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Analysis of Green Moral Obligation on Intention to Adopting Electric Vehicles (EV) with Openness to Changes and Self Enhancement as Moderating Variables

Sugeng Purwanto[1]*, Hesty Prima Rini[2]
University of Pembangunan Nasional Veteran Jawa Timur, Surabaya
Corresponding Author: Sugeng Purwanto sugengpurwanto.mnj@upnjatim.ac.id

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ABSTRACT

The purpose of this research is to predict and analyze the influence of Green Moral Obligation on consumers' intention to adopt EV (electric vehicle)s in Indonesia, with Self Enhancement and Openness to Change as moderating variables. The research subjects are driving consumers distributed across the entire territory of the Republic of Indonesia, with a sample size of 250 respondents distributed through online questionnaires using convenience sampling technique. The data analysis tool used SEM-PLS (SEM-Partial Least Squares). The results of this research indicate that the Green Moral Obligation variable has a significant impact on the intention to adopt electric vehicles, and the Self Enhancement and Openness to Change variables have been proven to positively moderate the relationship between Green Moral Obligation and the intention to adopt electric vehicles. This research is expected to be used for policy development in the automotive industry, as a reference for academics and researchers for further research or theory development.

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INTRODUCTION

The emergence of environmental degradation issues has often come to the forefront in recent years, as a consequence of continuous and uncontrolled emissions of harmful atmospheric pollutants through various human activities. The consumption of fossil fuels by industries and transportation systems is considered the main reason (Asadi et al., 2020; Ju et al., 2019).

Different studies have given considerable attention to vehicle-induced pollution, which has been widely analyzed due to its serious environmental outcomes. The global increase in individual vehicle ownership has been accompanied by significant energy consumption, contributing to the production of more greenhouse gases (Xu et al., 2019) and causing serious issues related to energy security and environmental conservation (Huang and Ge, 2019). As indicated by statistics from the International Energy Agency (IEA), an estimated one million vehicles have recently been put into use worldwide, with daily consumption reaching approximately 60 million barrels per day (nearly 70% of total oil production); almost 36 million barrels of daily oil consumption are associated with private vehicles, leading to emissions of 14 million tons of carbon dioxide (Sang and Bekhet, 2015). Consequently, replacing conventional vehicles with renewable energy vehicles can be seen as a promising solution (Tu and Yang, 2019).

In this context, electric vehicles (EVs) are expected to reduce negative impacts on the environment and help preserve scarce non-renewable fuel reserves throughout their lifecycle (Liu et al., 2019). EVs are considered an effective alternative for sustainable urban transportation by reducing oil dependence and subsequent air pollution, leading to significant health and environmental benefits (Wu et al., 2019). Previous studies have shown that EVs can result in a 30-50% reduction in carbon dioxide emissions and a 40-60% improvement in fuel efficiency compared to conventional fuel-dependent vehicles (Liu et al., 2019).

The deployment of EVs has become a focal point by setting targets and implementing policies, thereby enabling EVs to become a crucial component of future vehicles (Buekers et al., 2014). Currently, there has been an increase in EV registrations worldwide, with Indonesia, a country heavily reliant on energy sources, focusing on improving its energy productivity and striving to reduce its carbon emissions.

According to the Air Quality Live Index (AQLI), the air quality conditions in Indonesia have been consistently deteriorating over the past two decades and currently rank it as the 20th country with the worst air quality in the world. The World Health Organization (WHO) sets the annual average concentration of air pollutants or particulate matter (PM2.5) not to exceed 10 micrograms per cubic meter. PM2.5 consists of air particles that are smaller than 2.5 microns, which is 30 times smaller than a human hair. In regions with high pollutant levels, these particles can reduce visibility and pose a threat to human health.

These serious issues must be addressed to meet natural emission reduction goals, considering the fact that transportation consumes a significant portion of fossil fuels, and its contribution to carbon emissions is higher than in other sectors. As a result, electric vehicles (EVs) should be a potential future alternative to address the energy crisis and environmental concerns. This energy-efficient technology would be highly beneficial in reducing emissions.

