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Stakeholder Perspectives on Decarbonization: A Comprehensive Survey of Technology Priorities in the Maritime Industry

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Abstract: -
The maritime industry is a significant contributor to global pollution. Ships emit substantial quantities of greenhouse gases (GHGs) and other pollutants to the air. This paper examines various decarbonisation technologies that have been developed to curb emissions from ships and are being implemented in new designs and existing ships.The adoption of these technologies is a challenge for various stakeholders in the industry.Selecting the right decarbonisation technology for a ship is a multi-criteria decision-making process. This paper aims to do an analysis of these decision-making criteria, attempting to understand thehow various stakeholders arrive at decisions on implementation of the technologies in ships. The criteria studied are Technological maturity, Cost of implementation, GHG reduction potential, Ease of Installation and Maintenance requirements.As part of the research, as survey has been conducted among the selected stakeholders like Shipyards, Ship owners, Ship managers, Designers or consultants and Classification societies or regulatory bodies. An in-depth analysis of the results of a survey is presented with the author's conclusions.

1. Introduction

Trade between nations is largely dependent on transportation of goods from their source of production to the consumers. Sea transportation plays a major role in facilitating trade. When compared to other modes of transport, sea transportation of goods requires the lowest fuel consumption. As technology conquers new frontiers shipping is venturing into more hostile parts of the oceans, to greater depths to extract resources and enable world economic growth.

1.1. Emission from Ships

Shipping is the primary method for transporting cargo with the lowest pollution compared to other modes. However, ships still contribute significantly to pollution by emitting nitrogen oxides (NO_x), sulfur oxides (SO_x), carbon dioxide (CO_2), and particulate matter (PM) into the air[1]. The Fourth IMO Greenhouse Gas Study of 2020 reports that greenhouse gas (GHG) emissions, including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), measured in CO_2 equivalent, increased from 977 million tonnes in 2012 to 1,076 million tonnes in 2018[1]. The proportion of emissions from shipping grew from 2.76% in 2012 to 2.89% in 2018. Additionally, ships release substantial amounts of air pollutants like Volatile Organic Compounds (VOCs), Carbon Monoxide (CO), and Particulate Matter (PM). The marine environment also suffers from pollution due to the release of chemicals from antifouling paints, oil spills, and leaks during routine ship operations.

1.2. Regulatory Actions for mitigation

In the past decade, the shipping industry has made significant efforts seeking tocomply with the increasing environmental regulations. Some of these efforts concentrated on implementing operational changes and others on installing technologies. These steps have resulted in reduced fuel consumption and pollutant emissions when measured on a tonne-mile basis. In spite of the actions being taken, the global community's scrutiny on the shipping industry have only intensified in the recent years. This has resulted in demands for putting more stringent measures in place.The Paris Agreement, an international treaty on climate change, was adopted by 196 parties during the United Nations Climate Change Conference (COP21) in Paris, France, in 2015. This agreement, which came into effect on November 4, 2016, aims to keep the global temperature rise well below 2°C above pre-industrial levels and to pursue efforts to limit the increase to 1.5°C[2]

Ensuring that the shipping industry keeps up with global climate goals has been an important aim for international organizations. For example, the IMO has laid out plans for its initial greenhouse gas strategy and objectives. The MEPC 80 session of the IMO, that concluded in July 2023, approved the 2023 IMO Strategy for Reducing GHG Emissions from Ships. This updated strategy sets more ambitious targets, aiming for net-zero GHG emissions from international shipping by approximately 2050. It also stresses onadopting alternative zero and near-zero GHG fuels by 2030, with specific checkpoints established for 2030 and 2040[3].Other regional organisations like the European Union have also launched the FuelEU Maritime initiative to decarbonize ships operating within, to, and from the EU [4]

1.3. Objectives

This paper aims to identify the various stakeholders in the shipping industry, who have a major role to plan in the adoption of stricter environmental guidelines for emission from ships and consequent reduction in the contribution of the industry to global emissions. The reductions in emissions are possible only through implementation of new decarbonisation technologies or using alternate fuels, that cause lesser pollution. Once the key stakeholders are identified, the criteria that are important in deciding the type of decarbonisation technology that can be adopted for implementation on a ship are identified. The importance attached to each of these criteria by the industry, is sought to be identified based on a survey conducted among experienced professionals who are part of different stakeholder groups. Through an in-depth analysis of the results of the survey and feedbacks from the stakeholder groups, trends are sought to be identified.

2. Decision making factors for adoption of Energy Efficiency Technologies (EETs)

The transition towards decarbonization of the shippingindustry requiresimplementation of new technologies and usage of a mix of energy sources, as an alternative to carbon-based fuels. The selection of a suitable decarbonization technology is a huge challenge faced by various stakeholders in the industry. This paper aims to assess decision-making, based on several key criteria for the installation of Energy Efficiency Technologies

(EETs) on ships. These criteria are those that have been determined by the author as key influencing factors for stakeholders in deciding whether to adopt a particular technology. These are Technological maturity, cost of implementation, greenhouse gas (GHG) reduction potential, ease of installation, and long-term maintenance requirements.

2.1. Technological Maturity

Technological maturity is an important criterion when selecting EETs, as it directly impacts the reliability of the technology in question. Mature technologies, that have undergone testing and that have been used in operational conditions, result in more consistent performances. It will also greatly reduce any risk due to unexpected shutdowns or failures. For example, the International Maritime Organization (IMO) has always stressed on the importance of installing of technologies that are proven. This will ensure that stringent environmental regulations are complied with thus resulting in gainingmore trust from the public. Furthermore, it is more likely that mature technologies will be aligned with existing regulatory frameworks, thus reducing the uncertainties associated adopting them.

2.2. Cost of Implementation

The cost of installation of any Energy efficiency technology is a critical factor that stakeholders have to consider while deciding on its implementation. The feasibility of any project to implement a technology depends on the cost considerations involved. Cost is also an important factor to consider on any decision to scale up the installation for more number of vessels. The cost considerations are critical, since stakeholders have tobalance the initial investment costs against the long-term savings and benefits availed during operation [5]. The more a technology is cost effective, the higher its chances of adoption, particularly when the stakeholder considers a return on investment[6].

