DIJEMSS: Dinasti International Journal of Education Management and Social Science
E-ISSN: 2686-6331
P-ISSN: 2686-6358
https://dinastipub.org/DIJEMSS dinasti.info@gmail.com +62 811 7404 455
DINASTI PUBLISHER
DOI: https://doi.org/10.38035/dijemss.v7i1

The Effect of the Green Shipping Campaign and Greenhouse Gas Emission Reduction Policy on Electric Vessel Procurement Mediated by Shipowner Perceptions: A Case Study at PT Pertamina Trans Kontinental (2025)

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Abstract: Maritime transportation activities contribute to Greenhouse Gas (GHG) emissions. IMO adopted MARPOL Annex VI to prevent air pollution from ships. Several countries in the world have initiated the use of electric ships as a form of campaign. The Indonesian government also shows its commitment to reducing GHG emissions and encourages the use of electric transportation in the transportation sector. The government issued various policies supporting the use of electric transportation. However, electric transportation in Indonesia is still dominated by the land sector. The adoption of electric ships for some shipowners is still only a discourse that has not been realized, one of which is PT Pertamina Trans Kontinental (PTK). This study aims to analyze the influence of green shipping campaigns and GHG emission reduction policies on the procurement of electric ships mediated by shipowner perceptions. The method used is mixed methods with PLS-SEM analysis to 97 respondents followed by interviews with 5 informants determined by purposive sampling. The results show that green shipping campaigns have a significant effect on shipowner perceptions, and GHG emission policies have a significant effect on the procurement of electric ships. However, the relationship between green shipping campaigns and ship procurement and GHG reduction policies on perceptions is equally insignificant. Shipowner perceptions significantly mediated the effect of campaigns on electric ship procurement, but not the effect of GHG emission reduction policies. The implementation of electric ships in PTK is hampered by technical, operational, economic, regulatory, and sustainability awareness factors.

Keywords: Green Shipping, Greenhouse Gas Emissions, Electric Ships, Shipowner Perception, SEM-PLS, Mixed Methods

INTRODUCTION

Transportation plays a crucial role in supporting development and improving public welfare. A good transportation system facilitates access to resources and markets, boosting economic productivity and efficiency. Transportation accelerates the mobility of people and goods and contributes to equitable regional development. Furthermore, transportation supports connectivity between regions and facilitates urban growth through integrated planning. Therefore, transportation is not only a means of transportation, but also a key foundation for sustainable development (Nur et al., 2021).

While maritime transportation is more operationally efficient, it also faces challenges in terms of sustainability and environmental impact. Most ships worldwide still rely heavily on fossil fuels such as Marine Fuel Oil (MFO), Marine Diesel Oil (MDO), or High Speed Diesel (HSD) to power conventional engines, which produce high carbon emissions.(Reusser & Pérez Osses, 2021)Despite extensive research and innovation into alternative fuels and environmentally friendly ships, the reality is that the majority of ships still use fossil fuels, especially for long-distance voyages. Carbon emissions from maritime transportation activities increased by approximately 7.2%, or 730 million tons, from 2010 to 2019, in line with the increasing number of ships and global shipping activity. Projected carbon emissions will continue to increase annually until 2050 if no efforts are made to reduce carbon emissions.(Cardama Maruxa et al., 2021).

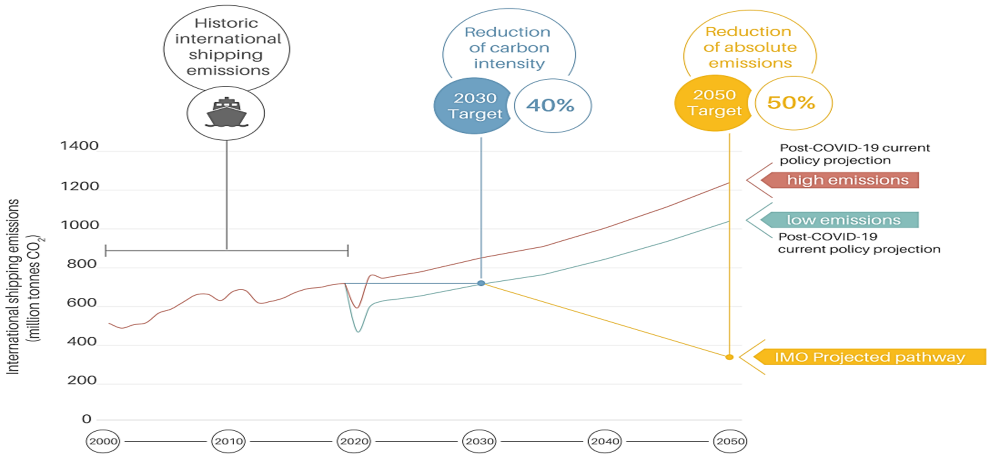

Figure 1. Projection of the amount of carbon emissions from global maritime activities