THEORETICAL REVIEW

Since EVs are relatively new technology in Indonesia, and electric vehicles are also relatively new in the Indonesian automotive industry. At the same time, this technology has recently been introduced to many consumers who have decided to adopt it. On the other hand, in developing countries, including Indonesia, where the government has recognized the benefits of adoption, steps have been taken to promote its use.

While it is crucial to adopt electric vehicles (EVs) for issues related to environmental sustainability and a sustainable transportation system, individual consumer acceptance must also be taken into account to further the adoption. The adoption of electric vehicles seems to be primarily linked to consumer choice, but this acceptance remains an alternative and a behavioral change. As a result, in this research, it is essential to identify the factors that drive their adoption at the individual level (Liu et al., 2019).

Several studies have explored the factors influencing EV adoption from a customer perspective. For example, Wu et al. (2019) investigated the impact of societal acceptance of autonomous electric vehicles. Their research findings indicated that environmental concern significantly correlates with people's intention to use autonomous EVs. Moons and De Pelsmacker (2012) identified determinants of consumer intention to use EVs from the Theory of Planned Behavior (TPB) perspective. Their results showed that attitude is the strongest determinant of consumer intent to purchase EVs, followed by subjective norm factors.

Several researchers have investigated the antecedents of individual intentions to adopt electric vehicles (EVs) from two perspectives. The mainstream emphasizes that the likelihood of EV adoption depends on the perception of instrumental or moral attributes. For example, Barbarosa (2017) states that Green Moral Obligation (GMO) is a variable that leads to the Adoption Intention (AI) of EVs. Green moral obligation is defined as a term that refers to an individual's or a group's moral responsibility or ethical obligation to act or take steps that support environmental preservation and sustainability. It reflects awareness of the negative impacts of human activities on the environment and the feeling that individuals or groups have a responsibility to do something to reduce those impacts. In this context, "green" refers to sustainability and environmentally friendly practices. In Barbarossa's research (2017), it is mentioned that the acceptance of EVs can be moderated by the variables of Self Enhancement (SE) and Openness to Change (OTC). Self Enhancement is defined as a behavior that relates to an individual's tendency to present themselves more positively or environmentally friendly when faced with environmental issues or when they engage in actions that support sustainability. It is one of the psychological aspects that can influence individual environmental behavior. On the other hand, Openness to Change is defined as behavior that relates to the extent to which individuals or society, in general, are willing and open to accepting changes in technology and transportation preferences, such as transitioning from internal combustion engine cars (fossil fuel-powered cars) to electric cars. This is one of the psychological factors that can affect the level of acceptance and adoption of electric vehicles.

Based on the above description, the objective of this research is to predict and analyze the influence of Green Moral Obligation on consumer intentions to adopt electric vehicles in Indonesia, with Self Enhancement and Openness to Change as moderating variables.

METHODOLOGY

The conceptual framework for this research was obtained from literature reviews and previous research as shown in the following figure :

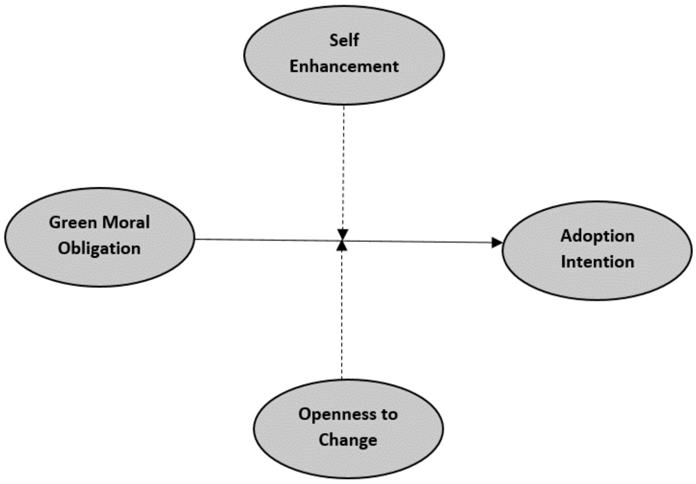

Figure 1. Research Conceptual Framework

This research is research using quantitative methods, with the aim of testing the influence of exogenous variables on endogenous variables directly and testing moderating variables with hypotheses including:

Hypothesis 1. Green Moral Obligation has a positive effect on Intention to Adopt Electric Vehicles in Indonesia.

