

A Study on the Determinants of the Transport Mode Choice of the Civil Servants in the Makassar Metropolitan Area

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ABSTRACT

To reduce dependence on private transportation, the central government, specifically the Ministry of Transportation, has launched a program to provide urban mass transportation services in 10 metropolitan areas in Indonesia, including Makassar. Efforts to support this government policy must begin with the closest and smallest scope, which is the government employees themselves, usually referred to as civil servants. The present study examines the factors that influence the transportation mode choices of civil servant commuters. It also investigates the travel characteristics and individual preferences of civil servants while choosing their commuting modes. The study was conducted with 352 participants randomly selected from civil servants in Makassar. A questionnaire was constructed, consisting of socio-demographic, travel behavior, and mode preferences as factors affecting the estimation of individual mode choice. Multinomial Logistic Regression (MLR) was employed to identify the determinants of transport mode choice by commuters. Reliability and multicollinearity tests were used to validate the data and the results of the regression model obtained. It was found that the mode choice preference for private modes, public transport, and taxi bikes was significantly influenced by age, income, motorcycle ownership, travel distance, and travel cost among commuters who own both cars and motorcycles. Moreover, for those who owned only motorcycles, the mode choice preference for public transport was highly affected by age, income, and travel costs. As the determinant increased, they exhibited a greater tendency to use private vehicles rather than relying on public transportation.

Keywords-transport mode choice; travel attributes; civil servants; commuters; multinomial logistic regression

I. INTRODUCTION

The rise in urban mobility is a new travel trend driven by factors such as population growth, housing, labor markets,

evolving economic conditions, and advancements in transportation infrastructure [1]. However, this increase in commuting trips has brought about various challenges,

particularly concerning transportation issues like peak-hour congestion [2].

In densely populated urban areas, transportation plays an important role in facilitating the movement of people and goods, thereby fuelling the economic activities of developing cities. As urbanization and industrialization progress, the demand for efficient transportation systems also intensifies. However, it is anticipated that the rate of urbanization in Southeast Asia will decline in the coming years [3-5].

Primarily, research on travel mode choice has traditionally been conducted in developed or high-income countries [6]. However, some studies have also been carried out in developing countries, such as Pakistan [7] and Bangladesh [8], which provide valuable insights into the travel mode preferences of commuters.

Commuting trips are a critical point for addressing urban challenges and advancing sustainable transportation systems, given their consistent daily patterns and the predominance of private mode usage [9, 10]. In Southeast Asian contexts, especially in the Philippines [11] and Malaysia [12], substantial efforts have been made to mitigate transportation problems through the expansion and promotion of public transportation. However, previous studies on commuter behavior have treated commuters as a general, homogeneous group, without explicitly distinguishing between users' travel modes based on the occupational status or vehicle ownership categories. Previous studies, particularly those on the mode choice concept, reveal that most travel behaviors are aimed at maximizing the utility of their own mode [10-12]. The present study focused on the users, especially on civil servants in Indonesia's urban regions. The study area is in the rapidly growing city of Makassar, in the eastern part of Indonesia.

However, there is limited research specifically addressing the choice of commuting mode and the factors affecting the latter. Several influential factors have been identified, including connectivity, accessibility to transportation modes, information availability, time satisfaction, user presence, convenience, security and safety, and environmental impact [13, 14]. Numerous studies have investigated the relationship between socio-economic and demographic indicators, as well as the impact of travel characteristics on the choice of commuting modes.

For instance, research conducted in the Greater Jakarta area of Indonesia discovered that significant factors affecting commuters' usage of public transportation include age, travel time, and distance [1, 6]. Similarly, in India, it was demonstrated that individuals aged 20-30 were more inclined to choose two-wheeled vehicles over buses. In Thiruvananthapuram, India, it was indicated that as income rises, commuters are more likely to opt for car usage [9]. Conversely, in Nanjing, China, commuters with higher incomes tend to prefer public transportation over private cars [1].

The preference for public transport over private cars increases travel costs [15]. These costs, in line with the income factors, also play a significant role in determining transportation mode choices. The level of transportation mode

availability is a crucial factor influencing mode choice decisions, with commuters often opting for motorcycles or cars as their primary mode of personal transportation [16]. Other studies even found a correlation between longer travel durations and a greater inclination toward using private transportation modes instead of public options [9, 16]. Additionally, departure time is also considered an essential determinant in mode choice, although it is a variable that has been rarely studied; it is also interrelated with the mode choice [17, 18].

Travel patterns have undergone a surge in urban and developing Asian cities, including those in Indonesia. Major Indonesian towns are grappling with severe traffic congestion, as many Indonesians rely on private cars and motorbikes as their primary mode of transportation, which is becoming unmanageable. The heavy dependence on private vehicles, coupled with the poor quality and declining usage of public transportation, has further exacerbated the situation [19, 20].

