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PERCEPTION INVESTIGATION BASED ON THE COMMUTING COST MODEL

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ABSTRACT

Travel expenses are a significant factor in transportation planning. In addition to the other aspect, travel time, the community considers expense as the necessary element in deciding which mode the communities should take. However, there is a gap between the actual transport expense and the commuter's perception. Thus, comprehensive knowledge is urgently needed particularly to be seen as a major variable in transportation planning that sided with underprivileged groups of transport poverty. The study focused on describing the correlation between income and commuting transportation expenses. The analysis was carried out using two methods. The first method is a descriptive analysis used to provide insight into the patterns and characteristics of the data obtained from interviews with 421 respondents. The second method is regression analysis (linear and nonlinear) to explain the relation pattern between the dependent (commuting transportation expenses) and independent (income) variables. The study's findings demonstrate that transportation expenses follow a negative polynomial regression pattern on income, further implying that the percentage of transportation expenses in low-income communities is significantly higher than those in high-income communities.

Keywords: Commuter; Commuting Cost; Income; Perception

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1. INTRODUCTION

Transportation expense is a major aspect of transportation planning, particularly regarding mode selection (Shiftan & Bekhor, 2002). Transportation expense is a major aspect of transportation planning, particularly regarding mode selection (Shahikhaneh et al., 2020). However, there is a gap between the actual transport expense and the commuter's perception (Henley et al., 1981; Parsons, 2003). Based on the argument, an understanding regarding the actual transportation expenses issue needs to be addressed.

Commuter travel expense has the highest daily transportation expense; a case study in England found that on average, people spend up to 139 hours per year on commuter trips, or roughly 36 minutes per day, with 19 working days each month (Lyons & Chatterjee, 2008). Moreover, community segments that do commuting the most are those with middle-class or lower-class income (Lin et al., 2017). It can be explained that low-

income communities have no choice but to live far from the hub since housing prices are more affordable. This situation results in what has been labeled "transport poverty communities" (transport poverty).

Transportation/mobility poverty in commuting occurs due to several disadvantages; geographical disadvantage, transportation disadvantage, and social disadvantage. Economic inequality further increases the complexity of the issue. Furthermore, low-income or socially disadvantaged communities who work or go to school in cities are more likely to live in the suburbs, where housing is less expensive (Kahachi & Brown, 2021; Rahmadaniyati et al., 2016). From the viewpoint of transportation, the condition refers to individuals categorized as “poor” in transportation due to geographic disadvantage or spatial mismatch, which causes these individuals to coerce to live far from their workplaces (Titheridge et al., 2014). Unfortunately, when the housing is located far from a major metropolitan region or hub, it becomes even more disconnected from basic physical transportation infrastructure, such as the road network or public transportation services. In this context, low-income communities are burdened by both transportation and geographical disadvantages. Additionally, this condition leaves communities with no other choice but to take motorcycles, which are generally considered to be more practical and cost-effective (Herwangi et al., 2015, 2017). This persisting problem would arguably result in more low-income individuals using motorcycles daily to get to work and school, worsening traffic flow and overcrowding the road, especially during rush hours. Thus, comprehensive knowledge is urgently needed particularly to be seen as a major variable in transportation planning that sided with underprivileged groups of transport poverty. The purpose of this study is focused on describing the correlation between income and transportation expense to precisely acquire the actual percentage of transportation expense for each income stratum based on communities' perceptions.

2. METHODS

2.1 Respondents

Respondents were chosen randomly from Yogyakarta Special Region (DIY) residents. The Slovin Formula is used to determine the bare minimum of responses required (Susanti et al., 2019) if the population at the time the survey was conducted was 4,021,816 people (Badan Pusat Statistik DIY, 2022), with a margin of error of 5%, then the minimum sample size is 399-400 people. The sampling of respondents was designed to be evenly distributed in the DIY area and to prioritize respondents coming from low-income communities. To accurately target respondents from low-income groups. The sampling distribution is also based on the results of an analysis of the population proportion in the sub-district with an undergraduate degree (Figure 3), presuming that the level of education influences income (Bartik & Hershbein, 2018; Stryzhak, 2020).

2.2 Questionaire of Respondent Characteristics and Transport Cost Investigation

Data was gathered via a questionnaire asking for information about their socioeconomic characteristics or backgrounds and their perceptions of daily travel expenses. Personalized questions about respondents' characteristics, including their residential address, will be used to assess how the respondents are geographically distributed, occupation, education degree, monthly income, and mobility patterns, such as questions on vehicle ownership and routine travel habits. The second section of the questionnaire is an investigative questionnaire that is designed to assess commuter travel expenses by asking respondents about their perceptions of their daily travel time, the distance between their house and place of work, the time needed to travel, and travel prices. This question's data will be used to analyze the connection between commuter travel costs and income.