Hypothesis 2. Openness To Changes moderates the relationship between Green Moral Obligation and Intention to Adopt Electric Vehicles in Indonesia.

Hypothesis 3. Self-Enhancement moderates the relationship between Green Moral Obligation and Intention to Adopt Electric Vehicles in Indonesia.

The population in this study consists of consumers of two-wheeled and four-wheeled vehicles spread across the territory of the Republic of Indonesia. The sample in this research uses Non-Probability sampling with a convenience sampling technique, which is based on the availability of elements and the ease of obtaining responses from respondents. Studies that use Structural Equation Modeling (SEM) analysis require a minimum of 5 to 10 times the number of indicators (Hair et al., 2010). In this study, the researcher used a sample of 250 respondents. Data collection was conducted through a survey method, and data were obtained by distributing questionnaires to respondents both online and offline. The analysis technique used is Partial Least Squares (PLS) because this research is both predictive and exploratory and aims to build a model to understand user behavior. It is believed that the PLS approach is more suitable for the current research (Chin, 1998b). The general stages in processing PLS data include:

1. Designing the Structural Model (Inner Model)
2. Designing the Measurement Model (Outer Model)
3. Converting Path Diagram into Equation System
4. Estimation: Weight, path analysis, and factor loading
5. Evaluating Goodness of Fit
6. Hypothesis Testing (Resampling Bootstraping)

RESULTS

Analysis using SmartPLS software obtained the following results:

Convergent Validity Test

Convergent Validity aims to measure the alignment between the indicators of measurement outcomes of a variable and the theoretical concept that explains the presence of those indicators of the variable. The Convergent Validity test can be evaluated in three stages, which are by examining outer loadings, composite reliability, and Average Variance Extracted (AVE).

From Table 1, you can see the estimated loading factor values for each indicator measuring the construct. These estimation results indicate that all indicators have met good validity criteria as they have loading factors greater than 0.50. Since the validity test with outer loadings has been met, the measurement model has the potential for further testing.

Table 1. *Outer Loading*

	AI	GMO	Moderating Effect 1	Moderating Effect 2	OTC	SE
AI1	0,811					
AI2	0,865					
AI3	0,931					
GMO*OTC				2,003		
GMO*SE			0,910			
GMO1		0,661				
GMO2		0,825				
GMO3		0,723				
OTC1					0,797	
OTC2					0,766	
OTC3					0,900	
SE1						0,839
SE2						0,900

Source : output smart-PLS (2023).

The next examination of Convergent Validity is reliability. Reliability is defined as the ability of instrument indicators to produce consistent (consistent) values in each research activity. The level of reliability is measured by the values of composite reliability and AVE (Average Variance Extracted). The composite reliability value assumes that all indicators have unequal weighting. A composite reliability value greater than 0.7 indicates that the construct has reliable reliability. The composite reliability output obtained from the PLS Algorithm Report SmartPLS is presented in Table 2 below.

Table 2. Uji *Composite reliability*

	Composite Reliability
AI	0,903
GMO	0,782
Moderating Effect 1	1,000
Moderating Effect 2	1,000
OTC	0,862
SE	0,861

Sumber : output smart-PLS (2023).

From Table 2, the results of the composite reliability test indicate that all constructs are reliable or have acceptable composite reliability values. This is because the composite reliability values for each construct are greater than 0.7. Another measurement used to test reliability is the Average Variance Extracted (AVE). The AVE value is intended to measure the level of variance of a construct component that is collected from its indicators while adjusting for the error level. Testing with the AVE value is more critical than composite reliability. The minimum recommended AVE value is 0.50. The AVE output obtained from the PLS Algorithm Report SmartPLS is presented in Table 3.

