Acceptance Analysis of the Eco-Routing Feature in Google Maps from the Perspective of TAM and Environmental Concern

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Abstract

The transportation sector is one of the main contributors to global greenhouse gas emissions. Google Maps' Eco-Routing feature is a technological innovation that recommends environmentally friendly routes. This study aims to examine the factors influencing students' intention to use Eco-Routing by integrating the Technology Acceptance Model (TAM) with Environmental Concern and Trust. A quantitative approach used questionnaire of college students who actively use Google Maps through Likert and open-end questions, and analyzed using PLS-SEM. The results show that Perceived Ease of Use and Trust have a significant positive effect on Behavioral Intention to Use Eco-Routing, while Perceived Usefulness and Environmental Concern do not. These findings indicate a value–action gap between environmental awareness and technology usage. This study provides improvements in ease of use, system reliability, route accuracy, and contextual presentation of environmental impact, contributing to literature and practical insights into sustainable information systems for the development of eco-friendly navigation.

Keywords: eco-routing, Technology Acceptance Model, Environmental Concern, Trust, sustainable transportation, Google Maps

Introduction

The transportation sector is one of the main contributors to greenhouse gas emissions globally, which has a significant impact on climate change and environmental degradation. Research shows that air pollution generated by transportation, particularly PM2.5 and ozone, contributes to 315,000 to 385,000 premature deaths worldwide, with emissions growing by 105% between 1990 and 2019 (Han, 2025).

In Indonesia, the dominance of private vehicles is clearly evident from data compiled by the Central Statistics Agency, which shows that motorcycles account for more than 84% of all motorized vehicles (Badan Pusat Statistik, 2023). The high use of these vehicles has triggered an increase in carbon dioxide

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(CO_2), nitrogen oxide (NO_x), and particulate matter (PM2.5) emissions, with the transportation sector in Jakarta alone contributing 93% of CO emissions (Lestari et al., 2020). With the serious impacts on health and the environment, sustainable transportation practices are now a crucial need, including implementing energy efficiency.

Amidst the rapid development of digital technology, navigation applications such as Google Maps have introduced a strategic innovation in the form of an eco-routing feature. This feature is designed to recommend the most fuel-efficient travel routes by taking into account variables such as elevation and traffic density (Google Sustainability, 2021). The implementation of this feature has been proven to reduce fuel consumption by 10% to 25% and help reduce more than 2.9 million metric tons of carbon emissions by the end of 2023. Implementation of this feature has been shown to reduce fuel consumption by 10% to 25% and help reduce more than 2.9 million metric tons of carbon emissions by the end of 2023, which is relevant to sustainable transportation goals to reduce carbon footprints (Huang et al., 2018).

This research is very important to be conducted at this time, given the global momentum in reducing the rate of global warming requires active participation from all levels of society through the adoption of green technology. Students were chosen as the main research subjects because they are a generation of digital natives who have a very high level of technological literacy and mobility. As the group that most frequently uses navigation applications in their daily activities, students have great potential to become early adopters who will influence future environmentally friendly behavior trends. Understanding students' perspectives on sustainable technology is key to predicting the effectiveness of future emission reduction policies.

To analyze this phenomenon, the study uses the Technology Acceptance Model (TAM) framework to identify the factors that drive the intention to use these features. Based on this model, behavioral intention is influenced by perceived usefulness, such as fuel savings, and perceived ease of use in accessing the feature (Sakulajo et al., 2023).

In addition, psychological factors such as environmental concern and trust in the accuracy of AI-based routes also influence the acceptance of eco-routing features. While this feature offers various benefits, there are still challenges such as uncertainty about travel time estimates and limited user understanding, which pose challenges to its adoption (Shao & Xu, 2023). Therefore, this study aims to evaluate these driving and inhibiting factors to optimize the use of environmentally friendly features among the younger generation.

Literature Review

Sustainable transportation involves developing transport systems that reduce energy use and environmental pollution while ensuring equitable access to mobility. Its implementation requires transportation policies and planning strategies that balance environmental protection, social well-being, and economic considerations (Heidari et al., 2023). One form of sustainable transportation is eco-routing, which recommends routes with lower energy consumption and emissions compared to the fastest route, taking into account traffic, road conditions, and vehicle type (Huang et al., 2018; Jovanovic et al., 2024). The effectiveness of eco-routing depends on route accuracy and suitability to user needs.