To address this issue, the government has improved public transportation by subsidizing the "Teman Bus" program in 10 metropolitan cities, including Makassar. The program contracts with operators that meet the minimum service standards to provide these services.

In implementing policies to support government programs, the socialization will naturally begin with the closest circle of government employees, or civil servants who commute daily. Knowing the mode choices and influential factors for commuting is crucial, as it can serve as a benchmark for commuters, particularly those in Makassar.

Understanding the factors that influence the transportation choices of civil servants, particularly their existing mode of transport, is crucial to supporting policies regarding public transport usage. Moreover, Makassar, as the capital of South Sulawesi province, is a strategic city that serves as an economic, educational, and transportation hub. Furthermore, the increasing frequency of international events in Makassar has boosted tourism, drawing visitors to the city's renowned culinary scene. This influx, coupled with Makassar's role as a regional hub, necessitates a robust urban transportation system.

Improving public transport and implementing sustainable options, particularly for commuting civil servants, is crucial for addressing Makassar's transportation challenges. Commuter mobility, also known as commuting, refers to the daily travel between residences and workplaces in different cities or districts within the suburban area. This research focuses on identifying the individual factors that influence the choice of transportation mode among civil servants, which has been less researched compared to other worker types when commuting to work [1, 2, 21]. Unlike research that discusses daily commuter trips from Bekasi to Jakarta (Jabodetabek area) among non-civil servants [10], or research on daily travel mode choices (active – walking/bicycle, and passive – car) [22], the current study focuses on the commuting patterns of civil servants, considering those who reside not only in Makassar [23] but also in the surrounding buffer cities of Maros, Gowa, and Takalar [24].

II. METHODOLOGY

A. Data Collection Method

The present study was conducted with target respondents in the government offices of South Sulawesi province. The data collection technique involved conducting a survey using structured questionnaires distributed directly to the respondents. This research was conducted in 18 office agencies, specifically targeting civil servants who commute daily. The data collection process consisted of a survey designed to gather information on individual and travel characteristics, as well as attributes of the trip chain and transportation modes used for commuting. The data collection process consisted of two stages: primary and secondary.

During the primary data collection stage, questionnaires were used as research instruments to gather data from the respondents. The stated preference survey method was employed, and the questionnaires were administered through direct interviews with the participants. This approach ensured that the collected data accurately reflected the actual conditions and experiences of the respondents in the field. To complement the primary data, additional information was gathered during the secondary data collection stage. This involved accessing the agency database to retrieve data such as, the names and number of workers, as well as their positions within the various government agencies.

Approximately 1,400 commuter workers are registered as civil servants in the Provincial Government offices. The random sampling is conducted based on this population sample, which comprises approximately 25% of the total sample, using cluster random sampling. The sample size of 352 respondents was determined using the Slovin formula to obtain a representative sample for the primary data collection. The sampling in this study was conducted using a systematic approach, beginning with the grouping of the population based on the institutions or offices where the respondents are employed. Subsequently, the population was clustered according to job grade levels, which reflect the hierarchical structure of each individual. Once the clustering by job grade was completed, a distribution coefficient was calculated to determine the proportion or percentage of each grade within the overall population. This calculation aimed to ensure that the predetermined sample size could be proportionally distributed across all job grade levels. As a result, the sample distribution provides a fair and balanced representation of the various job categories, ensuring that each grade is adequately represented among the respondents in this study. This sample size was chosen to provide a 95% level of accuracy with a maximum error rate of 5%. Table I presents the name and total sample size for each agency.

Questionnaires were distributed to each agency, and employees were asked to participate in the survey until the minimum sample size requirement was met. The respondents were selected using a random sampling method. From each agency's employee list, individuals were randomly chosen and asked if they were willing to participate by completing the questionnaire. The interview was conducted face-to-face with each respondent.

TABLE I. NAME AND NUMBER OF SAMPLES FOR EACH AGENCY/OFFICE

Agency/Office	Samples
Park Service Agency	21
Regional Income Agency	35
Health Agency	40
Communication and Information Agency	10
Labor Agency	25
Education and Culture Agency	21
Fire Agency	12
Public Work Service Agency	10
Transportation Service Agency	19
Cooperatives and Small and Medium Enterprises Agency	14
Housing and Local Government Building Agency	44
Culture and Tourism Agency	14
Industrial Agency	22
Spatial Planning Agency	6
Social Agency	6
National Land Agency	13
Regional Civil Service Agency	27
Municipal Agency	13
Total	352

B. Research Instrument and Variable

The questionnaire design was based on common themes found in research on commuting mode preferences, ensuring its suitability for analysis. The questionnaire used in this research was developed based on the design of research instruments used in previous studies conducted in Surabaya [16], Bali [25], and Makassar [26]. The categorization scheme used in this questionnaire, particularly in socio-demographics, is based on data from the Makassar Central Statistics Agency, released in 2024 [27]. The questionnaire instrument, however, is still grounded in previous research regarding travel characteristics. The questionnaire was specifically designed to gather data on various variables relevant to the research objectives. The questionnaire data were organized and presented in Tables II and III. Table II outlines the eight independent variables (X) examined in the questionnaire: age, education, income, car ownership, motorcycle ownership, travel distance, travel cost, and travel time. These variables were selected to determine their influence on the dependent variable (Y). The dependent variable in this study focuses on the mode choice of individuals who own personal vehicles, considering their selection from the available transportation options for their commute trips. The study aims to investigate the factors that influence the mode choice decisions of civil servants who own personal vehicles, examining how they select from the various transportation modes available to them for their daily commute.

