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ANALYSIS OF TRANSPORTATION MODE CHOICE IN MALANG CITY USING MULTINOMIAL LOGISTICS METHOD

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ABSTRACT

In every urban area, especially in Malang, transportation modes are increasingly diverse, ranging from private vehicles to public and online-based transportation. This research aims to determine transportation mode choice using multinomial logistic regression, supplemented with spatial analysis to visualize travel patterns. Data were collected from surveys conducted across five sub-districts in Malang City. The results indicate that private transportation is predominantly used by 11% of respondents for work purposes, while public transportation is preferred by 88% of working respondents and housewives. Interestingly, 9% of respondents opted for online transportation. Integrating multinomial logistic regression and spatial methods highlights significant factors such as travel time, parking availability, and waiting room facilities, emphasizing their influence on mode choice.

Keywords: *Daily Activities; Household; Multinomial Logistic Regression; Mode Choice; Spatial.*

1. Introduction

With so much potential in the city of Malang, including tourism, agriculture and education, it has become a magnet to visit [1]. Apart from that, increasing population growth and economic activity are supporting the increase in the amount of transportation [2]. Currently, every human activity requires transportation for its survival. With these activities, the number of facilities in the city is still small, with travel distances becoming wider and longer, which does not reflect sustainable development [3]. Therefore, in dense urban areas, especially the Malang area, there is a need for public transportation as facilities and infrastructure to support sustainable development [4].

In each particular urban area, transportation modes are currently increasingly diverse, ranging from private vehicles, and public transportation to online-based transportation [5][6]. Supportive transportation facilities are needed by communities throughout Indonesia. According to several transportation planning experts, mode selection is the most important planning stage because it helps identify what characteristics influence the transportation options we will choose [7].

After looking at travel behavior which has an impact on the possibility of determining the means of transportation, ways can be implemented to improve and enhance the services of users of the means of transportation [8]. As public services improve, it is hoped that every resident will be able to choose public transportation for every trip to reduce traffic congestion [9]. The choice of transportation system to be used is based on the reality that of all the characteristics of these transportation modes, passengers have special considerations or arguments for determining the transportation they want to use when traveling [10].

While previous studies focused solely on multinomial logistic regression to analyze mode choices, there remains a gap in integrating this approach with spatial analysis to provide a comprehensive understanding of travel patterns and demographic influences. This study addresses

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this gap by combining statistical and spatial methods to evaluate transportation choices in Malang City. Factors that influence transportation modes need to be considered, research from Tan Lie Ing, Ofyar Z Tamin [8], stated that integration between public transportation and feeder availability in addition to time, cost, distance and frequency of departure schedules is very necessary in selecting modes. Meanwhile, according to Sapto Setyodhono [9], the factors age, gender, education, worker status, average income, distance and travel time have a significant influence on the choice of transportation mode used, except for commuter workers with independent work status who use the APTB transportation mode or busway [9].

2. Materials and Methods

This research uses research methods with descriptive regression analysis with a quantitative approach[11]. Study This was carried out in 5 sub-districts in Malang City with a total of 316 respondents over 5 days using household data[12]. The purpose of this research is to determine the effect of independent variables which include age, gender, education, income on the dependent variable, namely the choice of transportation mode. The analytical methods used are descriptive statistics and multinomial regression models, this method was chosen to determine the effect of the independent variable on the dependent variable [11]. Next, the daily activity record data was analyzed using the multinomial logistic regression method to determine the mode choice model.

Next, to determine travel patterns, use the coordinate points of daily activity records which are analyzed using spatial methods [13]. With the research diagram below in Figure 1.