TAM can be used in sustainable technology studies to explain technology acceptance through Perceived Usefulness and Perceived Ease of Use, which directly influence the intention to use the technology. Perceived usefulness is the belief that the technology provides tangible benefits to users. Perceived Ease of Use describes the ease of using the technology without excessive effort (Davis, 1989). In eco-routing, PU related to fuel efficiency and emission reduction influences the intention to use sustainable transportation technology (Huang et al., 2018). while PEOU relates to the ease of understanding and accessing features, thereby increasing the acceptance of everyday navigation technology (Jovanovic et al., 2024).

Environmental Concern reflects an individual's level of concern for environmental issues, which is often associated with the adoption of environmentally friendly technologies. However, concern does

not always lead to actual behavior due to a gap between values and actions (Barbett & Landmann, 2024). In this case, trust in eco-routing is also necessary to follow routes that are not always the fastest, which can strengthen intentions to use digital technology. Behavioral intentions also reflect the likelihood of using technology in the future. BIU is directly influenced by perceived usefulness and perceived ease of use, and trust plays a significant role in increasing intentions to use recommendation-based systems (Davis, 1989).

Methodology

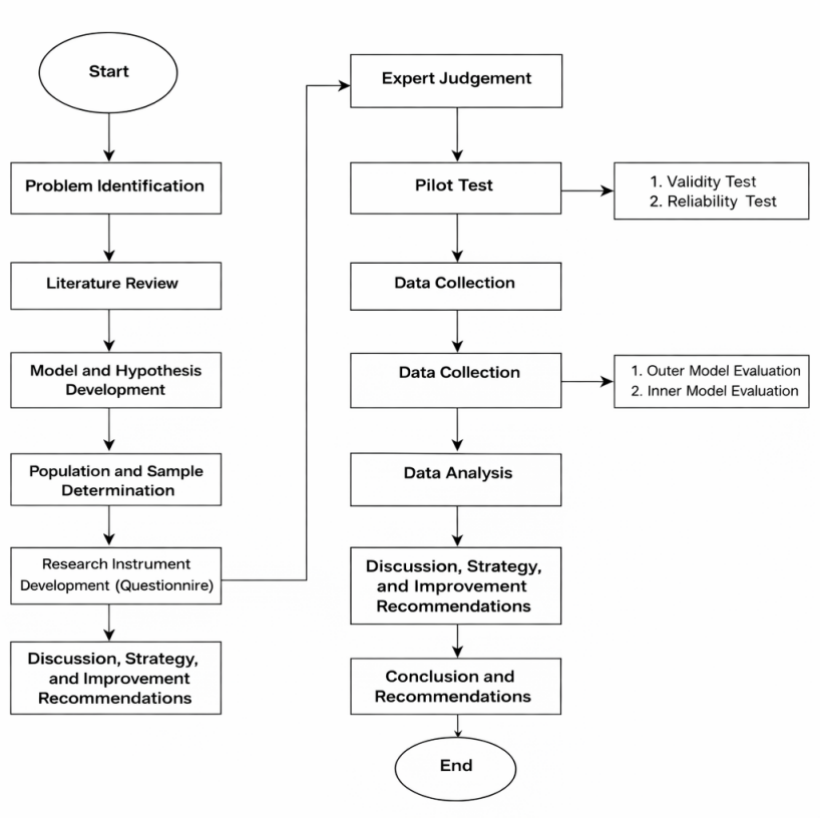


Figure 1. Method Flow

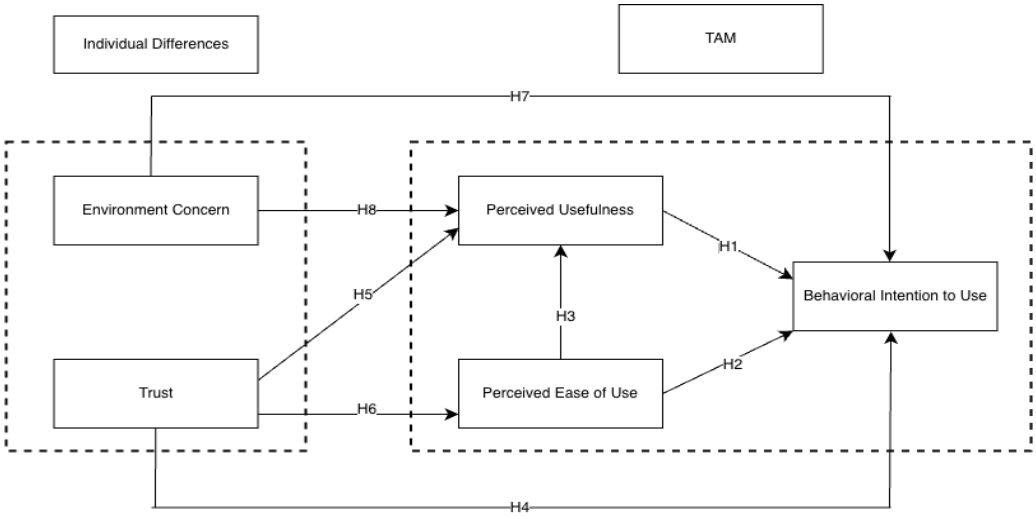


Figure 2. Research Model

This study is classified as non-implementation analytical research using a quantitative approach with quantitative data collection methods, in which a questionnaire survey was conducted to obtain feedback from respondents on both applications offering this efficient route feature. The research methodology can be seen in Figure 1.

The research model uses the Technology Acceptance Model (TAM) expanded with external variables, namely environmental concern and trust, to influence students' behavioral intention to use. This research model can be seen in Figure 2.

The researchers formulated eight main hypotheses based on the research model in Figure 2. The explanation related to the formulation of these eight hypotheses is as follows:

H1: Perceived Usefulness (PU) has a positive and significant effect on the Behavioral Intention to Use the Eco-Routing feature on Google Maps among students at Brawijaya University.

H2: Perceived Ease of Use (PEOU) has a positive and significant effect on Behavioral Intention to Use the Eco-Routing feature on Google Maps among students at Brawijaya University.

