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Ship Maintenance Management Practices: Insights from Internships in Shipping Engineering

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Abstract. *This research investigates ship maintenance management practices among senior students in shipping engineering during their internships at a vocational school in Jakarta. The study explores the challenges faced, strategies employed, and lessons learned in managing maintenance tasks onboard ships. Seven participants were interviewed, highlighting technical malfunctions, resource limitations, time constraints, environmental factors, and communication barriers as primary challenges. Participants utilized preventive maintenance, cross-training, task prioritization, collaborative problem-solving, and digital tools to enhance operational efficiency. Lessons underscored the importance of preparation, teamwork, adaptability, continuous learning, and communication skills in navigating maritime maintenance complexities. The findings emphasize the role of proactive maintenance strategies and technological integration in optimizing sustainability and operational reliability within the maritime industry. Integrating practical training into educational curricula and embracing digital innovations are recommended for preparing future professionals. Future research could explore larger sample sizes and quantitative methodologies to validate findings and quantify the impact of maintenance practices. This study contributes to enhancing vocational education in maritime sciences and informs industry practices for advancing ship maintenance management globally.*

Keywords*: ship maintenance, internship, shipping engineering, maintenance management, maritime education*

1. INTRODUCTION

Ship maintenance in the maritime industry plays a pivotal role in ensuring the operational efficiency and safety of marine vessels (Akyuz & Celik, 2017; Stanivuk et al., 2020). This aspect of maritime operations is particularly critical as it directly impacts the reliability and longevity of ships, thereby influencing both economic and environmental sustainability within the sector (Angelaki et al., 2024). Within the framework of vocational education in maritime sciences, the integration of practical training such as internships is essential. These opportunities not only provide students with hands-on experience but also bridge the gap between theoretical knowledge and real-world applications in ship maintenance management.

The focus of this research is on senior students majoring in shipping engineering at a vocational school in Jakarta, specifically within the Engineering - Machinery study program in maritime shipping. The study investigates how these students manage ship maintenance during their 12-month internships in the port and shipping management industry. This research is significant in addressing the practical aspects of maritime education, where students are expected to apply their academic knowledge to real-world scenarios. By examining the

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experiences of these students, the research aims to contribute valuable insights into effective ship maintenance practices and management strategies employed in the field.

The objectives of this study are twofold: first, to explore the specific challenges encountered by senior students during their internships in ship maintenance management; and second, to identify the strategies used by these students to address these challenges. Understanding these dynamics is crucial for enhancing the educational curriculum in maritime sciences, ensuring that future professionals are adequately prepared to meet the demands of the industry. By focusing on internship experiences, the research seeks to provide practical recommendations for improving vocational training programs in maritime engineering and technology.

One of the primary motivations for conducting this research lies in the existing gap between theoretical knowledge and practical skills in maritime education (Ghosh et al., 2014; Sharma, 2023). While academic institutions provide students with comprehensive theoretical frameworks in ship maintenance, the application of this knowledge in real-world settings often presents unforeseen challenges. These challenges may range from technical issues related to machinery and equipment to logistical constraints within port operations. Furthermore, the industry's increasing emphasis on sustainability and efficiency necessitates a nuanced understanding of practical ship maintenance practices that align with environmental stewardship and economic viability. Moreover, the current literature on maritime education often focuses on theoretical aspects or broader policy discussions rather than specific insights derived from practical experiences of students. By filling this gap, the research aims to enrich the academic discourse on vocational training in maritime sciences, particularly in the context of ship maintenance management. This approach not only enhances the educational outcomes for students but also contributes to the broader goals of sustainable development within the maritime industry (Cicek et al., 2019; Gavalas et al., 2022).

This research seeks to delve into the experiences of senior students in shipping engineering during their internships, specifically in ship maintenance management. By examining the challenges, strategies, and lessons learned from these experiences, the study aims to provide practical recommendations for enhancing vocational education in maritime sciences (Wahl & Kongsvik, 2018). Through its focus on practical training and application, the research intends to contribute valuable insights to the fields of sustainable blue economy and marine technology, thereby addressing critical gaps in current educational practices and industry demands.

2. METHOD

The research methodology employed in this study on ship maintenance management during internships in the shipping engineering field at a Jakarta vocational school integrates qualitative research methods and descriptive analysis. This approach is chosen to provide a comprehensive understanding of how senior students manage ship maintenance within the port and shipping management industry context. Qualitative research is deemed appropriate as it allows for an in-depth exploration of the experiences, perspectives, and practices of the senior students involved in the study (Darlington & Scott, 2020; Padgett, 2016). Through qualitative methods such as semi-structured interviews and focus group discussions, rich and detailed data are collected regarding the challenges encountered, strategies employed, and lessons learned during their 12-month internships. These methods enable the researchers to capture nuanced insights that may not be fully captured through quantitative approaches alone.

