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MAINTENANCE IMPLEMENTATION THROUGH MARINE ERP SYSTEMS

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Abstract

This research paper aims to examine how marine Enterprise Resource Planning (ERP) systems implement maintenance plans in the maritime industry. The objectives of this paper were to examine the evolution of maintenance practices in the maritime industry and the emergence of marine ERP systems as a transformative solution. It also investigates the role of marine ERP systems in optimizing maintenance planning and execution. The article further assessed the financial implications of implementing marine ERP systems for maintenance and explores the alignment between marine ERP systems and environmentally sustainable maintenance practices. The method used in this study was the quantitative technique and the data was collected using the questionnaire survey. The data collected has been analysed using SPSS software to evaluate how maritime ERP systems relate to different facets of maintenance effectiveness. The research's primary target areas are operational effectiveness, cost-cutting, safety improvement, and environmental sustainability. The results revealed that incorporating marine ERP systems in maintenance practices positively impacts all aspects analysed. The study advances knowledge of how technology-driven efforts, such as ERP systems, can transform the maintenance environment in the maritime industry for enhanced operational performance and overall excellence.

Keywords: Marine ERP systems, Maintenance implementation, Maritime industry, Operational efficiency, Environmental sustainability

1. INTRODUCTION

The marine sector is the backbone of international trade which links countries and economies across the enormous oceans. In this industry, ensuring the smooth operation of ships and offshore buildings is crucial for safety, economic vitality, environmental responsibility, and logistical reasons. Maintenance practices have experienced a significant evolution due to which the disruptive influence of technology has largely sparked. A new era of maintenance implementation has been ushered in by developing and integrating Enterprise Resource Planning (ERP) systems, which promise streamlined operations and optimal resource utilization.

However, the marine industry's maintenance was frequently reactive and calendar-based resulting in operational inefficiencies, needless downtime, and elevated hazards for many years. However, current research initiatives have continuously emphasized the potential advantages of using proactive maintenance strategies. Janowicz *et al*. (2020) highlighted the need to include data-driven solutions to improve maintenance efficiency. This research emphasized the importance of switching from conventional maintenance methods to predictive and condition-based models.

Additionally, earlier research by Gavidia (2017) highlighted the importance of ERP systems in developing a consistent information repository that helps with effectively managing spare parts inventories. Downtime due to insufficient parts availability is decreased by optimizing inventory management. Besides this, a key component of maritime success is operational effectiveness, and this is where marine ERP solutions have made a significant impact. ERP systems provide more precise planning, resource allocation, and scheduling by combining maintenance schedules, staff management, and resource allocation. Don (2021) explained how this optimization reduces vessel idle time, lowers overtime expenses, and boosts production. Wang and Aditchere (2022) also emphasized these systems for improving procurement procedures and lower wasteful spending on supplies and spare parts.

Maintaining the effective operation of ships and offshore buildings has been quite difficult for the maritime sector which is a cornerstone of international trade and transportation. Historically, most maintenance procedures in this sector were reactive, frequently triggered by calendar-based routines or in response to serious failures. This reactive approach increased operating risks, unplanned downtimes, and rising operational expenses. The advent of marine Enterprise Resource Planning (ERP) systems has

altered the scene and ushered in a new era of maintenance implementation characterized by proactivity and data-driven decision-making.

The capacity of marine ERP systems to connect many aspects of vessel operations under a single platform gives them their transformational potential. Alarcón *et al*. (2021) presented the integration of maintenance schedules, personnel management, procurement, and inventory control with ERP systems. It encourages a thorough strategy for managing resources and assets, minimising the overstock, cutting down on downtime, and increasing the productivity of workforce. The researcher further argued that maintenance schedules are essential for managing infrastructure and equipment. By incorporating these schedules with ERP mechanisms, businesses may allot resources as per the maintenance needs, avoiding unanticipated failures and expensive downtime. In addition, personnel management integration enhances staff allocation by matching skill sets to maintenance jobs and cutting downtime. The study of Alarcón *et al*. (2021) also reflects that supply chain management is improved by adding functions for inventory control and procurement. ERP systems can continuously track inventory levels and initiate procurement procedures when stocks rise to specified levels. It eliminates a buildup of surplus inventory and lowers the likelihood of shortages, thus increasing cost-effectiveness Alarcón *et al*. (2021).

Additionally, decision-makers receive thorough insights from the integration. ERP systems' data analytics and reporting capabilities enable more informed decisions about the deployment of workers, equipment performance, and resource allocation. The utilization of past data and patterns to predict equipment breakdowns and proactively schedule maintenance tasks is made possible by this data-driven approach Alarcón *et al*. (2021). Besides this, the integration enhances departmental collaboration. By coordinating efforts with maintenance schedules using real-time data exchange, procurement teams can ensure necessary materials are on hand when needed. Similarly, HR departments can match staffing needs with maintenance requirements, maximizing productivity and reducing bottlenecks Alarcón *et al*. (2021).