2.3. Efficiency of Greenhouse Gas (GHG) Emission Reduction Potential

The efficiency with which a technology helps to reduce the Green House Gas emission (GHG) is a crucial aspect in any decision-making on selecting the technology. This holds true, especially when there are strong regulatory pressures and compliance requirements in place [7].When the potential for GG reduction is higher in any technology, it follows that it helps the technology be more widely adopted and accepted by the stakeholders belonging to the broader industry.

2.4. Ease of Installation

Ease of Installation is another important criterionmeasured by stakeholders in the industry while deciding on selecting an EET. This factor is a crucial one, as it affects how quickly and smoothly can a technology be implemented onboard a ship. Any implementation of a new technology on a ship could disrupt the vessel operations. Specialised expertise would be required in order to minimise such disruptions. One of the main aims while installing anything new on a ship would be to ensure it seamlessly integrates with the existing vessel systems.

2.5. Maintenance Requirements

Long-term maintenance requirements are another essential and important criterion in evaluating EETs and comparing between them. Those technologies that have lesser maintenance requirements are generally more sustainable over time. This also increases the cost effectiveness of the solution under consideration. Lower maintenance requirements also ensures that there are minimal disruptions to operations during the lifetime of the ship. Hence this aspect will be an attractive one for any stakeholder in the industry while selecting a technology to implement [8]. In the same vein, technologies that demonstrate minimal maintenance requirements are more likely to operate at high efficiency over time, thus enhancing their overall effectiveness in reducing emissions.

3. Industry stakeholders

Considering that the industry is facing increased scrutiny and pressure from world's institutions to reduce greenhouse gas emissions and prioritise adoption of greener technologies, the perspectives of various stakeholders of the industry are critically important. The opinions and preferences demonstrated by these stakeholders are crucialin formalising the direction of technological adoption. The industry needs must be kept in mind, while identifying the most viable decarbonization technologies that also comply with regulatory frameworks. The financial realities of adoption of these new technologies are of high priority to most stakeholders. By giving due consideration to their priorities and concerns, the transition to sustainable practices in the maritime industry can be made both efficient and effective.

For the purpose of this research, five stakeholders have been shortlisted. These stakeholders—including ship owners, ship managers, ship designers and consultants, classification societies and regulatory authorities, and shipyards—each play a pivotal role in the decision-making process. These groups bring in, a wealth of experience, technical knowledge, and strategic insight.

3.1. Ship Owners

Ship owners are fundamental to the shipping industry. They bear the final responsibility for the ownership, management, and operation of ships in service. In the context of decarbonization of the industry, their role becomes even more critical since they are the primary decision-makers. Hence, they play a central role in the industry's efforts to reduce greenhouse gas (GHG) emissions and adopt sustainable practices [9].

For ship owners, compliance with the new regulations introduced by IMO to achieve decarbonisation, is not just a legal obligation, since any failure to adhere to these standards can result in penalties imposed by authorities. These could be in the form of loss of market access and damages to corporate reputations[10].Be itusage of alternative fuels or installing energy efficiency technologies, the efforts towards reducing emissions are those that require significant capital investment in new ships and retrofitting existing ones. For any ship owner, it is a decision to be taken after carefully evaluation of its long-term benefits, risks, and return on investments[11]. Forming partnerships with other stakeholders, like shipyards, equipment manufacturers, and regulatory bodies, will make the path towards development and adoption of innovative decarbonisation solutions, that much more easier to accomplish.

Furthermore, investors who get involved in the industry are putting higher priority to environmental performance. Ship owning companies with strong environmental track record are more likely to attract investments and secure long-term contracts. This will make decarbonization, a competitive advantage to them in the long run[12].

3.2. Shipyards

Shipyards' role in decarbonization is critical, as they the stakeholders who have the necessary infrastructure and expertise to build or retrofit ships with energy-efficient and environmentally friendly technologies. In addition to improvements in hull design and retrofitting of technologies that deliver improved hull performance in water, shipyards also must install the latest propulsion technologies into new build ships. Ships that operate on alternative fuelsrequire specialized machinery and systems and shipyards must be at the forefront of development of these for the future [13].

Retrofitting of existing vessels also carries as much importance towards achievement of decarbonization goals set for the immediate future. Many of the retrofits are major conversion works, that require the ships to be docked in shipyards, with major modifications made to the hull and machinery.Shipyards aim to achieve their objectives through collaboration with other stakeholders, including equipment manufacturers, designers, and classification societies.

As the demand for green ships increases and general environmental awareness increases within the general public and industry, shipyards that prioritize in building and retrofitting energy-efficient vessels will gain a competitive edge over others that dont. These shipyards will attract more clients looking to invest in sustainable shipping solutions and hence drive their growth and profitability. Moreover, compliance with environmental regulations ensures continued access to global markets and finances devoted to sustainability and in avoiding potential penalties and restrictions [9].

3.3. Ship Designers

Ship designers' role in achieving any decarbonization targets is critical, as they are responsible for integration of advanced technologies and sustainable practices into the design of new ships and the retrofitting of existing ones. Ship designers and consultants work on the forefront of creating solutions that enhance energy efficiency and environmental performance of ships[14].Ship designers of today also have toemploy advanced techniques like computational fluid dynamics (CFD) and various simulation tools to understand the hydrodynamic efficiency of ship hulls and propulsion systems due to implementation of new technologies. By integratingnew technologies and systems, ship designers and consultants can significantly improve the energy efficiency of vessels, thus making great contributions to the overall goal of decarbonizing the shipping industry .The economic benefits of undertaking such efficient designs towards decarbonization also is a motivating factor for ship designers to innovate further. When the demand for more efficient ships increases, designers who can specialize in designing energy-efficient and environmentally friendly vessels and those who can integrate such technologies in ship designs practically, will gain a competitive edge over others. Such designers and consultants can attract clients looking to invest in sustainable shipping solutions, driving their growth and profitability.