The justification for the categorization scheme is based on the demographic and socioeconomic profile of Indonesia's civil servants. The average age of the latter is approximately 30 years, while those aged 50–60 remain productive but are typically approaching the end of their careers. Historically, many older cohorts of civil servants entered the workforce with only an elementary-level education, whereas the majority of recent recruits now possess a Bachelor's or Master's degree. Income levels are determined in reference to the Regional Minimum Wage, with the lowest category, typically associated with elementary-educated civil servants, earning up to IDR 2 million per month, and the highest category, generally with

Bachelor's or Master's qualifications, earning between IDR 4–5 million per month, as reported by the Makassar Central Statistics Agency [27]. In terms of commuting distance, the shortest category is approximately 200 m, representing civil servants who walk to nearby offices. At the same time, the longest extends up to 10 km, reflecting inter-district commuting in Makassar. Travel cost and time also vary significantly: the lowest values are associated with the use of public transport, particularly paratransit, whereas the highest values correspond to the use of private vehicles.

TABLE II. CATEGORY CHARACTERISTIC RESPONDENT

No	Characteristic respondent	Category characteristic
X1	Age (years)	<30 c. 41-50 e. Not Known
		31-40 d. >50
X2	Education	Elementary School
		Junior High School
		Diploma (D3)
		Diploma (D4)
		Bachelor
		Master
X3	Income (IDR)	Others
		< 2.000.000
		2.000.000-3.000.000
		3.000.000-4.000.000
		4.000.000-5.000.000
X4	Car ownership	> 5.000.000
		0
		1
		2
		3
		4
X5	Motorcycle ownership	Other
		0
		1
		2
		3
		4
		5
X6	Travel distance (m)	6
		Other
		< 200
		200-500
		500-1000
X7	Travel cost (IDR)	1000-5000
		5000-10000
		>10000
		0
		< 5.000
		5.000-7.500
		7.500-10.000
		10.000-15.000
15.000-30.000		
X8	Travel time (min)	30.000-40.000
		40.000-50.000
		>50.000
		5-10
		10-15
		15-20
		20-25
		25-30
		30-35
35-40		
40-50		
50-60		

Table III presents the distribution of the dependent variable groups, which were categorized based on the assumed transportation mode options, including car, public transportation, motorcycle, and taxibike. The respondents were divided into three main groups: those who owned both a motorcycle and a car, those who only owned a motorcycle without a car, and those who did not own any personal vehicles and relied on public transportation or other modes of transportation for their commute. The basic assumption for grouping the dependent variables is considering the availability of transportation modes typically used for commuting. This is based on the respondents' vehicle ownership and the options they are likely to choose from. For instance, respondents who own both a motorcycle and a car have these as their options, in addition to public transportation and a taxibike. However, those who only own a motorcycle do not have the car option available to them.

TABLE III. DEPENDENT VARIABLES AND CATEGORIES

No	Characteristic Respondents	Category Characteristic
Y1	Respondents with car and motorcycle ownership	Car
		Motorcycle
		Public Transportation
		Taxibike
Y2	Respondents with a motorcycle but no car ownership	Motorcycle
		Public Transportation
		Taxibike

The required sample size was achieved, with a total of 352 respondents participating in the survey across the targeted agencies. The collected data enabled the classification of respondents into different groups based on the number of vehicles they owned, specifically motorcycles and cars. Respondent vehicle ownership was categorized into two groups: those who owned a vehicle and those who did not, as shown in Table IV. Respondents without a vehicle were excluded from further analysis. The remaining data were stratified based on vehicle ownership and the specific transportation modes used for their daily commutes. The analysis focused on two main groups: respondents who owned both a motorcycle and a car ($n = 213$) and those who owned only a motorcycle ($n = 118$). These groups were analyzed using STATA 16 software.

Of the 352 total respondents, 331 owned vehicles and were included in the analysis. This showed the groups of respondents who had both cars and motorcycles, as well as those who had only motorcycles, with no respondents owning neither cars nor motorcycles.