Seeing the increasing condition of Greenhouse Gas (GHG) emissions and their negative impacts on the climate and the environment globally, various rules and regulations concerning environmental and sustainability issues have begun to be promoted globally. The International Maritime Organization (IMO) adopted MARPOL Annex VI, which is part of the MARPOL International Convention to prevent air pollution from ships.(Mallouppas & Yfantis, 2021) The IMO set the Net Zero Emission (NZE) 2050 target as part of its green shipping campaign and a manifestation of its seriousness in reducing the impact of global climate change from the shipping sector, where the target is to reduce ship carbon emissions by 40% by 2030 and achieve Net Zero Emissions by 2050.(CLIA, 2024)The campaign aligns with the 2015 Paris Agreement, which aims to limit global temperature rise to well below 2°C, with an ideal target of 1.5°C above pre-industrial levels. This step is a driver of ship technology innovation and the transition from fossil fuels to alternative energy to support the achievement of these targets in the transformation of the maritime industry.(Nisiforou et al., 2022).

These challenges indirectly shape the perception of shipowners that the adoption of electric ships is still considered a high-risk option and is not yet feasible to implement in the near future.(Reusser & Pérez Osses, 2021). In fact, the practice of green shipping is being actively campaigned globally and the Indonesian government has issued various policies supporting the use of electric transportation/vehicles as an effort to reduce Greenhouse Gas (GHG) emissions. Likewise, in terms of operational characteristics, the use of electric ships in Indonesia is actually very potential. One of the shipping activities that can most likely be supported by battery-based electric ships is operations around the Port or Tersus/TUKS such as pilotage-tug activities, berthing-undocking of ships at the pier/jetty, mobilization of officers/personnel, patrols, handling oil spills at sea, or logistics considering the operational characteristics tend to be short-distance routes (more affordable) with fixed schedules, travel/operational times that are not too long, and close to the coast/pier so that it is easy to recharge.(Devarapali et al., 2024).

PT Pertamina Trans Kontinental (PTK) is a subsidiary of PT Pertamina International Shipping (PIS), which is part of the Integrated Marine Logistics Subholding owned by PT Pertamina (Persero). PTK has 379 ships of various types to support its business activities, most of which are assignments from the Pertamina Group in order to support oil and gas activities in the upstream and downstream sectors. In general, PTK provides integrated maritime services that include ship-related services, marine services, and logistics services. PTK's service area in the downstream sector includes 104 Tersus/TUKS Oil and Gas (97 Fuel Terminals and 7 Oil Refineries) spread throughout Indonesia. PTK also has 2 logistics shorebases located in Tanjung Batu and Kabil.

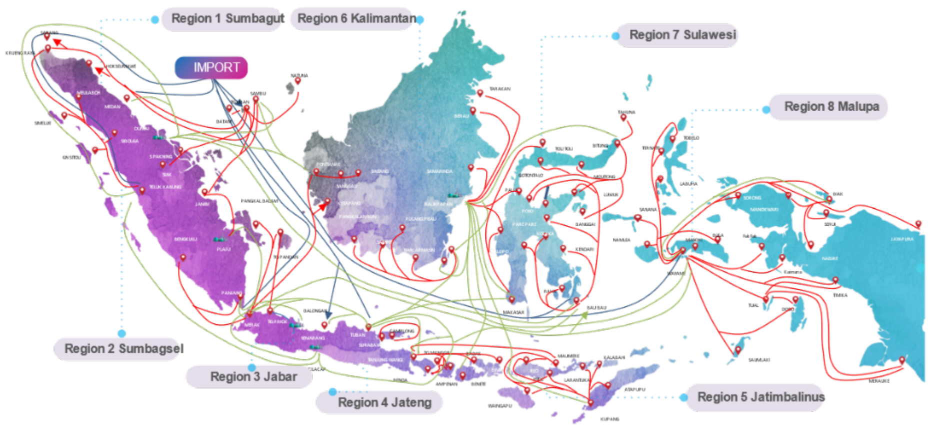

Figure 2 PTK Operational Area in the Downstream Sector

In keeping with the nature of its business, where PTK's operational activities are primarily focused on supporting oil and gas activities, the dominant type of vessel owned by PTK is currently support vessels (non-cargo). This reflects PTK's commitment to providing reliable maritime transportation services tailored to its customers' needs. The types of support vessels owned are diverse, tailored to the operational characteristics and specific needs of each line of activity. The following details the types and number of vessels owned by PT Pertamina Trans Kontinental:

Table 1. Details of the types and number of vessels owned by PTK

No.	Type of ship	Amount(Unit)
1	Anchor Handling & Tug Supply (AHTS)	6
2	Landing Craft Tanks (LCT)	2
3	Accommodation Work Barge	1
4	Patrol Boat	149
5	Mooring Boat	81
6	Harbor Tug	42
7	Pollution Fighting Craft	22
8	Crew Boat	18
9	Tug Boat	12
10	Pilot Boat	10
11	Barge	7
12	Fire Fighting Craft	4
13	Floating Crane	1
14	Dredger	1

No.	Type of ship	Amount(Unit)
15	Oil Tanker	9
16	Gas carrier	3
17	Asphalt Tanker	1
18	Tug & Barge (oil cargo)	7
19	Self-Propelled Oil Barge (SPOB)	3
	Amount	**379**

In 2019, PT Pertamina Trans Kontinental (PTK) commissioned the first environmentally friendly tugboat in Indonesia with dual-fuel HSD-LNG technology, the Transko Rajawali. This dual-fuel technology allows the vessel to use a combination of two types of fuel: LNG, an alternative fuel with lower emissions, and fuel oil (BBM). This dual-fuel vessel is considered in line with green shipping practices because its emissions are lower than those of ships running solely on BBM. The vessel's fuel consumption is claimed to be more efficient, reducing fuel consumption costs by up to 63.2%. The vessel is currently operating in Lhokseumawe to support the operational activities of PT Perta Arun Gas (PAG)'s LNG management.(Pertamina, 2019).

Figure 3. Example of a dual-fuel vessel owned by PTK

Based on the explanation above, it can be concluded that PTK is one of the shipowners with the largest number of vessels in Indonesia, with a specific operational focus around Tersus/TUKS. PTK also demonstrates its commitment to green shipping through the procurement of its new fleet. PTK has a ship rejuvenation roadmap until 2050, one of which is to gradually replace aging small craft (conventional engine) vessels with electric vessels (e-vessels). This condition makes PTK one of the potential shipowners who can adopt electric vessels in Indonesia.

The author is interested in examining the influence of the global green shipping campaign and GHG emission reduction policies on the procurement of electric ships, with shipowner perceptions as a mediating variable. Shipowner perceptions are important for further research because their perspectives and assessments of global policies and pressures will significantly determine the direction of electric ship technology implementation in Indonesia. This research focuses on PT Pertamina Trans Kontinental in the 2025 timeframe. Several previous studies have discussed green shipping practices, GHG emission reduction policies, or environmentally friendly vehicles, but there are still gaps that need further exploration, both in terms of focus, object, time, analytical approach, and geographic context. Several previous studies, such as those by Felício et al. (2021), which discuss the influence of green shipping on a sustainable economy in Europe, do not specifically discuss electric ships and do not include the perceptions of industry players. Likewise, the study by Bei et al. (2024) on ship electrification is limited to technical challenges and does not consider the perceptions of decision-makers, while the study by Devarapali et al. (2024) focuses more on electric tugboats without involving the behavioral aspects of decision-makers.

METHOD

A preliminary study is the initial stage of research, aiming to provide an understanding of the problem being studied and establish a foundation for developing a research model. Next, problem identification is carried out to clarify the research problem and make it measurable. While problem formulation serves to provide clear direction to the research objectives and maintain focus on relevant matters. A conceptual framework is the steps or sequence used to find solutions to the problem being studied, while a hypothesis is a tentative assumption proposed for further testing in the research.

Conceptualization of research variables explains the relationships between concepts within a research problem, while research design refers to the framework of methods and techniques chosen to achieve the research objectives. In this case, the research population is all objects targeted by the research, while the sample is a portion of these objects considered representative of the population. Operationalization of variables involves attributes with defined variations studied by the researcher. Data collection is the process of finding the data needed to achieve the research objectives.

This study involved a population of 97 individuals consisting of internal employees of PT Pertamina Trans Kontinental Group and affiliates relevant to the research topic of green shipping and ship procurement. The sampling technique used was saturated sampling for quantitative research and purposive sampling for qualitative research. In quantitative research, all members of the population were used as samples, considering the relatively small population size. Meanwhile, for qualitative research, five key informants were interviewed, who have knowledge and play important roles in the implementation of green shipping and environmentally friendly ship technology.

This study used a mixed methods approach, with a sequential explanatory design consisting of two stages. The first stage is quantitative analysis, followed by qualitative analysis. The quantitative method is used to test the hypothesis by collecting numerical data which is then analyzed statistically using descriptive and inferential statistics. To test the relationship between variables, the researcher used the Partial Least Square Structural Equation Model (PLS-SEM), which was processed using SmartPLS 4.0 software.

