Factors associated with choice of transportation mode among students commuting to school in Jabodetabek, Indonesia

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Abstract

Over the past decade (2010–2020), the journeys made by students in the Jakarta Metropolitan Area to and from school have predominantly relied on private transportation. To address the persistent issue of traffic congestion, this study focuses on identifying the characteristics of student commuters and exploring strategies to shift their transportation preferences from private transportation to sustainable mass public transit options. A binary logistic regression analysis was conducted to examine the influence of individual-level variables on students' mode of transportation choices. The findings reveal that 67% of student commuters opted for private transportation, while 33% used public transportation. Students' preference for public transit was significantly associated with factors such as gender, education level, travel distance, commute duration, and cost. To inform policy formulation, the study highlights the importance of implementing push-and-pull strategies. These include discouraging the use of private transportation and promoting public transportation or school buses. Such programs aim to encourage a shift towards more sustainable and efficient modes of mobility among students.

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INTRODUCTION

Jabodetabek is an agglomeration area that has the largest number of space shuttles than other agglomeration areas in Indonesia (Maharani Raijaya and Chotib, 2020). This area includes Jakarta, the capital city of Indonesia. It covers 13 districts/cities: Central Jakarta City, South Jakarta City, West Jakarta City, North Jakarta City, East Jakarta City, Bekasi Regency, Bogor City, Depok City, Tangerang Regency, Bekasi City, South Tangerang City, Bogor Regency, and Tangerang City.

Approximately 11.1% of Jabodetabek's 29.3 million residents aged over five years are commuters. A significant portion of these commuters are students, highlighting the critical role of transportation in facilitating daily activities. Efficient transportation systems are essential for connecting suburban residential areas to schools, ensuring accessibility and supporting the mobility needs of the population.

However, transportation in Jabodetabek continues to face challenges, particularly with traffic congestion and density on major roads due to the widespread use of private transportation (Purwoko and Yola, 2022). Growing population mobility and regional economic growth have further accelerated the rise in motor vehicle ownership. Unfortunately, the development of road infrastructure has not kept pace with this growth, leading to an imbalance between the number of private vehicles and

the road network's carrying capacity (Nayka and Sridhar, 2019). Addressing these issues requires real, effective, and innovative solutions that provide viable alternatives for resolving transportation challenges in the short, medium, and long term.

Traffic congestion in urban areas remains a significant challenge for the Jabodetabek region and is anticipated to worsen if effective measures are not implemented. The annual economic losses attributed to traffic congestion in Jabodetabek are substantial, amounting to approximately Rp. 3 trillion in vehicle operating costs and Rp. 2.5 trillion in lost travel time.

Moreover, if no improvements are made, the accumulated economic losses compared to a scenario where the transportation system is developed according to the proposed master plan would reach nearly Rp. 65 trillion (present value with a 12% discount rate). This includes Rp. 28.1 trillion in additional vehicle operating costs and Rp. 36.9 trillion in extended travel times (Chotib, 2019). While the economic crisis temporarily slowed the growth in car and motorcycle registrations, recent years have seen a resurgence in the number of vehicles on the road.

One contributing factor is the decline in the quality and availability of public transportation services. As the regional economy recovers, household incomes are expected to rise in the coming years, likely fueling an increase in motorization. If a growing number of people opt for private transportation, traffic conditions will deteriorate further, and environmental pollution will become even more severe than it is today (Indriany et al., 2019).

Usually, efforts to address transportation issues have focused on expanding infrastructure by constructing new road networks or widening existing roads. However, this approach is not always the most effective solution. A shift in strategy is needed, emphasizing management and demand-side approaches to mitigate congestion. Managing the demand for transportation has significant potential to enhance the efficiency and effectiveness of existing infrastructure. This involves optimizing current transportation facilities and encouraging behavioral changes among commuters, particularly students. Strategies could include reducing reliance on private vehicles and promoting the use of public transportation by influencing travel behaviors, such as frequency, destination, mode choice, and travel time (Pongprasert and Kubota, 2017).