2.3 Analysis Method

The analysis was carried out by three distinctive methods. The first method is descriptive analysis, often known as descriptive statistics or descriptive analysis, which is the process of applying statistical methods to describe or summarize data sets. This method is highly valued for its capacity to provide intelligible insights from raw

data (Kaur et al., 2018). The method has also been frequently applied in the field of transportation studies, particularly to interpret transportation behavior; an example would be a study on driver behavior during of COVID-19 pandemic (Katrakazas et al., 2020). Satisfaction measurement on public transportation (Lunke, 2020). To assess the central tendency and data distribution in a transportation-related conflict situation (Chandra et al., 2013). In this case, the method will be used to assess the outcomes of the inquiry into the respondents' socioeconomic characteristics.

The second method is regression analysis, the method to determine the relation pattern between the variables. Regression analysis is a collection of statistical procedures used to calculate the connection between a dependent variable and independent variables (Wagschal, 2016). This analytical method is also commonly used in transportation studies, such as anticipating transportation demand growth or demand forecasting (Varagouli et al., 2005; Zenina & Borisov, 2014). This method is further used to calculate daily public transportation usage (Konecný et al., 2021; Moeinaddini et al., 2015). Regression models with one independent variable come as equations (1).

$$y = \alpha + \beta . x + e \tag{1}$$

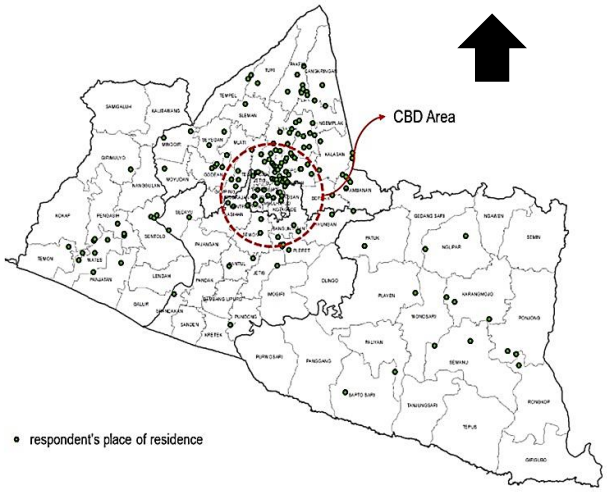
Where y = dependent variable; α = constanta; β = coefficient regression; e = error terms. The third method is non-linear regression models, the method that serves as an addition to the general form of linear regression models. This study used a polynomial non-linear regression model written as an equation below.