TABLE IV. NUMBER OF RESPONDENT VEHICLES

Vehicles	Motorcycle		Total	
	Own vehicles	No vehicle		
Car	Own vehicles	213	0	213
	No vehicles	118	21	139
	Unknown	0	0	0
	Total	331	21	352

C. Data and Modeling Analysis

Instrument validation is carried out by testing the validity of the instrument using the multi-objectivity and reliability (Cronbach's alpha) [28] methods to determine the extent of the relationship between variables. Thus, through these two tests, it can be ensured that the variables analyzed have adequate data quality and are suitable for inclusion in the analysis model.

The MLR method deployed in this study is particularly suitable for analyzing mode choice related to categorical dependent variables with more than two nominal categories, such as the choice between private and public transportation modes. Unlike the binary logistic regression method, which is limited to only two categories, or the linear regression method, which requires a continuous scale dependent variable, MLR allows modeling the probability of choosing each mode based on independent variables, such as income, travel time, travel costs, and travel distance. Compared to the discriminant analysis method, MLR is more flexible because it does not require the assumption of multivariate normality and equality of covariance matrices between groups. In addition, compared to the nested logit method, which requires a hierarchical structure in choices, MLR is simpler but still able to provide stable and interpretable estimates in the context of transportation modes that do not have a clear hierarchy between choices [10].

The coefficient of determination (R^2), with values below 0.05 or a pseudo- R^2 ranging from 0.1 to 0.6, is generally regarded as minor. Nevertheless, these estimates are indicative of a statistically valid model with representative explanatory variables, capable of accounting for transport mode choice behavior within a reliability interval of approximately 85%–95% [6, 8].

This research employed the MLR method to conduct a comprehensive significance analysis examining the complex relationships between the dependent and independent variables. The primary objective was to thoroughly determine the statistical significance of the associations between the mode of travel and various factors related to both individual and travel characteristics, utilizing the advanced STATA 16 software for the analysis. The scripts and functions used in STATA 16 are:

```
* Import data
use example:"transport_mode.dta", clear
* Variabel dependen: mode (1=Car,
2=Motorcycle, 3=PublicTransport,
4=Taxibike)
* Variabel independen: age, income,
car_own, mc_own, distance, cost, time
* Descriptive Statistics
summarize age, income, distance, cost,
time
tabulate mode
* Multinomial Logit Regression
mlogit mode age income car_own mc_own
distance cost time, baseoutcome(2)
* Noted:
* baseoutcome(2) is category 2
(Motorcycle), used as a basic comparison
```

```
Probability mode choice
predict p1 p2 p3 p4, pr
* p1 = Prob Car
* p2 = Prob Motorcycle
* p3 = Prob Public Transportasi
* p4 = Prob Taxibike
* Reliability (Cronbach's Alpha)
alpha
* Uji Multicolinearity
estat vif
```

The logistic regression method used in this research was the MLR, commonly employed when the dependent variable consists of three categories on a nominal scale [18]. MLR is a statistical technique used to analyze a polychotomous or multinomial dependent variable. This means that the variable of interest has three or more categories. The logistic regression probability function for each category is shown in:

$$\pi_1(x) = P(Y = 1|x) = \frac{\exp g_1(x)}{1 + \exp g_1(x) + \exp g_2(x)} \quad (1)$$

$$\pi_2(x) = P(Y = 2|x) = \frac{\exp g_2(x)}{1 + \exp g_1(x) + \exp g_2(x)} \quad (2)$$

$$\pi_3(x) = P(Y = 3|x) = \frac{1}{1 + \exp g_1(x) + \exp g_3(x)} \quad (3)$$

Model probabilities were obtained by comparing the cumulative probabilities of the response falling into or below a certain category ($Y \leq j|x_i$) with the likelihood of the response in a higher category ($Y > j|x_i$). These probabilities were calculated based on the values of the P predictor variables expressed in the vector (x_i). The formula for the probability models is presented in [21]:

$$\text{logit } P(Y \leq j|x_i) = \log \left(\frac{P(Y \leq j|x_i)}{P(Y > j|x_i)} \right) \quad (4)$$

In general, the logit function for a response variable with more than two categories can be calculated using:

$$g_j(x) = \log \left(\frac{P(Y \leq j|x_i)}{P(Y > j|x_i)} \right) = \beta_{j0} + \beta_{j1}x_1 + \beta_{j2}x_2 + \dots + \beta_{jp}x_p \quad (5)$$

The function, which is essentially an MLR model, was then used to analyze the factors influencing the respondents' mode choice of travel.

III. RESULTS

A. Characteristics of Respondents

The analysis considers various factors that influence individual and travel characteristics. Table V presents the detailed breakdown of the number and percentage of respondents in each category, highlighting their distribution and providing deeper insights into the varying group sizes and compositions. The data showed that the highest number of respondents fell within the 31-40 years age category, with 102 respondents accounting for 28.98%. This was closely followed by the 41-50 years age group, which comprised 26.99% of the total respondents. On the other hand, the smallest number belongs to the over 50 years category, with 48 respondents representing 13.64%. In terms of level of education, most

respondents hold a Bachelor's degree, with 165 accounting for 46.88% of the total. Only 2, or 0.57%, reported having an education level classified as School. Regarding income, the most significant proportion of respondents had a monthly

income ranging from IDR 4,000,000 to IDR 6,000,000, with a total of 116 or 32.95%. The smallest group reported an income above 5 million, with 21 individuals representing 5.97% of the total.