H3: Perceived Ease of Use (PEOU) has a positive and significant effect on Perceived Usefulness (PU) in the use of the Eco-Routing feature on Google Maps among students at Brawijaya University.

H4: Trust (T) has a positive and significant effect on Behavioral Intention to Use the Eco-Routing feature on Google Maps among students at Brawijaya University.

H5: Trust (T) has a positive and significant effect on Perceived Usefulness (PU) of the Eco-Routing feature on Google Maps among students at Brawijaya University.

H6: Trust (T) has a positive and significant effect on Perceived Ease of Use (PEOU)of the Eco-Routing feature on Google Maps among students at Brawijaya University.

H7: Environment Concern (EC) has a positive and significant effect on Behavioral Intention to Use the Eco-Routing feature on Google Maps among students at Brawijaya University.

H8: Environment Concern (EC) has a positive and significant effect on the Perceived Usefulness (PU) of the Eco-Routing feature on Google Maps among students at Brawijaya University.

The population in this study consisted of 62,415 active undergraduate students at Brawijaya University. The sampling technique employed was purposive sampling, which involved selecting respondents based on specific criteria relevant to the research objectives. Respondents were required to be familiar with and have used the eco-routing feature. Demographic information, including gender, age, and faculty, was collected through a questionnaire distributed via Google Forms.

The minimum sample size was determined using Slovin's formula, as presented in Equation 1,

$$n = \frac{N}{1 + Ne^2} \qquad \text{Equation (1)}$$

where n represents the minimum sample size, N represents the population size, and e represents the margin of error. Using a population size of 62,415 students and a margin of error of 10% ((e = 0.10)), the minimum sample size was calculated to be approximately 100 respondents.

The questionnaire consisted of Likert-scale items measuring the Technology Acceptance Model (TAM) variables and open-ended questions to collect suggestions regarding the feature under study. The questionnaire was evaluated by three experts, and Aiken's V was used to assess the content validity of the instrument. A pilot test involving 30 respondents was conducted to assess item validity using Pearson's correlation and reliability using Cronbach's alpha in SPSS. The collected data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM), involving outer and inner model evaluations performed with SmartPLS software. Responses to the open-ended questions were analyzed using thematic analysis.

