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THE MODE CHOICES AND COMMUTING STRESS: EMPIRICAL EVIDENCE FROM JAKARTA AND DENPASAR

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Abstrak. Jabodetabek dan Sarbagita merupakan metropolitan dengan populasi komuter pekerja tertinggi di Indonesia. Akan tetapi, Jabodetabek memiliki cakupan angkutan umum yang beragam dan lebih bervariasi daripada Sarbagita. Studi ini menganalisis hubungan antara penggunaan moda transportasi tertentu dengan stres perjalanan. Model Regresi logistik diestimasi menggunakan data dari Survei Komuter Jabodetabek dan Survei Komuter Sarbagita. Menggunakan regresi logistik, hasil studi menunjukkan bahwa pilihan moda, jenis kelamin, dan waktu perjalanan memiliki pengaruh yang signifikan terhadap stres perjalanan. Hasil analisis juga menunjukkan bahwa baik di metropolitan dengan impedansi tinggi maupun impedansi rendah, komuter yang menggunakan mobil dianggap lebih rentan stres daripada komuter non-mobil. Pada kondisi dengan pilihan moda yang terbatas, para komuter yang menggunakan mobil memiliki peluang lebih besar mengalami stres dalam perjalanan. Lebih lanjut, temuan penelitian ini juga mengimplikasikan pembatasan penggunaan mobil dan juga evaluasi kebijakan pembukaan jalan tol sebagai solusi kemacetan perkotaan.

Kata kunci: moda transportasi; komuter mobil; stres perjalanan; trasportasi perkotaan

[Title: The Mode Choices and Commuting Stress: Empirical Evidence from Jakarta and Denpasar]. *Jabodetabek and Sarbagita have the highest worker commuter population in Indonesia. However, Jabodetabek has various and larger coverage of public transport than Sarbagita. This study analyzes the relationship between the usage of specific transport modes and commuting stress. Multiple logistic regression models have been estimated using data of both Jabodetabek Commuter Survey and Sarbagita Commuter Survey. Using logistic regressions, the results show that mode choices, gender, and travel time have a significant effect on commuting stress. The analysis also indicates that both in high impedance and low impedance metropolitans, car commuting is perceived to be more stressful than non-car commuting. In a condition of restricted mode choices, commuters who use cars have a greater probability of commuting stress. Furthermore, the findings of this study imply limitation of car usage and as an evaluation of the policy of opening toll roads as a solution to urban congestion.*

Keywords: *car commuting; commuting stress; transportation mode; urban transportation*

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1. INTRODUCTION

The location of workplaces that administratively differ from the residence town, well known as commuting, is a common labor migration phenomenon today. Commuting is considered as a more acceptable alternative than permanent migration (Wagner & Mulder, 2015). Rational individuals are only willing to take longer commuting if they are compensated. This compensation can be in the form of either better housing or better job characteristics. On the other hand, commuting has an opportunity cost. The occurrence of being stuck in congestion or waiting for a delayed train/bus is understandable as

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difficulty and quite prevalent. Stress is one of the implications of bad commuting in mental health.

The existence of commuters is inseparable from the transportation system. A high share of private transport use and other public policies in Indonesia, such as fuel subsidy policy, contributes to a less sustainable transport system. It is not surprising that congestion is the main problem of urban transportation in Indonesia. The congestion solution carried out in urban Indonesia is generally characterized by the existence of paid toll roads, instead of providing affordable mass transportation. This solution tends to accelerate the increasing number of private car ownership in Indonesia cities, especially cars. The present study, therefore, investigates the effect of commuting by car mode on the mental health of commuters.

Jabodetabek (Jakarta-Bogor-Depok-Tangerang-Bekasi) and Sarbagita (Denpasar-Badung-Gianyar-Tabanan) are similarly Indonesian metropolitans with high standards of living, high congestion level, and paid access toll roads. Jakarta, as Indonesia's largest growth pole, has various public transportation with different routes. While Sarbagita has fewer and limited public transportation mode choices. We deliberately consider 2 study locations with the contrasting quality of public transportation services to compare stress propensity experienced by commuter workers in both growth poles.

In this paper, the data results of Jabodetabek Commuter Survey 2014 and Sarbagita Commuter Survey 2015 are used to study the causality between commuting stress and (i) travel characteristics such as mode choices, commuting time, mileage and as driver/passenger; and (ii) socio-economic characteristics. This study also describes how stress is perceived in Jabodetabek, a growth pole which has various public mode choices but a higher impedance, as well as in Sarbagita, a growth pole which has fewer public mode choices with a lower impedance. This study focused on samples that commute only during rush hour because it considers the fact that transportation policies are based on rush hour conditions. Understanding diversity in determinants of commuting stress can aid to formulate policies aiming to make transport systems more comfortable and user-friendly.

