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Analysis of the Role of Seafarers in the Adaption of Green Shipping Practice

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Abstract: The study examines the role of seafarers in the adoption of green shipping practices in the maritime industry. It reveals that seafarers have varying levels of knowledge about environmentally friendly practices and the extent of their adoption varies across crews and vessels. The research emphasizes the need for comprehensive training programs, awareness campaigns, and incentives to encourage seafarers to engage in green shipping practices. However, the assurance of such programs varies among companies, indicating a need for more structured initiatives. The study also highlights the impact of shipping companies' sustainability initiatives and education programs on seafarers' roles. Sustainability initiatives significantly influence seafarers' responsibilities, emphasizing the adoption of new operational methods and technologies to reduce environmental threats. Education and training programs are crucial in equipping seafarers with the necessary skills and mindset to adapt to evolving industry requirements and sustainability measures. Seafarers' perceptions of environmental impact shape their conduct and participation in green activities onboard ships, contributing to a culture of environmental responsibility and innovation within the maritime sector. However, limitations such as sample size and scope warrant further research to explore specific training needs, program effectiveness, implementation barriers, and the long-term impact of green shipping practices on environmental sustainability metrics.

Keywords: *Green Shipping Practices, Sustainability, Perceptions of the Environment, Green Shipping Training Programs.*

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I. INTRODUCTION

The shipping industry has played an essential role in the development of global trade over the centuries, acting as a creative pillar in the sense that it has provided the sailing flow for the exchange of resources and goods from one country to another via sea transport. The effect of the shipping sector represents an area of interest that is being closely looked at, however, this is waking up a lot of people to the impasse that if climate change is not tackled then we are condemned. Therefore, it can be considered as the main characteristic of marine pollution. In the face of the increased risks, the industry side turned to green shipping, which is a broad concept that involves combined methods developed to decrease the environmental harm connected to maritime operations.

The routes of safe shipping go to a vast scope of measures that contain different implementation methods such as energy-efficient equipment, decreased greenhouse gas emissions, environmentally friendly energy sources, better handling of waste along compliance with the international regulations established by the IMO and MARPOL regarding energy conservation and emissions reduction. These mechanisms are compulsory for the continuation of the maritime sector to the international shipping and economy while decreasing its environmental damage (Fischer, 2019).

The shipping industry does as well have a certain level of carbon footprint, yet it serves a very essential role in global trade and shipping. This is an industry that systematically releases huge amounts of gases that are contributors to global warming at present. Fossil fuels are responsible for releasing CO2 and other harmful pollutants through their combustion in the ship engines, hence they affect the whole ecosystem of the environment, and also, they influence the climate of the planet in a different way (IMO, 2020). Furthermore, the emissions of CO2 are just one of the polluting factors for shipping vessels, as sulfur and nitrogen oxides may also have an impact on air and water quality. (Lloyd's Register, 2019).

Chemical pollution is one of the environmental hazards that the chemical used on board is responsible for. The ballast water, which is often used for the stability of ships, may truly move the invasive of one species to another and that may invoke ecological disorder (BWE, 2021). Another waste, on the other hand, is waste such as sewage, oily water, and solid waste, having that it is poorly managed in some cases can transform the coastal areas pollution and harm the marine habitats (Ng & Achour, 2019).

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For a green maritime industry, it is critically understood by the current environmental questions and this matter. To decrease the negative environmental consequences of sea operations, a multilateral approach was suggested, as this allows adjusting all sides of ecological shipping. These rules span from developments in technology that mitigate the impact on the environment to improved regulations within the sector itself that increase the use of green strategies, and finally improved planning for the future (UNCTAD, 2020).

Green shipping practices consist of many systems and one of these major components is energy efficiency. The notoriety of the bunkering industry is attributed to the use of such fuel, and this retreating can tremendously lower the carbon footprint in the maritime sector. This initiative, alone, reduces the burning of fuel. For instance, it creates hull designs, air lubricating systems, and high-efficiency propulsion systems that reduce fuel consumption. The availability of advanced weather routing systems and the possibility to come onshore for electrification in ports among others also assists in the reduction of the quantity of emitted gas by the ships as they run.(Chen et al.,2023).

Concurrently with the green shipping policy that the maritime industry has in place, the most prominent pursuit has been towards cleaner and environmentally friendly fuels. The burning of LNG/liquefied natural gas as a marine fuel is an example worth of attention because the greenhouse gas emissions it generates are smaller than those caused by coal, or conventional marine fuels (UNCTAD, 2020). This reorientation of the shipping industry towards a cleaner world also does not mean adopting alternate fuels, which include the likes of biofuels (Sames et al., 2018).