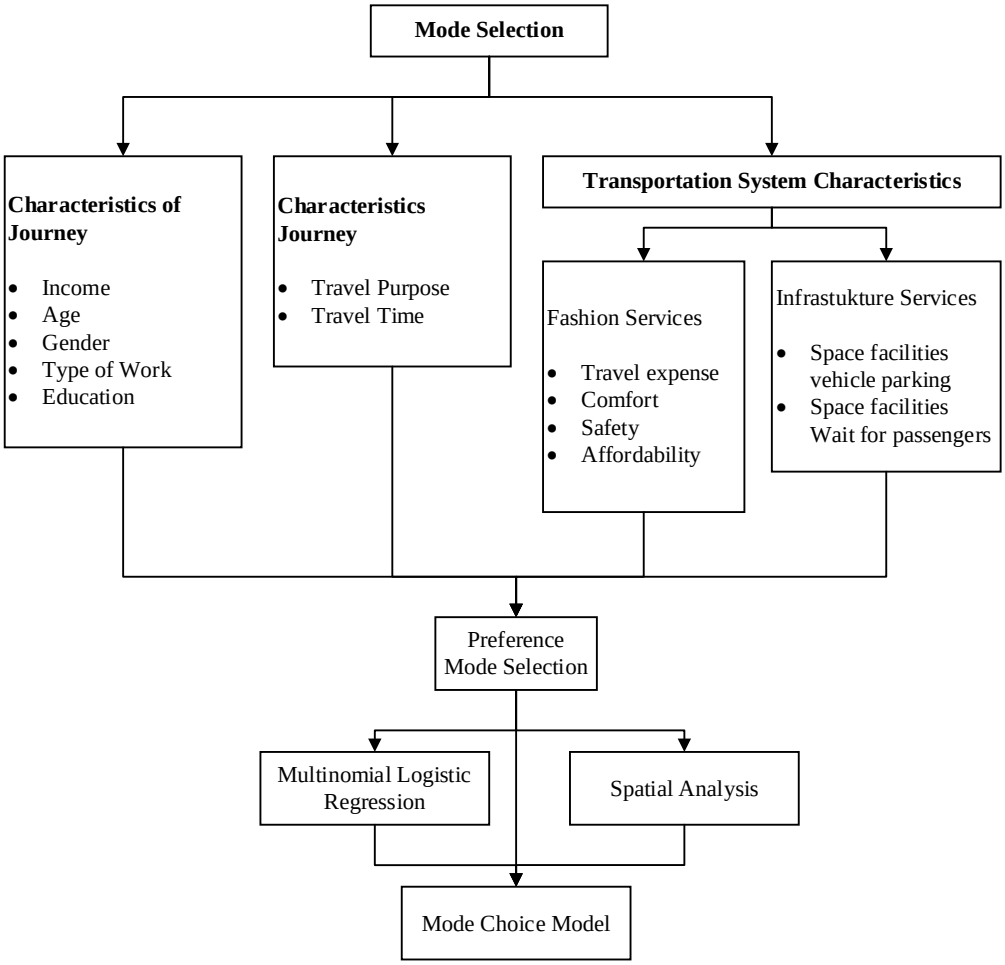

Figure 1. Research Flow Diagram
(Source: Author, 2023)

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3. Results and Discussion

Research variable

The results of the validity test for the traveler variable (X1) and travel variable (X2) show that all indicators are valid, but for the transportation system variable 2 indicators are invalid, while the other 11 indicators are declared valid. Next, eliminate 2 invalid variables to produce 11 valid indicators as a new model. Each indicator is said to be valid if the R-calculated value is greater than the R-table. In Table 2, the validity test results confirm that most variables, including age, travel time, and parking facilities, significantly influence transportation mode choice. Notably, comfort and affordability indicators showed lower reliability, suggesting potential improvements in survey design for future studies.

The variables used in this research can be seen in the table below:

Table 1. Research Variables

Variable	Indicator	
Independent	Travel Behavior Characteristics (X1)	$X_{1.1}$ = Total Income
		$X_{1.2}$ = Age
		$X_{1.3}$= Gender
		$X_{1.4}$= Job Type
		$X_{1.5}$= Education
	Trip Characteristics (X2)	$X_{2.1}$= Travel Destination
		$X_{2.2}$= Travel Time
	Transportation System Characteristics (X3)	$X_{3.1}$= Travel Costs
		$X_{3.2}$= Comfort
		$X_{3.3}$= Safety
		$X_{3.4}$= Affordability
		$X_{3.5}$= Parking Space Facilities
		$X_{3.6}$= Waiting Room Facilities
Dependent	Vehicle Selection (Y)	Y = Mode Selection

(Source: Author, 2023)

Validity test

Table 2. Validity Test Results

Variable	Indicator	R-Table	R-Count	Information
Travel Behavior Characteristics (X1)	X1.1 = Total Income	0.1190	0.775	Valid
	X1.2 = Age	0.1190	0.512	Valid
	X1.3 = Gender	0.1190	0.401	Valid
	X1.4 = Type of Job	0.1190	0.267	Valid
	X1.5 = Education	0.1190	0.360	Valid
Trip Characteristics (X2)	X2.1 = Travel Destination	0.1190	0.482	Valid
	X2.2 = Travel Time	0.1190	0.364	Valid
	X3.1 = Travel Costs	0.1190	0.600	Valid

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Variable	Indicator	R-Table	R-Count	Information
Transportation System Characteristics (X3)	X3.2 = Comfort	0.1190	0.070	Invalid
	X3.3 = Safety	0.1190	0.584	Valid
	X3.4 = Affordability	0.1190	-0.006	Invalid
	X3.5 = Parking Space Facilities	0.1190	0.211	Valid
	X3.6 = Waiting Room Facilities	0.1190	0.601	Valid

(Source: Author, 2023)

Reliability Test

After carrying out the validity test, it is continued with the reliability test. There are 3 variables in the model tested, namely travel behavior, travel, and transportation system.