RESULTS AND DISCUSSION

Results

This study was conducted through a survey using a questionnaire instrument distributed via Google Form. There were 97 respondents eligible as research samples. Based on the demographic data of the respondents displayed, the majority of respondents in this study were male, 86 people (89%), while female respondents numbered 11 people (11%). In terms of age range, the largest number of respondents were in the 31–40 age group, 44 people (45%), followed by 41–50 years old, 31 people (32%), 20–30 years old, 13 people (13%), and the remaining 9 people aged over 50 years old, 9%. This pattern indicates that most respondents are in their productive and professionally mature age, which allows them to have relevant experience and understanding of the research topic. Meanwhile, in terms of education level, the majority of respondents had a bachelor's degree (65 people (67%), followed by a master's degree (28 people (29%), a diploma (3%), and only 1 respondent (1%) had a doctoral degree. The high proportion of respondents with undergraduate and postgraduate degrees indicates that they tend to have a higher educational background. This can support the validity of the research results, especially for research topics requiring specific conceptual or technical understanding.

Outer Model

The following are the results of the indicator validity test for each variable.

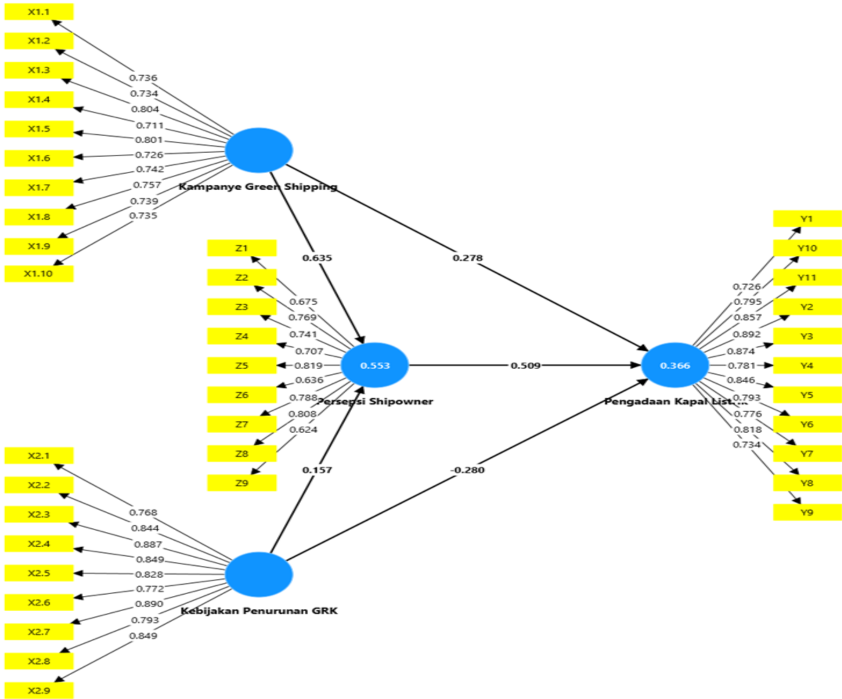

Figure 4. Outer Model Structural Model

Loading Factors Testing:

The results of convergent validity testing for each indicator in each variable in the model. All indicators in the Global Green Shipping Campaign (X1), Greenhouse Gas Reduction Policy (X2), Shipowner Perception (Z), and Electric Ship Procurement (Y) variables show loading factor values that meet the convergent validity criteria (more than 0.6). Overall, these results confirm that all indicators in this research model can consistently and validly reflect the measured latent constructs. Indicators with lower loading factor values, such as indicators Z1, Z6, and Z9, are still considered valid because they remain within the acceptable range and do not reduce the overall quality of the construct.

Reliability Testing and Construct Validity:

The results of the reliability and construct validity tests using three main indicators: Cronbach's Alpha, Composite Reliability (rho_A and rho_C), and Average Variance Extracted (AVE). All variables in this research model showed excellent results, with Cronbach's Alpha and Composite Reliability values above the minimum threshold of 0.70, indicating very high internal consistency. In addition, the AVE value for all constructs was also above 0.50, indicating that each construct has good convergent validity. These results prove that this research instrument has adequate reliability and validity for use in further research.

Fornell-Larcker Criterion Between Variables:

The results of the discriminant validity test using the Fornell-Larcker Criterion approach. The results show that each diagonal value (square root of AVE) is higher than the correlation value between other constructs, indicating that each construct in this research model is unique and does not overlap with other constructs. In other words, all constructs can be clearly distinguished from each other, confirming the discriminant validity of the tested model.

Heterotrait-Monotrait Ratio (HTMT) value:

The results of the discriminant validity test using the Heterotrait-Monotrait Ratio (HTMT) approach. All HTMT values between constructs are below the threshold value of 0.85, indicating that there are no significant overlapping issues between constructs in this research model. Thus, discriminant validity can be considered achieved, and each construct in the model can be clearly distinguished.