Several studies have found a link between travel time and stress. Commuting time is positively correlated and has a positive effect on commuting stress (Gottholmseder, Nowotny, Pruckner, & Theurl, 2009; Legrain, Eluru, & El-Geneidy, 2015; Wener & Evans, 2011). The longer the commuting time, the higher the level of stress experienced by the commuters. This is also reinforced by the work of Stutzer and Frey (2008) and Roberts, Hodgson, and Dolan (2011) who revealed that commuter time was negatively correlated with life satisfaction. Research by Wener, Evans, Phillips, and Nadler (2003) shows that decreasing travel time can reduce the effects of perceived stress significantly. In terms of commuting distance, the study by Rüger, Pfaff, Weishaar, and Wiernik (2017) has shown that the long-distance commute was affiliated with higher stress.

Several dimensions of the commuting situation, such as travel impedance, have been the focus of much literature in commuter stress. High impedance on the road is often associated with congestion levels. The impedance model is initially developed by Novaco, Stokols, and Milanesi (1990). Basically, the impedance is a combination of the distance traveled and the time needed to travel that distance.

Recent researches have compared the stress of driving car. The study of Wener and Evans (2011) revealed higher stress among car drivers than among both bus commuters and train commuters. In a UK Context, commuting by private car was found to be more stressful than walking and cycling (Gatersleben & Uzzell, 2007). Car commuting has been shown to be the most strain in Canada. Nevertheless, walking or using public transport may be more gratifying (Legrain et al., 2015).

Contradicting these previous research studies, a study of drivers in the United Kingdom concluded that drivers had high control over the time of departure, route and driving speed compared to users of transit mode. This further impacts on lower stress levels (Williams, Murphy, & Hill, 2008). A study by Novaco et al. (1990) also concludes that

having personal control over travel reduces this stress. These travel characteristics are often characterized by car travel.

Individual socio-economic and demographic characteristics also notify sensitivity and responses to commuting stress. Being male is also related to less stress (Roberts et al., 2011). As for age variables, the study of Graham and Ruiz Pozuelo (2017) confirms that the form of the relationship between age and stress is an inverted U-curve. An established empirical generalization in the field of mental health is that stress is inversely proportional to the level of income. The greater the individual's income, the less psychological pressure reported (Thoits & Hannan, 1979).

Meanwhile, there is few research on the psychological health of commuter workers in Indonesia. One of these studies was conducted by Rahmadana (2014) who examined the quality of life of commuters in Medan-North Sumatra by involving only hundreds of samples. Whereas, qualitative research was carried out by Sugianti and Anggorodi (2013). They examined the stress experienced by TransJakarta bus passengers. Similar quantitative research with many samples is still limited. Therefore, this research is conducted to fill the research gap.

2. METHODS

Data for this study originated from two comparable travel surveys: Jabodetabek Commuter Survey (JCS) of 2014 and Sarbagita Commuter Survey (SCS) of 2015. JCS covers 13 cities/regencies namely Kota Jakarta Selatan (South Jakarta City), Kota Jakarta Timur (East Jakarta City), Kota Jakarta Pusat (Central Jakarta City), Kota Jakarta Barat (West Jakarta City), Kota Jakarta Utara (North Jakarta City), Kabupaten Bogor (Bogor Regency), Kota Bogor (Bogor City), Kota Depok (Depok City), Kabupaten Tangerang (Tangerang Regency), Kota Tangerang (Tangerang City), Kota Tangerang Selatan (South Tangerang City), Kabupaten Bekasi (Bekasi Regency), and Kota Bekasi (Bekasi City). SCS covers four areas in Bali Province, namely Kota Denpasar (Denpasar City), Kabupaten Badung (Badung Regency), Kabupaten Gianyar (Gianyar Regency), and Kabupaten Tabanan (Tabanan Regency). Both surveys were conducted by Statistics Indonesia. SCS and JCS data collections were conducted in April and May respectively. The sub-population for the present study consisted of a sample of 1,755 individuals who live in Jabodetabek and Sarbagita, commuting to work by vehicles during 06.00 – 09.00 a.m., and take a daily trip as far as 20-60 kilometers.

The model employed in the study was based on the literature review. We utilized several variables from the JCS 2014 and SCS 2015 selected according to our interest in predictors of commuting stress, including commute characteristics, and socio-demographic characteristics (Table 1). The primary exposure of the interest was obtained from the question “Do you feel stress due to travel to work?”. Next, the binary dependent variable (stress=1, no stress=0) was created.