Table 3 *Average Variance Extracted* (AVE)

	Average Variance Extracted (AVE)
AI	0,758
GMO	0,547
Moderating Effect 1	1,000
Moderating Effect 2	1,000
OTC	0,677
SE	0,757

Source : output smart-PLS (2022).

From table 3 the test results with AVE values show that all constructs have potential reliability for further testing. This is because the AVE value for all constructs is greater than 0.50.

Discriminant Validity Test

Discriminant validity is the degree of differentiation of an indicator in measuring instrument constructs. To test discriminant validity, you can perform cross-loading checks, which involve comparing the correlation coefficient of an indicator with its associated construct (loading) to the correlation coefficient with other constructs (cross-loading). The correlation coefficient of an indicator should be higher with its associated construct than with other constructs. A higher value indicates that an indicator is more suitable for explaining its associated construct compared to other constructs. Another way to test discriminant validity is by comparing the correlation between variables with the square root of AVE (√). The measurement model has good discriminant validity if the √AVE of each variable is greater than the correlation with other variables. SmartPLS, as a tool for PLS-SEM analysis, includes tests for discriminant validity. The assessment of discriminant validity generated by SmartPLS uses the Fornell-Larcker Criterion and cross-loadings criteria. The following are the cross-loading results obtained from the PLS Algorithm Report SmartPLS presented in Table 4.

Table 4. *Cross Loading*

	AI	GMO	Moderating Effect 1	Moderating Effect 2	OTC	SE
AI1	0,811	0,471	-0,199	-0,374	0,419	0,366
AI2	0,865	0,374	-0,263	-0,236	0,386	0,446
AI3	0,931	0,396	-0,100	-0,230	0,554	0,492
GMO * OTC	-0,318	-0,738	0,526	1,000	-0,616	-0,164
GMO * SE	-0,210	-0,336	1,000	0,526	-0,361	0,111
GMO1	0,379	0,661	-0,255	-0,441	0,263	0,060
GMO2	0,315	0,825	-0,134	-0,650	0,545	-0,018
GMO3	0,339	0,723	-0,339	-0,547	0,465	0,106
OTC1	0,263	0,423	-0,228	-0,473	0,797	0,080
OTC2	0,306	0,304	-0,156	-0,247	0,766	0,335
OTC3	0,592	0,592	-0,414	-0,678	0,900	0,235
SE1	0,384	0,130	0,148	-0,203	0,221	0,839
SE2	0,481	0,006	0,057	-0,095	0,245	0,900

Source : output smart-PLS (2023).

It can be observed that indicators AI1, AI2, and AI3 have higher correlations with their associated construct, Adoption Intention (AI), with correlation coefficients of 0.811, 0.865, and 0.931, respectively. The correlation coefficients of these indicator blocks have values greater than those with other constructs.

Indicators GMO1, GMO2, and GMO3 also have higher correlations with their associated construct, Green Moral Obligation (GMO). Similarly, other construct indicators have higher correlations with their associated constructs compared to other constructs, indicating good discriminant validity.

The next examination involves comparing the correlation between variables with the √AVE. The measurement model has good discriminant validity if the √AVE for each variable is greater than the correlations with other variables. The √AVE values can be seen from the output of the Fornell-Larcker Criterion in SmartPLS, presented in the following table.

Tabel 5. *Fornell-Larcker Criterion*

	AI	GMO	Moderating Effect 1	Moderating Effect 2	OTC	SE
AI	0,870					
GMO	0,473	0,740				
Moderating Effect 1	-0,210	-0,336	1,000			
Moderating Effect 2	-0,318	-0,738	0,526	1,000		
OTC	0,525	0,568	-0,361	-0,616	0,823	
SE	0,502	0,070	0,111	-0,164	0,269	0,870

Source : output smart-PLS (2023).

The way to interpret the Fornell-Larcker Criterion table in Table 4.10 is based on rows. It can be seen that the √AVE value for the Adoption Intention variable is 0.870, whereas the highest correlation value of the Adoption Intention variable with other variables is only 0.473. Therefore, the √AVE of the Adoption Intention variable is greater than the correlation of Adoption Intention with other variables. Similarly, for other variables that show √AVE values greater than the inter-variable correlations, the criterion for discriminant validity with √AVE has been met.