The integration of maintenance scheduling, labour management, procurement, and inventory control with ERP systems by Alarcón *et al*., thus, marks a fundamental development. Organizations can achieve increased operational efficiency, decreased downtime, ideal inventory levels, and improved decision-making by tearing down departmental walls and encouraging cross-functional collaboration. This integration serves as a model for companies looking to use technology to develop an operational

framework that is more adaptable, flexible, and resource-efficient.

This all-encompassing integration streamlined the information flow, ensuring that maintenance teams have access to up-to-date information on the equipment status, planned maintenance tasks, and available resources. Whereas, beyond technical factors, effective maintenance management includes smooth stakeholder communication. According to research by Qi (2021) marine ERP systems provide enhanced communication between ship sailors, maintenance staff, and shore-based management. Real-time collaboration made possible by these solutions guarantees that maintenance chores are carried out as per the schedule and any alterations or difficulties are quickly resolved.

The constant pursuit of operational continuity sits at the core of marine operations. Downtime caused by unanticipated equipment breakdowns or ineffective maintenance procedures can impact ship timetables, cargo deliveries, and port operations. Tulloch *et al*. (2020) highlighted that effective maintenance practices and the financial resilience of marine organisations are directly correlated. Employing maritime ERP systems provides businesses with a toolkit that helps them coordinate maintenance tasks with operational priorities, reducing disruptions and preserving income streams. Furthermore, safety is paramount in the marine sector, where precious assets and human lives are on the line. Inherently safer, well-maintained equipment and boats decrease the risk of mishaps, collisions, and environmental catastrophes. Oluyisola (2021) explained how ERP systems improve safety by anticipating potential equipment breakdowns through predictive analytics and real-time monitoring. It lowers operational risks, improves worker safety, and makes the maritime environment more secure.

Furthermore, the interplay between employees, spare parts, money, and time is complex in the maritime sector. Ineffective resource management can result in wasteful spending and logistical snags. According to Papathanasiou *et al*. (2020), marine ERP systems maximize resource use by coordinating maintenance schedules with crew availability, the availability of replacement parts, and the procurement cycle. This optimization improves the entire operational environment by cutting expenses while increasing maintenance activities' effectiveness. Besides this, the marine sector is under pressure to lessen its ecological impact as worldwide concerns about environmental sustainability grow. This objective contrasts with traditional maintenance techniques, characterized by reactive interventions and excessive resource usage. Papathanasiou *et al*. (2020) also found that marine ERP systems support sustainability initiatives

by minimizing wasteful resource use, maximizing energy efficiency, and lowering energy costs. Thus, this study expands the scope of its significance to include environmental responsibility in line with international efforts to create a more environmentally friendly future. Moreover, Marine ERP solutions open the door to comprehensive operational excellence rather than isolated maintenance operations improvements. These solutions enable marine organizations to make well-informed decisions based on real-time data and predicted insights by seamlessly combining repair activities with more general vessel operations. This research is important because it reveals the many advantages of marine ERP systems, including cost savings, increased safety, improved environmental stewardship, and operational resilience.

Concisely, combining technical breakthroughs and fresh research findings has fueled the marine industry's shift from reactive to proactive maintenance practices. Previous research has emphasized the drawbacks of conventional maintenance techniques and the possibility of data-driven, predictive alternatives. One cannot understate the importance of marine ERP systems in facilitating this transformation. These systems enable marine organizations to make knowledgeable decisions and optimize maintenance activities, resulting in safer, more effective, and more affordable operations. They do this by integrating multiple parts of vessel operations, providing real-time monitoring, and boosting communication. This study intends to explore the complex mechanisms by which marine ERP systems revolutionize maintenance applications in the maritime industry. It also contributes to a better understanding of how technology-driven initiatives might alter the maritime sector's maintenance landscape by examining their influence on operational efficiency, cost reduction, safety enhancement, and environmental sustainability.

2. REVIEW

2.1 Evolution of maintenance practices in the legacy system of the maritime industry and the emergence of the enterprise resource planning (ERP) system as a transformative Solution

The transformation of the world is offering change as per the need of the setup. ERP is a supportive solution to aid in this transformation. Legacy systems can be supplemented by ERP solutions by linking maintenance procedures to the larger organisational ERP for more thorough integration and efficiency. By utilising satellite communications, these integrated systems provide improved maritime communication capabilities. They give businesses a uniform platform on which to

manage and easily integrate crucial elements. By enabling resource planning and online monitoring, various ERP software programs have demonstrated their value (Shan, 2022).