As of today, various international regulations and innovative technologies can be seen in the claim that is green shipping practices widely adopted. The IMO is of greatest importance in drafting, applying, and standardizing international shipping rules. Another example of a regulation is that of the MARPOL Annex VI, which defines the emissions standards for the ships and identifies the pollutants that they contribute. The pollutants include nitrogen and sulfur oxides (IMO, 2020). As well as that, another attempt of the IMO to improve the energy efficiency of existing ships by reducing their carbon emissions is the Energy Efficiency Existing Ship Index (EEXI) (IMO, 2021). The maritime industry is obliged to achieve environmental objectives while implementing technological upgrades and refining operations by the agreed-upon regulations.

At the moment shipping sector stands at a crucial juncture because of the recent features and trends in this industry. It must hold its key position in world trading whilst gradually undertaking the necessary measures to create a sustainable environment. Green shipping strategies play the deciding role here. These strategies provide the maritime sector the reassurance that it is moving in the direction of a sustainable environment and a prospect that mariners will become more environmentally friendly.

- *Problem Statement*

The maritime industry plays a vital part in both commerce and international relations of the world, as backbone to it. It ties together different countries and serves as a conduit for the free circulation of goods. While there is an environmental cost because of such an increase in mobility, the benefits it brings to society and overall development would exceed the negative impacts. Industry releases create premises such as emissions, contaminants, and waste., so that environmental effects can be appreciated and discussed. With the emergence of an industry that is steadily straightening towards setting eco-friendly regulations and a cleaner environmental imprint, addressing environmental issues has become the top priority which, therefore, implies that the emphasis of the industry should shift towards environmental protection and sustainable development.

Green shipping has become an effective set of comprehensive actions aimed at solving both of such environmental problems which are nowadays becoming the most relevant ones. These measures include energy-efficient procedures, a decrease in emissions, effective waste management, and devotion to international laws and regulations, such as those put in place by the International Maritime Organization (IMO) to increase energy efficiency and reduce emissions. Even though seafarers play significant role, this issue has very rarely become subject of much scientific interest in the sphere of 'green shipping' theory.

The area of the research is significant, but not as analyzed as necessary, when it comes to describing the implementation of green shipping solutions by seafarers, although the situation is changing and more focus is here turning to. The dearth of literature focusing on the delineation of the same causes is the major obstacle to developing a complete knowledge of all underlying factors related to the involvement of seafarers in green shipping practices.

It is inarguable that we need to fill the blanks to raise awareness and also to provide policies for Green practices .Make plans for a well-trained seafarer for the green sustainable maritime sector. Sustainable shipping operations come to the fore in this study, highlighting environmental friendliness and putting the main sources of air pollution on the surface via the diverging views of seafarers.

This study acknowledges the crucial part that seamen play in environmentally friendly shipping practices. It emphasizes the importance of empowering seafarers to act as major change agents and the human element in responsibility for the environment. The findings of the study can be used as a basis for initiatives and training programs aimed at improving seafarers' awareness of and participation in sustainability efforts.

- *Research Aim*

This research aims to investigate the role of seafarers in the adaptation of green shipping practices to evaluate substitutes for sustainability.

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➢ *Research Objectives*

- RO1: To determine the level of seafarers' knowledge of environmentally friendly shipping practices, including their familiarity with environmental laws, environmentally conscious innovations, and eco-friendly practices.
- RO 2: To measure extent to which seafarers actively adopt and implement eco-friendly shipping practices in their day-to-day operations
- RO 3: To make possibilities for seafarers in the adaptation of green shipping practices practically.
- RO 4: To assure training programs for green shipping practices.

➢ *Research Questions*

- RQ1: Do seafarers aware of green shipping practices?
- RQ2: Are seafarers trained for green shipping practices?
- RQ3: Are seafarers playing a significant role in the adaptation of green shipping practices?
- RQ4: Do seafarers follow the green practice of shipping?

II. RESEARCH METHOD

The method used in achieving research objectives is centered around researching the role of seafarers in green practice using the methodology map in Figure 1 followed by an explanation:

- Make a questionnaire (Contain open-ended and closed-ended questions) Conduct a pilot study by this questionnaire with a select 15 seafarers to gather information on the role of seafarers.
- Check the reliability of the questionnaire by the pilot data from step 1 and then complete the survey from same questionnaire analyze their replies.
- Quantitatively evaluate the data gathered in step 2 and examine variables related role of seafarers in green practices adoption.
- To gather descriptive and operational statistics pertinent to the function of seafarers, do a literature review of pertinent information sources, including peer-reviewed articles, academic literature, and trustworthy online sites, using the list as the framework for qualitative research.
- Perform a quantitative analysis of the data gathered from the results of the search.
- Examine Seafarers' Adoption of Green Shipping Practices.
- Examine the connection of seafarers' role with training programs, Shipping Company's Sustainability Initiatives, and Seafarers' Perceptions of Environmental Impact.
- Discuss the results and do additional studies to iteratively advance knowledge and learning.
- Make suggestions for additional Green shipping practices-related studies and summarize the results.