Table 3. Reliability Test Results

Variable	Cronbach's Alphaa	Information
Travel behavior	0.476	Quite Reliable
Journey	0.689	Reliable
Transportation system	0.568	Quite Reliable

(Source: Author, 2023)

ResultsReliability testing refers to the consistency and accuracy of measurements. Which means the data is quite reliable or accurate.

Multinomial Logistic Regression Analysis

The Chi-square test of 0.965 shows data suitability between the model that has been formed and the actual data because it shows an alpha of more than 0.05. so it can be concluded that the model is fit.

Table 4. Chi-square results

Chi-square	***P-Value***
312.819	0.965

(Source: Author, 2023)

There are 3 categories in mode selection: private, public, and online. If there are 3 categories in the dependent variable, then in applying the multinomial logistic model there are 2 logit models formed. The results of multinomial logistic regression models 1 and 2 can be seen in the following table:

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Table 5. Parameter Estimates

Logit	Predictor Variables	B	P-Value	Logit	B	P-Value
Personal	constant	5,376	0.410	General	36,916	0,000
	Revenue Amount=[1]	-0.516	0.713		-0.929	0.459
	Revenue Amount=[2]	-2,212	0.072		-0.487	0.650
	Age=[1]	3,310	0.153		3,509	0.033
	Age=[2]	2,202	0.231		2,712	0.023
	Gender=[1]	1,103	0.113		0.271	0.624
	Gender=[2]	0b	0,000		0b	0,000
	Job Type=[1]	-0.730	0.733		-1,646	0.371
	Job Type=[2]	-1,376	0.444		-2,281	0.155
	Education=[1]	2,984	0.601		-2.136	0.255
	Education=[2]	1,882	0.744		-2,176	0.274
	Trip Destination=[1]	0.472	0.729		1,646	0.168
	Travel Destination =[2]	0.225	0.749		0.699	0.289
	Travel Time=[1]	5,513	0.006		5,460	0,000
	Travel Time =[2]	3,776	0.064		2,970	0.056
	Expenditure Amount=[1]	-0.757	0.541		-0.177	0.871
	Expenditure Amount=[2]	-0.816	0.379		-0.007	0.992
	Health Level=[1]	-1,061	0.442		-1,338	0.193
	Health Level=[2]	-0.293	0.818		-0.495	0.599
	Parking Space Facility=[1]	0.595	0.588		2,226	0.030
	Parking Space Facilities=[2]	0.262	0.757		2,464	0.003
	Waiting Room Facilities=[1]	-11,714	0,000		-40,063	0,000
	Waiting Room Facilities=[2]	-12,929	0,000		-39,237	0,000

(Source: Author, 2023)

Table 5 shows that with significant variables as a model, namely duration of use of private vehicles and waiting room facilities, the following regression function can be obtained.

$$g_1(x) = 5.376 + (1) - (1) - (2)\, 5.513_{2.2}\, 11.714_{3.6} 12.929_{3.6}$$

$$g_2(x) = 36.916 + 3.509_{1.2}(1) + 2.712_{1.2}(2) + 5.460_{2.2}(1) + 2.970_{2.2}(2) + 2.226_{3.5}(1) + 2.464_{3.5}(2) - 40.063_{3.6}(1) - 39.237_{3.6}(2)$$

Based on the logit function equation 1, the constant value is 5.376, where a positive value means a situation that forces immediate action to be taken. Travelers who have high flying hours make a person prefer public transportation modes by 5,513. The condition of the passenger waiting room

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facilities is better, the chance of someone using public transportation modes is 11,714 and the chance of using online transportation is 12,929.

The logit equation 2 constant value is 36,916, where a positive value means a situation that forces immediate action to be taken. Younger respondents are 3,509 more likely to use public transportation and 2,712 more likely to choose online modes. The longer the trip duration, the more opportunities there are to choose public transportation modes of 5,460 and online transportation of 2,970. The availability of adequate parking space for private vehicles means the opportunity to use public transportation is 2,226 and online voting is 2,464. Passenger waiting room facilities such as bus stops and proper terminals have a greater opportunity to use public transportation by 40,063 and easy pick-up points have a greater opportunity to use online transportation by 39,237 [3].