The Fourth Industrial Revolution, often known as Industry 4.0, has fueled the use of maintenance systems as the maritime industry continues to develop. This revolutionary change is changing how seaports function, highlighting the necessity of a thorough reform. Min (2022) emphasises the value of ERP in enabling quick technology advancements in the marine industry's maintenance system. In line with the maritime industry's transition to more environmentally friendly practices, the integration of marine ERP systems has been shown to significantly reduce energy consumption during maintenance tasks.

An increasing focus is being placed on creating smart port systems within the ERP architecture to adapt to the changing environment. This strategy makes use of contemporary resources and sparks investor interest, furthering the development of maritime operations. As a result, the marine industry is being reshaped for greater efficiency and sustainability through the integration of maintenance practices into the organisational ERP.

2.2 Marine ERP systems in optimizing Legacy systems like maintenance

The use of some positive and technical approaches including the integration of data from various sensors and sources can be employed with marine maintenance systems. Papoutsidakis *et al*. (2019) reviewed the specific concepts that are related to Information Systems for enterprises. It has evaluated the use of the place for the emphasis on Information Systems in the area of shipping companies. The study reviewed the specific concepts and terms that are related to shipping and its varied categories in the maritime industry. This is an effort to weigh the shipping companies that are referred to in the present aspects. They are also reviewed with the responsibilities of shipping departments. This can also help to be used for better approach applications.

Papoutsidakis *et al*. (2019) revealed that more use of combining technical breakthroughs and fresh research findings has fueled the marine industry's shift from reactive to proactive maintenance practices. This can be analyzed from the drawbacks of conventional maintenance techniques and the possibility of data-driven, predictive alternatives. The popular platform for marine companies has to manage and integrate the essential work plans using modern technology. Many ERP software applications are ideal and help organizations because they can also implement resource planning with

planned optimisation. One may have good results by arising from the information systems. This is explored in the companies which can check for shortages of raw materials. The ERP is ideal for material goods and makes important decisions. This can manage the increase in their sales. Information systems are always helpful so they may have a positive impact on the management of the ship processes. Shan (2022) reviewed the use of some marine exploration under scientific research enterprises which has a positive influence in the context of optimisation. It is applying the use of some better processes of marine exploration with the help of GPS sensors.

2.3 Financial implications of implementing marine ERP systems for maintenance

The role of financial tools must be considered for implementing a marine ERP system of maintenance in the maritime sector. It may include smart applications by the potential reduction in maintenance-related costs and overall operational expenditures. Papoutsidakis *et al*. (2019) indicated that financial support can be taken from ERPs of shipping organizations to manage the concept of Information Systems in their respective discourse. If the ERP of maritime organizations is cost-effective then it is adding more value to the functioning with the help of Internet applications. This is also called ERP for smart working e-maritime in the maritime sector. ERP maintenance plays an essential role that involves checking the record online and updating the software from time to time within the organizational setup. It is also involving the use of some hardware, and network components in the marine ERP system with costs. This can be done by performing backups and data recovery which may promote the use of software up gradation. Min (2022) claims that it can control financial costs because it is a more efficient management system offshore with engineering exploration activities.

Cost-effectiveness is an important factor and needs to be addressed in all businesses, including marine services. Hence, one can be capable of applying for the ERP system which is also running smoothly. The use of some securely planned purposes and using the reliably may help to promote the role of sorting any kind of issues detected. Lun *et al*., (2017) support that they can be resolved from time to time. The use of devices instead of humans may apply the role of smart tools which may not demand safety concerns. It is financially compatible as the use of an ERP information system helps manage machine working. It can help to manage their amount of information better.

The information systems can help every shipping company with the use of modern tools like the system to automate the processes for saving valuable time. This is good for saving time and also having a complete view of its operations.

2.4 Alignment between ERPs of organization and environmentally sustainable maintenance practices

There is a need to focus on the reduction of waste, energy consumption, and environmental impact. Using an ocean fleet may indeed include personnel and materials that may help the teams in coordination and better dealing with special characteristics of marine exploration. Lun *et al*. (2017) claim that ERP can be helpful as it may save the perspective of dealing with the use of an ERP mechanism that can effectively control the ocean fleet with less or no pollution. The online systems and coordination may be dealing with the scientific research units that have to manage the entire process of marine exploration. This can be effectively environment-friendly by exploring non-human but machine items. Environment is an important concern that cannot be ignored in any regard. This is why green practices can promote more betterment.