Cross Loading between Latent Variables and Indicators:

The results of the discriminant validity test using the cross-loading approach. Each indicator showed the highest loading value on its original construct, meaning that no indicator had a higher loading on another construct. This confirms that each indicator in this research model is conceptually unique and can differentiate itself from other constructs. Therefore, the discriminant validity of this model can be considered well met through the cross-loading test, as well as the two previous methods (Fornell-Larcker and HTMT).

Structural Model (Inner Model)

The inner model is a structural model that describes the causal influences between variables based on existing theory. Inner model testing (structural model analysis) is conducted to ensure that the constructed structural model is robust and accurate. The inner model will provide an overview of the causal influences between the variables studied. In this section, several things will be tested:

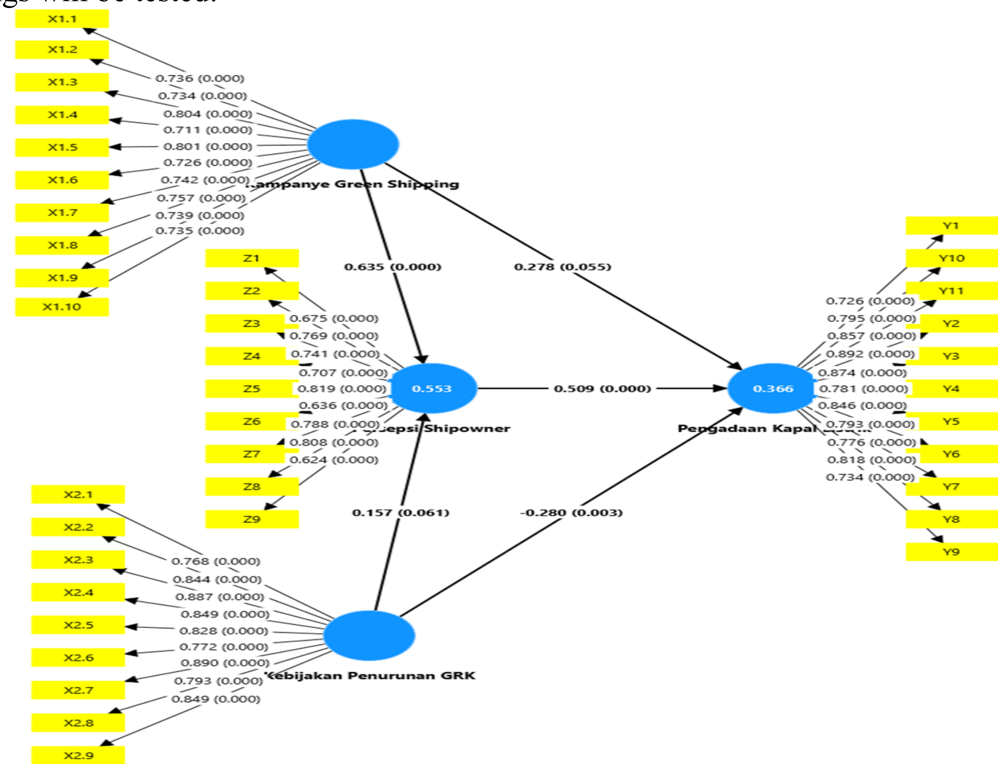

Figure 5. Graphical Output Bootstrapping

The following is a discussion of each part of the structural model testing (inner model) that has been carried out in this research:

Multicollinearity Test (Variance Inflation Factor - VIF)

Multicollinearity testing aims to ensure there is no strong linear relationship between independent variables in the model that could distort the interpretation of the path coefficients. Based on the Variance Inflation Factor (VIF) values, they are below the specified threshold of 5, with most being below 3.30. Low VIF values indicate that the independent variables in the model do not overlap excessively in explaining the dependent variable. This strengthens the validity of the structural model and ensures that the path coefficient estimates are not distorted by multicollinearity issues, allowing for more accurate and independent test results for the relationship between variables.

R-Square (Coefficient of Determination)

The R-square value for two endogenous variables: Electric Vessel Procurement and Shipowner Perception. The R-square value for Electric Vessel Procurement is 0.366, which means that 36.6% of the variation in electric vessel procurement can be explained by exogenous variables in the model. This is included in the moderate category according to Chin (1998). Meanwhile, for Shipowner Perception, the R-square value of 0.553 indicates that 55.3% of the variation in shipowner perception can be explained by exogenous variables, which indicates a fairly strong and substantial contribution. The stable R-square value, even with adjustments (adjusted R-square), strengthens the accuracy of the structural model built in this study.