General questions regarding their socio-economic and demographic information were gathered. The travel time variable and the distance variable captured an individual’s stated one-way commute travel characteristics. Monthly individual income was truncated to remove a very large number and over 50 million rupiah in income, as it was considered that such income does not represent the monthly Indonesian citizen’s income per capita in general. These variables were log-transformed in our model. The value of 0 remained set to 0 as well as not transformed. The explanatory factors identified above might have a different effect on commuting stress in each growth pole.

Mode choice binary variables were derived from the question “What main transportation modes do you usually use to go to work?”. This variable is a simplification and combination of the Wener and Evans (2011) and Gatersleben and Uzzell (2007) models. Mode choice variables were divided into Car Commuting and Non-Car Commuting. Car Commuting included travel by cars and official cars, while non-car commuting included travel by bicycle, motorbike/motorbike-taxi, and public transport such as train, bus, and conventional city transport. Non-car commuting was included in the reference category. The main transportation referred to the transportation modes which were used for the furthest distance or which required the longest

time. Walking mode observations were excluded due to the existence of the driver status variable (driver=1, passenger=0) and small sample sizes. Descriptive statistics of the sample is presented in Table 1.

Overall there were 1,755 survey participants for this analysis. This sample was composed of more than 70% male commuters. Approximately one in five Jabodetabek respondents (18.96%) and four in fifty Sarbagita respondents (8.27%) used the car to commute to work. These commuters were more likely to be productive aged (between 30-50 years), married, and had middle-class income. Jabodetabek commuters had higher income rather than the Sarbagita counterparts. Jabodetabek commuters travelled a longer distance which was reflected in the higher mean and standard deviations. This was due to the area of Jabodetabek which is 6,400 km^2, three times larger than Sarbagita which is only 1,754 km^2.

We applied multiple logistic regressions to approximate the effects of travel characteristics and individual characteristics towards commuting stress. Given the response variable's binary scale, it would be obvious to be a natural fit for a logistic regression model. The transformed logistic regression model is written as follows:

$$Ln\left(\frac{p}{1-p}\right) = Ln\left(\frac{stres}{not\ stres}\right) = \beta_0+\beta_1\,Dist+\beta_2 Mode+\beta_3\,Driv+\beta_4 Time+\beta_5 Wage+\beta_6 Age+\beta_7 Age^2+\beta_8 Sex+\beta_9 Mar+\beta_{10.1}Edu_1+\beta_{10.2}Edu_2+\varepsilon \quad \text{Eq. (1)}$$

The logit results of Eq. (1) are given in Table 2.

Table 1. Sample Descriptive Statistics

Variables	Jabodetabek		Sarbagita	
	Mean (prop)	SD	Mean (prop)	SD
Dependent Variable				
Stress	(41.84)		(25.90)	
Not Stress	(58.16)		(74.10)	
Independent Variable				
Commuting				
Travel time (min)	78.10	32.28	49.39	20.12
Distance (km)	29.79	98.83	27.95	76.27
Car mode (1-0)	(18.96)		(8.27)	
Driver status (1-0)	(67.91)		(96.40)	
Socio-economic and				
Age (year)	37.31	10.84	34.75	10.93
Male (1-0)	(71.71)		(70.86)	
Married (1-0)	(68.86)		(73.02)	
Wage (000 rupiahs)	4, 754	4, 412	3, 119	1, 956
Education				
Elementary school or	(10.77)		(7.91)	
High school	(43.94)		(49.28)	
College	(45.29)		(42.81)	
N	1,477		278	

Table 2. Results of Multiple Logistic Regressions of Commuting Characteristics and Individual Characteristics on Commuting Stress in Jabodetabek 2014 and Sarbagita 2015. Dependent Variable: Commuting Stress.

Variables	Jabodetabek		Sarbagita	
	Marginal Effect	Odds Ratio	Marginal Effect	Odds Ratio
Commuting				
Travel time	0.140 **	1.782	0.091	1.630
Mileage	-0.032	0.878	0.179	2.632
Car mode (1-0)	0.094 **	1.465	0.205 *	2.576
Driver Status (1-0)	0.053	1.244	-0.162	0.469
Socio-economic and demographic				
Age	0.007	1.031	0.016	1.093
Age squared	-0.0001	0.999	-0.0002	0.999
Male (1-0)	-0.062 *	0.776	-0.033	0.840
Married (1-0)	0.039	1.175	-0.086	0.643
Income (rupiahs)	-0.026	0.898	0.062	1.630
Education				
Elementary school or lower	ref. category	ref. category	ref. category	ref. category
High school	0.051	1.236	-0.753	0.666
College	0.028	1.120	-0.113	0.537
Intercept	-	0.213	-	0.0000137
Model fit				
Count R-square		58.9		73.7
Log-likelihood intercept		-1004.028		-159.016
Log-likelihood full		984.577		-150.316
Probability> Chi Sq		0.0001		0.0966
N		1477		278