➢ *Sampling Technique*

The study was a quantitative approach and descriptive. Non-probability sampling method (selecting respondents from a population using a non-random or subjective method) is used for data collection from on-duty seafarers. Snowball sampling technique (new respondents are enlisted by other respondents to take part as sample) employed to recruit a representative sample of 120 seafarers who work on ships. The reasons of selecting Snowball sampling are that is quite easy, cost-effective, and needs less workforce as compared to other sampling techniques.

➢ *Research Framework*

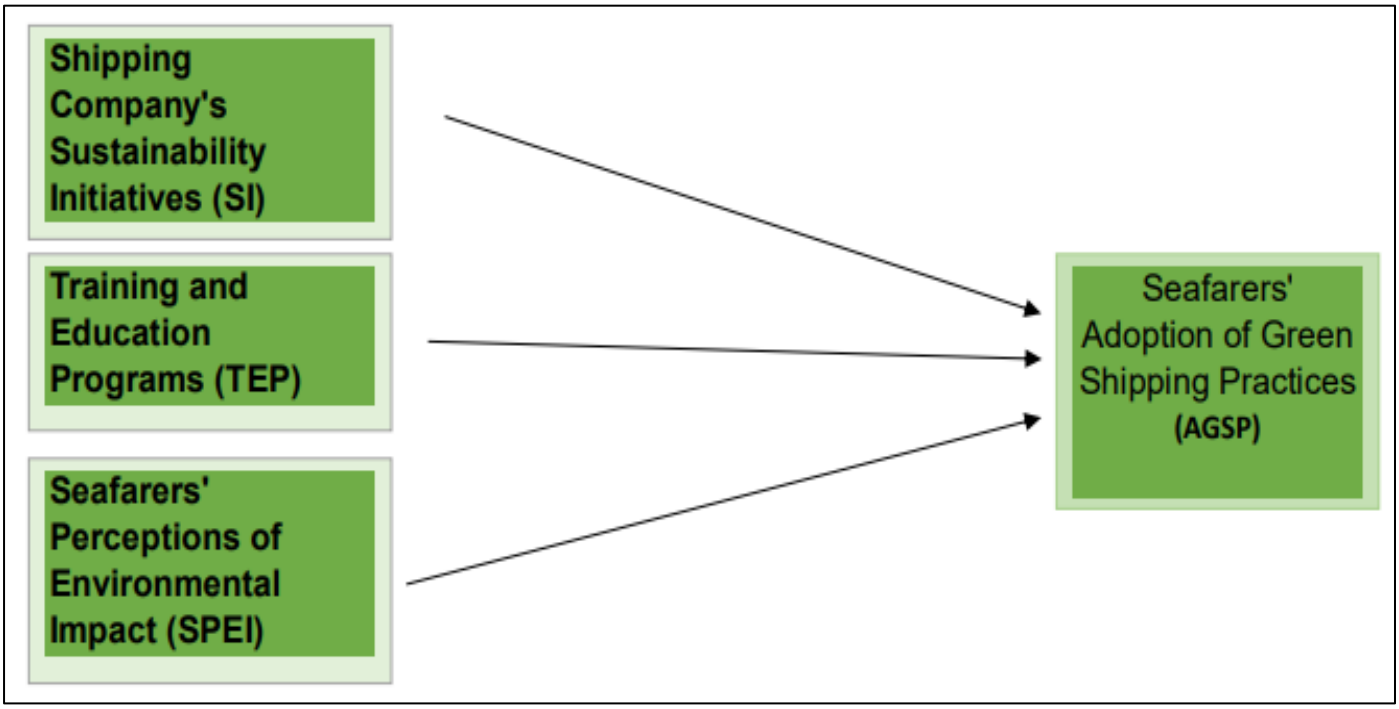

Fig 1 Research Model

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Figure 1 shows the Research model, which contains Independent Variables (Shipping Company's Sustainability Initiatives, Training and Education Programs, Seafarers' Perceptions of Environmental Impact) And Dependent Variables (Seafarers' Adoption of Green Shipping Practices)

➢ *Hypotheses*

- H1: The Shipping Company's Sustainability Initiatives have a significant impact on the Seafarers' Adoption of Green Shipping Practices
- H2: Training and Education Programs significantly impact Seafarers' Adoption of Green Shipping Practices.
- H3: Seafarers' Perceptions of Environmental Impact significantly impact Seafarers' Adoption of Green Shipping Practices.