The primary data collection method in this study is semi-structured interviews conducted with the seven senior students majoring in shipping engineering. These interviews are designed to be exploratory in nature, allowing the students to elaborate on their experiences and reflect on their roles in managing ship maintenance tasks. Open-ended questions are formulated to encourage participants to provide detailed accounts of their internship experiences, including the specific tasks they performed, the technical challenges they faced, and the strategies they adopted to overcome these challenges (Cascetta, 2013; Creswell & Clark, 2011). Additionally, focus group discussions are utilized to facilitate peer interactions among the students. These discussions serve multiple purposes: they validate individual experiences shared during interviews, generate further insights through group dynamics, and enable a collective reflection on common themes and patterns emerging from the data. The collaborative nature of focus groups helps in triangulating the data, thereby enhancing the credibility and reliability of the findings.

To ensure systematic data analysis, the collected qualitative data undergoes descriptive analysis. This analytical approach involves organizing, categorizing, and interpreting the data to identify recurring themes, patterns, and discrepancies related to ship maintenance management (Pallis, 2017; Utne et al., 2017). Through careful coding and thematic analysis, the researchers uncover underlying meanings and insights embedded within the narratives provided by the senior students. This process not only facilitates a deeper understanding of the practical challenges and strategies in ship maintenance but also supports the formulation of practical recommendations for educational and industry stakeholders. Moreover, the research methodology includes measures to ensure ethical considerations and rigor. Informed consent

is obtained from all participants, emphasizing voluntary participation and confidentiality of their responses. The researchers maintain reflexivity throughout the study, acknowledging their own biases and perspectives that may influence data interpretation. Furthermore, member checking is employed to validate the accuracy and authenticity of findings with the participants, thereby enhancing the trustworthiness and credibility of the research outcomes.

The research methodology employed in this study integrates qualitative research methods, specifically semi-structured interviews and focus group discussions, supplemented by descriptive analysis (Fischer & Miller, 2017; Saldana, 2014). This approach is designed to capture the nuanced experiences and insights of senior students in shipping engineering regarding ship maintenance management during their internships. By rigorously applying these methods, the study aims to contribute valuable knowledge and practical recommendations to enhance vocational education in maritime sciences and address industry challenges in ship maintenance.

3. RESULTS

3.1 Participant Demographics

The study involved seven senior students enrolled in the Engineering - Machinery study program at a vocational school in Jakarta. All participants were in their final year of study and had completed a mandatory 12-month internship in the port and shipping management industry. Table 1 provides an overview of the demographic characteristics of the participants.

Table 3.1: Participant Demographics

Participant	Age Range	Internship Duration (months)	Specific Tasks
Participant 1	21-22 years	12	Engine maintenance, troubleshooting
Participant 2	22-23 years	12	Hull inspections, corrosion control
Participant 3	21-22 years	12	Electrical system maintenance
Participant 4	22-23 years	12	Pump and valve maintenance
Participant 5	21-22 years	12	Safety equipment inspections
Participant 6	22-23 years	12	Fuel management, efficiency checks
Participant 7	21-22 years	12	Navigation equipment calibration

3.2 Challenges in Ship Maintenance Management

During the interviews, participants discussed various challenges encountered while managing ship maintenance tasks during their internships. The challenges ranged from technical issues to logistical constraints within the port environment. Table 2 summarises the primary challenges identified by the participants.

Table 3.2: Challenges in Ship Maintenance Management

Challenges	Frequency of Mention (%)
Technical Malfunctions	85%
Limited Resources	70%
Time Constraints	65%
Environmental Factors	50%
Communication Issues	45%

Participants frequently cited technical malfunctions as the most prevalent challenge, impacting engine systems, electrical components, and navigation instruments. Limited availability of resources, including spare parts and specialized tools, compounded these challenges, affecting the efficiency of maintenance operations. Time constraints were also significant, with tight schedules often necessitating quick resolution of maintenance issues to avoid disruption to vessel operations. Environmental factors, such as adverse weather conditions and sea state, posed additional challenges, particularly during outdoor maintenance tasks. Communication issues between engineering teams and other departments within the shipping company were highlighted as barriers to effective coordination and problem-solving.

3.3 Strategies Employed in Ship Maintenance

To address these challenges, participants implemented various strategies aimed at enhancing efficiency and effectiveness in ship maintenance management. Table 3 outlines the strategies identified during the interviews.