3.4. Classification Societies

Since classification societies are independent organizations that establish and maintain technical standards for the construction and operation of ships, their role in decarbonization is crucial. It is essential that however environmentally sound a design or a technology is, it must be ensured that the vessels that operate with these meet the necessary safety, environmental, and performance standards. By setting and enforcing stringent guidelines for energy efficiency and emissions, classification societies assist the adoption of greener technologies and practices across the shipping industry [15].One of the primary functions of classification societies and other regulatory authorities like flag states and national governments is to develop technical standards, rules and codes that promote safety and environmental sustainability. It is not only about review of designs, but the class societies and regulatory bodies also have toconduct rigorous assessments and inspections of new ships and retrofits to ensure compliance with technical standards and regulatory requirements. Classification societies work closely with shipowners, shipyards, equipment manufacturers, designers and research institutions to develop and implement standards that advance environmental sustainability. For classification societies, there are economic benefits also. As demand for certification and classification services related to energy efficiency and emissions reduction increases, those societies that move ahead in these areas gain a competitive edge. They attract clients looking to ensure compliance with environmental regulations and enhance the sustainability of their operations [16].

3.5. Ship Management Companies

Ship management companies' role in reducing emissions is critical, as they are the ones to actually implement and monitor the practices and technologies that are designed and installed on the ships.One of the primary ways ship management companies can contribute to decarbonization is by adopting energy-efficient operational practiceswhile running a ship and maintaining it. They also play a crucial role in installation of energy efficiency technologies onboard ships. They supervise the installation and operation of these technologies. Crew training is avery essential component of a ship management company's role in decarbonization. As newer technologies get implemented, well-trained crews are crucial for the success of energy-efficient practices and technologies [17].Through improved energy efficiency of vessels, the operational costs associated with fuel consumption will be directly reduced. This improves the profitability of shipping operationsand such ships are more competitive in winning more charters with environmentally conscious companies. By demonstrating a commitment to sustainability, ship management companies can also attract clients who prioritize environmental performance [18].Considering that ship management companies are the primary "users" of the newly implemented technologies to reduce emissions, their feedback is of high importance in understanding the methods of selection of the right technology for the ships.

4. Survey Methodology

The conduct of a comprehensive survey in an industry with multiple stakeholderslike the shipping industrywas one that needed good planning and execution. The mainaim of the survey was to ensure awide range of opinions on the factors that influence the adoption of decarbonization technologies is obtained. To achieve this aim, a rigorous methodology was employed for the survey. This ensured that the survey that was carried out was representative and comprehensive. It had to be capable of generating actionable inferences to understand the preferences and choices of the responders of the survey. This would give an insight into the thoughts of the wider industry in general.The survey was conducted between August 2023 and August 2024. Responses were collected from industry experts located in geographically diverse regions, including the Middle East, Europe, and the Far East. This ensured that a global perspective on the criteria for selecting EETs and alternate fuels was available to the author.

4.1. Survey Approach

The survey approach involved seeking of responses through physical and online modes , in order to maximize the reach towards potential respondents of the survey.

- Online Surveys: An online version of the survey was created through a survey generator website. This online version was distributed through emails and social media messaging applications, to wide network of industry contacts. Thus the online format resulted in a broader geographic coverage, enabling participation from stakeholders across different time zones and regions.

• Physical Surveys: In parallel with the online survey, physical surveys were conducted at industry conferences, seminars, and exhibitions, in different parts of the world. These direct events gave an opportunity to engage with participants directly. This allowed immediate feedback and clarification of any questions. Direct meetings were also held with a significant number of responders, to obtain their responses.

The combination of these two methods ensured that the survey reached and resultingly generated a wide range of responses, reflecting the global and multifaceted nature of the marine and shipping industry.

4.1. Survey Design

The survey was designed with the aim of being comprehensive but straightforward at the same time, ensuring easy completion while gathering valuable data. As discussed earlier in the paper, the key aspects of decarbonization technologies assessed in the survey, were as below. Each of these were quickly explained as below to responders who needed further clarity on the questions.

• Technological Maturity: Evaluating the reliability and readiness of a technology for practically installing onboard a ship.

• Cost of Installation: Assessing the financial investment needed to install the technology on ships.

• GHG Reduction Potential: Measuring the efficiency of the installed technology in the reduction of greenhouse gas emissions from the ship

• Ease of Installation: A measure of the practicality of integration of the technology into the ship, including extent of modifications needed for existing ship systems.

• Maintenance Requirements: Understanding the operational requirements of the technology and any costs associated during its operation.

All the participants of the survey were requiredto rate the importance of each aspect using a Likert scale, with responses ranging from "Not Important" to "Extremely Important." This design allowed respondents to record their priorities clearly and quickly. This was a crucial aspect in maintaining engagement, especially among busy industry professionals who were part of the survey.

4.2. Ensuring Comprehensive Stakeholder Coverage

In order to ensure that the survey considered opinions and feedbacks from all main stakeholders in the industry, a deliberate effort was made to ensure inclusion of respondents from all key stakeholder groups. The 79 respondents who completed the survey were drawn from the below five main stakeholder categories, which were discussed earlier.

- Shipyards or Service Providers
- Ship Managers
- Ship Owners
- Classification Societies or Regulatory Authorities
- Designers or Consultants

4.3. Geographic and Experience Diversity

Considering the global nature of the shipping industry, it was important to ensure that the survey incorporatedviewpoints from across different regions. Hence it was aimed to try and ensure that the respondents hailed from various countries, representing the international character of the industry.

In addition to geographic diversity, the survey also encompassed a broad range of professional experience. Respondents ranged from those with just a year of industry experience to seasoned professionals with up to 35 years in the field. This diversity in experience levels allowed the survey to capture both established industry practices and emerging trends, offering a comprehensive view of how different factors influence decision-making across the industry.

4.4. Respondent Engagement and Data Collection

To achieve a high response rate, over 120 stakeholders were initially approached, resulting in 79 completed surveys. Several strategies were employed to encourage participation and ensure the collection of meaningful data:

- Personalized Outreach: Initial contact with potential respondents was personalized, drawing from the author's extensive industry contacts and emphasizing the importance of their input for the survey's objectives. This approach was particularly effective in engaging senior industry professionals who might have otherwise overlooked a general survey request.
- Follow-up Communications: Follow-up emails and reminders through messaging services were sent to those who did not respond to the initial request. For physical surveys, participants were approached multiple times during events where needed, thusbringing in higher engagement rates and ensuring that those interested had multiple opportunities to participate.
- Ease of Participation: The survey was designed to be quick and easy to complete. It required no more than 10 minutes of the respondent's time, with some of the experienced professionals requiring as less as three minutes to complete the surveys. This was critical among busy professionals who could be deterred by more time-consuming surveys.