Result

Respondent Demographic Results

The demographics of the respondents provide an overview of the characteristics of the research sample, which consisted of 101 people, all of whom met the specified criteria. Based on these results, the majority of respondents were aged 21–23 years (78.9%) and 18-20 years (21.1%), with the majority coming from the Faculty of FILKOM (29.4%). The complete results regarding the demographics of the respondents are presented in Table 1.

Table 1. Demographic Results of Respondents

Characteristic	Category	N	%
Age	18–20	21	21.1%
	21–23	80	78.9%
Faculty	FH	3	2.8%
	FEB	4	3.7%
	FIA	7	6.4%
	FP	4	3.7%
	FAPET	7	6.4%
	FT	6	5.5%
	FK	3	2.8%
	FPIK	4	3.7%
	FMIPA	5	4.6%
	FTP	12	11%
	FISIP	3	2.8%
	FIB	2	1.8%
	FKH	2	1.8%
	FILKOM	32	29.4%
	FKG	8	7.3%
	FIKES	7	6.4%

Results of Descriptive Statistical Analysis

Descriptive statistical analysis aims to present the distribution of data for each indicator representing a variable. The researchers present the results of the descriptive analysis in the form of scores (1 to 5), mode, median, mean, standard deviation, and variance. The results of the analysis provide an overview

of the positive trends of respondents for each variable in supporting the intention to use sustainable transportation through the Google Maps application.

Outer Model Test Results

Indicator reliability testing is used to assess how well the variance of each indicator can be explained by the relevant latent variable. The ideal outer loading value should be > 0.7 (Hair et al., 2021). Indicator reliability testing in this study was conducted twice because there were several indicators that had outer loading values < 0.7. The final test results showed that all indicators had outer loadings > 0.7, so they were declared valid and suitable for use in subsequent tests.

Internal consistency reliability test to assess the extent to which indicators in a variable have consistent relationships (Hair et al., 2021). This test was conducted using Cronbach's Alpha (CA) and Composite Reliability (CR), each of which must have a value > 0.7 for the variable to be declared reliable (Urbach & Ahlemann, 2010). The results of the internal consistency reliability test show that all variables have a value > 0.7, so they are declared reliable. Table 2 shows the results of the internal consistency reliability test in detail.

Table 2. Internal Consistency Reliability Results

Variable	CA	CR	Desc
Perceived Usefulness (PU)	0.789	0.878	Reliable
Perceived Ease of Use (PEOU)	0.857	0.903	Reliable
Environment Concern (EC)	0.782	0.902	Reliable
Trust (T)	0.855	0.902	Reliable
Behavioral Intention to Use (BIU)	0.847	0.908	Reliable

The convergent validity test aims to ensure that the indicators of a variable converge with each other compared to the indicators of other variables. This test uses the Average Variance Extracted (AVE) method with an AVE value that must be > 0.50 (Urbach & Ahlemann, 2010). The test results show that all variables obtained an AVE value > 0.5, thus meeting the validity criteria. Table 3 shows the detailed results of the convergent validity test.

Table 3. Convergent Validity Test Results

Variable	AVE	Desc
Perceived Usefulness (PU)	0.706	Valid
Perceived Ease of Use (PEOU)	0.699	Valid
Environment Concern (EC)	0.821	Valid
Trust (T)	0.697	Valid
Behavioral Intention to Use (BIU)	0.766	Valid

Discriminant validity testing is used to ensure that each variable is empirically different from other variables in the structural model (Hair et al., 2021). There are three methods for testing discriminant validity, namely Cross-loadings, Fornell-Larcker criterion, and Heterotrait-Monotrait Ratio (HTMT). The test results show that all indicators have the highest loading on their own variables, the AVE square root value of each variable is > its correlation with other variables, and all HTMT values are < 0.90. Thus, all variables meet discriminant validity and are eligible to proceed to inner model testing.