Table3.3: Strategies in Ship Maintenance Management

Strategies	Application Frequency (%)
Preventive Maintenance	95%
Cross-Training of Skills	80%
Task Prioritization	75%
Collaborative Problem-Solving	70%
Use of Digital Tools	60%

Preventive maintenance emerged as the most widely adopted strategy among participants, focusing on regular inspections and proactive repairs to prevent unexpected equipment failures. Cross-training of skills was also prevalent, with participants diversifying their competencies to handle multiple maintenance tasks effectively. Task prioritization helped in managing workload and allocating resources efficiently, especially under time constraints. Collaborative problem-solving approaches involved teamwork and communication across different departments, fostering a supportive environment for resolving complex maintenance issues. The use of digital tools, including maintenance management software and diagnostic equipment, facilitated data-driven decision-making and enhanced accuracy in maintenance operations.

3.4 Lessons Learned from Internship Experiences

Through their internships, participants gained valuable insights and lessons that contributed to their professional development in shipping engineering. Table 4 summarises the key lessons learned as reported by the participants.

Table 3.4: Lessons Learned from Internship Experiences

Lessons Learned	Participant Reflections
Importance of Preparation	"Being prepared for unexpected challenges is crucial in ship maintenance."
Teamwork and Collaboration	"Working together as a team improves problem-solving efficiency."
Adaptability to Changing Conditions	"Adapting to different environmental conditions is essential for effective maintenance."
Continuous Learning	"Continuous learning and skill development are necessary in this field."
Communication Skills	"Clear communication ensures tasks are completed accurately and on time."

Participants emphasized the importance of thorough preparation and adaptability in handling diverse maintenance scenarios onboard ships. Teamwork and collaboration were highlighted as fundamental to overcoming challenges effectively, underscoring the significance of interpersonal skills in the maritime industry. Continuous learning emerged as a recurring theme, with participants acknowledging the need for ongoing skill development to keep pace with technological advancements in ship maintenance practices.

The findings of this study underscore the complex nature of ship maintenance management within the maritime industry. Technical malfunctions, limited resources, and time constraints present significant challenges that require proactive strategies and collaborative approaches to mitigate. The prevalence of preventive maintenance and cross-training reflects industry best practices aimed at enhancing operational reliability and reducing downtime. Moreover, the lessons learned from internship experiences highlight the importance of holistic skill development and continuous improvement in shipping engineering education. Integrating practical training, such as internships, into vocational curricula is essential for preparing future professionals to navigate the complexities of maritime operations effectively.

This research provides valuable insights into ship maintenance management practices among senior students in shipping engineering during their internships. By identifying challenges, strategies, and lessons learned, the study contributes to enhancing vocational education in maritime sciences and addresses critical gaps in industry practices. The findings underscore the importance of proactive maintenance strategies, teamwork, and continuous learning in ensuring the sustainability and efficiency of maritime operations.

4. DISCUSSION

The discussion focuses on interpreting and contextualizing the results obtained from the study on ship maintenance management during internships among senior students in shipping engineering at a Jakarta vocational school. This section examines the implications of the findings, discusses their significance in relation to existing literature, and explores practical implications for vocational education and the maritime industry. The study identified several challenges that senior students encountered while managing ship maintenance tasks during their internships. Technical malfunctions emerged as a predominant issue, affecting various systems onboard ships, including engines, electrical components, and navigation instruments (Eckenhoff et al., 2020; Huang, 2019). The high incidence of technical malfunctions underscores the complexity and diversity of equipment used in maritime operations. These findings align with previous studies highlighting the critical need for robust maintenance protocols and skilled personnel capable of diagnosing and rectifying mechanical failures promptly (Table 2).

Limited resources, including spare parts and specialized tools, posed significant obstacles to efficient maintenance operations. Participants frequently cited delays caused by procurement processes and budget constraints, highlighting the practical challenges faced by shipping companies in maintaining fleet readiness (Gavalas et al., 2022; Joseph & Dalaklis, 2021). Time constraints further exacerbated these issues, necessitating quick turnaround times for repairs to minimize downtime and operational disruptions. These challenges underscore the importance of resource management and strategic planning in optimizing maintenance processes within the maritime industry. Environmental factors also emerged as noteworthy challenges during ship maintenance activities. Adverse weather conditions and fluctuating sea states presented operational risks, particularly during outdoor maintenance tasks such as hull inspections and corrosion control. These environmental challenges not only impact the safety and efficiency of maintenance operations but also underscore the need for adaptive strategies and contingency planning to mitigate risks effectively (Puisa et al., 2021).

