the Mass Rapid Transit (MRT) and Light Rapid Transit (LRT). The rail-based Mass Public Transport System (SAUM) was

put into operation to complement the integration of the intermodal transportation in Dukuh Atas, following the opening of the airport fast train, Transjakarta, and the Busway Integrated Border Transportation (APTB). If it were already operating, most respondents claimed that they would switch to the MRT; 81.3% of residents and 79.3% of commuters. However, the propose used of the LRT mode was much lower at only 18.75 of commuters and 6% of residents.

A. Analysis of Structural Equation Modeling

The travel behavior resident and commuter TOD area model was then analyzed using a SEM approach.

SEM research proposes that a normed fit index (NFI) be the first measurement after the calculation of the Chi-Square value (Bentler & Bonett, 1980). NFI values are between 0 and 1; the closer to the value is to 1 or when it is above 0.90, the model is seen to have acceptable compatibility. The NFI value in Table 3 was found to be 0.533, and as this value was between 0 and 1, the model was judged to be of average acceptability. The standardized root mean square residual (SRMR) value is used as a measure of goodness of fit to avoid misspecification in the model (Dijkstra & Henseler, 2015). From the SRMR value of 0.092 or <0.08 shown in Table III, it was concluded that there was no model misspecification. From Table III, it can also be seen that the model form was not good enough because the indicator variables in the model were not significant to each other.

TABLE I. RESPONDENT CHARACTERISTICS

Social-Economics	Frequency (%)	
	<i>Inhabitants</i>	<i>Commuters</i>
Gender		
Male	87 (58%)	79 (52.7%)
Female	63 (42%)	71 (47.3%)
Age		
15–25	32.0%	38.7%
26–35	28.7%	34.0%
36–45	20.7%	16.7%
46–55	8.7%	10.7%
56–65	4.0%	0.0%
66–80	6.0%	0.0%
Job		
Employee	32%	60.7%
Entrepreneurship	12,7%	21.3%
Merchant	7.3%	1,3%
Housewife & Student	39.3%	14.7%
Others	8.7%	2%

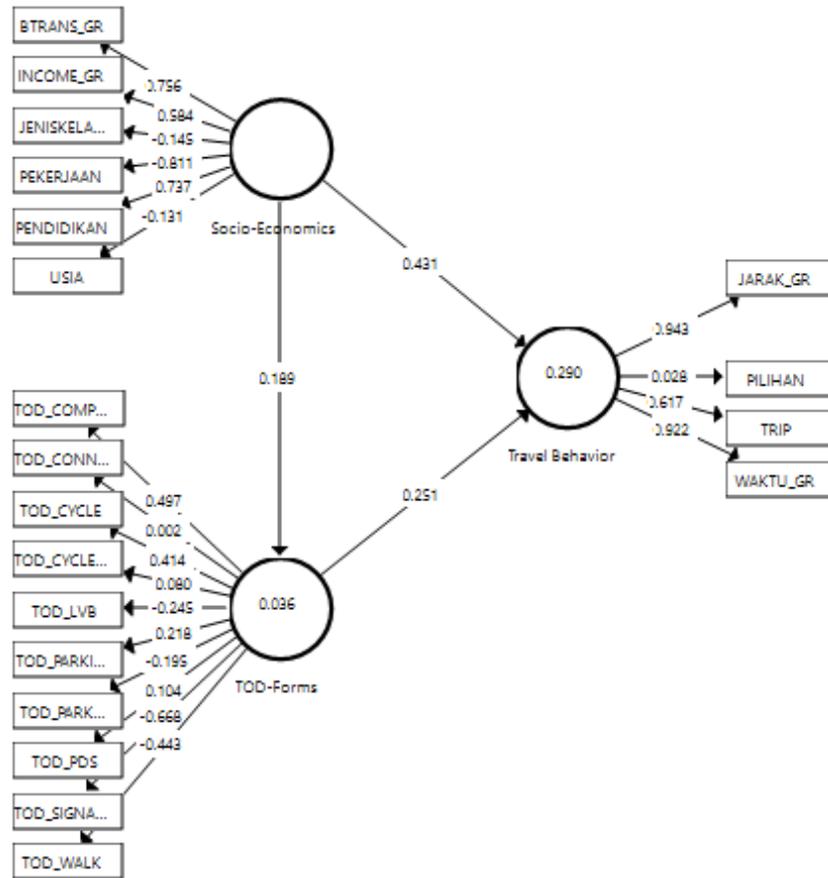


Fig. 3 SEM Result

TABLE II. TRAVEL BEHAVIOR CHARACTERISTICS

Travel Behavior	Frequency (%)	
	<i>Inhabitants</i>	<i>Commuters</i>
Distance (km)		
00 - 0.4 km	70.0%	76.7%
0.41 - 1 km	26.7%	13.3%
1.1 - 4 km	2.7%	9.3%
4.1 - 7 km	0.7%	0.7%
Time (min)		
<= 0 - 2 minutes	68.0%	73.3%
2.1 - 7 minutes	2.0%	5.3%
7.1 - 15 minutes	26.0%	18.0%
15 - 30 minutes	4.0%	3.3%
Trip		
Walking	6.0%	1.3%
1 time	60.7%	46%
2 times	18.0%	46%
More than 3 times	15.3%	6.7%
Public transport usage		