4.5. Data Collection and Result Tabulation

Once the surveys were collected, the data was carefully tabulated to ensure accuracy and reliability. The following steps were taken during this process:

- Data Validation: Every response was reviewed individually to identify and rectify any inconsistencies or incomplete data. This step was crucial in maintaining the integrity of the dataset. Only fully completed and reliable responses were included in the analysis detailed herein.
- Categorization: The responses were categorized according to the stakeholder group, geographic region, designation and experience level of the respondents. This helped in performing a more detailed analysis of the data, making it possible to identify trends and patterns within specific groups.
- Quantitative Analysis: The Likert scale responses were quantified to determine the relative importance of each aspect of decarbonization technologies. A score of 1 to 5 was assigned to the responses wit 1 being assigned to the response of "Not important", 2 for "Slightly important", 3 for "Important", 4 for "Fairly important" and 5 for "Extremely Important". This involved calculating the mean and median scores for each category, as well as identifying any significant deviations or outliers.

5. Results and analysis

The survey results were summarized using statistical analysis as below understand the central tendencies and variability in the responses for each factor.

5.1. Analysis of survey results based on Criteria to select the Energy Efficiency Technologies (EETs) over all stakeholder groups.

Technological Maturity

- Mean: 4.28

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- Standard Deviation: 0.80

Respondents generally consider technological maturity to be very important, with most ratings clustering around 4 and 5. Most respondents rated this factor as very important, with scores primarily clustering around 4 and 5.

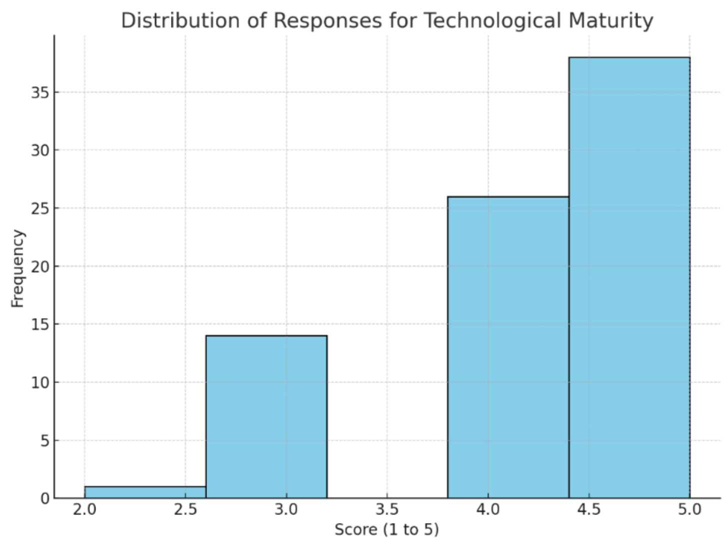

Fig. No.1 : Distribution of responses for the aspect - Technological Maturity

Cost of Installation

- Mean: 4.01
- Standard Deviation: 0.90

Cost is seen as an important factor, with moderate variability in responses received. With similar trending as technological maturity, cost was rated as important by most respondents, with a significant number of ratings of around 4 and 5.

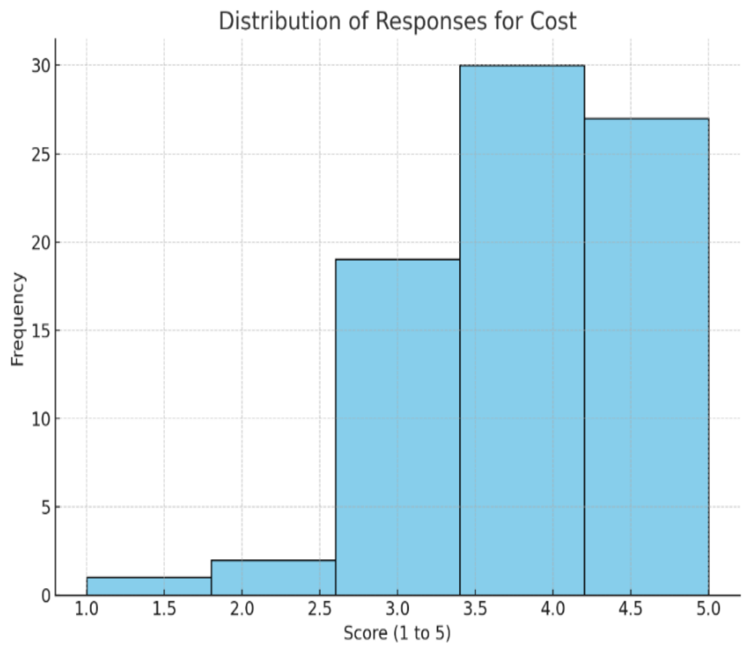

Fig. No.2 : Distribution of responses for the aspect –Cost of Installation

GHG Reduction Potential:

- Mean: 3.94
- Standard Deviation: 0.77

Environmental considerations are valuedby respondents, with most ratings clustering around 3 and 4. Ratings for this factor were concentrated around 3 and 4, suggesting that respondents recognize the importance of environmental impact but with some variability in the degree of importance, compared to other factors in consideration.

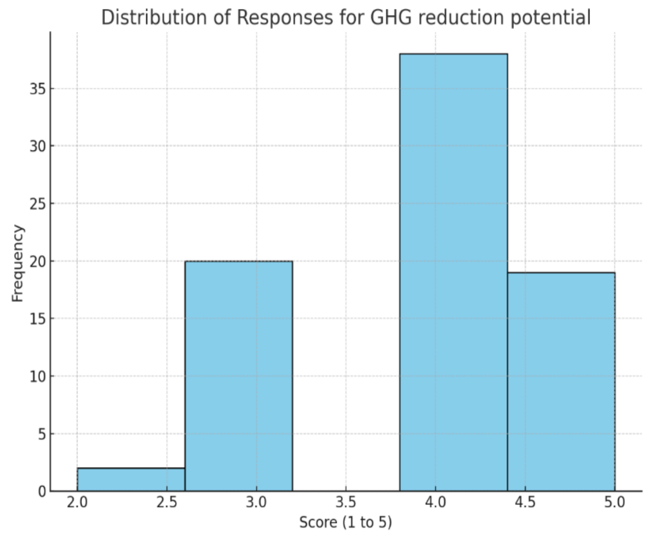

Fig. No.3 : Distribution of responses for the aspect – GHG reduction potential

Ease of Installation:

- Mean: 3.76
- Standard Deviation: 0.88

Ease of installation is considered important but slightly less when compared to the other factors. Responses for ease of installation were more spread out. This indicates a more balanced view among respondents, with notable ratings around 3 and 4.

