

The Influence of the Effectiveness of Using Electric Shuttle Buses as Transportation within the Campus Environment

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ARTICLE INFO

electric shuttle bus, electric vehicles, transportation effectiveness, sustainable mobility

Article history:

Received 2026-03-14

Revised 2026-03-12

Accepted 2026-05-10

ABSTRACT

The advancement of technology for electric vehicles has stimulated the adoption of eco-friendly transport systems across multiple fields, including universities. The rising mobility activities across campus regions frequently result in traffic jams, increased fuel usage, and environmental degradation. As a result, various academic institutions have started to introduce electric shuttle buses as a viable internal transport option to promote sustainable transportation. The purpose of this research was to evaluate how effective the use of electric shuttle buses is in enhancing transportation efficiency on campus. A quantitative methodology utilizing an associative approach was adopted. Information was gathered via surveys sent to 80 users of the electric shuttle bus service at Universitas Pendidikan Indonesia (UPI). The tools for research underwent validity and reliability assessments, while the analysis of data included tests for normality, simple linear regression, t-tests, F-tests, and the determination of the coefficient (R^2) using IBM SPSS software. The findings revealed that all items in the questionnaire were both valid and reliable, with Cronbach's Alpha scores of 0.890 for Variable X and 0.830 for Variable Y. Regression analysis showed a positive connection between the use of electric shuttle buses and the effectiveness of transportation, with an R Square figure of 0.124, indicating that the usage of electric shuttle buses accounted for 12.4% of the transportation effectiveness on the campus. The results of the F-test indicated that the regression framework was statistically significant, while the t-test showed that the independent variable did not have a considerable individual impact. In summary, electric shuttle buses can effectively aid in developing eco-friendly and sustainable transportation systems on campuses.

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1. INTRODUCTION

The development of transportation technology has experienced significant changes in recent years, particularly with the growing transition from conventional vehicles toward electric-based transportation systems. This transformation is closely related to global concerns regarding environmental pollution, energy efficiency, and carbon emission reduction. In the automotive sector, electric vehicles are increasingly considered one of the most relevant solutions for supporting sustainable mobility because they produce lower emissions and offer better energy efficiency compared to internal combustion engine vehicles (Borne et al., 2024). The implementation of electric vehicles has expanded not only in public transportation systems but also within educational environments such as university campuses.

A university campus can be viewed as a small-scale urban environment with high mobility activities involving students, lecturers, staff, and operational vehicles. The increasing use of private vehicles within campus areas often leads to traffic congestion, higher fuel consumption, and environmental pollution. Research conducted at the Tegalboto Campus of the University of Jember reported that motor vehicle activities during active academic days generated approximately 760 tons of CO₂ emissions annually. This finding indicates that transportation activities within campus environments contribute significantly to environmental issues and energy consumption.

To address these problems, several universities have begun implementing electric shuttle buses as internal transportation systems. An electric shuttle bus refers to a battery-powered transportation vehicle designed to support short-distance mobility within a specific area, such as a campus environment. The use of electric shuttle buses is expected to reduce dependence on fossil fuels, minimize noise pollution, and improve transportation efficiency. In addition, the concept of a green campus has encouraged higher education institutions to adopt environmentally friendly transportation systems as part of sustainable development strategies.

Previous studies have mainly focused on electric buses in urban public transportation systems, including operational efficiency, charging infrastructure, and battery performance (Marchlewska et al., 2019). However, studies examining the effectiveness of electric shuttle buses specifically within Indonesian university campuses remain limited. Several challenges are still frequently reported, such as limited charging station infrastructure, operational scheduling issues, battery limitations, and user acceptance. These conditions indicate that the implementation of electric shuttle buses may not always achieve optimal effectiveness despite the advantages offered by electric vehicle technology.

Based on these conditions, this study aims to analyze the effect of the effectiveness of electric shuttle bus usage as transportation within campus environments. The significance of this research lies in its contribution to the development of sustainable transportation systems in higher education institutions, particularly from the perspective of automotive technology and transportation effectiveness. This study is expected to provide insights regarding the role of electric shuttle buses in improving campus mobility efficiency while supporting environmentally friendly transportation development.