Spatial Analysis

After statistical calculations, the data will be translated into spatial data in the form of images of the respondent's destination. which can be seen in Figure 2 below:

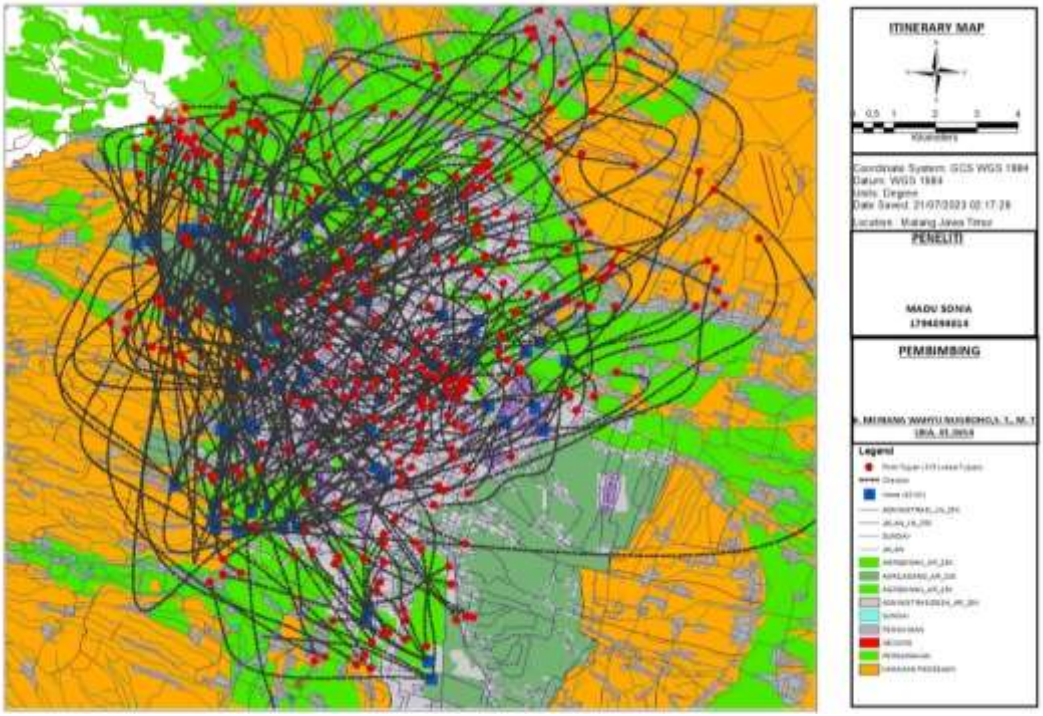

Figure 2. Origin Destination Model
(Source: Author, 2023)

In this figure, you can see the results of transportation analysis or modeling in Malang City showing that the majority of people go to places of education for learning needs, and others have different destinations for work for each respondent. 11% of respondents who need to work as entrepreneurs, civil servants, or housewives use private vehicles, while 3% of respondents who are still students go from home to places of education using private transportation. Respondents who use public transportation for work and household purposes as their mode of choice are 88% and those who use public transportation for educational activities are 97% so those who use online vehicles for work are 9% and 0% of respondents are still students [3]. Figure 2 also illustrates the origin-destination model, where educational trips dominate the travel patterns in Malang City. The

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spatial visualization reveals concentrated clusters of educational destinations, particularly in densely populated sub-districts, aligning with the preference for public transportation shown in Table 5.

Table 5 highlights travel time and waiting room facilities as the most significant predictors for mode choice. Respondents with longer travel times showed a higher likelihood of choosing public transportation, supported by better-designed waiting areas, as also depicted in the spatial analysis in Figure 2.

4. Conclusion

This study reveals that factors such as travel time, parking facilities, waiting room conditions, and age significantly influence transportation mode choices in Malang City. The multinomial logistic regression model demonstrates strong predictive capabilities, supported by spatial analysis that visualizes concentrated travel patterns. Public transportation is the dominant mode choice among respondents, driven by convenience and infrastructure availability. The integration of statistical and spatial methods provides a comprehensive framework for understanding urban travel behaviors. The model obtained is good and fits based on the Chi-square and P-Value values which are 312.819 and 0.965. In the spatial analysis, the majority of Malang city residents go from home to places of education and work using private transportation modes as much as 11%, public 88%, and online 9%.

Future research should explore integrating real-time travel data with spatial analysis to enhance accuracy in predicting mode choices. Additionally, incorporating qualitative data on user perceptions of transportation modes can provide deeper insights into behavioral factors influencing mode selection. Expanding the scope to include other urban areas can also validate the robustness of the proposed model.

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