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Spatial Analysis of Socioeconomic Influences on Generation Z's Transportation Mode Choices in Sidikalang City

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Abstract. This research analyzes the socio-economic influence of Generation Z on transportation mode selection in Sidikalang City using a spatial approach. The main objective of this study is to understand the socio-economic characteristics that affect Generation Z's preferences in choosing transportation modes, both private and public vehicles, as well as to measure the probability of mode selection through regression analysis and binary logit models. Data were collected through questionnaires from 100 Generation Z respondents. The results indicate that 69% of respondents prefer private vehicles for travel, while 31% opt for public transportation. The dominant socio-economic characteristics include male gender (60%), age 22-26 years (48%), students/university students (59%), and monthly income of less than Rp500,000 (56%). Multiple linear regression analysis shows that vehicle ownership (X3) and comfort (X9) are two significant factors influencing transportation mode selection. The spatial movement pattern displays a strong point of origin from Sidikalang City regarding transportation mode selection, especially for those who own private vehicles. This pattern supports the importance of comfort and the availability of private vehicles in Generation Z's transportation preferences. These findings provide a basis for policymakers to improve public transportation by enhancing comfort, in order to encourage Generation Z to shift from private vehicles.

Keywords: *Generation Z, mode selection, spatial analysis*

1. Introduction

Generation Z, born between 1997-2012 and aged around 8-26 years, is known as the internet generation due to their rapid adaptability to technology and high creativity. This generation excels at leveraging technological advancements, which impacts their socio-economic conditions. Socio-economics describes a person's position in society, determined by their job, education, and income. Low education reduces job opportunities, thus affecting income and welfare. Generation Z takes advantage of broader access to education and information technology, but other aspects such as transportation also need to support this.

The choice of transportation modes is an important component in transportation planning, especially since public transportation usually has more efficient routes than private vehicles. Switching to public transportation can reduce congestion, save road space, and optimize infrastructure. Sidikalang, the capital of Dairi Regency, is a center of activity, including recreation in city parks. However, Generation Z in Sidikalang prefers private vehicles due to comfort and lifestyle preferences, resulting in suboptimal use of public transportation. Therefore, there is a need for efficient transportation mode selection that considers the socio-economic behavior of Generation Z to support their activities and reduce congestion in the city of Sidikalang.

This study will analyze the spatial probability of transportation mode choices between private and public vehicles by Generation Z. Understanding the socio-economic characteristics and their influence on Generation Z's transportation choices will enable improvements and enhancements in related transportation services.

2. Literature Review

2.1 Mode Selection

According to Tamin (2000), the factors influencing the choice of transportation modes are divided into three main groups, namely:

- Road User Characteristics. The individual characteristics of those using transportation modes, such as age, income, and personal preferences.
- Movement Characteristics. Travel patterns, destinations, frequency, and distances traveled that affect the choice of transportation modes.
- Transportation Mode Facility Characteristics. The availability, comfort, and quality of transportation facilities provided, including the accessibility and efficiency of the mode.

2.2 Sampling Method

To calculate the required sample size, Slovin's formula is used.

$$n = \frac{N}{1+(N.e^2)} \quad (1)$$

Information:
n : number of samples studied
N : number of population studied
e : level of accuracy

2.3 Discrete Choice Model

The utility function can be formulated into a multiple linear equation as follows:

$$U = a + b1\ X1 + b2\ X2 + \ldots\ldots + bnXn \quad (2)$$

Information:
U : utility value mode
a : constant
b1 s/d bn : regression coefficient

2.4 Bxinary Logit Biner

The binary logit model is a model that selects the mode with the highest satisfaction value among two transportation options, such as public transport and private transport. The following is the equation used.

$$P(1) = \frac{x^y}{1+e^y} \quad (3)$$

$$P(2) = \frac{1}{1+e^y} \quad (4)$$

Information:
P(1) : private vehicle opportunity
P(2) : public vehicle opportunity
y : value of multiple linear regression
e : exponential

2.5 Spatial Analysis

Spatial analysis is an approach in geography using geographic data to understand patterns, relationships, and spatial distribution. Spatial analysis is depicted by the thickness of the color and the size of the dots according to the number of answers from each respondent, which is carried out on all independent variables.