$$y = \alpha + \beta_1 x + \beta_2 x^2 + \cdots + \beta_n x^n + e \tag{2}$$

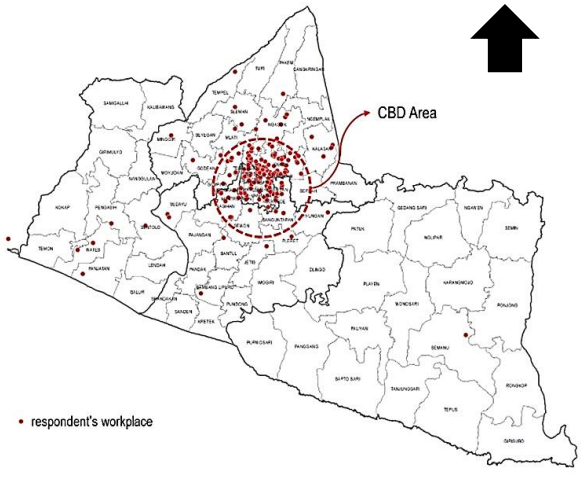
3. RESULTS AND DISCUSSION

3.1 Characteristics of Respondent Mobility

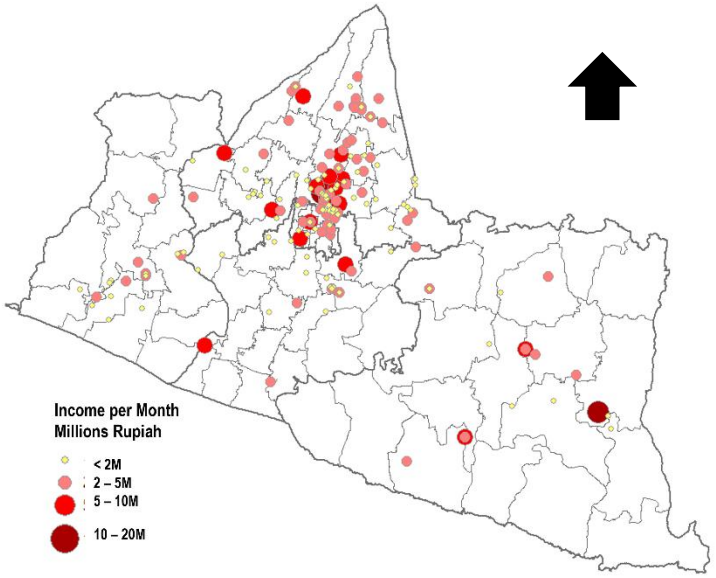
Residents from 50 Yogyakarta's Special Region sub-districts participated in this survey (DIY). Respondents consisted of regular commuters that travel from their houses to the city center to work or education, or other daily necessities in the center (Yogyakarta Urban Agglomeration or Central Business District - CBD). As the sampling model, the researcher used the purposive sampling method. The results suggest that respondents' residence locations are practically distributed over all DIY areas (Figure 1a); however, the commuters' workplaces are located in more concentrated urban areas such as the City of Yogyakarta and Sleman Regency (Figure 1b).



(a) Distribution of Residence



(b) Place of Work of Respondents



(c) Distribution by Income

Figure 1. Distribution of Residence, Place of Work of Respondents, and Distribution by Income

However, unlike middle- and high-income communities, low-income communities are physically segregated from the urban region (Yogyakarta City and Sleman Regency). Data demonstrates that the number of low-income communities highly outnumbers the number of middle- and high-income communities (Figure 1c). Table 1 below shows the characteristics of the respondents.

Table 1. Socio-Economic Characteristics of Respondent

	Content	Frequencies	%
Gender	Male	230	54.63
	Female	191	45.37
Age	< 20 y.o	64	15.20
	20-30 y.o	282	66.98
	30-40 y.o	47	11.16
	40-50 y.o	17	4.04
	50-60 y.o	11	2.61
Education	Primary school	5	1.19
	Junior HS	14	3.33
	Senior HS	268	63.66
	Diploma	18	4.28
	Bachelor	112	26.60
	Postgraduate	2	0.48
	Doctoral	1	0.24
	Student	1	0.24
Income per Month	< 2.000.000 IDR	250	59.38
	> 2.000.000 IDR - 5.000.000 IDR	140	33.25
	> 5.000.000 IDR - 10.000.000 IDR	24	5.70
	> 10.000.000 IDR - 20.000.000 IDR	5	1.19
	> 20.000.000 IDR	2	0.48
Jobs	Freelance	31	7.36
	Professional	5	1.19
	Self-employed	40	9.50
	BUMN Employees	1	0.24
	Private sector employee	146	34.68
	Student	154	36.58

	Content	Frequencies	%
	Teacher/Lecturer	10	2.38
	Factory workers/employees	22	5.23
	Pharmacist assistant	1	0.24
	Copy Operator	1	0.24
	Government employees	7	1.66
	Doctors/Health Workers	1	0.24
	Banking	1	0.24
	Tailor	1	0.24
Number of Families	1-2	48	11.40
	3-4	239	56.77
	5-6	110	26.13
	7-9	24	5.70
Number of Motorcycles	0	8	1.90
	1	79	18.76
	2	130	30.88
	3	139	33.02
	> 3	65	15.44
Number of Cars	0	272	64.61
	1	113	26.84
	2	22	5.23
	3	11	2.61
	> 3	3	0.71
Type of main Moda	Motorcycle	386	91.69
	Train	1	0.24
	Walking	9	2.14
	Car	11	2.61
	Sharing vehicle	1	0.24
	Taxibike	11	2.61
	Cycling	1	0.24
	Public transport	1	0.24

Based on education level, the highest number of respondents were those with high school education or equivalent at 63,66%, followed by respondents with undergraduate degrees at 26,60%, and the rest consist of elementary/junior high school/diploma/postgraduate education category. Most respondents have a monthly income below 2 million Rupiah (around 128 USD) (59,38%). These variables precisely correlate to the primary goal of the research objectives, which is to give more account to underprivileged communities. The next largest proportion are respondents with an income of 2-5 million Rupiah per month (around 128 to 318 USD) (33,25%); the rest are those who earn 5-10 million per month (5,7%) and more than 10 million per month (0,48%). According to occupation, 34,68% of respondents work as private employees, which is the highest proportion. Respondents who are students are placed in the second with 36,58%, followed by respondents who serve as entrepreneurs.