F-Square (Effect Size)

The relative contribution of each exogenous variable to the endogenous variable in the model is measured using the F-square value. The F-square value for the relationship between Green Shipping Campaign → Shipowner Perception is 0.545, which is included in the large effect category, indicating a significant influence of the green shipping campaign on shipowner perception. Conversely, the F-square value for the relationship between Green Shipping Campaign → Electric Ship Procurement is 0.048, indicating a weak effect. This indicates that although the green shipping campaign makes a significant contribution to shipowner perception, its influence on electric ship procurement is relatively small. The F-square values for other relationships, such as between GHG Reduction Policy and endogenous variables, also show small effects, reflecting the limited contribution of GHG reduction policy to the dependent variables.

Predictive Relevance (Q^2 Value)

The Q^2 value for Electric Ship Procurement is 0.224, indicating moderate predictive relevance, meaning the model has a fairly good ability to predict this variable. Similarly, the Q^2 value for Shipowner Perception is 0.287, also classified as moderate predictive relevance, indicating the model is quite good at explaining the perceptions formed by shipowners. However, for two exogenous constructs, namely the Green Shipping Campaign and GHG Reduction Policy, the Q^2 value is 0.000, because both function as predictor variables in the model that are not influenced by other variables in the model.

Hypothesis Testing (Bootstrapping)

Hypothesis testing is conducted to determine the significance of the influence between variables using bootstrapping. The results of this analysis will provide p-values and t-statistics to determine the significance of the relationship between variables.

Table 2. Direct Effect Hypothesis Test

H	Direct Influence	Path Coefficient	*T-Statistics*	*P-Values*	*F Square*
H1	Global green shipping campaign (X1) → shipowner perception (Z)	0.635	**8,419**	**0.000**	0.545
H2	Greenhouse Gas Emission Reduction Policy (X2) → shipowner perception (Z)	0.157	1,870	0.061	0.033
H3	Global green shipping campaign (X1)→procurement of electric ships (Y)	0.278	1,920	0.055	0.048
H4	Greenhouse Gas Emission Reduction Policy (X2)→procurement of electric ships (Y)	-0.280	**2,959**	**0.003**	0.072
H5	Shipowner's perception (Z)→procurement of electric ships (Y)	0.509	**3,981**	**0.000**	0.183
H	**The Influence of Mediation**	**Path Coefficient**	***T-Statistics***	***P-Values***	***Upsilon (V)***
H6	Global green shipping campaign (X1) → shipowner perception (Z) →procurement of electric ships (Y)	0.323	3,381	0.001	0.104
H7	Greenhouse Gas Emission Reduction Policy (X2) → shipowner perception (Z) →procurement of electric ships (Y)	0.080	1,681	0.093	0.006

This study also used method triangulation to analyze the factors influencing the failure to procure electric ships at PT Pertamina Trans Kontinental (PTK). The triangulation method combined key informant interviews, literature documentation, field observations, and quantitative analysis to provide a deeper understanding and reduce bias. The analysis identified five key interrelated aspects of decision-making: technical, operational, economic, regulatory, and sustainability awareness. The technical aspect remains a major obstacle, with challenges such as limited battery technology, human resource readiness, and safety risks. The operational aspect also identified constraints related to limited supporting infrastructure, particularly in areas outside Java. From an economic perspective, the high initial investment in electric ships, the costs associated with batteries and crew training, are important considerations. Inadequate regulations, particularly in terms of fiscal incentives and funding, also limit the adoption of electric ships. Furthermore, despite positive green shipping campaigns, sustainability awareness among stakeholders remains low, thus hampering the potential for electric ship procurement. However, positive perceptions of green innovations can strengthen the transition potential, provided they are supported by adequate policies, infrastructure, and training.

Discussion

The Impact of the Global Green Shipping Campaign on Shipowner Perceptions

The research results show that the global green shipping campaign significantly influenced shipowner perceptions at PT Pertamina Trans Kontinental, with a significant positive impact. This campaign proved effective in building awareness and positive attitudes toward sustainable shipping, in line with the strategic communication theory of Mahoney and Rogers & Storey (Fatmawati, 2021), which emphasizes the importance of structured campaigns aimed at changing audience knowledge, attitudes, and behavior. This demonstrates that the campaign is not merely a means of disseminating information but also a declaration of global commitment to a clean energy transition in the maritime sector. This campaign is supported by global institutions such as the IMO, UNFCCC, EU, and ICS, which lend credibility and legitimacy to the message (Mi et al., 2024). Reinforced by Everett Rogers' innovation diffusion model (Venus, 2018), sustainable green shipping campaigns conducted through strategic forums have proven more effective in shaping positive perceptions of the sustainability of the maritime industry. In this case, the credibility of the communicator and the media used are key factors in influencing shipowners' perceptions of the transition to sustainable shipping (Rice & Paisley, 1981; Fatmawati, 2021).