3. Research Methods

The stages of the research activities in this study are as follows:

- The first stage is to formulate the problem. by identifying the transportation modes to be studied and the current conditions of public transport and motorcycles.
- The second stage is a literature review. that includes the theoretical framework and calculation methods to be used for data processing or analysis.
- The third stage is to formulate the questionnaire.
- The fourth stage is the collection of primary and secondary data.
- The fifth stage is the discussion or processing of data. The data obtained from the questionnaire results are collected, processed, and presented in a simpler form (percentage of respondents' choices) to facilitate the next stage.
- The sixth stage is data analysis. In this stage, the processed data is analyzed using regression models with the SPSS program. Then, the probability values are calculated using a binary logit model.
- The seventh stage is spatial analysis. In this stage, the questionnaire data is analyzed for the distribution of movements from each respondent using ArcGIS Pro.
- The eighth stage is conclusions and recommendations. In this stage, conclusions are drawn regarding the factors influencing transportation mode choice and their probability values.

4. Result and Discussion

4.1 Questionnaire results and discussion

Tabel 1. variable description and summary statistics.

Dependent Variable		
Variable	Mean	Modus
Types of transportation modes	0.6	1
Independent Variable		
Variable	Mean	Modus
Gender	0.6	1
Income	1.310.000	500.000
Vehicle ownership	0.58	1
Driver license ownership	0.33	0
Time of travel	1.77	2
Travel time	0.25	1
Distance traveled	0.23	1
Travel cost	0.35	1
Comfort	2.18	2
Safety	2.24	2

Based on the descriptive analysis of the questionnaire results as shown in the table above, the highest average value for variable X (categorized with a dummy variable) is the gender variable at 0.6, while the lowest is the travel distance variable at 0.23. Meanwhile, the highest average value for the variables that are not categorized as dummy variables is the safety variable at 2.24, and the lowest is the travel time variable at 1.77.

4.2 Results and Discussion of Multiple Linear Regression

Tabel 2. Significance of independent variables using multiple linear regression analysis.

Variable	A	Significant	Information
X1	0.05	0.053	Not Significant
X2	0.05	0.071	Not Significant
X3	0.05	0.000	Signifikan
X4	0.05	0.902	Not Significant
X5	0.05	0.017	Significant
X6	0.05	0.592	Not Significant
X7	0.05	0.320	Not Significant
X8	0.05	0.539	Not Significant
X9	0.05	0.007	Significant
X10	0.05	0.680	Not Significant

From the table, it is evident that the variables that have been shown to be significant in the choice of transportation mode are X3 (ownership of private vehicles), X5 (travel time), and X9 (comfort).

Tabel 3. recapitulation of variables with value B.

Variable	B	Significant
X1	0.144	0.053
X2	- 0.107	0.071
X3	0.603	0.000
X4	- 0.009	0.902
X5	- 0.095	0.017
X6	0.043	0.592
X7	- 0.080	0.320
X8	- 0.043	0.539
X9	0.134	0.007
X10	0.023	0.680

Based on the results of multiple linear regression in the table above, the following linear regression equation is obtained.

$$Y = 0.074 + 0.144\ X1 - 0.107\ X2 + 0.603\ X3 - 0.009\ X4 - 0.095\ X5 + 0.043\ X6 - 0.080\ X7 - 0.043\ X8 + 0.134\ X9 + 0.023\ X10$$

4.2.1. Simultaneous F Test

Table 4. Simultaneous f test

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	18.258	10	1.826	28.300	.000[b]
	Residual	5.742	89	.065		
	Total	24.000	99			

a. Dependent Variable: Mode selection
b. Predictors: (Constant), Safety, Vehicle ownership, Traveling time, Travel time, Monthly income, Travel expense, SIM ownership, Comfort, Travel distance, Gender

The table anova explains whether there is a significant effect of the variables of safety, vehicle ownership, travel time, journey duration, monthly income, travel costs, driving license ownership, comfort, distance traveled, and gender. Based on the ANOVA table above, the calculated F value (Fhit) is 28.300, and the tabulated F value (Ftab) from Appendix A.4 is 1.94, thus Fhit > Ftab. Additionally, the significance value is 0.00, which means 0.00 < 0.05. Therefore, it can be concluded that the independent variables (safety, vehicle ownership, travel time, journey duration, monthly income, travel costs, driving license ownership, comfort, distance traveled, and gender) have a significant effect on the dependent variable (mode of transportation choice) simultaneously.