Notes:

** Significant at 0.05

* Significant at 0.1

Furthermore, multiple regression logistic model was also applied to the same JCS 2014 data set without a distance limitation of 20-60 km (*N=3,307*) to find out the most stress-prone mode. This was performed to find out the stress-prone modes at all impedance levels. JCS was chosen to apply this model because of the complete reasons for mode choices available. The 16 modes of choice listed in the JCS questionnaire are re-classified into 5 types, namely bicycles, motorbikes, cars, buses, and trains. Binary variables of these mode choices (user=1, non-user =0) are created. Bicycle travel is included in the reference category. The model can be written as:

$$Ln\left(\frac{p}{1-p}\right) = Ln\left(\frac{stres}{not\ stres}\right) = \beta_0 + \beta_1\, moto + \beta_2 Car + \beta_3\, Bus + \beta_4 Train + \varepsilon \quad \text{Eq. (2)}$$

The logit results of Eq. (2) are presented in Table 3.

3. RESULTS AND DISCUSSION

Table 2 presents the results of our regression analyses. In both study location, most of the determinant variables regarding individual characteristics are found to be insignificant. Overall for Sarbagita residents, no significant relationship between individual characteristics and reporting

stress is observed. From one point of view, this can be elucidated by low expectations caused by a lack of other job choices. Commuting is a necessity in order not to become unemployed, so this encourages commuters to do coping strategies to deal with commuting stress.

Based on the demographic characteristics, only the gender variable has a negative and significant effect on commuting stress. This result is in line with previous research by Roberts et al. (2011) which states that women tend to have a higher probability of experiencing stress compared to men. Generally, women play a greater role in household responsibilities. Compared to men commuters, women commuters may have more chain-trips such as grocery shopping or picking up family members. Women's greater responsibility for daily household tasks makes them to be more sensitive of feeling stress. Moreover, Jabodetabek commuters must take a longer time than the Sarbagita counterparts (Table 1). The longer the commuting time coupled with the allocation of time for household production makes women's leisure timeless. This is what explains why the female commuters in Jakarta are more stressed whereas the Sarbagita commuter women are less stressful.

The results of the regression analysis in Table 2 show that the travel time has a positive effect on stress in Jabodetabek but has no positive effects in Sarbagita. Considering Jabodetabek has higher mean travel time in the same distance range (see Table 1), this mean value also indicates that Jabodetabek has a higher impedance than Sarbagita. Regarding the value of the marginal effect, it can be concluded that decreasing commuting time for 1 minute will be reducing the probability of experiencing stress at 0.14. Regarding other commuting variables such as driver status and distance variables, they have no significant effects on commuting stress.

Consistent with the findings of previous studies Wener and Evans (2011), this paper used a sample of JCS and SCS to show that car commuters are likely reported to have poorer mental health compared to the non-car commuters. Interestingly, both in areas with many choices and areas with few public transportation options, car commuting is stress prone. Meanwhile, the effect of mode choice in the commuting stress is an average increase of 0.094 points on the response scale for Jabodetabek and of 0.205 for Sarbagita. This result reveals that the probability of car commuters in Sarbagita to experience stress is higher than in Jabodetabek. In Jabodetabek, the chances are 1.465 times relatively to non-car commuters, while in Sarbagita are 2.6 times respectively. Due to lack of accessibility by public transport, the Sarbagita citizens are forced by circumstances to solve their transportation problems by themselves. Car drivers in Sarbagita must undergo an aggressive attitude from other road users, most of whom (over 90%, see Table 1) are motorbike users.

Furthermore, to examine the general effects of mode choices to commuting stress, logistic regression is applied to the same JCS data set without the distance variable limitation of 20 - 60 km. The results in Table 3 show that train mode is not stress-prone at the 5% significance level. Whereas those commuting using bus and motorbike have a larger probability of reporting stress than the bicycle group. As congestion increases among bus, car and motorbike commuters, this makes them report a more negative effect. For Jabodetabek residents, train commuting is less stressful than commuting by bicycle. Nevertheless, travel by motor, car and public bus transport has a statistically strong positive effect on commuting stress. They are the ones who often undergo congestion. Congestion may be less related to train commuters because they are not a train operator, and they usually have a little familiarity with the level of congestion on the railroad track. The probability of car commuting to undergo stresses was almost 10 times more than the non-car commuting group. The bus commuters experience a higher stress rather than the train commuters. This is probably due to a longer car waiting time than the train waiting time.