TABLE V. INDIVIDUAL AND TRAVEL CHARACTERISTICS OF RESPONDENTS

Variable	Category-code	Frequency (percentage)
Age	<30-1/ 31-40 years-2/41-50 years-3/>50 years-4/not known-5	50(14.2%)/102(28.9%)/95(26.99%)/48(13.6%)/57(16.19%)
Education	Elementary School-1/ Junior High School-2/ Diploma (D3)-3/ Diploma (D4)-4/ Bachelor-5/ Master-6/others-7	2(0.57%)/54(15.34%)/11(3.13%)/3(0.85%)/165(46.88%)/49(13.92%)/68(19.32%)
Income (IDR)	< 2,000,000-1/2,000,000-3,000,000-2/3,000,000-4,000,000-3/4,000,000-5,000,000-4/> 5,000,000-5	51(14.49%)/112(31.82%)/116(32.95%)/52(14.77%)/21(5.97%)
Car ownership	0 unit -1/1 unit-2/ 2 unit-3/>2 unit-4	31(8.81%)/146(41.48%)/50(14.20%)/125(35.51%)
Motorcycle ownership	0 unit -1/1 unit-2/ 2 unit-3/>2 unit-4	0(2.28%)/138(39.20%)/100(28.41%)/106(30.11%)
Travel distance (m)	< 500 m-1/500-1,000 m-2/1,000-5,000 m-3/ 5,000-10,000 m-4/>10,000 m-5	26(7.40%)/40(11.36%)/128(33.6%)/79(22.44%)/79(22.44%)
Travel cost (IDR)	<5,000 IDR-1/5,000 – 7,500 IDR-2/7,500-10,000 IDR-3/10,000-15,000 IDR-4/15,000-30,000 IDR-5/30,000-40,000 IDR-6/40,000-50,000 IDR-7/> 50,000 IDR-8	22(9.09%) / 48(13.64%) / 63(17.9%) / 79(22.44%) / 79(22.44%) / 20(5.68%) / 14(3.98%) / 17(4.83%)
Travel time (min)	5-10 min-1/10-15 min-2/15-20 min-3/20-25 min-4/25-30 min-5/30-35 min-6/35-40 min-7/40-50 min-8/50-60 min-9	47(13.35%) / 57(16.19%) / 74(21.02%)/ 42(11.93%) / 44(12.50%) / 32(9.09%) / 19(5.40%) / 16(4.55%) / 21(5.97%)

In terms of vehicle ownership, the highest number of respondents reported owning one vehicle each, with 146 for cars and 138 for motorcycles, respectively. About 128 individuals, or 36.36%, reported traveling distances of 1-5 km. The smallest group consisted of only seven individuals, with travel distances of less than 200 m. Most respondents reported travel costs falling within the 10-30 thousand range, while the smallest group reported costs within the 40-50 thousand range. Finally, in terms of travel time, it can be seen that the most frequent intention is within the 15–20-min range, with a total of 74, accounting for 21.4% of the total, while the least frequent is within the 40–50-min range, with a percentage of 5.03%.

B. Instrument Validation

The reliability test employed in this study follows the Cronbach's Alpha method to assess the internal consistency of the measured variables. Based on Table VI, the obtained alpha value exceeds 0.60, indicating that the instrument is considered reliable. The test yielded an average Cronbach's Alpha of 0.8832, signifying a robust inter-item correlation across all components of the instrument, and confirming that the questionnaire meets the criteria for excellent reliability.

C. The MLR Results

The study employed MLR to examine the relationship between the explanatory variables (X1-X8) and the categorical dependent variable (Y1 and Y2), which has multiple outcome categories. The multinomial logit model is a type of generalized linear model that characterizes the association between the predictor variables and the response variable with more than two categories. During the MLR analysis, the independent variables included individual characteristics and travel-related factors. The results of the established multinomial logit model are presented in Table VII, specifically for the model results of the group that owns a car and a motorcycle (Y1).

The analysis of the respondents who own both a car and a motorcycle reveals the impact of the independent variable, age,

on the choice between a car and public transportation. The negative coefficient for cars suggests that respondents of higher age are less likely to choose a car over a motorcycle. This finding aligns with the respondent characteristics shown in Figure 1(a), which indicates a nearly balanced usage of motorcycles and cars. Additionally, the negative coefficient value for public transportation suggests that as respondents' age increases, the likelihood of selecting public transportation decreases, with a preference for motorcycles. This observation is consistent, highlighting the more frequent selection of motorcycles over public transportation.