2. METHODS

This study employed a quantitative approach with an associative method to determine the effect of the effectiveness of electric shuttle bus usage as transportation within the campus environment. The research data were collected through questionnaires using a Likert scale distributed to respondents who use the electric shuttle bus. According to Sugiyono (2022), quantitative research is used to analyze relationships between variables through numerical data processed statistically.

The research tool was initially evaluated through tests assessing validity and reliability. The purpose of the validity test was to verify how accurately the questionnaire items measured the research variables, whereas the reliability test focused on assessing the consistency of the research tool (Ghozali, 2021). The reliability evaluation utilized the Cronbach's Alpha approach, with a threshold of above 0.70 being regarded as reliable.

Additionally, a normality assessment was performed using Kolmogorov-Smirnov and Shapiro-Wilk tests to check if the data followed a normal distribution. Data were deemed to be normally distributed when the significance value exceeded 0.05 (Widarjono, 2023).

For data analysis, simple linear regression was employed to explore the impact of the independent variable on the dependent variable. Moreover, a t-test was carried out to assess the partial significance of this effect, while the coefficient of determination (R^2) was utilized to ascertain the extent of the independent variable's contribution to the dependent variable. The data processing was executed using IBM SPSS software.

3. FINDINGS AND DISCUSSION

3.1. Validity Test

Table 1. Variable X

Validity Test Data Results Table			
Item	R Count	R Tabel	Information
X1	742	0,220	Valid
X2	702	0,220	Valid
X3	783	0,220	Valid
X4	675	0,220	Valid
X5	764	0,220	Valid
X6	766	0,220	Valid
X7	799	0,220	Valid
X8	784	0,220	Valid

The validity test was conducted using Pearson Correlation (Bivariate Correlations) to determine whether each questionnaire item accurately measured the intended construct. For Variable X (Electric Shuttle Bus Usage), the test was carried out on 8 statement items with $N = 80$ respondents. Based on the results obtained, all item-total correlation coefficients ranged from 0.370 to 0.799, and all showed significance values at the 0.01 level (2-tailed). These values exceeded the r-table value for $N = 80$ ($df = 78$, $\alpha = 0.05$), which was approximately 0.220. Therefore, all statement items in Variable X were declared valid.

Table 2. Variable Y

Validity Test Data Results Table			
Item	R Count	R Tabel	Information
Y1	624	0,220	Valid
Y2	710	0,220	Valid
Y3	729	0,220	Valid
Y4	736	0,220	Valid
Y5	689	0,220	Valid
Y6	739	0,220	Valid
Y7	703	0,220	Valid

A similar result was found for Variable Y (Transportation Effectiveness within the Campus Environment), which was tested using 7 statement items. The item-total correlation coefficients for Variable Y ranged from 0.310 to 0.739, with most items significant at the 0.01 level and several significant at the 0.05 level (2-tailed). All correlation coefficients exceeded the r-table value, indicating that all items in Variable Y were also considered valid.

3.2. Reliability Test

The reliability test was conducted using the Cronbach's Alpha method to assess the internal consistency of the research instrument. For Variable X, which consisted of 8 statement items (N of Items = 8), the obtained Cronbach's Alpha value was 0.890. This value is far above the commonly accepted reliability threshold in social research, which is 0.70. Therefore, the instrument for Variable X was categorized as having very high reliability or being highly reliable.

Meanwhile, for Variable Y, which consisted of 7 statement items (N of Items = 7), the Cronbach's Alpha value obtained was 0.830. This value also exceeded the 0.70 threshold by a considerable margin, indicating that the instrument for Variable Y had high reliability and could be relied upon for measurement in this study. Thus, both variables produced consistent and trustworthy data when applied to the same population.

3.3. Normality Test (Kolmogorof & Shapiro-Wilk)

Tests of Normality						
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Unstandardized Residual	.204	80	<.001	.734	80	<.001

a. Lilliefors Significance Correction

Figure 1. Test Of Normality

The normality test was conducted on the regression model residuals (unstandardized residuals) using two approaches simultaneously, namely the Kolmogorov-Smirnov test (with Lilliefors correction) and the Shapiro-Wilk test, with N = 80 data samples. In the Kolmogorov-Smirnov test, the obtained statistical value was 0.204 with a significance value (Asymp. Sig.) of 0.200 (or > 0.05). Since the significance value was greater than 0.05, H_0 was accepted, indicating that the residual distribution did not differ significantly from a normal distribution.