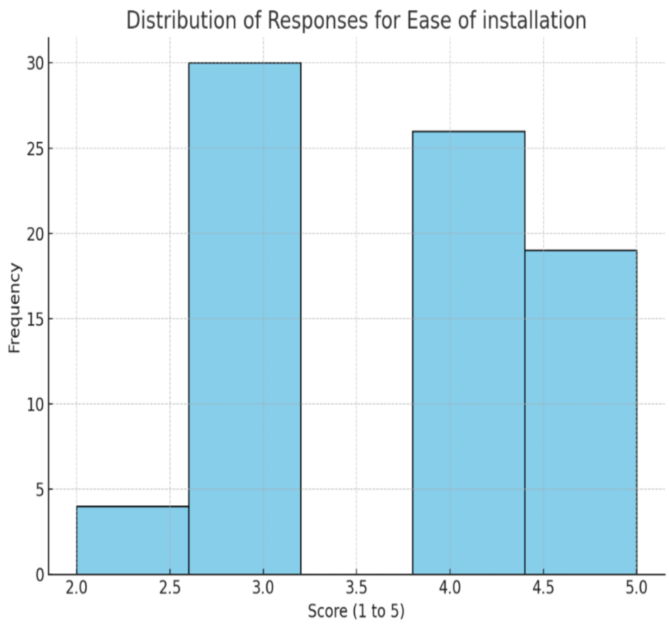

Fig. No.4 : Distribution of responses for the aspect – Ease of Installation

Maintenance Requirements:

- Mean: 4.14
- Standard Deviation: 0.84

Maintenance requirements are highly prioritized by most respondents. Most of them consider this factor as important to extremely important. Most responses clustered around 4 and 5, similar to the trending for technological maturity and cost.

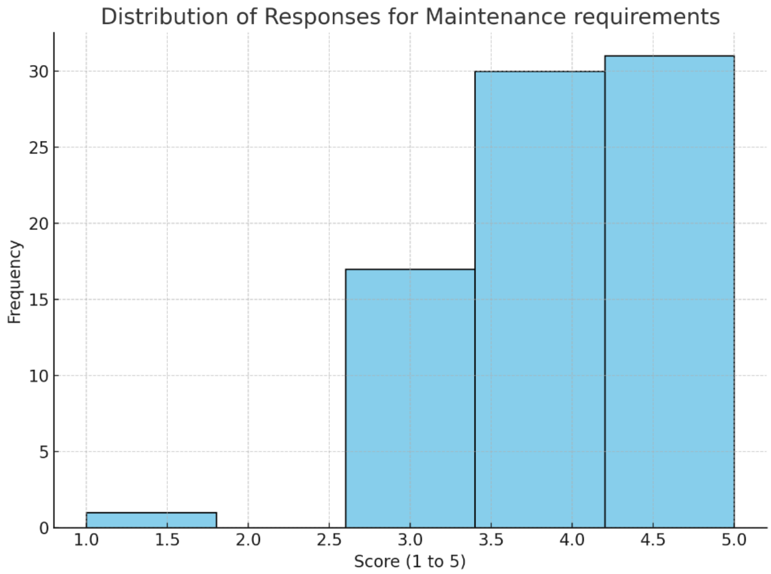

Fig. No.5 : Distribution of responses for the aspect – Maintenance requirements

5.2. Analysis of survey results based on stakeholder groups and their preferences of the criteria to select the EETs

Consultants/Designers

- **Technological Maturity:** Consultants/Designers rate technological
-
- maturity as very important, with most responses clustered at the highest score of 5.
- **Cost:** This group also considers cost to be important, though their primary focus remains on technology and innovation.
- **GHG Reduction Potential:** Consultants prioritize environmental sustainability, with many respondents rating GHG reduction potential as highly important.
- **Ease of Installation:** Ease of installation is moderately important for this group, but not as critical as other factors.
- **Maintenance Requirements:** Maintenance is a top concern, with consultants giving it high ratings, recognizing the need for long-term, maintainable solutions.