TABLE VI. RELIABILITY TEST RESULT

Cronbach's Alpha	Reliable (Alpha>0.6)
0.8832	Reliable

Furthermore, the education level variable, with a Bachelor's degree as the base outcome, only impacted the choice of taxibike with a positive coefficient value. This indicates that respondents with an undergraduate education level are more likely to select a taxibike, while non-graduates prefer motorcycles. This observation is supported by the data collected in the field, which highlights a significant use of motorcycles among respondents with a non-graduate education level. The income variable also significantly impacted the car choice, as indicated by the positive coefficient value.

This suggests that as the respondent's income increases, there is a greater likelihood of selecting a car as their primary mode of transportation. This finding is consistent with the patterns observed in developing cities and is supported by Figure 1(b), which illustrates that as respondents' income increases, their preference for cars also rises. Additionally, respondents with higher incomes are more likely to incur higher travel costs, further reinforcing their preference for cars as a mode of transportation. The motorcycle ownership variable has a significant impact on the choice of car and public transportation, as indicated by the negative coefficient values. These values suggest that as the number of motorcycles owned

by the respondents increases, their likelihood of selecting a car and public transportation decreases. This implies that respondents have a preference for motorcycles over cars and

public transportation. It is also supported by field observations, which consistently indicate a strong preference for motorcycles among the respondents.

TABLE VII. MODEL RESPONDENTS WITH CAR AND MOTORCYCLE OWNERSHIP

Variable	Car		Public transportation (para-transit)		Taxibike		
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	
Age	-0.0242	0.032*	-0.0285	0.074**	-0.0082	0.787	
Education	0.1253	0.739	-0.5504	0.33	1.7726	0.079**	
Income	0.4418	0.015*	0.0453	0.865	0.1872	0.728	
Car ownership	0.1595	0.577	0.2479	0.548	-13.6995	0.979	
Motorcycle ownership	-0.6389	0.004*	-0.9264	0.019*	-0.6262	0.183	
Travel distance	-0.0319	0.501	0.1395	0.037*	-0.5090	0.024*	
Travel cost	0.0842	0.000*	0.0666	0.001*	0.0745	0.035*	
Travel time	0.0085	0.692	-0.0297	0.380	-0.0130	0.873	
Cons	-2.3741	0.033	-0.4057	0.798	11.0583	0.98	
Number of observations						213	
Prob > Chi ²						0.000	
Pseudo R ²						0.2537	

Notes: Base Outcome: Motorcycle, * Significance level is 95%, ** Significance level is 90%

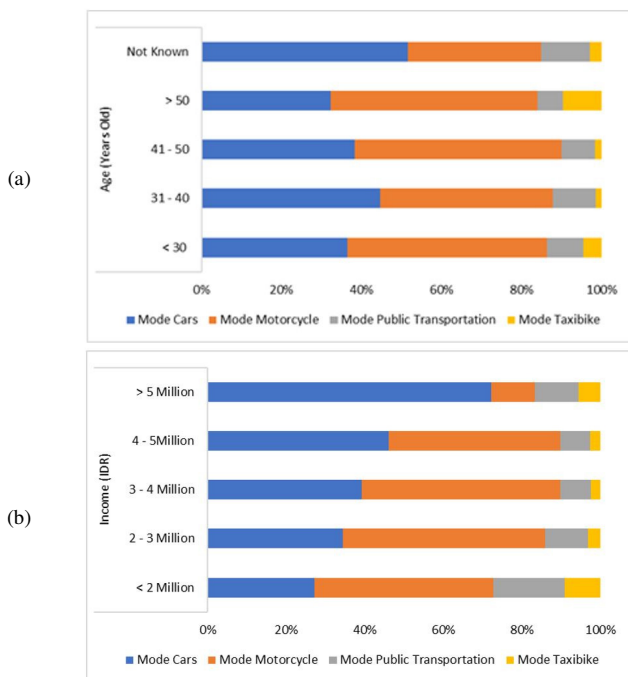


Fig. 1. Characteristics' relationship: (a) mode of travel and age, (b) mode of travel and income.

Meanwhile, the independent variable of travel distance also plays a role in the choice of public transportation and taxibike. The positive coefficient value for public transportation suggests that as the travel distance of the respondents increases, their likelihood of selecting public transportation also rises. This means that respondents prefer public transportation over the base outcome of motorcycles for longer travel distances. On the other hand, the negative coefficient value for a taxibike implies that as the travel distance increases, the likelihood of selecting a taxibike decreases. Respondents tend to prefer motorcycles over taxibikes for longer travel distances. These findings align with similar research, which highlights that travel cost and trip purpose are influential factors in the choice of transportation modes [29].