Vehicle ownership and respondents' affordability of public transit facilities are indicators of transportation accessibility. The main variable that must be highlighted is ownership of a motorized vehicle (motorcycle or car) as the primary mode of transportation in daily routine. Based on the results of the questionnaires, it can be identified that the highest number of motorcycles owned in a household is three (33% of respondents) per household, followed by two per household (32% of respondents). Meanwhile, 64,61% of respondents answered not to possess a car, and 26,68% said they possessed only one car. From the type of vehicle owned, it turns out that almost 91,69% of respondents prefer to use motorbikes for their daily trips. The majority of respondents left their homes to get to the workplace at 07:00 WIB, with others leaving between 05:00 WIB and 10:00 WIB (GMT +7) (Figure 2).

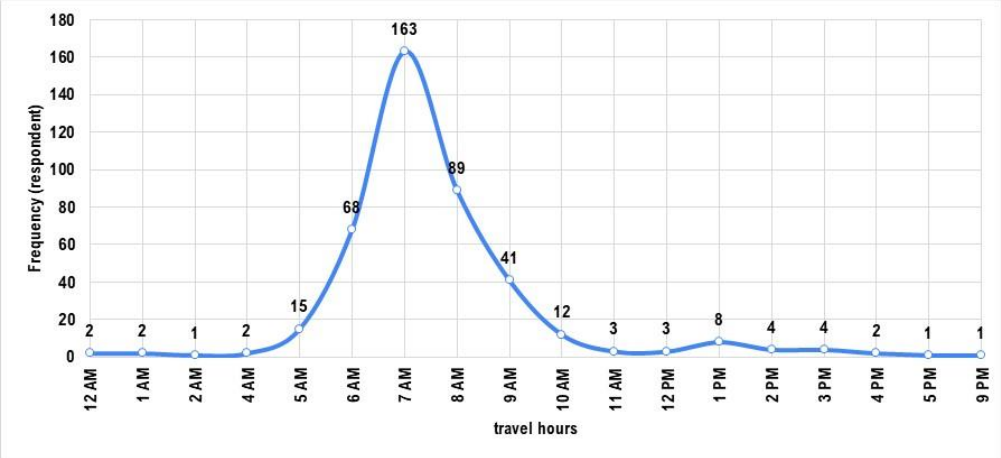
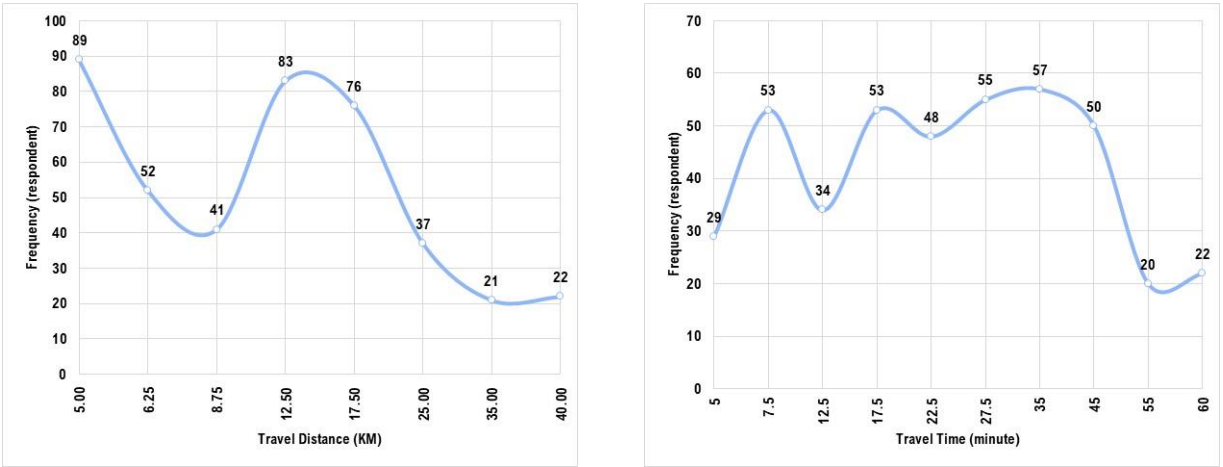