Gholami *et al*. (2016) claim that people working on green Information Systems (IS) show less importance to the ecologies. It is required as a priority while considering sustainable development goals. This is needed with the review as mentioned by SDG goals for IS solutions that also contribute to dealing with climate change positively. More sustainable practices by employing machines and sensors instead of humans can be promising activities that may be eco-friendly. They may need less safety and support in the long run by ensuring the use of green technologies. They may include ERP applications with less or no waste at all. It is productive as it will also be an interplay between employees, spare parts, money, and time is complex in the maritime sector. This will lead to support the gaps for ineffective resource management that can result in wasteful spending and logistical snags.

2.5 Literature Gap

Several existing studies have been examined in the literature review of the deployment of maintenance with marine ERP systems. These studies provide insightful information about the possible advantages and uses of ERP in the marine industry. According to Min (2022), ERP systems have a significant outlook in the context of the marine industry and are important for accelerating technical advancements. The researcher further expressed that the Fourth Industrial Revolution and ERP systems are significantly relevant to this advancement. Whereas, by highlighting the function of green ERP in fostering sustainability within the maritime domain, Gholami *et al*. (2016) focused attention on the environmental side of ERP. In addition, Lun *et al*. (2017) highlight the significant influence of ERP systems as a strategic instrument in contemporary enterprises, illuminating their versatile utility. However, Papoutsidakis *et al*. (2019) provide a thorough overview of the area while delving into specific issues relevant to Information Systems in modern organisations. The critical examination of existing literature reveals that there is a plethora of research work on the exploration of the benefits and applicability of ERP systems in the marine industry, but still, there is a research gap about the specific role and influence of ERP in optimizing maintenance practices for environmental sustainability and waste reduction in the marine industry.

On behalf of the thorough analysis of existing research findings and subsequent identification of the research gap, some research questions are formulated to conduct the current study.

1. How can marine ERP systems optimise maintenance practices in the context of ship projects?
2. How can marine ERP systems be used in maritime projects to reduce waste production and encourage environmentally friendly operations?

With these research questions as a guide, the current research explores, examines, and adds to the expanding body of information about marine ERP systems and their function in maintenance optimisation.

3. METHODOLOGY

3.1 Methodological Choice and Data Collection

The research philosophy is the framework that assists the researcher in conducting the study based on the ideas, type of knowledge, and reality (Basci *et al*., 2022). For the current research paper, the positivist research philosophy adopted implies a dedication to empirical observation and the methodical verification of facts. By using quantitative data and meticulous testing, positivism emphasizes objectivity and the notion that knowledge may be obtained from observable facts. This strategy is in line with the idea that the laws and principles that govern both the physical and social worlds can be identified via methodical investigation (Ryan, 2018). In the context of the current study, positivism research philosophy acts as the theoretical foundation for the research, highlighting the careful and methodical analysis of the influence of maritime ERP systems on maintenance procedures.

Research design narrates the complete strategy that the researcher chooses for the integration of different elements in a rational way. The study has been conducted using the quantitative approach to study the maintenance of the implementation through the marine ERP system. In the quantitative approach, the data can be gathered and interpreted through numerical values based on the observations of participants (Jamieson *et al*., 2022). The quantitative approach is useful because it helps in the identification of the facts about the link between factors. For this research, the data was collected using primary sources which include a questionnaire survey.

The research instruments are the tools for the collection, measurement, and analysis of the data related to the subject. The research instrument used in this study is the questionnaire survey and the purpose is to understand the maintenance implementation of the marine ERP system. The closed-ended question in the form of a Likert scale was used to understand the experiences of the participants.

3.2 Sample size and sampling technique

Sampling is the method of the selection of the participants for the research and is used for making statistical inferences by estimating the characteristics of the overall population (Fischer *et al*., 2023). The selection of a suitable sample size and sampling method is crucial for a research study to ensure the reliability and legitimacy of its results. The researcher used a non-probability sampling technique with a snowball sampling approach. The sample size of 23 shipping businesses

was selected for the research paper on maintenance implementation through maritime ERP systems based on predetermined criteria. The criteria behind the selection of these 23 shipping businesses included companies' size, location, and prior use of marine ERP systems. The features of the chosen organisations, such as their geographic distribution, size (small, medium, large), and industry sectors were also critically examined to ensure that the sample is representative of the industry.

However, the snowball sampling method, in which individuals invite coworkers or acquaintances to take part, has benefits but also the potential for bias. Therefore, to prevent its potential biases in the current study, the researcher ensured that participants made referrals for people with various backgrounds and perspectives relevant to the targeted area of the current study.