The analysis showed that travel cost significantly influences the choice of three modes: car, public transportation, and taxibike. The positive coefficient value for cars indicates that the likelihood of selecting a car increases as the travel cost increases. This suggests that respondents prefer cars over motorcycles as their travel cost rises. The findings align with Figure 2, which shows that as travel cost increases, the number of respondents selecting cars also rises. Similarly, in the case of public transportation, the positive coefficient value signifies that as travel cost increases, the likelihood of choosing public transportation also increases. This implies that as travel costs rise, respondents are more inclined to select public transportation over motorcycles. Furthermore, the positive coefficient value for taxibike indicates that the likelihood of choosing a taxibike also increases as travel costs increase. This suggests that respondents are more likely to opt for a taxibike over a motorcycle when travel costs increase. The overall analysis showed a Prob>Chi² value of 0.000, indicating that the independent variables significantly affect the dependent variables. The pseudo-R² value of 0.2418, or 24%, suggests that the independent variables explain approximately 24% of the variance in the mode selection of cars, public transportation, and taxibike.

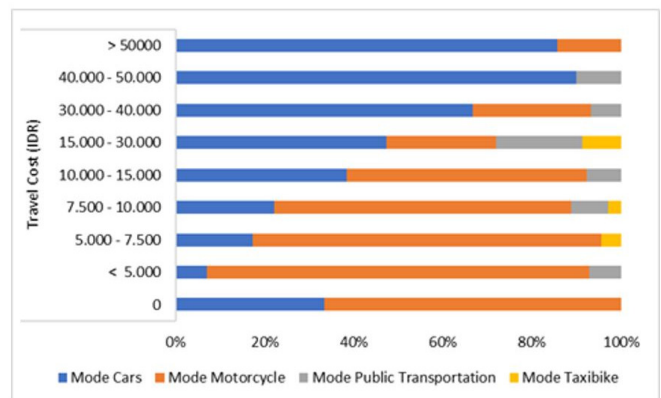


Fig. 2. Relationship of mode and travel cost.

At a confidence level of 90%-95%, the results reveal significant variables influencing respondents' mode selection among car, public transportation, and taxibike. On the other hand, the model results for the group that owned only motorcycles are presented in Table VIII. The independent variables that significantly influence mode choice are similar to the previous group, including age, income, and travel cost.

TABLE VIII. MODEL RESPONDENTS WITH MOTORCYCLE AND NO CAR OWNERSHIP

Variable	Public transportation (para-transit)		Taxibike	
	Coefficient	p-value	Coefficient	p-value
Age	-0.0899	0.076**	-0.7057	0.999
Education	20.1592	0.997	-51.4218	0.999
Income	-1.3348	0.084**	-20.0326	0.999
MC ownership	0.2386	0.412	7.5753	0.999
Travel distance	0.2386	0.447	-5.5230	0.998
Travel cost	-0.1272	0.041*	0.6677	1.000
Travel time	-0.0210	0.786	0.1417	1.000
Cons	-47.797	0.997	88.1862	0.999
Number of observations				118
Prob > Chi ²				0.0076
Pseudo R ²				0.6466

Notes: Base Outcome: Motorcycle, * Significance level is 95%, ** Significance level is 90%

The analysis, specifically for the respondents who own a motorcycle and do not have a car, as shown in Table VIII, revealed that all independent variables significantly affect the choice of public transportation. The independent variable, age, has a negative coefficient, indicating that as the respondent's age increases, the likelihood of selecting public transportation decreases, and they prefer motorcycles.

Additionally, the independent variable, travel cost, has a positive coefficient, suggesting that as travel cost increases, the likelihood of selecting the public transportation mode also increases. In the selection of taxibike mode, as displayed in Table VIII, none of the independent variables significantly affect the dependent variable (taxibike). This is evident from the p-value, which is all above 0.1 or below the 10% significance level. Overall, the analysis conducted on respondents who own a motorcycle but do not own a car and their mode choice for commuting to work reveals a p-value of 0.0029, indicating a significant effect of the independent variable on the dependent variable. The pseudo R² value of 0.6450, or 64.5%, suggested that the independent variables explain a significant portion of the data. The p-value further shows the importance of the independent variables at a 90%-95% confidence level. These results highlight the significant variables that influence the mode selection of respondents, particularly in public transportation and taxibike modes.

Older individuals are more likely to rely on private vehicles, as this stage of life is generally associated with greater income stability and increased family responsibilities. Similarly, those with higher incomes tend to favor private vehicles due to their enhanced purchasing power, the demands of efficiency and occupational status, as well as household

obligations that require more convenient and flexible modes of transport. Furthermore, as travel costs, time, and distance increase, the majority of individuals prefer private vehicles because they are perceived to offer superior efficiency, comfort, and flexibility compared to public transportation. The use of private vehicles also enables commuters to independently manage departure times and select alternative routes to avoid congestion.