Structural Model Evaluation

The structural model evaluation aims to test the presence or absence of influence between constructs, R Square, and the indirect effects between constructs. The structural model is evaluated using p-values to determine the significance of the coefficients of the structural path and R Square to assess whether independent latent variables have a substantive influence on dependent latent variables.

Evaluation of R Square Values

R Square values are used to explain the influence of exogenous variables on endogenous variables. R Square values are obtained from the PLS Algorithm Report SmartPLS and can be seen in Table 6.

Tabel 6. *R Square*

	R Square
Adoption Intention	0,549

Source : output smart-PLS (2023).

The R Square value for the Adoption Intention variable is 0.549, which means that the variables Green Moral Obligation, Self Enhancement, and Openness to Change, when considered together, can explain 54.9% of their influence on the Adoption Intention variable, while the remaining 45.1% is explained by other variables outside the researched model.

Next, for the assessment of goodness of fit in this study, it can be determined from the Q-Square value. The Q-Square value has the same meaning as the coefficient of determination (R-Square) in regression analysis, where a higher Q-Square indicates a better fit of the model with the data. The calculation result for the Q-Square value is as follows:

Q-Square = $1 - (1 - R_1^2)(1 - R_2^2) \ldots (1 - R_p^2)$

= 1 – [(1 – 0,549)
= 0,549

Based on the above calculation, the Q-Square value obtained is 0.549. This indicates that the proportion of data variability explained by the research model is 54.9%. The remaining 45.1% is explained by factors outside the scope of this research model. Therefore, based on these results, it can be stated that this research model has a good goodness of fit.

Evaluate the Significance of the Path Relationship to the Research Hypothesis

To conclude whether the hypotheses are accepted or rejected, the p-value at a significance level of α = 5% or 0.05 is used. If the p-value is < 0.05, then H_0 is rejected, indicating that there is an influence. Conversely, if the p-value is > 0.05, then H0 is accepted, indicating no influence. Below are the results of the structural model evaluation obtained from the Bootstrapping Report SmartPLS, presented in Table 7.

Table 7. *Path Coefficients T-Values, P-Values*

	Path Coefficients	T Statistics	P Values	Explanation
Green Moral Obligation -> Adoption Intention	0,529	4,641	0,000	Accepted
Moderating Effect 1 -> Adoption Intention	0,234	2,700	0,007	Accepted
Moderating Effect 2 -> Adoption Intention	0,221	3,338	0,001	Accepted

Source : output smart-PLS (2023).

The bootstrapping output for evaluating direct effects by looking at the path coefficient values and P-values is presented in the following figure.