➢ *Data Collection Process*

A questionnaire was created according to all factors of the study to get data from responders, The online survey form 's link of complete forms (including information sheet, consent form, questionnaire, and withdraw option) were sent to participants, giving time to participants for reading carefully before participating in my project survey. Initially, pilot study open-ended questions were created then for further actual research questionnaire have 7 open-ended questions (related to awareness and adaptation of green shipping practice) and 5 closed-ended questions be answered by seamen as volunteers.

➢ *Data Analysis and Outputs*

All information on demographics, awareness levels, perceived barriers, and extent of green practice adoption were gathered through survey form. After collecting data, it was tabulated and calculated by SPSS using statistical tools, like "Cronbach's Alpha, Mean, percentages, regression and Standard deviation". Cronbach's Alpha was used for checking reliability of questionaire. The mean was used for summarize all responses. Percentage was calculated for presenting statistical demographic information related to seafarers' awareness and adoption of green shipping practices. Regression analysis was done for the adoption rate in seafarer regarding green practices. In order to predict the value of the dependent variable for role of seafarers whom some information concerning the explanatory variables (Shipping Company's Sustainability Initiatives, Training and Education Programs, is available, or in order to estimate the effect of explanatory variable on the dependent variable (Seafarers' Adoption of Green Shipping Practices).

Visual representations such as charts, graphs, and tables can enhance the clarity of the findings. The results of this research are significantly influencing how the maritime industry approaches environmental sustainability, enhance the standard of living for seafarers, and support a more resilient and environmentally friendly maritime ecosystem, can create awareness campaigns to raise awareness of the value of eco-friendly shipping practices among seafarers, shipping companies, and the general public. The research findings can be used in these campaigns to increase awareness and promote constructive behavioral change.

III. DATA ANALYSIS

In this chapter, a pilot study was conducted from 15 responses from the questionnaire. Then check the reliability of the constructed questionnaire. After taking a good threshold of Cronbach Alpha, further data collection from 120 seafarers proceeded with the same questionnaire.

Table 1 Case Processing Summary

		N	%
Cases	Valid	120	100.0
	Excluded[a]	10	1.0
	Total	120	100.0
a. Listwise deletion based on all variables in the procedure.			

Out of 130 responses, 120 were valid and no one was considered an invalid response which means the data gathered is quite valid and is eligible to be used for statistical techniques.

➢ *Reliability*

Questionnaires with Likert scales were used as instruments of data collection. Relaibility of the questionnaire was checked by using Cronbach's alpha and the number of valid responses, the Cronbach's Alpha test on the instrument was used to check reliability from pilot data.

Table 2 Reliability Statistics

Reliability Statistics	
Cronbach's Alpha	N of Items
0.75	24

The above reliability statistics table 2 shows that the Cronbach alpha is 0.75 which means it is 75% reliable and thus the data gathered can be processed further for more statistical tests and analysis. The alpha reliability statistic supplied vital information on the internal consistency of a collection of items in the survey or different items tested. The analysis of the test of the 24 items has shown that Cronbach's Alpha coefficient is 0.75. The high value indicates the degree of internal consistency among the 24 items. Finally, greater values on Cronbach's Alpha show inconsistency when assessing a single construct. The Cronbach's Alpha could be any value from 0 to 1.

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In this situation, the value of 0.75 demonstrates that the item's measurement shows a good structure of a coherent and consistent construct. The reliability of the internal consistency coefficient is considered highly reactive with the prevailing standard of 0.70. With the notation over 0.70 commonly recognized as an extremely favorable one. Cronbach's alpha is a metric that is extensively employed by researchers and analysts to conclude the scale or questionnaire's internal consistency. A total of 24 items are recorded, and it is all based on four coded questions that aim to capture the enduring nature of the proposed concept. The scale's Cronbach's Alpha value of an above-average height has displayed the reliability of its internal consistency, and as a result, trust in the tool's consistency and dependability has been boosted. Additionally, the researcher must use a questionnaire to test the hypothesized psychological or behavioral traits in a more valid and useful way. The items must be used to gather data expressing a particular dimension of the construct, which should be common to all items.

Table 3 Distribution of Demographics

Characteristic	Options	Percentage%
Gender	Male	90%
	Female	06%
	Missing	04%
Age	18-29	47.6%
	30-39	41.7%
	40-49	8.7%
	50-above	2%
Department	Nautical	37.5%
	Engineering	62.5%
Total n= 120		100%

➢ *Distribution of Demographics*

The demographic characteristics of seafarers are tabulated according to their defined ranges, shown in Table 3.