The opening of new toll roads is predicted to increase the car usage. To strengthen our argument, we enclosed figures on the number of cars pre and post the operation of the new toll roads in Table 4. Because of limited data and representative reasons, we only display the figures for the province of Bali. Bali Mandara toll road is the only toll road in Bali. This toll road connects the city of Denpasar and

Table 3. Results of Logistic Regression of Mode Choice on Commuting Stress in Jabodetabek 2014. Dependent Variable: Commuting Stress.

Variables	Percentage	Coefficient		Marginal Effect	Odds ratio
Motorbike	62.14	1.807149	*	0.398	6.093
Car	15.45	2.294351	*	0.499	9.918
Bus	15.6	2.158201	*	0.477	8.656
Train	6.17	1.645156		0.378	5.182
Bicycle	0.54			ref. category	
Intercept	-	-2.251291		-	0.105
Model fit					
Count R-square					58.5
Log-likelihood intercept					-2248.116
Log-likelihood full					-2225.205
Probability > Chi Square					0.000
N					3307

Note: * Significant at 0.05

Table 4. Number of Cars (in Units) and Percentage Growth in Bali Province

Types of Car	Number of Cars (*Growth*)		
	4 years before Opening Toll Roads 2009	The Opening of Bali Mandara Toll Road 2013	4 years after Opening Toll Road 2017
Passenger Cars	499,264	603,277	878,193
		(20.83%)	*(31.31%)*
Buses	26,948	32,603	37,418
		(20.99%)	*(12.87%)*
Trucks	212,867	254,078	32, 517
		(19.36%)	(21.46%)

Badung regency, which is one of the areas of our sample targets. This toll road was officially operational in 2013.

As shown in table 4, the growth in the number of passenger cars and goods cars has increased dramatically since the opening of the Mandara toll road. Before the operation of the Mandara toll road, the growth in the number of passenger cars in the range of 2009-2013 was only 21%. At the same year range of 4 years after the operation of the toll road, the growth of passenger cars jumped dramatically by 31%. But this is not the case for bus vehicles. Of the reason, the public transportation system in the Province of Bali does not provide many alternative modes of public choices. As a result, the growth in the number of bus vehicles has slowed down even after the opening of the toll road.

This finding is important to promote the decrease of car usage, especially private cars and is needed to encourage the public to switch to the public transportation system. Compared to other modes of transportation, the use of private cars takes up larger space. In urban areas, such as Jakarta and Bali where the streets are crowded, uncontrolled car usage will worsen traffic congestion. However, the construction of road infrastructure is a partial solution to congestion. If the government does not limit the number of cars, it will continue to grow uncontrollably. This results in economic inefficiencies.

4. CONCLUSION

The study finds that commuting stress is barely affected by socio-economic and demographic characteristics. The gender variable is the only one having a significant effect on commuting stress. However, gender variables only affect commuting stress in high impedance growth pole. The choices of modes, both in high-impedance and low-impedance growth poles, contribute positively to commuting stress.

Some policy suggestions arise from our findings. As explained above, the solution to congestion which is often applied in Indonesia is the construction of toll roads. At least there will be an additional of 254 km of toll roads from the existing length of 226 km in Jabodetabek which will be targeted in 2020 with an investment of almost 70 trillion rupiahs (Badan Pengatur Jalan Tol, 2019). Toll Road is only for vehicles with a minimum of four wheels, which means that only cars and trucks can make use of them. The construction of toll roads has been only increasingly driving the number of car usage in urban Indonesia.

The results of this study are important to show that the policy of toll road development is not effective to overcome congestion and this policy has had a detrimental effect on public mental health. On the other hand, the addition of coverage of public transportation services, especially mass public transportation, is an absolute thing to do so that commuting stress does not occur. Bus companies should at least make service innovations that can provide better information to users, such as accurate bus arrival information, as the one which has been done by train services.

In addition to replicating the findings with stronger research design and a better sample, several other enhancements in the present study are required. Besides the problem of unbalanced sample size between modes, the high level of homogeneity in the gender of our sample may be of concern. Considering April - May in Indonesia is commonly not the season with bad weather, future researches need to be carried out across a longer time frame allowing for weather fluctuation. Such improvement is expected to be more precise and representative of the effects of different weather conditions.

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