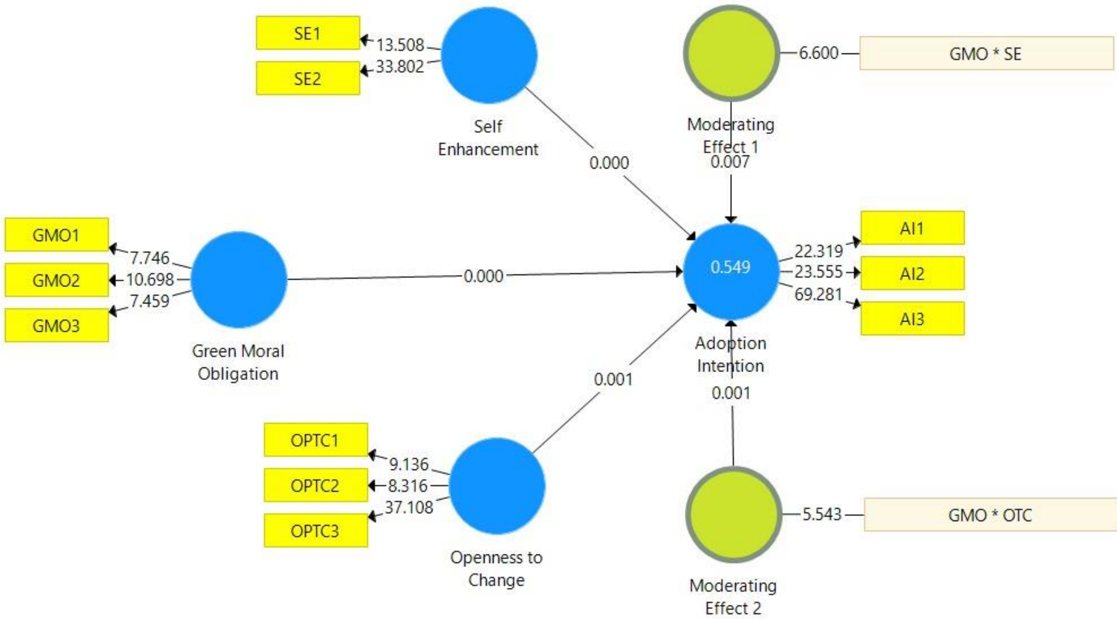

Figure 2. output bootstraping

DISCUSSION

The Effect of Green Moral Obligation toward Adoption Intention

Based on the data analysis results, it is shown that Green Moral Obligation has a positive and significant influence on Adoption Intention. This is indicated by a path coefficient of 0.613 with a P-Value (significance) of 0.000 < 0.05, meaning that the contribution of the test between these two variables resulted in a coefficient of 61.3%. This proves that Green Moral Obligation, as a Green Person, plays a significant role in the intention to adopt electric vehicles. It indicates that someone with a high environmental consciousness is more likely to have a higher level of concern for the environment, which is in line with previous research that has found a positive influence of Green Moral Obligation on Adoption Intention (Alvin, n.d.; Bastian Adhitama, n.d.; Tung et al., 2017).

Self Enhancement Moderates the Influence of Green Moral Obligation on the Adoption Intention of Electric Vehicles

Based on the data analysis results, it is shown that Self Enhancement, which involves improving one's capabilities and portraying oneself positively in environmental preservation, acts as a variable that can moderate the relationship between Green Moral Obligation and the Adoption Intention of electric vehicles. This moderation effect is evident and can be described as having a positive influence. It is indicated by a path coefficient of 0.234 with a P-Value (significance) of 0.007 < 0.05, which is considered significant. This suggests that when individuals exhibit behavior reflecting a moral responsibility or ethical obligation to act in ways that support environmental preservation and sustainability, they are more likely to be inclined to easily accept or adopt electric vehicles.

Openness To Change Moderates The Influence Of Green Moral Obligation On The Adoption Intention Of Electric Vehicles

Based on the data analysis results, it is evident that Openness to Change moderates the relationship between Green Moral Obligation and Adoption Intention of electric vehicles, as indicated by a path coefficient of 0.221 with a P Value (significance) of 0.00` < 0.05, which is considered significant. This implies that when individuals have a tendency to be willing and open to accepting changes in technology or transportation preferences, it strengthens their moral responsibility or ethical obligation to adopt electric vehicles or choose environmentally-friendly transportation options as a means of protecting the environment and reducing the negative impact on the planet Earth.

CONCLUSIONS AND RECOMMENDATIONS

The Green Moral Obligation variable has a significant impact on the intention to adopt electric vehicles, and the Self Enhancement and Openness to Change variables have been proven to positively moderate the relationship between Green Moral Obligation and the intention to adopt electric vehicles.
From the results of this research analysis, researchers can provide the following suggestions:

1. To shift society from using fossil fuels to electric vehicles, there is a need to enhance environmental awareness campaigns and education on the importance of being environmentally conscious individuals, starting from early education to higher levels of education.
2. Encouraging the automotive industry to boost the promotion of electric vehicle usage by offering more economically viable and affordable electric product options, thus increasing people's interest in transitioning to electric vehicles.

FURTHER STUDY

For future researchers, the findings of this study can serve as a foundation for further research on public acceptance of electric vehicles, aiming to conserve the environment and provide benefits for future generations.

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