➢ *Gender Distribution*

A pie chart demonstrates that 90 percent of respondents are male, 6 percent are female, and 4 percent prefer not to disclose their gender when working in the marine industry as to the 120 workers' total numbers. It is shown in Figure 4 Our research has so far shown that this emerging identity predominantly corresponds to males as 90% identified themselves as males whereas 6% declared themselves to be female. This distribution, which draws a big gender disparity gap, is one of the significant inequalities in the industry where men operate a large number of the workforce compared to women.

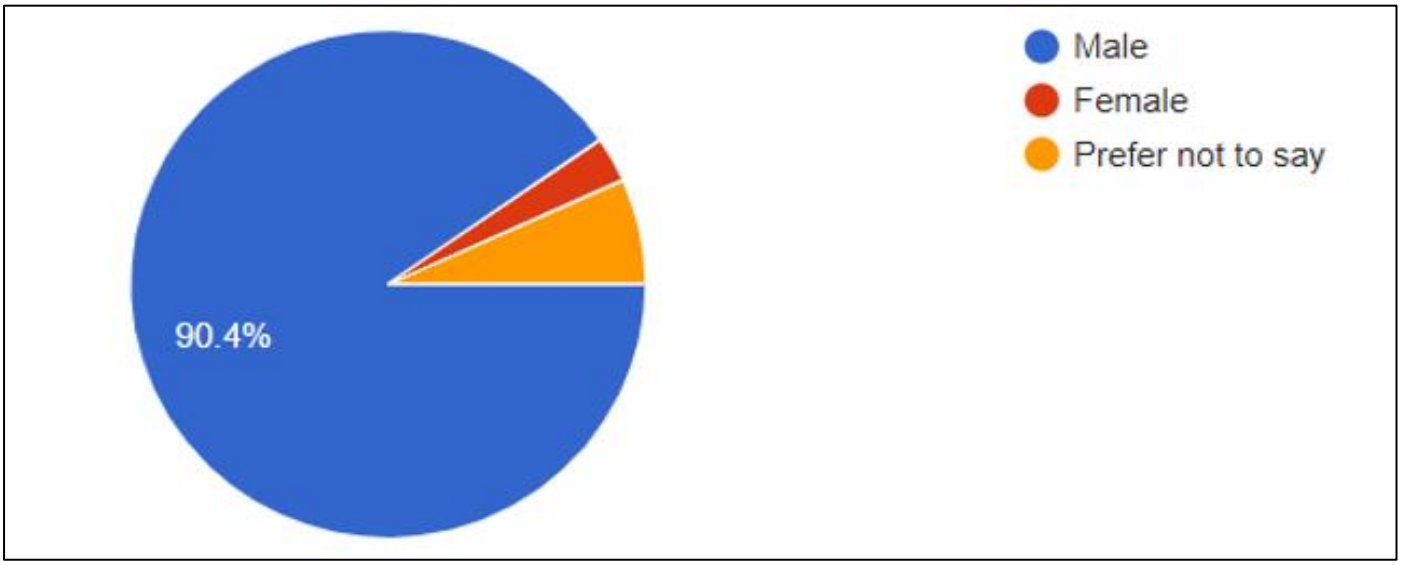

Fig 2 Pie Chart of Gender Distribution

➢ *Age Distribution*

Figure 5, displays the age distribution of marine industry representatives by displaying a pie chart based on a sample size of 120 individuals. The respondents' age group of 47.6% are in the ages range of 18-29 years old; the largest age group. The age group that records the highest output is that of 30-39 years with a number representing 41.7% of the respondents, the second-largest cohort. A fairly small percentage, though 8.7% out of all, encompasses seafarers belonging to the age group of 40-49 years. On top of that, there is another category for adults over the age of 50 that is seen in a very small proportion, which is just about 2 % of the total. This trend reveals a marine industry in which the majority of seamen are of younger age groups, while lower numbers are observed as the age groups are older.