The Impact of Greenhouse Gas Emission Reduction Policies on Shipowner Perceptions

In contrast, the government's greenhouse gas (GHG) emission reduction policies have not significantly impacted shipowner perceptions. This indicates a gap between established policies and their implementation on the ground. As noted by Smith & Larimer (2017) and Dwiyanto (Ravyansah et al., 2022), policy effectiveness is strongly influenced by institutional structures and the quality of policy design, as well as stakeholder engagement. In the maritime sector, the lack of concrete support such as fiscal incentives, limited infrastructure, and suboptimal policy communication have resulted in a mismatch between regulations and industry player readiness (Munthe et al., 2024). This aligns with Shi's (2019) findings, which emphasize that carbon trading policies will only be effective if balanced with technical support and policies responsive to industry needs. Therefore, to improve the effectiveness of GHG policies, a more inclusive and collaborative approach is needed, with active involvement of industry stakeholders and improvements in supporting infrastructure (Gerston, Ravyansah et al., 2022).

The Impact of the Global Green Shipping Campaign on Electric Ship Procurement

The findings of this study indicate that although the global green shipping campaign has a strong ideological objective, its influence on the procurement of electric ships at PT Pertamina Trans Kontinental remains insignificant. According to Rice & Paisley (1981), the success of a campaign depends on effective, relevant messaging that can change the audience's perspective on innovation. In this case, although most shipowners acknowledged the relevance of the global green shipping campaign message, they felt the information conveyed was less applicable and difficult to understand. Fatmawati (2021) and Setiawan (2019) explain that a campaign must be able to deliver a structured message that can influence changes in perception and action. This indicates that the global green shipping campaign has not fully succeeded in bridging global environmental aspirations with the practical needs of the maritime industry, as described in the Componential Campaign Model (Venus, 2018). Thus, changes in communication strategies are needed to make the campaign more effective in encouraging the adoption of electric ship technology in the maritime sector.

The Impact of Greenhouse Gas Emission Reduction Policies on Electric Ship Procurement

This study reveals that GHG emission reduction policies have a negative impact on the procurement of electric ships. This finding demonstrates a mismatch between policies and operational realities on the ground. As Heim (2024) noted, policies that are not accompanied by operational support, clear incentives, or ease of implementation actually hinder the adoption of environmentally friendly technologies. This is reinforced by Smith & Larimer (2017), who stated that public policy will only be effective if translated into concrete actions with adequate support. Furthermore, Munthe et al. (2024) stated that while government policies can raise awareness, concrete support such as incentives and infrastructure significantly influence investment decisions by industry players. Therefore, there needs to be stronger synergy between GHG reduction policies and incentive support and infrastructure improvements to accelerate the transition to electric ship technology (Becker et al., 2023; Camargo-Díaz et al., 2022).

The Influence of Shipowner Perceptions on Electric Ship Procurement

The results of the study indicate that shipowner perceptions significantly influence the procurement of electric vessels at PT Pertamina Trans Kontinental. Shipowners' positive perceptions of electric vessel technology are a key factor in supporting the transition to environmentally friendly shipping. This finding reinforces the theory proposed by L'Orange

Seigo et al. (2014) and Utari (2024) which shows that stakeholder perceptions significantly influence the adoption of environmentally friendly technologies. Furthermore, Atthariq et al. (2024) also found that price perceptions have a positive influence on electric vehicle purchasing decisions, which is relevant in the context of major investments such as ship procurement. However, despite the positive perceptions, descriptive statistics revealed that shipowner readiness to adopt electric vessels remains limited, with some respondents indicating a reliance on fossil fuels and concerns about the efficiency and reliability of the technology. This suggests that the transition to electric vessels requires profound behavioral changes and greater organizational readiness, as explained by Duru (2019) who emphasized the importance of shipowners' strategic decisions that consider the risks and long-term profit prospects of the investment.

The Indirect Effect of the Global Green Shipping Campaign on Electric Ship Procurement Mediated by Shipowner Perceptions

This study reveals that the global green shipping campaign significantly influences the procurement of electric ships through the mediation of shipowner perceptions. Although this campaign does not directly influence the decision to procure electric ships, shipowner perceptions act as a mediator linking the campaign to the decision to adopt electric ship technology. This aligns with the campaign concept described by Mahoney (2023) and Rogers & Storey (1987) in Fatmawati (2021), which states that well-designed campaigns can change public knowledge, attitudes, and behavior through a structured and long-term approach. Mi et al. (2024) also emphasized that campaigns covering environmentally friendly technologies, emission reduction policies, and energy efficiency have a significant impact, although the impact is stronger through the formation of positive perceptions among industry players. This is consistent with the Diffusion of Innovation theory (Rogers, 1983), which explains that perceptions of relative advantage and compatibility of technology are key determinants in innovation adoption decisions. Therefore, the global green shipping campaign can indirectly influence the procurement of electric ships by forming positive perceptions among shipowners, which then plays a role in supporting the transition to more environmentally friendly technologies.