Figure 2. Distribution of Hours of Going to Work/Daily Activities of Respondents

3.2 Relation Model of Commuter Travel Cost with Income

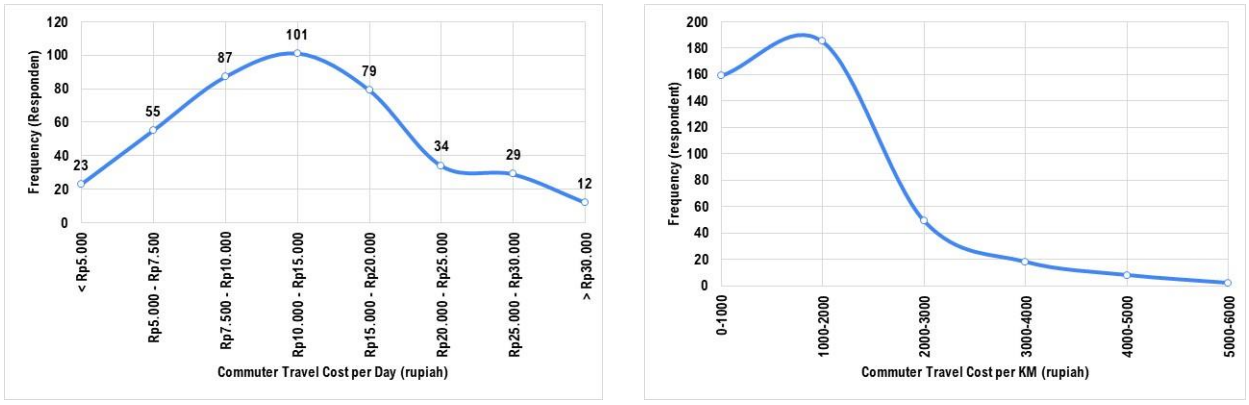
The majority of the respondent are motorcycle users, 91,96%--the data proves that the communities rely heavily on this vehicle. Respondents utilize motorcycles for various reasons, including efficiency, affordability, and flexibility; the data also revealed that respondents have no access to other types of transportation. Only 60% of respondents to had an issue with this matter. Subsequently, efficiency and affordability are very sensible reasons for responders to choose motorcycles as daily trips. The distance traveled on normal excursions may vary. Each respondent's mileage variance was also influenced by the location of their homes across the region (Figure 3).



(a) Commuter Travel Distance **(b) Commuter Travel Time**

Figure 3. Distribution of Travel Distance Frequency and Commuter Travel Time

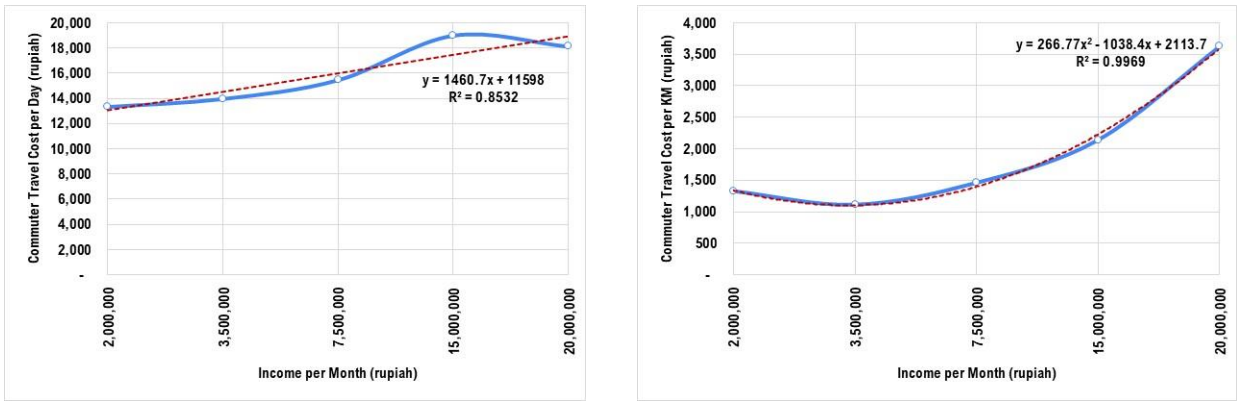
Starting from the closest to the farthest (less than 5 KM to more than 40 KM), the average distance is 14,34 KM. The periodicity is most prevalent between 5 KM and 12,5 KM - 17,5 KM. Additionally, the commuting time ranges from 5 to 60 minutes, depending on the commuter's perception. To evaluate the correlation between transportation expenses and monthly income, respondents were also asked about their perceptions of their daily travel expenses. Figure 4a. Travel expenses are calculated based on the daily kilometer distance traveled, as illustrated in Figure 4b. The respondents' highest average travel expense per kilometer was Rp. 1,000-Rp. 2,000. The travel cost per KM is the travel cost for each commuter according to the type of daily vehicle (not specifically motorbikes) they use.