Inner Model Test Result

The coefficient of determination test uses the R-square value to measure the extent to which independent variables explain the variance in dependent variables (Tanlim & Ruslim, 2024). The interpretation of the R-square value consists of three criteria, namely a value of 0.670 is considered substantial, a value of 0.333 is considered moderate, and a value of 0.190 is considered weak (Urbach & Ahlemann, 2010). The test results show that the independent variables have a fairly good ability to explain the variance in each dependent variable. The Perceived Ease of Use (PEOU) variable can be explained in the moderate category (44.5%), and Perceived Usefulness (PU) can also be explained in the moderate category (49.6%) by the exogenous variables. Meanwhile, Behavioral Intention to Use (BIU) can be explained in the moderate category (57.2%) by the variables included in the research model. Thus, this research model is able to describe the influence of factors affecting users' intention to use the eco-routing feature. Table 4 presents the detailed results of the coefficient of determination test.

Table 4. Results of the Coefficient of Determination Test

Variable	R-Square	Desc
Behavioral Intention to Use (BIU)	0.572	Moderat
Perceived Ease of Use (PEOU)	0.445	Moderat
Perceived Usefulness (PU)	0.496	Moderat

Test path coefficients to assess the strength and direction of influence between variables in the structural model. The testing was conducted using the bootstrapping method with Smart-PLS. The hypothesis was considered valid if the path coefficient value was between -1 and +1. The relationship between variables was considered significant if the t-statistic value was > t-table (1.96) and the p-value was < 0.05 (5%) (Hair et al., 2021). The test results show that 8 research relationships are positive and significant ($t > 1.96$, $p < 0.05$), while 2 research relationships are insignificant because the t-statistic and p-value values do not meet the specified criteria ($t < 1.96$, $p > 0.05$). These results also prove that there is sufficient evidence to accept 8 research hypotheses and insufficient evidence to accept 4 research hypotheses based on the hypotheses made in the research model. Table 5 shows the detailed results of the path coefficients test.

Table 5. Path Coefficient Test Result

Path	Path Coef.	T-Statistic	P-values	Hypothesis
PU→BIU	0.096	1.092	0.275	H1 Rejected
PEOU→BIU	0.291	3.235	0.001	H2 Accepted
PEOU→PU	0.605	5.639	0.000	H3 Accepted
T→ BIU	0.534	4.865	0.000	H4 Accepted
T→PU	0.116	0.1038	0.299	H5 Rejected
T→ PEOU	0.667	10.849	0.000	H6 Accepted
EC→BIU	-0.106	1.256	0.209	H7 Rejected
EC→PU	0.027	1.255	0.798	H8 Rejected

Effect size testing uses the f-square value to assess the magnitude of the substantial influence of independent variables on dependent variables in structural models. The interpretation of the f-square value is divided into three categories, namely 0.02 for a low effect, 0.15 for a moderate effect, and 0.35

for a large effect (Urbach & Ahlemann, 2010). The test results show that 8 relationships meet the criteria and 2 relationships have no effect on the model ($f^2 < 0.02$), namely the influence of attitude and subjective norm on the intention to sell used items online. Overall, 4 relationships have a low effect, 2 relationships have a moderate effect, and 2 other relationships show a large effect. Thus, the model is able to provide a clear picture of the strength of each variable in influencing structural relationships. Table 6 presents the effect size test results in detail.

Table 6. Effect Size Test Result

Path	F-square	Desc
PU→BIU	0.011	No Effect
PEOU→BIU	0.077	Low
PEOU→PU	0.396	High
T→ BIU	0.261	Mid
T→PU	0.011	No Effect
T→ PEOU	0.803	High
EC→BIU	0.013	No Effect
EC→PU	0.001	No Effect

The predictive relevance test uses the Q-square value to assess the extent to which the research model is able to accurately predict latent dependent variables. This test is conducted through PLS predict in SmartPLS software. A model is said to have good predictive relevance if the Q-square value is > 0 (Urbach & Ahlemann, 2010). The results of the predictive relevance test show that all dependent variables have a Q-square value > 0.

Discussion

Factors that Encourage Users to Use the Eco-Routing Feature on the Google Maps Application

The results of the study indicate that Perceived Ease of Use (PEOU) has a positive and significant effect on students' intention to use the Eco-Routing feature ($t=3.235$; $p=0.001$; $f^2=0.077$). This finding supports the study by Li & in (2022), but differs from Maghfiroh et al. (2023), who found a negative effect on other platforms. Analysis of open-ended questions reinforces this, with 69.4% of respondents feeling that this feature is easy to use because it is directly integrated with the familiar Google Maps interface, thereby minimizing cognitive load in daily navigation.