3.3 Data analysis technique

The data analysis is the cleaning, organization, and gathering of the data, and for this research statistical approach was used. The SPSS data analysis toque was used for the analysis of quantitative data that helps in searching with data sets for reporting, analysis, and identification of different research patterns. The questionnaire of this study was design to collect the opinions of stakeholders regarding maintenance implementation through marine ERP systems. Therefore, majorly frequency analysis under SPSS was done to better examine the frequencies of participants' opinions. However, there is room for further investigation in this domain to examine the relationship between the maintenance implementation through marine ERP systems and its subsequent impacts.

3.4 Ethical Consideration

Ethical considerations have to be considered when research is being conducted using the primary quantitative approach. The informed consent is one of the most important aspects in this respect which has to be filled by the participants conducting the survey. The researcher has ensured the informed consent, maintained privacy and confidentiality of the participants, and ensured that they are taking voluntary participation.

3.4 Limitations of the Study

One of the limitations of the study is the bias in the sampling and results may not fully reflect the implementation strategies of the marine ERP system. Additionally, there may exist biases by using the questionnaire alone for the data gathering. Data mistakes resulting from participants while giving answers were one of the limitations of the study.

4. FINDINGS AND ANALYSIS

4.1 Demographic analysis

The demographic data gathered from survey participants shows a gender distribution that is balanced, with 18 identifying as female, 3 of the total respondents as male, and 1 of the individuals opting not to disclose their gender. Respondents' professional experience in the shipping business is diverse. Approximately 4 of the total respondents have 2 to 5 years of experience, 5 of the total respondents have 6 to 10 years, and 14 of the total respondents have more than 10 years. This distribution reflects a mix of early-career and seasoned shipping personnel, broadening the range of viewpoints for assessing the congruence between maritime ERP systems and sustainable maintenance practices.

Gender

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	Female	18	78.3	81.8	81.8
	Male	3	13.0	13.6	95.5
	Prefer not to mention	1	4.3	4.5	100.0
	Total	22	95.7	100.0	
Missing	System	1	4.3		
	Total	23	100.0		

Professional experience in the shipping industry

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	2 to 5 years	4	17.4	17.4	17.4
	6 to 10 years	5	21.7	21.7	39.1
	More than 10 years	14	60.9	60.9	100.0
	Total	23	100.0	100.0	

4.2 Role of marine erp systems in maintenance

The table below contains responses to questions about the impact of marine ERP systems on maintenance processes in the shipping sector. Respondents' perspectives on the statement "The integration of marine ERP systems has improved the overall efficiency of maintenance processes" are distributed in terms of frequency as follows: 4 individuals strongly agree, 15 individuals agree, 4 individuals are indifferent, and 5 individuals disagree. This reflects a generally good opinion of efficiency enhancement, with a sizable majority agreeing.

In response to the claim that "Marine ERP systems have positively impacted the accuracy of maintenance data recording and analysis," the distribution of responses is as follows: 8 of the total highly agree, 14 of the total agree, and 1 of the total are neutral. This indicates that a significant proportion recognises the positive influence on data accuracy and analysis.

In addition to this, respondents' perspectives on the statement "The implementation of marine ERP systems has led to better resource allocation for maintenance tasks" are recorded as: 4 of 23 strongly agree, 14 of 23 agree, and 5 of 23 are indifferent. This reveals a generally good opinion of efficiency enhancement, with a sizable majority agreeing.

The integration of marine ERP systems has improved the overall efficiency of maintenance processes in the shipping industry.

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	Strongly agree	4	17.4	17.4	17.4
	Agree	15	65.2	65.2	82.6
	Neutral	4	17.4	17.4	100.0
	Total	23	100.0	100.0	

Marine ERP systems have positively impacted the accuracy of maintenance data recording and analysis.

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	Strongly agree	8	34.8	34.8	34.8
	Agree	14	60.9	60.9	95.7
	Neutral	1	4.3	4.3	100.0
	Total	23	100.0	100.0	

The implementation of marine ERP systems has led to better resource allocation for maintenance tasks.					
		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	Strongly agree	4	17.4	17.4	17.4
	Agree	14	60.9	60.9	78.3
	Neutral	5	21.7	21.7	100.0
	Total	23	100.0	100.0	

Furthermore, the tables below provide information on the perceived influence of marine ERP systems on several elements of maintenance implementation in the shipping sector. Regarding the statement "Training programmes provided for effectively using marine ERP systems have contributed to successful maintenance implementation," the following comments have been distributed in terms of number of respondents: There are 4 individuals who highly agree, 12 individuals who agree, 6 individuals who are neutral, and 1 individual who disagree. This shows that while a sizable majority recognises the favourable significance of training programmes to successful maintenance implementation, a sizable number remains studied to agree with the question statement.