(a) Commuter Travel Cost per Day **(b) Commuter Travel Cost per KM**

Figure 4. Commuter Travel Cost Frequency Distribution per Day and KM

The average commuting cost per day is associated with the respondents' monthly income, as demonstrated in Figure 5a. The average commuting cost per day is correlated with the respondents' monthly income, as illustrated in $y = 1{,}460.7x + 11{,}598$ ("x" as in income per month). While the correlation between commuters' transportation expenses and their monthly income is illustrated in an exponential regression equation $y = 266.77x^2 + 1{,}038.4x + 2{,}113.7$ ("x" as in income per month). The commuting fee based on income per day follows a linear pattern, and the commuting fee based on income per km follows an exponential pattern. These two graphs (Figure 5a & 5b) show that commuters' daily transportation costs are the same because high-income commuters are expected to live closer to the CBD than low-income commuters. However, the cost per KM for commuters with high income is higher because it is estimated to use a car. It needs further in-depth research in the future.



(a) Commuter Travel Cost per Day with Income per Month **(b) Commuter Travel Cost per KM with Income per Month**

Figure 5. The Relation Between Commuter Travel Cost per Day/per KM and Income per Month

Low-income people are disproportionately burdened because commuter travel costs as a percentage of income are substantially higher than the average, even when commuter travel costs (per day or km) follow the level of income. Low-income people are disproportionately burdened because commuter travel costs as a percentage of income are substantially higher than the average, even when commuter travel costs (per day or km) follow the level of income. The fact that commuter costs are lower for those with higher incomes thus indicates inequality. The equation for the relation between the percentage of commuter travel costs and income follows a negative exponential pattern, namely $y = 1.0292x^2 - 9.7372x + 25.338$ ("x" equal to income per month).

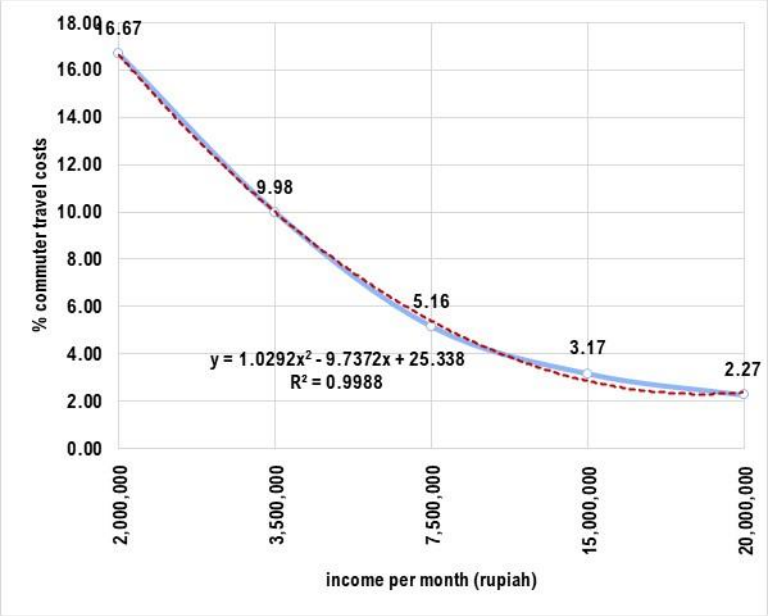


Figure 6. Relation between Commuter Travel Cost Percentage and Income per Month

4. CONCLUSION

The study results show that the commuting cost follows a negative polynomial regression pattern on income, meaning that the percentage of commuting costs in low-income communities would be higher than that of high-income communities. Low income communities must travel further because of geographic disadvantages, which correspondingly increases the overall cost of transportation. Nevertheless, the majority of communities choose the same mode of transportation (by motorcycle). In other words, while the distance traveled varies and is distributed evenly in Yogyakarta regions, the average cost per kilometer remains in exact numbers of between 1,000 and 2,000 Rupiah (around 0.13 USD).

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