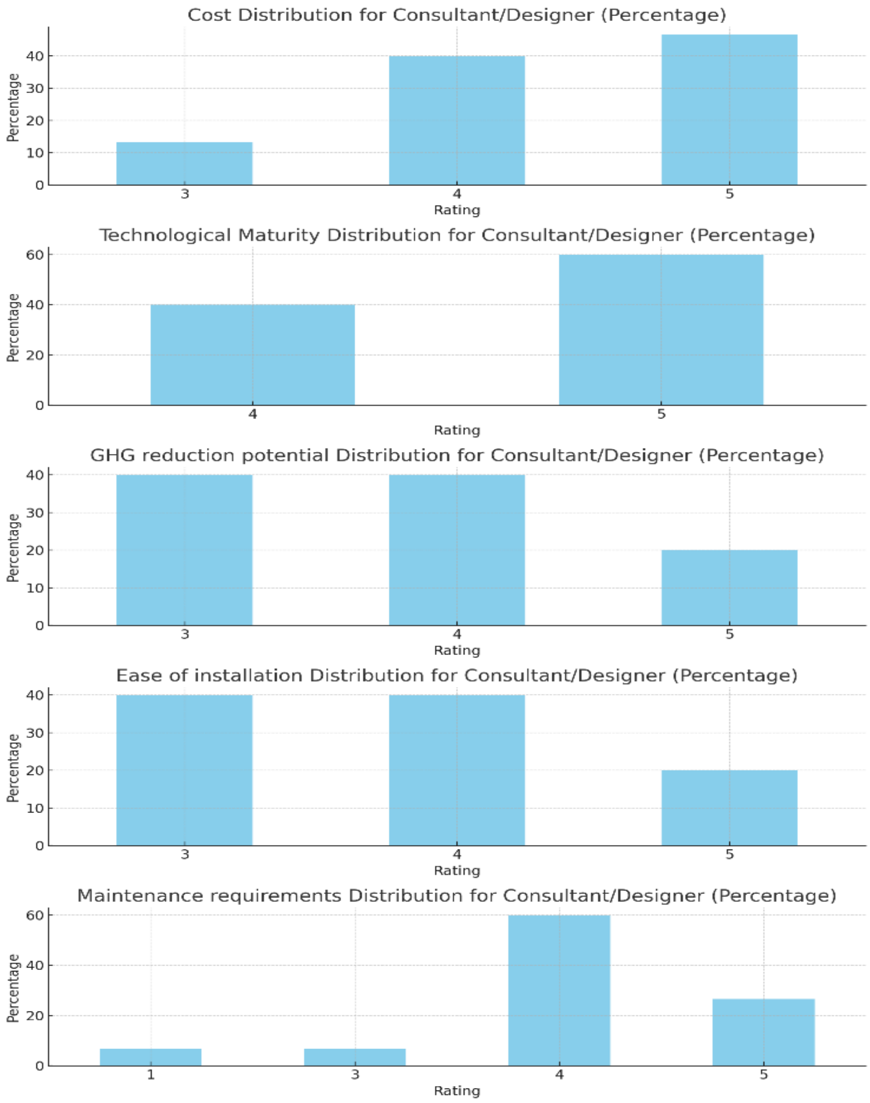

Fig. No.6 : Distribution of responses for all aspects by Consultants and designers

Consultants/Designers focus on technological innovation, sustainability, and practical concerns like cost and maintenance. Ease of installation is less of a priority, possibly because of the reason that they handle more complex projects which require more technologically challenging solutions.

Ship Owners

- **Technological Maturity:** Ship Owners have varied responses but lean towards high ratings, indicating the importance of keeping up with technological advances.
- **Cost:** Cost is a significant factor for Ship Owners, with a wide range of responses but a strong emphasis on high importance.
- **GHG Reduction Potential:** Ship Owners show more variability in their ratings for GHG reduction, indicating that environmental concerns are important but not uniformly prioritized.
- **Ease of Installation:** Ease of installation receives mixed ratings, reflecting the practical challenges that Ship Owners face when implementing new solutions.
- **Maintenance Requirements:** Maintenance is highly rated by Ship Owners, similar to consultants, indicating a strong focus on ensuring long-term reliability.

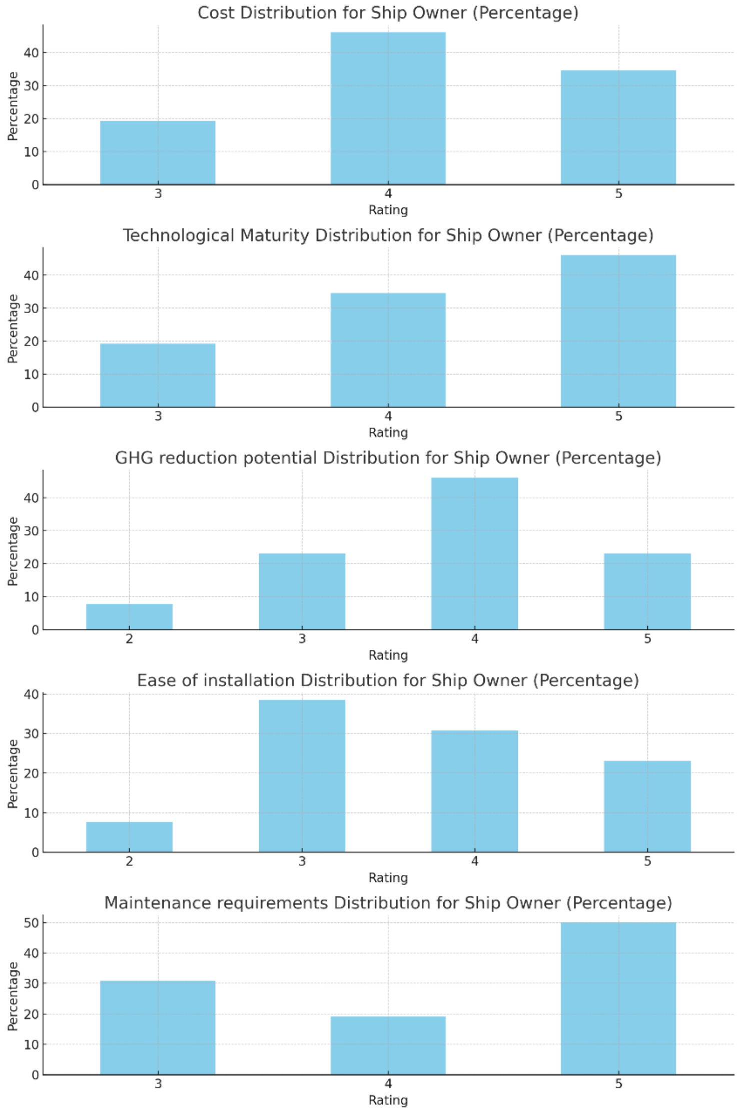

Fig. No.7 : Distribution of responses for all aspects by Ship owners

Ship Owners balance technological maturity and cost with practical considerations like ease of installation and maintenance. While environmental sustainability is important, it may be secondary to more immediate concerns practicality and feasibility.

Ship Managers

- **Technological Maturity:** Ship Managers tend to rate technological maturity as important but with more variability compared to other groups.
- **Cost:** Cost is a significant concern for Ship Managers, reflecting their focus on operational efficiency.
- **GHG Reduction Potential:** Ship Managers have mixed responses to GHG reduction potential, indicating that while sustainability is recognized, it may not be a top priority for all.
- **Ease of Installation:** Ease of installation receives a wide range of responses, suggesting that Ship Managers face varying challenges depending on their specific operations.
- **Maintenance Requirements:** Maintenance is rated as important, but with some variability,

reflecting the need for reliable solutions that minimize downtime.