According to the response distribution for the assertion "Marine ERP systems have facilitated better communication and collaboration among maintenance teams," 3 of 23 strongly agree, 16 of 23 agree, 3 of 23 are indifferent, and 1 of 23 disagree. This demonstrates a divided view of the amount to which communication and collaboration have improved, with a sizable portion agreeing with the statement.

According to the distribution of responses to the statement "The ease of accessing real-time maintenance information through marine ERP systems has enhanced decision-making for maintenance strategies," 7 of the total highly agree, 9 of the total agree, and 7 of the total are neutral. These responses highlight a generally positive outlook on the improvement of decision-making through real-time information availability.

Training programs provided for using marine ERP systems effectively have contributed to successful maintenance implementation.					
		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	Strongly agree	4	17.4	17.4	17.4
	Agree	12	52.2	52.2	69.6
	Neutral	6	26.1	26.1	95.7
	Disagree	1	4.3	4.3	100.0
	Total	23	100.0	100.0	

Marine ERP systems have facilitated better communication and collaboration among maintenance teams in the shipping industry.					
		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	Strongly agree	3	13.0	13.0	13.0
	Agree	16	69.6	69.6	82.6
	Neutral	3	13.0	13.0	95.7
	Disagree	1	4.3	4.3	100.0
	Total	23	100.0	100.0	

The ease of accessing real-time maintenance information through marine ERP systems has enhanced decision-making for maintenance strategies.					
		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	Strongly agree	7	30.4	30.4	30.4
	Agree	9	39.1	39.1	69.6
	Neutral	7	30.4	30.4	100.0
	Total	23	100.0	100.0	

The following responses to the statement “The implementation of marine ERP systems has reduced vessel downtime due to streamlined maintenance practises” are divided as follows: There are 3 of the total who highly agree, 12 of the total who agree, and 8 of the total who are neutral. This indicates that a sizable proportion recognises the reduction in vessel downtime as a result of streamlined maintenance practices. Whereas, in response to the statement “Marine ERP systems have improved the tracking and management of spare parts inventory for maintenance purposes,” the response distribution is as follows: 7 of the total highly agree, 13 of the total agree, 2 of the total are neutral, and 1 of total disagree. This reflects a generally positive assessment of enhanced spare parts inventory tracking and management, albeit some remain sceptical.

The implementation of marine ERP systems has reduced the downtime of vessels due to streamlined maintenance practices.					
		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	Strongly agree	3	13.0	13.0	13.0
	Agree	12	52.2	52.2	65.2
	Neutral	8	34.8	34.8	100.0
	Total	23	100.0	100.0	

Marine ERP systems have improved the tracking and management of spare parts inventory for maintenance purposes.					
		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	Strongly agree	7	30.4	30.4	30.4
	Agree	13	56.5	56.5	87.0
	Neutral	2	8.7	8.7	95.7
	Disagree	1	4.3	4.3	100.0
	Total	23	100.0	100.0	

In response to the statement, “There is a need for continuous updates and customization of marine ERP systems to align with evolving maintenance requirements,” 13 of 23 strongly agree, 9 of 23 agree, and 1 of 23 are neutral. This demonstrates a common understanding of the need for continual upgrades and customisation.

There is a need for continuous updates and customization of marine ERP systems to align with evolving maintenance requirements.					
		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	Strongly agree	13	56.5	56.5	56.5
	Agree	9	39.1	39.1	95.7
	Neutral	1	4.3	4.3	100.0
	Total	23	100.0	100.0	

esponses to the statement, “Marine ERP systems have played a significant role in optimising maintenance practises to minimise waste generation and promote environmentally friendly operations,” are as follows: 2 of 23 strongly agree, 14 of 23 agree, 5 of 23 are indifferent, and 2 of 23 disagree. This demonstrates a significant appreciation for the role these systems play in fostering environmental sustainability through waste reduction and environmentally beneficial practices.

Regarding the statement "The integration of marine ERP systems has led to measurable reductions in energy consumption during maintenance activities, contributing to more sustainable practises," the distribution of responses is as follows: 2 of the total respondents strongly agree, 11 of them agree, 5 of total are indifferent, and 5 of total respondents disagree. This highlights the understanding of how merging these systems might save energy. Whereas, in response to the claim that "the use of marine ERP systems has enhanced our ability to track and manage environmental impacts associated with maintenance, such as emissions and disposal of hazardous materials," the following responses have been made: 10 people agree, 8 people are neutral, 3 people strongly disagree, 10 people agree, and 2 people disagree. This highlights how important maritime ERP solutions are for better environmental management and monitoring.

Marine ERP systems have played a significant role in optimizing maintenance practices to minimize waste generation and promote environmentally friendly operations.