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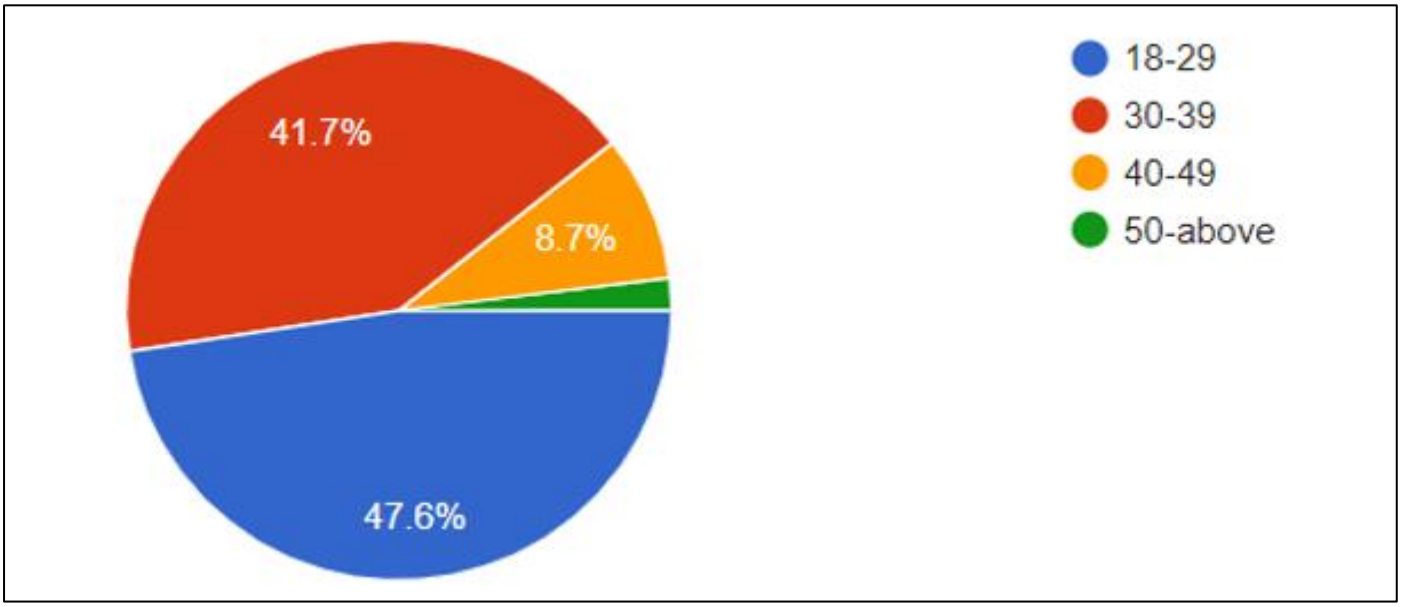

Fig 3 Pie Chart of Age Distribution

➢ *Department Distribution*

The pie chart figure 6, reflects on the share of responders amongst different departments in this industry and it is based on an analysis of 120 individuals. 37.5% of those interviewed work in the Nautical department, whereas the number of individuals who work in the Engineering department rises to 62.5% in the category of interviewees.