4.2.2. Partial T Test

Table 5. Partial t test

Coefficientsa						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.074	.153		.484	.630
	Gender	.144	.074	.144	1.964	.053
	Monthly income	-.107	.058	-.108	-1.825	.071
	Vehicle ownership	.603	.086	.608	7.001	.000
	SIM ownership	-.009	.070	-.008	-.123	.902
	Travel time	-.095	.039	-.137	-2.430	.017
	Traveling time	.043	.080	.038	.538	.592
	Travel distance	-.080	.080	-.070	-1.000	.320
	Travel expense	-.043	.069	-.042	-.616	.539
	Comfort	.134	.048	.186	2.771	.007
	Safety	.023	.055	.026	.413	.680
a. Dependent Variable: Mode selection						

From the table partial, it is known that the constant value is 0.074, the Thit values, and the significance values of each variable. Meanwhile, the Ttab value in Appendix A.3 is 1.986. Thus, there are two variables that have a significant partial effect on the choice of transportation mode, namely X3 and X9. X3 has a Thit value of 7.001 > 1.986 and a significance value of 0.00 < 0.05, leading to the conclusion that X3 (vehicle ownership) has a significant partial effect on the dependent variable (choice of transportation mode). X9 has a Thit value of 2.771 > 1.986 and a significance value of 0.007 < 0.05, leading to the conclusion that X9 (comfort) has a significant partial effect on the dependent variable (choice of transportation mode).

On the other hand, the variables X1, X2, X4, X5, X6, X7, X8, and X9 (gender, monthly income, driver's license ownership, travel time, travel duration, distance traveled, travel costs, and safety) do not have a partial effect on the choice of transportation mode because the Thit values are < Ttab and the significance values are > 0.05.

4.2.3. R Square

Table 6. R square

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.872a	.761	.734	.254
a. Predictors: (Constant), Safety, Vehicle ownership, Traveling time, Travel time, Monthly income, Travel expense, SIM ownership, Comfort, Travel distance, Gender				

The table R square explains the magnitude of the correlation/relationship (R), which is 0.872, and clarifies the percentage of influence of the independent variables on the dependent variable, referred to as the coefficient of determination, which is the square of R. From the regression results above, it can be seen that the R square value is 0.761 or 76.1%. This value indicates that the variables of security, vehicle ownership, travel time, journey duration, monthly income, travel costs, driving license ownership, comfort, distance traveled, and gender can explain the dependent variable by 76.1%. Meanwhile, the remaining 23.9% is explained by other variables that are unknown or not accounted for in this research analysis.

4.3 Binary Logit Model Analysis

Tabel 7. Generation Z's probability of transportation mode selection.

No	Means of transportation	Persentase
1	Private vehicles	69%
2	Public vehicles	31%

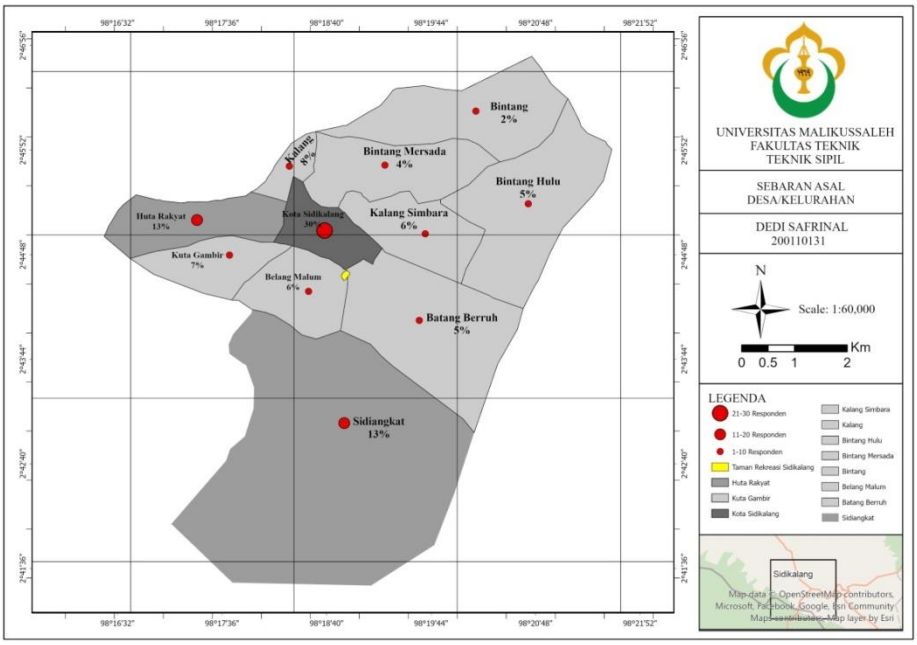
Based on the table above, it can be seen that private vehicle users account for 69% of trips to the Sidikalang recreational park attraction. Meanwhile, public transportation users make up 31% of trips to the Sidikalang recreational park attraction.