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	Strongly agree	2	8.7	8.7	8.7
	Agree	14	60.9	60.9	69.6
	Neutral	5	21.7	21.7	91.3
	Disagree	2	8.7	8.7	100.0
	Total	23	100.0	100.0	

The integration of marine ERP systems has led to measurable reductions in energy consumption during maintenance activities, contributing to more sustainable practices.

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	Strongly agree	2	8.7	8.7	8.7
	Agree	11	47.8	47.8	56.5
	Neutral	5	21.7	21.7	78.3
	Disagree	5	21.7	21.7	100.0
	Total	23	100.0	100.0	

The use of marine ERP systems has enhanced our ability to track and manage environmental impacts associated with maintenance, such as emissions and disposal of hazardous materials.

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	Strongly agree	3	13.0	13.0	13.0
	Agree	10	43.5	43.5	56.5
	Neutral	8	34.8	34.8	91.3
	Disagree	2	8.7	8.7	100.0
	Total	23	100.0	100.0	

The responses in the above analysis reveal a generally good opinion of the impact of marine ERP systems on maintenance practices in the shipping industry. Professionals are unanimous in their belief that these systems improve maintenance efficiency, data accuracy, and resource allocation. Furthermore, it is acknowledged that ERP systems promote communication, collaboration, and decision-making. Similarly, views on their contribution to waste reduction and environmental sustainability are also agreed on adopting the systems that play a significant role in fostering environmental sustainability through waste reduction and environmentally beneficial practices. These findings imply that, while maritime ERP systems provide major benefits, there is still room for improvement in aligning them with sustainable practices, necessitating additional research to increase their environmental impact.

5. DISCUSSION

5.1 ERP System in the Shipping Industry

The marine industry is characterized by complex operations and international reach that need efficient software solutions for the management of marine systems. Therefore, Enterprise Resource Planning (ERP) has been designed for the industry to enhance operational efficiency and gain profits (Nikolopoulos *et al*., 2003). The ERP system brings all the business into a single platform and integrates different operations like inventory management, procurement, sales, human resources, and finance. The integrated approach helps streamline operations, reduce redundancies, and improve efficiency. The survey responses in the current study offer important insights into how maintenance practices in the shipping industry are impacted by marine ERP systems. The findings show that these systems and their contributions to various maintenance activities are viewed favourably. Most respondents concur that the integration of maritime ERP systems has increased maintenance process efficiency. This is in keeping with the primary goals of ERP systems, which are to increase operational efficiency, reduce waste, and streamline processes.

5.2 Role Of Marine ERP Systems In Maintenance

The results from the findings illustrate that participants showed that by utilizing the ERP system maintenance is easy and quick, most respondents showed positive results and agreed about the results significance of ERP systems in the marine industry. According to Oluyisola (2022), the ERP system helps keep track of the day-to-day processes and operations including maintaining the types of equipment.

Marine operations are challenging and usually, there exist ineffective maintenance procedures, cargo deliveries, and port operations, for this purpose effective maintenance is required and the implementation of the marine ERP system has provided a toolkit for the business to improve operations, maintenance, and deduction in disruptions (Janowicz *et al*., 2020). Thus, participants of the research agreed on the benefit of ERP systems in marine systems and helped in the justification of the research objective.

5.3 Marine ERP for the Data Recording And Analysis

The participants responded positively to the Marine ERP for data recording and analysis in the shipping industry. 14% of participants agree that the ERP system is useful in maintaining records and this indicates the data accuracy and its similarity with findings from the literature. According to Gavidia (2017), maritime logistics use an ERP system to help better control the business to gain technical competencies, solution-based dynamics, and appropriate control of the equipment and operations of the business. However, the affirmative response to the claim that maritime ERP systems have improved the accuracy of maintenance data recording and analysis further demonstrates the system's capacity to deliver accurate and trustworthy information for informed decision-making.

5.4 Importance of Training Programmes for the Effective Use of ERP System

ERP system is an advanced system so most employees in the marine industry are unaware of the technology. Therefore, the question was asked participants regarding the importance of the training of the employees regarding ERP and 12% of participants agreed. The training of the employees regarding the ERP system ensures the appropriate understanding of employees about the system. The training of the ERP system helps enable staff to complete the task quickly and this helps in increasing the productivity of employees (Alarcon *et al*., 2021). Thus, training programs ensure positive outcomes regarding the implementation of the ERP system in the marine industry. Therefore, by implementing an ERP system and ensuring its benefits in the industry, marine business managers offer training to employees to keep their knowledge upgraded so the industry gets the expected and positive outcomes with the utilisation of the latest technology system. However, responses to questions about cooperation and communication across maintenance teams reveal a more polarised viewpoint. While many people recognise the gains, there is also evidence that more improvements are required. To ensure the successful application of these tools

in encouraging greater communication and collaboration, customization and advanced training may give fruitful results.