Table IX presents the results of multicollinearity testing, measured through the Variance Inflation Factor (VIF), on several independent variables in the regression model. All VIF values are recorded well below the threshold of 10, with the highest value being 1.17 and the average at 1.09. This condition indicates that there is no high correlation among the independent variables that could potentially lead to multicollinearity. Thus, the regression model used can be considered adequate and appropriate, as the predictors within it do not exhibit excessive linear influence on each other.

TABLE IX. RESULT OF MULTICOLLINEARITY

Variable	VIF	1/VIF
Age	1.17	0.856809
Education	1.15	0.866234
Income	1.08	0.928397
Motorcycle ownership	1.08	0.928708
Travel distance	1.07	0.936343
Travel cost	1.05	0.955365
Travel time	1.03	0.967781
Mean VIF	1.09	

IV. DISCUSSION

The multinomial logit model showed the significant variables that have an impact on the mode choice of respondents who own both motorcycles and cars, particularly in the modes of cars, public transportation, and taxibikes. These modes are preferred in developing cities due to their cost-effectiveness, shorter travel times, flexibility in selecting alternative routes, and convenience in avoiding congestion. The results also suggest that the variables influence the choice of public transportation mode for respondents who own motorcycles but do not have cars. In developing cities, respondents prefer motorcycles over public transportation due to factors related to drivers. Conversely, when selecting the taxibike mode, the independent variables do not affect the dependent variable.

The results of the study showed similarities with research conducted in various countries. For instance, a survey conducted in the Philippines [30-32] identified the cost of travel, trip purpose, and mode itself as the most influential variables in mode choice. Similarly, a study conducted in Korea [33] found that age was the most effective individual characteristic in mode choice. In Australia, research [34] highlighted the significance of travel characteristics and mode attributes in tourist responsiveness. A study conducted in Mumbai, India [7], emphasized the importance of individual characteristics, such as age and gender, in mode choice. These findings align with research conducted in major cities in Indonesia, including Jakarta. Authors in [2] revealed that socio-

economic and demographic factors, travel characteristics, and transportation quality played a role in influencing the choice of the main commuting mode for workers in the Jabodetabek area of Jakarta. Factors, such as gender, education, distance, trip duration, travel speed, and practicality were found to influence mode choice. According to research conducted in Jakarta, Indonesia [35], private car users are the most sensitive to higher travel expenses.

The current study examined the impact of changes in travel costs and trip times for routes that traverse residential areas. This research stands out from previous studies due to its distinctive approach, which involves categorizing respondents based on their vehicle ownership, and specifically comparing the choice of motorcycle to other modes of transportation. This method has not been observed in the previously discussed research. As in a study in Korea [36], which although explained how the travel characteristics, such as travel costs, travel time and transfer costs, are related to modes of transportation, it only grouped respondents based on income and age groups. Similarly, studies conducted in the USA [37], Ghana [38], and Indonesia [39] explained the influence of travel characteristics on commuter transportation but differed from the current study in the modes of transportation used.

Variables, such as income, age, vehicle ownership, travel distance, and travel cost, are statistically significant because they reflect social and behavioral realities: higher income and job stability encourage car use, younger age groups prefer flexible modes like motorcycles, and longer distances or higher costs push commuters to weigh efficiency and affordability.

Regular and repetitive commuting patterns tend to reinforce the consistent use of the same mode of transport, reflecting a tendency to maximize available utility under conditions of limited modal alternatives. Although public transportation is available, commuters continue to weigh the option of using private vehicles. In the context of Makassar, despite government subsidies for public transport, the findings of this study indicate that commuters predominantly prefer private vehicles as the public transport services and traffic conditions do not provide sufficient certainty regarding travel costs and time. Moreover, travel cost emerges as a highly sensitive factor in mode choice, whereas travel time, while relevant, has not yet become a primary determinant in decision-making.

V. CONCLUSION

This study examined the factors influencing the travel mode choices of civil servants commuting in Makassar, considering individual and trip characteristics, such as age, education, income, vehicle ownership, travel distance, cost, and time. Using multinomial logit regression models based on a survey of civil servant commuters, the research identified and quantified the factors affecting travel mode selection. The findings indicate that the group of commuters who owned private vehicles was influenced by factors, such as age, income, motorcycle ownership, travel distance, and travel cost, which significantly impacted their mode choices. In contrast, the other group was influenced by age, income, and travel cost in choosing public transportation, while none of the variables significantly affected their decision to choose a taxibike. This

work provides strategic insights to support urban transportation decision-makers in effective planning and management. However, the study is limited to the Makassar metropolitan area and may not be generalizable to other contexts. Further research is needed to investigate the applicability of the findings in different regions. For practical implications, the results suggest that policymakers, transport operators, and urban planners should enhance the quality and affordability of public transport, regulate motorcycle-based services, and develop integrated mobility strategies to reduce reliance on private vehicles and support sustainable urban transport.

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