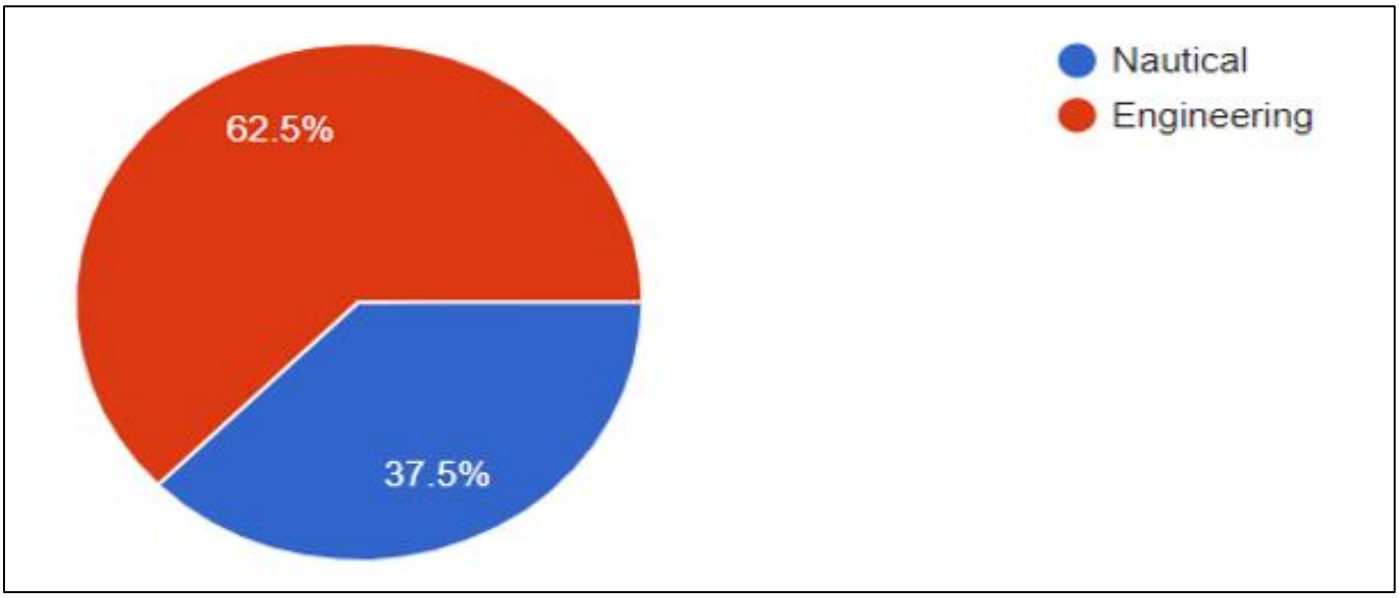

Fig 4 Pie Chart of Department Distribution

➢ *Descriptive Statistics*

Table 4 Descriptive Statistics

	Mean	Std. Deviation	N
Adoption of Green Shipping Practices	3.55	1.300	120
Sustainability Initiatives	3.62	.543	120
Training and Education Programs	3.64	.526	120
Seafarers' Perceptions of Environmental Impact	3.46	.911	120

Table 4 presents key statistical outcomes related to the maritime industry, revealing seafarers' roles in the adoption of Green Shipping Practices and shipping companies' sustainability efforts. The Role of Seafarers in the adoption of Green Shipping Practices AGSP metric shows a mean score of 3.55, indicating the perceived effectiveness of seafarers in their duties. The Shipping Company's Sustainability Initiatives (SI) measure reflects the extent and

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efficacy of sustainability initiatives undertaken by shipping firms, covering environmental, social, and economic dimensions. The Training and Education Programs (TEP) aspect scores 3.649, emphasizing moderate skill development and good knowledge enhancement for seafarers. The Seafarers' Perceptions of Environmental Impact (SPEI) metric shows a mean score of 3.466, highlighting a moderate level of seafarers' awareness and attitudes towards environmental sustainability. These statistics provide valuable insights into the current state, challenges, and potential improvements within the maritime sector, guiding strategic decisions and initiatives for enhanced sustainability and efficiency.

➢ *Regression Analysis*

Table 5 Regression Analysis

Regression Analysis Model Summary[b]					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.387[a]	.173	.149	.7704	1.683
a. Predictors: (Constant), SI, TEP, SPEI					
b. Dependent Variable: AGSP					

In Table 5, the Role of Seafarers' Adoption of Green Shipping Practices and the predictors (Shipping Company's Sustainability Initiatives, Training and Education Programs, Seafarers' Perceptions of Environmental Impact) have a somewhat positive association (R = 0.387), according to the multiple regression analysis. With model complexity taken into consideration (Adjusted R Square = 0.149), the predictors account for approximately 17.3% of the variability in AGSP (R Square = 0.173). How well the model predicts AGSP is shown by the estimate's standard error, which is 0.7704. Yet, there may be some positive autocorrelation in the residuals, as shown by the Durbin-Watson statistic of 1.683, which calls for more investigation. Additional research is advised to resolve this problem and improve the forecasting capabilities of the model.

IV. SURVEY RESULTS

According to the survey, It is analyzed that seafarers are willing to implement green shipping practices to minimize environmental impact and promote sustainability. Job roles such as 2nd Engineer, Chief Officer, Junior Engineers, Cadets, Motormen, and 3rd Engineers and Officers contribute to the industry's efforts to reduce fuel consumption, emissions, and overall environmental impact through consistent adherence to green shipping practices. Raising awareness of eco-friendly shipping practices involves various strategies, including educational campaigns, industry collaborations, certification programs, green labeling, and technology adoption.

Seafarer perceptions are clear regarding green practices ,They understand GP prioritize protecting marine ecosystems, preventing oil spills, reducing greenhouse gas emissions, and conserving water resources. Seamen believe that reputable sources like the International Maritime Organization (IMO), the United Nations Environment Programme (UNEP), national naval agencies, and academic institutions offer regulations, guidelines, and best practices for sustainable shipping and environmental protection.

According to responses ,having a standardized reporting system for environmental incidents or potential pollution concerns during a voyage is considered essential by seafarers for consistency in reporting, timely response to incidents, compliance with regulatory requirements, transparency in data analysis, and minimizing environmental impacts. Educating the ship's crew about the environmental impact is seen as crucial and necessary, with several benefits identified by respondents.

All ship companies have not been actively implementing sustainability initiatives to reduce their environmental impact. Common measures include improving fuel efficiency, adopting alternative fuels, installing emission control technologies, investing in cleaner vessel designs, managing ballast water, and electrifying ports. Some companies also conduct regular meetings, and training sessions, and provide educational materials to raise awareness and promote eco-friendly practices.