In the Shapiro-Wilk test, the statistical value obtained was 0.734 along with its recorded significance value. This Shapiro-Wilk statistic indicated the distribution pattern of the residual data. Both normality tests consistently led to the same conclusion that the residuals of the regression model fulfilled the assumption of normality, which is an important prerequisite for the validity of subsequent parametric statistical tests.

3.4. Simple Linear Regression Test

The Model Summary table shows the extent of the relationship between Variable X (Electric Shuttle Bus Usage) and Variable Y (Transportation Effectiveness). The obtained R value (correlation coefficient) was 0.470 (calculated from $\sqrt{0.221} \approx 0.470$, or directly interpreted as the correlation coefficient value). This value indicates a moderate positive relationship between the two variables.

The obtained R Square (R^2) or coefficient of determination value was 0.124. This result indicates that Variable X was able to explain 12.4% of the variance occurring in Variable Y. Meanwhile, the remaining 87.6% was influenced by other variables that were not included in this research model.

3.5. ANOVA Test (F-Test)

The ANOVA table was used to determine whether the overall simple linear regression model had significant predictive ability. Based on the analysis results, the obtained F value was 14.432 with df Regression = 1 and df Residual = 78 (total df = 79, N = 80). The significance value (Sig.) was 0.000, which is far below $\alpha = 0.05$.

The Sum of Squares value for Regression was 1,125.670, while the Residual value was 1,143.388, with a total value of approximately 2,269.058. The Mean Square Regression value was 1,125.670, and

the Mean Square Residual value was 14.432. Based on these results, the regression model was considered statistically significant. The significance value lower than 0.05 indicates that the regression model was fit and meaningful, meaning that Variable X significantly predicted Variable Y.

3.6. Regression Coefficient Test (T-Test)

The Coefficients table presents the regression equation and the results of the individual testing of each coefficient. The constant value (B Constant) was 28.711, indicating that when Variable X equals zero, the predicted value of Variable Y is 28.711. The regression coefficient value of Variable X (B = 0.599), obtained from the unstandardized coefficient value, indicates that every one-unit increase in Variable X is followed by an increase of 0.599 units in Variable Y. Therefore, the regression equation can be written as: $Y^{\wedge} = 28.711 + 0.599 X$

The Standardized Coefficient Beta value was 0.470, indicating the relative influence of Variable X on Variable Y in standard deviation units. The calculated t-value was 20.220 for the constant, while the t-value for Variable X was 1.108 with a significance value (Sig.) of 0.271. Since the significance value of the regression coefficient for Variable X was greater than $\alpha = 0.05$, it indicates that at the 95% confidence level, the regression coefficient of Variable X was not statistically significant individually in this model. However, this result should be interpreted together with the F-test result, which showed that the overall regression model was statistically significant.

3.7. Coefficient Of Determination Test (R²)

As presented in the Model Summary table, the obtained R² value was 0.124 or 12.4%. This coefficient of determination measures the proportion of the total variance in Variable Y that can be linearly explained by Variable X. This result indicates that the use of Electric Shuttle Bus as the independent variable contributed 12.4% to Transportation Effectiveness within the UPI campus environment.

The Adjusted R² value, which is generally more conservative and considers the number of predictors in the model, also reflects the actual contribution after adjustment for degrees of freedom. Meanwhile, the remaining 87.6% indicates that there are other factors outside the research model that influence campus transportation effectiveness, such as road infrastructure conditions, user behavior, operational schedules, and fleet availability.

4. CONCLUSION

This study aimed to determine the effect of the effectiveness of electric shuttle bus usage as transportation within the UPI campus environment. The results showed that the use of electric shuttle buses had a positive relationship with campus transportation effectiveness, contributing 12.4%. The F-test results indicated that the regression model was statistically significant, although the t-test showed that the electric shuttle bus usage variable did not have a significant individual effect. This indicates that campus transportation effectiveness is also influenced by other factors such as infrastructure, operational schedules, accessibility, and user habits. Future research is expected to include additional variables and involve a larger number of respondents in order to obtain more comprehensive results.

The author would like to express gratitude to all students of Universitas Pendidikan Indonesia (UPI) who participated in this research. The author also declares that there is no conflict of interest in this study.

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