4.4Spatial Analysis

Tabel 8. Origin village sub-district.

No	Origin Village sub-district	Total Generation Z
1	Sidiangkat	13
2	Batang Berruh	5
3	Belang Malum	6
4	Bintang	2
5	Bintang Mersada	4
6	Bintang Hulu	5
7	Kalang	8
8	Kalang Simbara	6
9	Kota Sidikalang	31

10	Kuta Gambir	7
11	Huta Rakyat	13
Total		100



Gambar 1 Distribution of movement of origin of village/sub-district.

From the table and image above, it can be seen that only respondents from the city of Sidikalang have a score of 21 – 30, with a total of 31 respondents. Huta Rakyat and Sidiangkat have scores of 11 – 20, with 13 respondents each. Additionally, the respondents with scores of 1 - 10 are Kalang Simbara with 6 respondents, Kalang with 8 respondents, Bintang Hulu with 5 respondents, Bintang Mersada with 4 respondents, Bintang with 2 respondents, Bellang Malum with 6 respondents, and Batang Berruh with 5 respondents.

5. Conclusion and Suggestion

The conclusion is the result of an analysis conducted based on field facts in the form of questionnaires from 100 respondents of Generation Z in Sidikalang City. The following is the conclusion of the research titled "Spatial Analysis of the Socio-Economic Influence on Generation Z's Transportation Mode Choices in Sidikalang City."

5.1 Conclusion

1. The questionnaire results reveal key characteristics influencing transportation mode selection among respondents. The socio-economic profile indicates a predominance of male travelers (60%), primarily aged 22 to 26 years (48%), with a majority being students (59%) and having completed Senior High School (SMA)/Madrasah Aliyah (MA) (75%). Most respondents report a monthly income of less than Rp.500,000 (56%), own private vehicles (58%), and a significant portion does not possess a driver's license (67%).
   Travel characteristics show that 30% of respondents originate from the village/sub-district of Sidikalang City, with a notable 90% traveling for recreational purposes. Private vehicles are the

preferred mode of transportation (60%), with travel typically occurring during non-peak hours (10:00 AM to 12:00 PM) for 45% of respondents. The majority travel for 5 to 10 minutes (51%) over distances of 1 to 3 kilometers (46%), with travel costs ranging from Rp.5,000 to Rp.10,000 (50%).

Regarding land transportation facilities, comfort while using vehicles is rated as sufficient by 50% of respondents, while safety is rated as sufficient by 64%. These insights highlight the socio-economic factors, travel patterns, and perceptions of transportation facilities that influence mode selection.

2. After analyzing the factors influencing transportation mode selection using multiple linear regression analysis with SPSS software, the utility function equation obtained is Y = 0.074 + 0.144 X1 – 0.107 X2 + 0.603 X3 – 0.009 X4 – 0.095 X5 + 0.043 X6 – 0.080 X7 – 0.043 X8 + 0.134 X9 + 0.023 X10. It is found that there are two variables that significantly affect transportation mode selection, namely; X3 (vehicle ownership) and X9 (comfort). Therefore, the socio-economic characteristic that influences transportation mode selection is X3 (vehicle ownership). Meanwhile, the other variables X1 (gender), X2 (monthly income), and X4 (driver's license ownership) do not have a significant effect on transportation mode selection.
3. Two significant variables were used in the binary logit model equation, resulting in a probability of Generation Z choosing private vehicles at 69%. Meanwhile, the probability of Generation Z opting for public transportation is 31%.
4. The results of the spatial analysis show the distribution of significant movement points based on the origin of the Village/Subdistrict, where the significant points range from 21-30, is the City of Sidikalang with a total of 31 respondents.

5.2 Suggestion

1. From the characteristics found in the research questionnaire, it can be illustrated how the Dairi Regency Environmental Agency plans or improves the quality of services for the recreational park facilities in Sidikalang. As a result, the people of Sidikalang, from any generation, can easily access the Sidikalang recreational park.
2. To enhance the use of public transportation, efforts are needed from public transport service providers to improve vehicle quality, along with regulations from the local government, specifically the Dairi District Transportation Office, regarding the arrangement of bus stops and the operation of routes from each village/sub-district in Sidikalang.

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