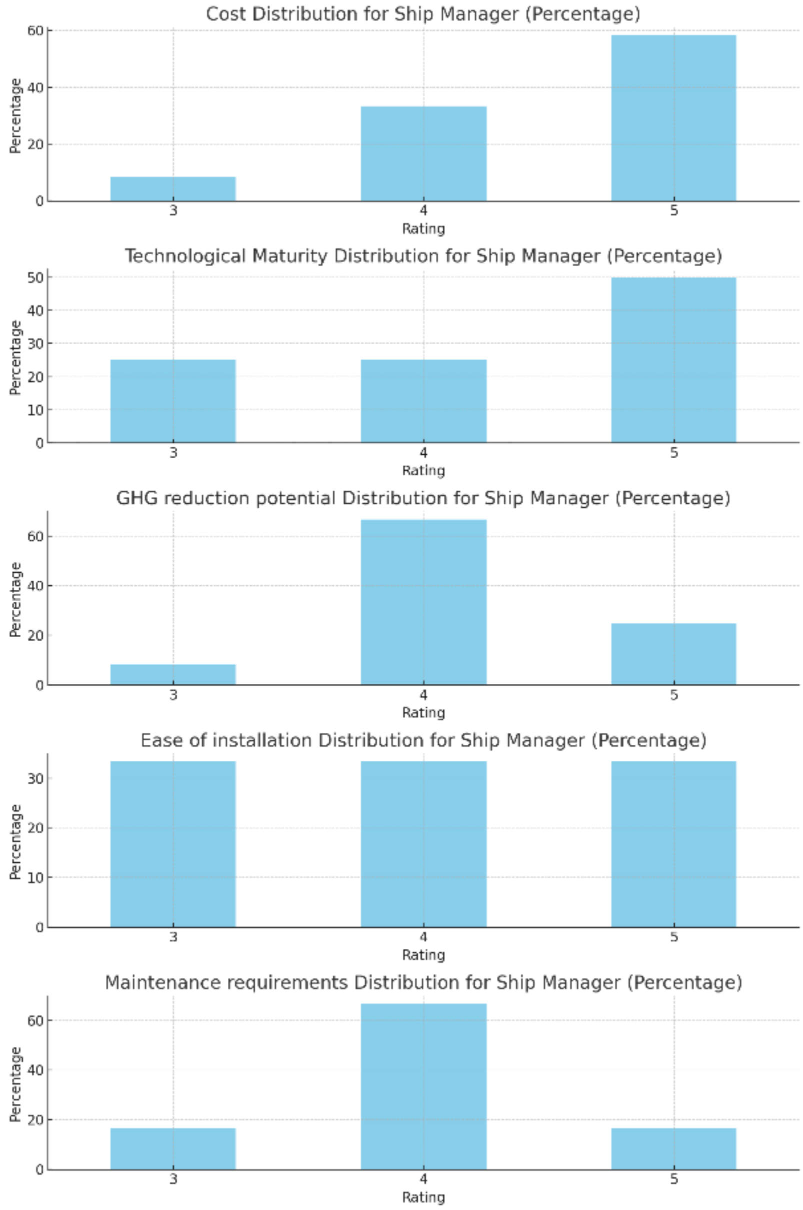

Fig. No.8 : Distribution of responses for all aspects by Ship managers

Ship Managers balance technological and financial considerations with practical concerns such as ease of installation and maintenance. Their responses show more variability, reflecting the diverse challenges they face in their operations.**lass Society/Regulator Body**

- **Technological Maturity:** This group highly values technological maturity, likely due to their role in overseeing industry standards and ensuring that the latest technologies are implemented.
- **Cost:** Cost is also a consideration for Class Society/Regulator Body respondents, though technological advancements take precedence.
- **GHG Reduction Potential:** Sustainability is a priority for this group, with high ratings for GHG reduction potential.

- **Ease of Installation:** Ease of installation is moderately important, with a focus on ensuring that new technologies can be practically implemented.
- **Maintenance Requirements:** Maintenance is rated as highly important, reflecting the need for durable and reliable technologies that meet regulatory standards.

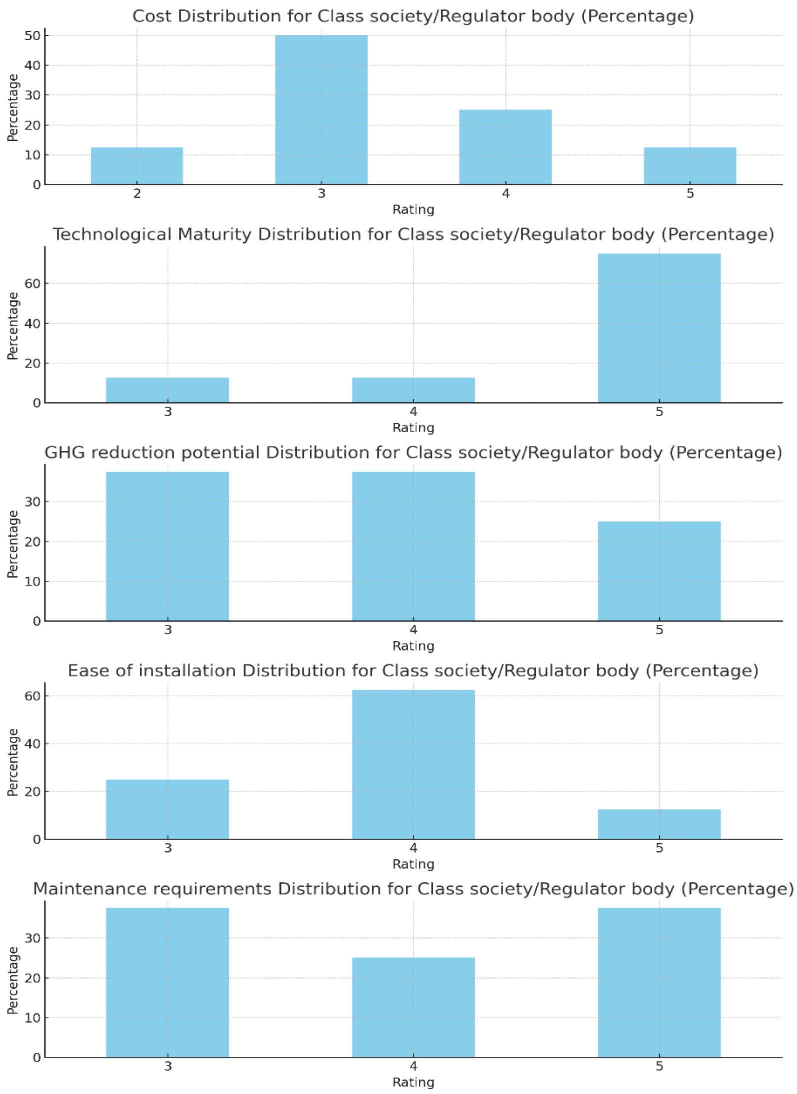

Fig. No.9 : Distribution of responses for all aspects by Classification societies and Regulatory bodies

Class Society/Regulator Body respondents prioritize technology, sustainability, and maintenance, with a focus on ensuring that industry standards are met. Cost and ease of installation are secondary concerns, probably since the practicality and feasibility of installation being of lower priority to the rule making authorities.