In other words, efforts should focus on reducing reliance on road-based vehicles while providing alternative mobility options that are more efficient, safe, and environmentally friendly. Understanding the mobility patterns and behavioral characteristics of commuters in Jabodetabek is crucial for analyzing students' transportation mode choices. Students, in particular, exhibit unique characteristics in their selection of transportation modes, making it possible to develop more rational, sustainable, and equitable transportation planning. Therefore, it is essential to explore the factors influencing students' choices of transportation modes, as changes in these factors can lead to corresponding shifts in their preferences (Zhou, 2014).

Schools are major travel hubs, attracting significant numbers of people daily. To address congestion, this article focuses on identifying key factors that can encourage users to shift their transportation modes, thereby reducing the reliance on private motor vehicles and promoting sustainable mobility through mass public transportation. According to Bringolf-Isler et al. (2007), schools share organizational similarities with municipalities, but their members often exhibit greater openness to adopting new habits. Over the past decade, the majority of school-related journeys by

students have been made using private vehicles, further exacerbating traffic issues (Henning et al., 2020).

This trend has contributed to environmental and traffic-related issues around schools, emphasizing the need for measures to promote active and environmentally friendly transportation modes, such as cycling and walking. Active transportation options like walking and cycling are cost-effective alternatives for students commuting to and from school. However, the lack of adequate and efficient infrastructure both within and around schools discourages the use of these modes and reinforces the reliance on motorized transportation.

The implementation of school child transport is a key aspect of public policy, designed to enhance public services and mobility, improve the economy and urban environment, and elevate the comfort and quality of life in urban areas (Utami, 2021). As a public policy initiative, the development of school transportation requires careful policy analysis during the decision-making process. The goal of policy analysis is to provide decision-makers with relevant information that can inform their choices, facilitating effective problem-solving (LAN, 2015).

Related to previous research, Irjayanti et al. (2021) examined the use of commuter transportation types in metropolitan areas, including Jabodetabek, using data from the Jabodetabek Commuter Survey published by the Central Statistics Agency in 2014. The study focused on commuter workers in Jabodetabek and their primary modes of transportation (Setyodhono, 2017). While these studies provide a comprehensive analysis, they primarily focus on individual-level data and do not delve deeply into the transportation choices of students commuting within Jabodetabek (Chotib, 2020).

Public transportation in Jabodetabek should be considered one of the ideal transportation modes for students. However, most students currently rely on private vehicles to commute to school, contributing to increased traffic volume and congestion on certain roads. Therefore, the central question of this study is: how can the utility of public transportation for students in Jabodetabek be improved?

Policies for Organizing School Transportation in Selected Countries

The policy for implementing school transportation in Indonesia differs from those in other countries. In countries like Australia and the United Kingdom, school transportation policies do not distinguish between shuttle services and city transport for schoolchildren. For example, the administration of school transportation in the State of Victoria, home to the capital city of Melbourne, is governed by the School Bus Program Policies and Procedures, issued by the Department of Education and Training in 2013. This program is guided by the 2007 Education and Training Act and the 2009 Bus Transport Safety Act. The implementation of school buses in Victoria is carried out in collaboration with the Victorian Public Transport Institute. According to the policy in Victoria, there are three criteria that govern school bus services, which are influenced by location factors: the proximity of the school to students' homes, students living 4.8 km or more from the school, and students residing within Victoria (Department of Education & Training, State Gov't Victoria, 2013).

In Victoria, school-age students can access the school bus service for free under certain conditions. These conditions include situations where the student is not enrolled in the school nearest to their home, if the student needs to attend a different

school within the same zone for specific subjects not offered at their local school, and if the student resides in Victoria. However, there is an exception to the free school bus service: students who attend a school more than 10 km from their place of residence are not eligible for the free service.

The School Transport Policy in South Australia was introduced by the Government of South Australia through the School Transport Policy 2014, which was published in 2012 and officially approved on September 14, 2014. This policy governs various aspects of school transport services, including requirements, liability, bus driver standards, and bus criteria. The regulations for school child transport services in South Australia are outlined in Article 9, Paragraph 8 of the Education Act, which states that the Ministry has the authority to provide and regulate transportation for schoolchildren and may finance part or all of the associated costs.

Schoolchildren's transport services in South Australia include both services provided directly by the relevant ministry or government agency and those operated by contractors under agreements with the ministry. The ministry has the authority to issue permits for new routes for school transport services. A new school transport service can be established if there are at least 10 students living 5 km or more along a route that crosses the boundary of a state school.