Never	15.3%	8.0%
Sometimes (<5 times a week)	50.0%	43.3%
Often (5–10 times a week)	21.3%	14.0%
Yes, always (> 10 times a week)	13.3%	34.7%
Mode Choice		
Not Using Public Transport	20%	17.3%
KRL / Commuter line	38%	49.3%
Transjakarta bus	30.7%	32.7%
Public vehicles with routes (Metromini, Kopaja, Mayasari Bakti, etc.)	8.7%	0.7%
Busway Integrated Border Transportation (APTB)	2.0%	0%
Pick-up public transportation	0.7%	0%
Future Mode Choice		
MRT	81.3%	79.3%
LRT	6.0%	18.7%
Airport Train	7.3%	0.7%
Others	4.0%	1.3%

TABLE III. MODEL FIT

	Saturated Model	Threshold	Evaluation
SRMR	0.092	<0.08	-
Chi-Square	586.122	Small	-
NFI	0.533	Between 0 to 1	-
Prob.	0.000	>0.05	Good

TABLE IV. AVERAGE VARIANCE EXTRACTED (AVE)

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics ((O/STDEV))	P Values
Socioeconomics	0.359	0.358	0.017	21.135	0.000
TOD Forms	0.123	0.131	0.014	9.044	0.000
Travel Behavior	0.530	0.532	0.015	34.528	0.000

Source: Primary Data, processed with SmartPLS, 2018

Hypotheses test are used to assess the probability value of each variable if the value of $P < 0.05$. When the value of $P > 0.05$, this indicates that there is no correlation between the variables. As shown in Table IV, the AVE was found to have a correlation with all formative indicators < 0.05 , with all socioeconomic variables, TOD forms, and travel behavior being 0.000, clearly indicating that there was a significant effect between the independent variables and the dependent variables. As the t-statistic value for the formative indicator had a value higher than 1.96, the null hypothesis was rejected, which meant that all the formative indicators were in accordance with the study hypotheses.

Therefore, it was found that the travel behavior of Dukuh Atas TOD users was influenced more by socioeconomic status (0.431) than TOD land use (0.251). In general, income, transportation costs, and educational background had the most influence on the socioeconomics of the respondents. The choice of the place of residence was also influenced by the social status of the respondent, which indirectly affected travel behavior (Van Acker et al., 2007). That is, indirectly, the respondents who had higher transportation costs and travelled further for a longer time used several modes of transport to get to their place of activity before transiting in the Dukuh Atas TOD area. The behavior related to the respondents' travel was not found to be influenced by the transit area facilities, which was in disagreement with research in San Diego, in which it was found that this type of land use greatly influenced travel behavior (Boarnet & Crane, 2001). The difference between these findings was possible because of the marked differences between the socioeconomic status of the respondents and the urban facilities in Jakarta and those in San Diego. The model analysis indicated that even though respondents were not satisfied with the service facilities in the transit area, the highly educated and high income respondents used public transportation because they lived quite far away and the travel time was quite long; however, socioeconomic status was not found to affect respondent activities in Dukuh Atas (0.189). Although in general the respondents were not satisfied with the infrastructure services at Dukuh Atas, the travel behavior was more influenced by social status, with respondents having a higher social status travelling longer distances for a longer time and taking more trips per day. Travel behavior was found to be less complex in respondents who had fewer household responsibilities and those living in urban environments.

IV. CONCLUSION

Based on the analysis results, the following conclusions were made.

- The commuter and resident trip behavior around the transit area were somewhat similar. Most respondents did not see public transportation as the main means for their daily activities. In addition, both the commuters and residents were less willing if they had to walk and/or use bicycles to conduct their activities in the transit area.

- The income, transportation costs, and educational background variables were found to be the most influential socioeconomic variables, and the respondent travel behavior was not found to be influenced by the transit area facilities. Respondents' socioeconomic backgrounds were found to have a greater influence on travel behavior than the land use in the TOD area. In contrast to many previous studies, in which it was found that compact land use significantly affected walking and public transportation use travel behavior, this was not found in this study, possibly because most respondents expressed a degree of dissatisfaction with the Dukuh Atas land use infrastructure quality .

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