Shipyard/Service Providers

- **Technological Maturity:** Shipyard/Service Providers emphasize technological maturity, reflecting the importance of staying competitive with advanced solutions.
- **Cost:** Cost is a significant consideration for this group, with a focus on maintaining operational efficiency while adopting new technologies.
- **GHG Reduction Potential:** Environmental considerations are important, though with some variability in how strongly they are prioritized.

- **Ease of Installation:** Ease of installation is rated as moderately important, reflecting the practical challenges of implementing new technologies.
- **Maintenance Requirements:** Maintenance is highly valued, with a strong focus on ensuring that new solutions are durable and reliable over time.

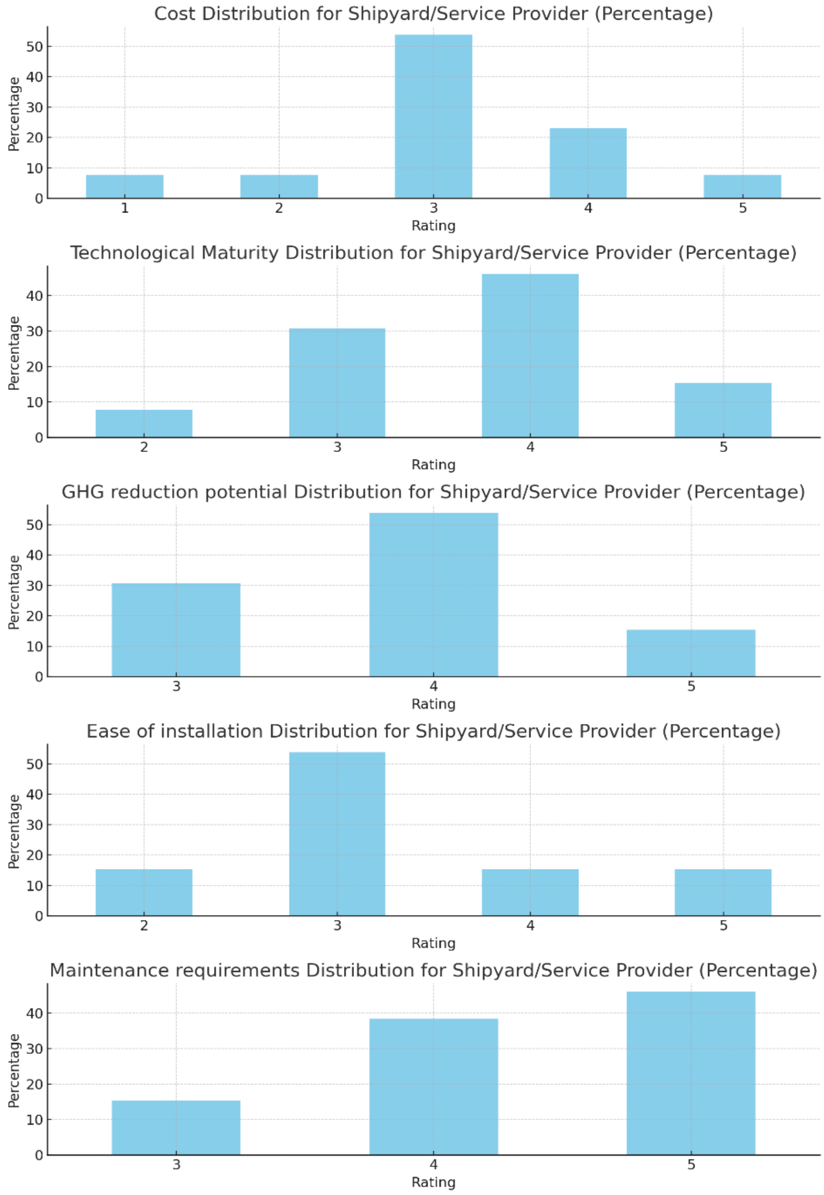

Fig. No.10 : Distribution of responses for all aspects by Shipyards and service providers

Shipyard/Service Providers prioritize technological maturity and cost while balancing environmental considerations and practical concerns like ease of installation and maintenance.

5.3. Key Findings of the statistical analysis and conclusions

- **Technological Maturity, Cost, and Maintenance Requirements** are perceived as the most important factors, with the highest average ratings and concentrations of responses in the upper range of the Likert scale.

- **GHG Reduction Potential** also holds significance, though with slightly more variability in responses, suggesting that while it is important, the emphasis may vary across respondents.
- **Ease of Installation** shows a broader distribution of responses, indicating that while it is considered important, it may not be as universally critical as the other factors.
- The survey results suggest that respondents generally prioritize **Technological Maturity**, **Cost**, and **Maintenance Requirements** when considering important factors in their respective fields.
- **GHG Reduction Potential** is also valued, but with some variability in its perceived importance.
- **Ease of Installation** appears to be an important but slightly less critical consideration for many respondents.

These findings provide valuable insights into the factors that stakeholders consider crucial in their decision-making processes and can guide future research and strategic planning in related fields.

The analysis also reveals several common themes across all respondent types:

- **Technological Maturity** is consistently rated as highly important across all groups.
- **Cost** remains a critical consideration, though it is often balanced with other factors like technological innovation and sustainability.
- **GHG Reduction Potential** is valued, particularly by **Consultants/Designers** and **Class Society/Regulator Body** respondents, though it may be less of a priority for other groups.
- **Ease of Installation** shows more variability in responses, reflecting the different operational challenges faced by each group.
- **Maintenance Requirements** are universally recognized as important, with all groups emphasizing the need for reliable, long-term solutions.

These insights can help guide decision-making and strategy development in various industries, ensuring that the priorities of different stakeholders are considered in future projects.

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