In the United Kingdom, the government issued the *Guidelines for Transport and Travel from Home to School* in July 2014 for local governments (Department for Education, Government of the United Kingdom, 2014), replacing the previous *Guidelines for Transport and Travel from Home to School Number 00373-2007BKT-EN*. These guidelines emphasize sustainable transportation and the provision of appropriate transport for schoolchildren. Local governments are required to meet the transportation needs of children in their areas, oversee sustainable transportation infrastructure, develop strategies for enhancing such infrastructure, particularly for schoolchildren, promote sustainable transportation options for school trips, and publish strategies that encourage the use of sustainable modes of travel.

METHOD

Data

The data used in this study was sourced from the 2019 Jabodetabek Commuter Survey conducted by BPS. Data collection was carried out door-to-door by visiting households selected as samples (Purwoko et al., 2022). The survey aimed to provide datasets and a monitoring system to support researchers and policymakers in studying commuting patterns in Jabodetabek. The survey recorded approximately 3.2 million commuters in Jabodetabek, categorized by demographic factors, socioeconomic attributes, and travel characteristics. This study specifically analyzed data from 855 respondents who met the criteria of being students. It focused on individuals who attended school and used transportation for daily mobility in Jabodetabek in 2019.

Students who commute to school daily develop distinct travel patterns and trip characteristics. Modes of transportation play a crucial role in facilitating the movement of students from their homes (origins) to their schools (destinations). Research by Wati and Khikmah (2020) highlights student travel characteristics through an effective transportation monitoring system aligned with educational facility standards.

Key independent variables influencing student travel include travel time, distance, transportation costs, and the availability of public facilities, all of which impact individual accessibility to school locations. Accessibility—defined as the ease of reaching a destination—depends on factors such as the distribution of routes across service areas, vehicle capacity, service frequency and operating hours, stop and vehicle features, and the availability of information on distances, schedules, and other travel details.

Measurements

This study employs both descriptive and inferential analyses using binary logistic regression methods. Data processing was conducted using the SPSS software. The binary logistic regression model applied is a random intercept model, which assumes that the effect of each independent variable is consistent across all districts/cities at the second level. This analysis is used to examine the influence of individual-level independent variables on the choice of transportation modes among commuter students in Jabodetabek.

It uses a binary logistic regression modeling as one of the most commonly used approaches to developing predictive models (van Smeden et al., 2019). Binary logistic regression is used to analyze cases where the dependent variable is on a nominal scale with two categories. In this model, the binary dependent variable forms a logistic function to represent the relationship between the independent and dependent variables (Hosmer et al., 2013).This model is the following:

$$\text{Logit}(Y) = \beta^0 + \beta^1 * X1 + \beta^2 * X2 + \beta^3 * X3 + \ldots + \beta PXP \tag{1}$$

The stages of binary regression analysis are as follows:

Partial Parameter Testing

The regression coefficient can be tested individually using the Wald test. This partial test is used to identify which independent variables have a significant relationship with the dependent variable.

Interpretation of Parameters

In this study, the regression coefficients were used to determine the relationship and the likelihood of the selection of modes of transportation. As shown in Table 1, the study used six independent variables and one dependent variable. The following table is the independent variables. The dependent variable is whether using private or public transportation.

Tabel 1. Independent Variables

Variable	Data Type	Code	Information
Gender	Categorical	0	Female*
		1	Man
Age	Categorical	0	≤20 years *
		1	>20 years
Education	Categorical	0	≤Junior high school*
		1	> Senior high school
Mileage	Categorical	0	Near (≤ 30 km)*
		1	Far (> 30 km)

Variable	Data Type	Code	Information
Time	Categorical	0	Close (≤ 60 minutes)*
		1	Far away (> 60 Minutes)
Transportation Costs	Categorical	0	≤ Rp. 10,000*
		1	> Rp. 10,000

Note: *) refers to reference category

The equation used in this study is the following:

$$Logit\ (Y) = \beta_0 + \beta_1 * Gender + \beta_2 * Age + \beta_3 * Education + \beta_4 * Distance + \beta_5 * Time + \beta_6 * Cost \tag{2}$$

Where:

Y	=	Use private or public transportation
Gender	=	0 if female; 1 if male
Age	=	0 if ≤20 years old; 1 if >20 years old
Education	=	0 if ≤ junior high; 1 if ≥ high school
Distance	=	0 if close (≤30 km); 1 if far away (>30 km)
Time	=	0 if the trip has a short duration (≤60 minutes); 1 if the trip has a long duration (>60 minutes)
Cost	=	0 if the cost incurred ≤ Rp.10,000 (approximately USD 0.6); 1 if the cost incurred > Rp.10,000

The mileage to the place of activity was measured as a one-way distance from home to the place of activity, not the round-trip. The length of travel from residence to the place of activity is the length of travel calculated from the place of residence to the place of activity, including the waiting time for public transportation (Central Bureau of Statistics, 2019).

RESULTS

Descriptive Analysis

The results of the 2019 Jabodetabek Commuter Survey processing showed that overall there was 67 percent of students who commuted using private transportation modes, and 33 percent used public transportation. The use of private transportation by commuting students seems to assert that comfort, safety, and reliability can be met by private transportation.

Table 2 shows a descriptive analysis on the factors associated with the choice of transportation mode, whether using private or public transportation. Based on the results of calculations of the characteristics of students who commuted in Jabodetabek based on the level of education it is shown that as many as 50.7% of students were high school graduates or equivalent. This data also shows that as many as 60% of students or half of all student respondents studied in Upper Secondary School. Next is the respondent having undergraduate graduate education l with a percentage of 20.7% and junior high school/equivalent of 10.1%.

Table 2. Overview of characteristics of commuting students in Jabodetabek in 2019

Factor	Category	Frequency	%	Public Transportation	Private Transportation
Gender	Male	432	51%	24,1	75,9
	Female	423	49%	42,3	57,7
Age	≤20 years	316	37%	34	66
	>20 years	539	63%	31,6	68,4
Education	≤ junior high school	380	44%	32,9	67,1
	≥ senior high school	475	56%	33,3	66,7
Distance	≤30 km	789	92%	30,5	69,5
	>30 km	66	8%	63,6	36,4
Travel Time	≤60 minutes	751	88%	29,4	70,6
	>60 minutes	104	12%	59,6	40,4
Cost	≤10,000	445	52%	14,8	85,2
	>10,000	410	48%	52,9	47,1

Source: calculated by the authors

Among the 855 student respondents, the use of transportation by gender shows minimal differences. Both male and female respondents predominantly use private transportation over public transportation. Specifically, 75.9% of male respondents and 57.7% of female respondents use private transportation. When analyzed by age group, private transportation usage remains dominant, with 66% of respondents under 20 years old and 68.4% of those over 20 years old opting for private transportation

The proportion of respondents using public transportation based on their highest completed education level was highest among those with education beyond high school at 8.7%, while only 6.3% of respondents with education below the junior high school level were willing to switch to public transportation.

In this study, travel distance was measured from the respondent's residence to their school and categorized into two groups: short distance (≤30 km) and long distance (>30 km). Students commuting longer distances were more willing to switch to public transportation, with 63.6% expressing this preference. In contrast, students traveling shorter distances (≤30 km) predominantly preferred private transportation, with 69.5% opting for it. This finding aligns with Irfan and Nooraeni (2021), who observed that most commuters use motorcycles—a mode less suitable for long-distance travel due to comfort limitations.

Inferential Analysis

Inference analysis was conducted using logistic regression due to the binary nature of the dependent variable, which consists of two categories: public transportation and private transportation. In this regression model, private transportation users were coded as "1", while public transportation users were coded as "0", serving as the reference category. The test results are presented as follows:

The inferential analysis was conducted using logistic regression due to the binary nature of the dependent variable, which consists of two categories: public transportation and private transportation. In this regression model, private transportation users were coded as "1", while public transportation users were coded

as "0" and served as the reference category. The overall test results from the logistic regression analysis are presented as follows:

Table 3. Estimated Parameters of Student Transportation Mode Choice in Jabodetabek