The Trust (T) variable was identified as the most dominant predictor of usage intention ($t=4.865$; $p=0.000$; $f^2=0.261$). Trust in the accuracy of the system and the credibility of Google Maps were the main foundations for students to adopt environmentally friendly routes. These findings are in line with Sakulajo et al. (2023) and supported by qualitative data showing that 74.1% of respondents felt they could contribute to reducing emissions without sacrificing comfort, confirming that system reliability is key to behavioral change.

Factors that Prevent Users from Using the Eco-Routing Feature on the Google Maps Application

Conversely, Perceived Usefulness (PU) was not found to have a significant effect on usage intention ($t=1.092$; $p=0.275$; $f^2=0.011$), thus rejecting H1. In line with (Phuangsuwan et al., 2024), the ecological benefits of this feature are not yet perceived as a major functional advantage over the fastest route.

Qualitative data showed that 43.5% of respondents considered the Eco-Routing route to be less than optimal in terms of time, so based on Task-Technology Fit Theory (Goodhue & Thompson, 1995), this technology does not yet fully meet users' practical needs for efficiency.

The Environmental Concern (EC) factor also did not show a significant effect on usage intention or perceived usefulness ($t=1.256$; $p=0.209$; $f^2=0.013$). This phenomenon indicates the existence of a value–action gap, where students' environmental concerns do not automatically translate into behavior to use the feature of Barbett & Landmann (2024) that pro-environmental behavior is multidimensional; without the support of convenience and direct practical benefits, environmental awareness alone is not strong enough to encourage the sustainable adoption of Eco-Routing.

Recommendations and Improvements to Make the Eco-Routing Feature on Google Maps More Acceptable to Users

The strategy for improving the perceived usefulness of the Eco-Routing feature focuses on improving functional performance, referring to Task–Technology Fit (Goodhue & Thompson, 1995), which emphasizes the alignment of technology with the user's main task, namely travel efficiency. The perception of more circuitous routes indicates the need for vehicle profile personalization to improve route accuracy, in line with the principle of personalization in User Experience Design. Furthermore, based on the Value-Based Adoption Model (Kim et al., 2007), the benefits of Eco-Routing need to be communicated in utilitarian terms, such as estimated fuel cost savings, to reinforce its usefulness and reduce the perceived trade-off in travel time.

The Environmental Concern handling strategy focuses on reducing the value–action gap, considering that environmental concerns do not directly encourage the use of Eco-Routing, in line with Barbett & Landmann (2024). A digital green nudging approach based on Nudge Theory (Thaler & Sunstein, 2009) is recommended through emissions feedback and social reference, as well as increased discoverability of features through contextual orientation. This strategy aims to transform abstract environmental concerns into concrete and repeated actions in the use of Eco-Routing.

Conclusion

This study concludes that Perceived Ease of Use (PEOU) and Trust (T) are the main drivers of students' intention to use the Eco-Routing feature. Low cognitive load ease of access and high trust in system reliability are the main foundations for adopting this technology. This shows that the integration of familiar features and route accuracy are more decisive in user interest than mere functionality.

Conversely, Perceived Usefulness (PU) and Environmental Concern (EC) were not found to be significant. A value–action gap was found, whereby environmental concern does not automatically trigger usage if the practical benefits (time efficiency) do not exceed those of the fastest route. Users still prioritize travel comfort and speed over abstract ecological benefits.

As a development strategy, Eco-Routing must transform into behavior-shaping technology by optimizing route algorithms to remain competitive in terms of time. Improvements need to focus on transparency of real environmental impacts and strengthening intuitive interfaces. By balancing functional efficiency and system trust, this feature can shift from being a mere add-on to an integral part of sustainable transportation habits. Further research needs to expand the model by integrating behavioral and system quality variables such as habit, system quality, and perceived risk. In addition, the generalization of results can be improved by involving more heterogeneous respondents, such as the general public or workers with high mobility. The use of mixed methods and comparative studies between environmentally friendly navigation platforms is highly recommended to explore user experiences more comprehensively and evaluate the effectiveness of cross-application features.

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