➢ *Hypothesis Summary*

Table 6 Hypothesis Summary

Results		
	Hypothesis	RESULT
H1	Shipping Company's Sustainability Initiatives have a significant impact on the Seafarers' Adoption of Green Shipping Practices	Accepted
H2	Training and Education Programs have a significant impact on the Seafarers' Adoption of Green Shipping Practices	Accepted
H3	Seafarers' Perceptions of Environmental Impact have a significant impact on Seafarers' Adoption of Green Shipping Practices.	Accepted

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V. DISCUSSION

This research investigates the role of seafarers in implementing green shipping practices and evaluating alternatives within the maritime industry. The study found that seafarers' knowledge of environmentally friendly practices varies, with some being familiar with environmental laws and innovations while others show gaps in their understanding. The extent to which seafarers actively adopt and implement eco-friendly shipping practices varies across different crews and vessels.

Several possibilities for seafarers to actively engage in the adaptation of green shipping practices include training programs, awareness campaigns, and incentives for sustainable practices. The assurance of training programs for green shipping practices varied among companies, with some providing comprehensive training while others lacked structured programs. The findings suggest that while there is awareness among seafarers regarding green shipping practices, there are gaps in knowledge and implementation. Seafarers play a significant role in the adaptation of green shipping practices, but there is room for improvement in training programs and industry-wide initiatives to promote sustainability.

The importance of shipping company initiatives has a strong correlation with seafarers' role in adoption. Shipping operators often implement sustainability measures to reduce environmental threats, satisfy regulations, and improve their market position. Green seafaring projects could involve new ways of managing waste, pollutants, and monitoring the environment, changing the prices seafarers have to pay in their daily tasks and actions onboard.

Education and training programs have a significant impact on seafarers' adoption of green shipping practices. The maritime industry develops the skill of seafarers in using innovative technology, the rule of the law, and corporate sustainability requirements. However, education programs are under research, health and safety measures, security procedures, and cultural understanding, which may pose obstacles to education and adaptation.

Seafarers' perceptions of environmental impact also have a significant impact on their adoption of green shipping practices. Their cognition regarding environmental management significantly impacts their conduct, thinking, and participation in green activities on the shipping sector. Seafarers' perceptions may drive innovation, expand cooperation, and provide means for further improvement of shipping companies.

Limitations of this research include the sample size and scope, limited access to data or information from companies or regulatory bodies, and potential limitations in future research.

VI. CONCLUSION

This research explores the role of seafarers in implementing green shipping practices in the maritime industry. It reveals varying levels of knowledge and adoption of eco-friendly practices among seafarers, with some showing familiarity with environmental laws and innovations, while others have gaps in understanding. The adoption and implementation of eco-friendly practices vary across crews and vessels, with some showing high commitment while others face challenges. The study suggests the need for comprehensive training programs, awareness campaigns, and incentives for sustainable practices, but the assurance of such programs varies among companies, indicating room for improvement in industry-wide initiatives.

Sustainability initiatives and education programs significantly influence seafarers' roles, emphasizing the need for new operational methods and technologies to reduce environmental threats. Education and training programs are crucial in equipping seafarers with the necessary skills and mindset to adapt to evolving industry requirements and sustainability measures. Seafarers' perceptions of environmental impact shape their conduct and participation in green activities, contributing to a culture of environmental responsibility and innovation within the maritime sector.

The research's limitations suggest that further research is needed to explore specific training needs, evaluate program effectiveness, explore implementation barriers, and assess the long-term impact of green shipping practices on environmental sustainability metrics.

RECOMMENDATIONS

- Investment in seafarers' training and education should be major investments for shipping companies to ensure they have the skillset and knowledge to manage the green transition in shipping.
- Strengthen the green shipping principle among seafarers with an environment awareness campaign, which should include seminars, presentations, and workshops. Promoting environmental stewardship culture will motivate seafarers to actively join green initiatives and encourage the protection of the seas and chartering.
- Deploy productive technologies to fast-track green shipping practices' adaptation, such as the purchase of low-consumption ships, more efficient propulsion systems, and emissions reduction technology.
- Encourage maritime vessel operators to imbibe green ways of managing the crew by hiring seafarers who demonstrate a keen interest in protecting the environment and offering bonuses or other benefits to transfer green habits.
- Implement strong monitoring and evaluation methods to examine the effectiveness of green shipping practices and identify areas for improvement.
- Work closely with industry forums, working groups, and networks of knowledge exchange to share best practices and solve issues affecting the maritime industry.

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