Variable	B	S.E.	Wald	Df	Sig.	Exp(B)
Gender	0.785	0.167	22.026	1	0.000	2.193
Age	0.167	0.234	0.509	1	0.476	1.182
Education	0.921	0.248	13.817	1	0.000	2.511
Distance	-0.719	0.314	5.232	1	0.022	0.487
Time	-0.811	0.262	9.604	1	0.002	0.445
Cost	-2.003	0.194	106.508	1	0.000	0.135
Constant	1.060	0.162	42.593	1	0.000	2.887

Source: calculated by the authors

The table above shows the following estimated models.

$$Logit\ (Y) = 1{,}060 + 0{,}785 Gender + 0{,}167 Age + 0{,}921 Education - 0{,}719 Distance - 0{,}811 Time - 2{,}003 Cost \tag{3}$$

Previous research by De Witte et al. (2013) explains that transportation mode selection is a decision-making process involving the choice between various transportation alternatives. This decision is shaped by a combination of individual socio-demographic factors, spatial characteristics, and socio-psychological influences.

The data presented above indicates that students, regardless of gender, tend to prefer private transportation for commuting. This finding aligns with the empirical research by Irjayanti et al. (2021). Due to the diverse needs of female students, they often prefer more flexible transportation options. Therefore, public transportation services must be designed to accommodate a wider range of travel routes, align with school schedules, and ensure safety and comfort.

Additionally, the education level of commuting students shows a significant and positive relationship with transportation choice. This suggests that regardless of the level of education completed, students still tend to use private transportation, as also highlighted by Mansyur (2009).

Building on the analysis of previous variables, the following factors demonstrate a tendency for commuter students to prefer public transportation. Specifically, travel distance, travel time, and travel costs all show significant results with negative effects. This indicates that these variables significantly influence commuter students to opt for public transportation.

Additionally, shorter travel times discourage commuter students from switching to public transportation, suggesting that those with quicker commutes are more likely to continue using private transportation.

Preferences for the implementation of school transportation policies in Jabodetabek, based on cross-tabulation analysis, are associated with gender, distance

from home to school, and awareness of the School Bus program. However, this analysis does not quantify the extent to which these variables influence students' willingness to use the School Bus service.

Given these findings, further research is necessary to explore the factors that significantly impact preferences for school transportation programs. Additionally, the current study's respondents are generally categorized, leading to notable differences in travel characteristics and behavior. To enhance the generalizability of the findings, future research should include a broader and more diverse sample of respondents.

In general, school buses are considered the most comfortable and safest option for school transportation policies. However, financing and maintenance remain critical concerns due to regional budget constraints in procuring and managing school transportation facilities. These challenges, however, could be addressed through Corporate Social Responsibility (CSR) initiatives.

Given these considerations, it is essential to conduct a cost-benefit analysis of alternative policies for implementing school bus services in Jabodetabek. Currently, DKI Jakarta has introduced a transportation card system, which should be expanded to include students across Jabodetabek. By offering transportation cards to students, the government can support school transportation through targeted subsidies. This approach would reduce students' transportation expenses and better support their learning activities.

CONCLUSION AND RECOMMENDATION

The study concludes that in 2019, among students who commuted actively in Jabodetabek, the use of private transportation was more prevalent than public transportation. The choice of public transportation was influenced by factors such as gender, education level, travel distance, commute duration, and costs. Interestingly, age did not significantly affect the preference between private and public transportation modes.

Currently, mass transportation systems have not effectively replaced the dominance of private transportation in Jabodetabek. To alleviate persistent congestion on many roads, public transportation presents an alternative to steer urban mobility toward a more sustainable trajectory. However, significant efforts are still required to shift away from cars as the predominant mode of transportation in the region. Without robust public transportation alternatives, implementing policies to address congestion and ensure student safety becomes challenging. This is particularly critical, as commuting is not merely an optional activity but a necessity for most users who rely heavily on private vehicles for their daily travel.

To enhance safety and encourage the use of public transportation among students who commute actively in Jabodetabek, a collaborative approach involving key stakeholders is essential. Policy formulation could leverage strategies that both discourage the use of private vehicles (push strategies) and promote public transportation or school buses (pull strategies). For instance, the government could implement targeted interventions such as subsidized transport cards or mandatory school bus programs, providing students with safer, more affordable, and accessible commuting options.

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Conflicts of Interest
None declared.

Author's Contributions
All authors contributed equally to this work.

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