The Indirect Effect of Greenhouse Gas Emission Reduction Policy on Electric Ship Procurement Mediated by Shipowner Perception

The results of the study indicate that the indirect effect of GHG emission reduction policies on the procurement of electric ships through the mediation of shipowner perceptions is insignificant. This indicates that although government policies to reduce GHG emissions aim to encourage a clean energy transition, these policies have not succeeded in forming perceptions strong enough to influence shipowners' decisions in procuring electric ships. According to Cook & Schioli (Ravyansah et al., 2022), policies should be able to bridge the government's macro vision with concrete actions at the organizational level, however, in this case, shipowner perceptions are not sufficiently influenced by existing policies. Smith & Larimer (2017) and Arafat (2023) suggest that deficiencies in stakeholder engagement and the quality of policy design that is not responsive to industry needs reduce the effectiveness of these policies. These results show that GHG emission reduction policies that are not accompanied by sufficient operational support and clear incentives hinder the adoption of electric ships in the maritime sector, as also found by Permana et al. (2023). Therefore, there is a need for changes in policy strategy, by improving strategic communication, direct incentives, and active involvement from the maritime industry to support more effective policy implementation.

Analysis of the Reasons Why the Procurement of Electric Ships at PT Pertamina Trans Kontinental Has Not Been Achieved

Several factors contributing to the unrealized electric ship procurement at PT Pertamina Trans Kontinental have been analyzed through five main aspects: technical, operational, economic, regulatory, and sustainability awareness. From a technical perspective, the limitations of battery technology, which has a lower energy density than fossil fuels, as well as safety risks such as the potential for battery fires, are major obstacles to the adoption of electric ships (Bei et al., 2024; Reusser & Pérez Osses, 2021). Furthermore, the lack of trained crew members in operating electric ships is also a significant obstacle, as found by Devarapali et al. (2024). Operationally, supporting infrastructure, such as limited charging stations and the uneven distribution of infrastructure throughout Indonesia, also hamper the procurement of electric ships (Karimi et al., 2020; Tri Setyoko et al., 2022). On the economic side, the high initial investment costs of electric ships and significant battery maintenance costs make this technology less economically viable than conventional ships (Kim et al., 2020; Reusser & Pérez Osses, 2021). Regulations that are still focused on the land sector and the lack of fiscal incentives for the maritime sector also exacerbate barriers to the adoption of electric ships (Raditya, 2022; Irma & Gusmira, 2023). Finally, low sustainability awareness among stakeholders also contributes to the slow transition to electric ship technology, as explained by Ferdiansyah (2024) and Hafsyah (2023). Therefore, the procurement of electric ships in PTK requires a comprehensive solution that addresses these obstacles, including improvements in technical, operational, economic, regulatory aspects, and increased sustainability awareness.

CONCLUSION

The global green shipping campaign has been shown to have a significant impact on shipowner perceptions at PT Pertamina Trans Kontinental, but has not directly influenced the procurement of electric ships. This campaign is effective as a communication tool to build awareness and positive attitudes towards sustainable shipping, but has not yet been able to encourage concrete investment decisions regarding electric ships. Furthermore, GHG reduction policies negatively affected electric ship procurement, reflecting a mismatch between regulatory policies and operational readiness in the field. This is due to the lack of clear incentives and weak supporting infrastructure, which has led to resistance among shipowners.

Shipowner perceptions significantly influence the procurement of electric ships, suggesting that positive attitudes toward adopting environmentally friendly technologies can accelerate the energy transition in the maritime sector. The global green shipping campaign has a significant indirect influence on the procurement of electric ships through the mediation of shipowner perceptions. This finding suggests that maritime industry players' perceptions play a significant role in enhancing the campaign's impact on investment decisions. However, GHG emission reduction policies have failed to bridge the decarbonization vision with the reality of investment decisions, as their influence on the procurement of electric ships through shipowner perceptions is insignificant.

Several factors hamper the realization of electric ship procurement at PT Pertamina Trans Kontinental, including: (1) technical aspects such as limited battery technology, crew competency, and battery safety risks; (2) operational aspects including inadequate supporting infrastructure and operational limitations of electric ships; (3) economic aspects including expensive investment value and high battery maintenance costs; (4) regulatory aspects that focus more on the land transportation sector, and (5) low levels of sustainability awareness among stakeholders.

Overall, despite positive perceptions and encouragement from green shipping campaigns, significant technical, operational, and economic challenges remain that hinder the adoption of electric ships. Therefore, improvements in policies, incentives, infrastructure development, and increased sustainability awareness are needed to encourage wider adoption of electric ships in Indonesia's maritime sector.

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