5.5 Implementation of the Marine ERP helps in reducing Vessel downtime

The response regarding reducing vessel downtime and improved tracking of the spare parts in the ERP system was also positive. Participants agree that marine ERP helps in improving operations as the tracking stay well aligned and the management of inventory stay controlled. It demonstrates that the use of the ERP system is appropriate in the management, maintenance, and operations of the shipping business. Thus, the ERP system proves to be efficient for the marine industry as it makes the marine transport system efficient and reduces vessel downtime.

6. CONCLUSION

The crux of the current research's findings revealed that the Enterprise Resource Planning (ERP) system deployment in the marine sector marks a crucial step towards utilising cutting-edge technology for simplified operations, effective maintenance, thorough tracking, and precise record-keeping. This study strongly supports the need for marine firms to implement ERP systems in light of the identified benefits they offer, including the optimisation of maintenance procedures, the reduction of waste creation, and the facilitation of environmentally sustainable operations. It has been found that the deployment of ERP systems gives an efficient and computerised method of controlling and maintaining marine operations and systems. However, employee training is essential for the effective alignment of these systems within marine firms. This gives them a thorough awareness of the system's capabilities and gives them the ability to come up with creative solutions for their tasks. As a result, the trained employees lead to increased data accuracy, resource allocation effectiveness, and operational efficiency.

Additionally, the research's findings unambiguously show how ERP systems aid in better decision-making, promote environmental sustainability, and lessen waste production. Their significant advantages are highlighted, and there is room for improvement in terms of better integrating ERP systems with marine business-related operations. Notably, the research findings clarify the crucial role that ERP systems play in inventory control, in streamlining transportation and shipping processes, and in the rigorous upkeep of shipping records. Besides this, it has also been acknowledged that ERP systems are also connected to

simplified maintenance and transportation planning, strengthened distribution management, increased transparency, and lower operating costs. Thus, their adoption enables the marine industry to carry out shipping activities more affordably, increasing the industry's overall value and competitiveness.

7. RECOMMENDATIONS

In light of the above findings of the current research paper, it is advised that maritime industry professionals give employee training top priority to maximise the ERP system's effective utilization. Employees are better equipped to take advantage of the system's full potential through this investment in education, which ultimately increases data accuracy and operational efficiency (Kaydos, 2020). However, the results of this research work should also be taken into account by management as a strategic requirement for resource allocation and informed decision-making. The study shows that ERP systems have a significant positive impact on promoting environmental sustainability, reducing waste production, and improving inventory control. Additionally, management's active involvement in their integration is required due to the systems' contribution to cost-effective operations through better maintenance, transportation scheduling, distribution management, and decreased expenses.

8. RESEARCH IMPLICATIONS

The findings of the study are crucial for developing policies in the marine industry. The advantages of fostering greater ERP system use in the marine industry should be acknowledged by policymakers. Such a push for policy not only supports environmental sustainability but also improves the sector's economic performance and competitiveness. To hasten the adoption of ERP systems and improve the sector's environmental stewardship and overall economic resilience, this policy development may include incentives or rules which will surely prosper the sector economically.

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10. APPENDIX: SURVEY QUESTIONNAIRE

Demographic

Gender:

Male-1

Female-0

2- Prefer not to mention

Professional experience in the shipping industry

2-5 years – 0

6-10 years -1

More than 10 years -2

Statements	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
The integration of marine ERP systems has improved the overall efficiency of maintenance processes in the shipping industry.					
Marine ERP systems have positively impacted the accuracy of maintenance data recording and analysis.					
The implementation of marine ERP systems has led to better resource allocation for maintenance tasks.					
Training programs provided for using marine ERP systems effectively have contributed to successful maintenance implementation.					
Marine ERP systems have facilitated better communication and collaboration among maintenance teams in the shipping industry.					
The ease of accessing real-time maintenance information through marine ERP systems has enhanced decision-making for maintenance strategies.					
The implementation of marine ERP systems has reduced the downtime of vessels due to streamlined maintenance practices.					
Marine ERP systems have improved the tracking and management of spare parts inventory for maintenance purposes.					
There is a need for continuous updates and customization of marine ERP systems to align with evolving maintenance requirements.					
Marine ERP systems have played a significant role in optimizing maintenance practices to minimize waste generation and promote environmentally friendly operations.					
The integration of marine ERP systems has led to measurable reductions in energy consumption during maintenance activities, contributing to more sustainable practices.					
The use of marine ERP systems has enhanced our ability to track and manage environmental impacts associated with maintenance, such as emissions and disposal of hazardous materials.					