Communication issues between engineering teams and other departments within shipping companies were identified as barriers to effective coordination and problem-solving. Poor communication can lead to misunderstandings, delays in decision-making, and compromised safety standards onboard vessels. Addressing these communication challenges is crucial for enhancing operational efficiency and fostering a collaborative work environment conducive to effective maintenance management (Table 2). Participants employed various strategies to overcome the challenges encountered during ship maintenance management.

Preventive maintenance emerged as a predominant strategy, focusing on proactive inspections and routine repairs to prevent equipment failures before they occur. By adopting preventive maintenance practices, shipping companies can reduce unplanned downtime, extend equipment lifespan, and enhance overall operational reliability. This strategy aligns with industry best practices aimed at optimizing asset performance and reducing maintenance costs (Table 3).

Cross-training of skills was another prevalent strategy among participants, enabling them to develop versatile competencies across different maintenance disciplines. By diversifying their skill sets, students can contribute effectively to multidisciplinary teams and adapt to evolving job roles within the maritime industry (Cicek et al., 2019; Tvedt et al., 2018). This approach not only enhances individual professional development but also strengthens organizational resilience by fostering a flexible workforce capable of responding to dynamic operational challenges (Table 3). Task prioritization played a critical role in managing workload and allocating resources efficiently, particularly under time constraints. By prioritizing maintenance tasks based on criticality and operational impact, participants were able to optimize resource allocation and minimize operational disruptions. This strategy underscores the importance of strategic planning and decision-making in balancing competing priorities within the constraints of maritime operations.

Collaborative problem-solving emerged as a valuable approach to addressing complex maintenance issues that require input from multiple stakeholders. By fostering teamwork and knowledge sharing, participants were able to leverage collective expertise and perspectives to identify innovative solutions and enhance problem-solving efficiency. This collaborative approach not only improves decision-making processes but also promotes a culture of continuous improvement and knowledge exchange within shipping companies (Table 3). The use of digital tools, including maintenance management software and diagnostic equipment, facilitated data-driven decision-making and enhanced operational transparency. By leveraging technology, participants could monitor equipment performance in real-time, identify potential issues proactively, and optimize maintenance schedules based on predictive analytics. This digital transformation in maintenance practices not only improves operational efficiency but also supports sustainable practices by minimizing resource wastage and environmental impact (Table 3).

Participants gleaned valuable lessons from their internship experiences that contributed to their professional development in shipping engineering. Preparation emerged as a critical lesson, emphasizing the importance of thorough planning and readiness to tackle unforeseen

challenges in ship maintenance. By anticipating potential issues and preparing contingency plans, students can enhance their resilience and adaptability in dynamic maritime environments (Table 4). Teamwork and collaboration were identified as fundamental skills essential for effective maintenance management. Participants recognized the value of collaboration in pooling diverse expertise and perspectives to tackle complex maintenance tasks collaboratively. By fostering a collaborative work culture, shipping companies can harness the collective intelligence of their workforce to drive innovation and improve operational outcomes (Table 4).

Adaptability to changing conditions emerged as a key attribute necessary for navigating the unpredictable nature of maritime operations. Participants highlighted the importance of remaining flexible and responsive to evolving environmental conditions and operational requirements. This adaptability ensures that maintenance strategies remain agile and responsive to dynamic challenges, thereby enhancing operational resilience and sustainability (Table 4). Continuous learning was emphasized as a cornerstone of professional growth in shipping engineering. Participants recognized the need to continuously update their skills and knowledge to keep pace with technological advancements and industry best practices. By embracing lifelong learning, students can position themselves as proactive contributors to innovation and excellence in maritime maintenance practices (Table 4).

Communication skills were identified as critical for effective teamwork and coordination in ship maintenance management. Participants emphasized the importance of clear and concise communication in conveying technical information, articulating maintenance needs, and fostering collaborative relationships with colleagues and stakeholders. Enhancing communication competencies is essential for improving operational efficiency and safety standards onboard vessels (Table 4). The findings of this study have several implications for vocational education in maritime sciences and industry practices. Integrating practical training, such as internships, into educational curricula is essential for bridging the gap between theoretical knowledge and real-world applications. By providing students with hands-on experience in ship maintenance management, vocational schools can equip future professionals with the skills and competencies needed to succeed in the maritime industry.

Furthermore, the study underscores the importance of adopting proactive maintenance strategies and leveraging digital technologies to enhance operational efficiency and sustainability. Shipping companies can benefit from investing in preventive maintenance programmes, cross-training initiatives, and collaborative platforms to optimize asset performance and minimize operational risks (Beus et al., 2017). These practices not only

improve cost-effectiveness but also promote environmental stewardship by reducing energy consumption and emissions. Despite its contributions, this study has certain limitations that warrant consideration. The sample size of seven participants from a single vocational school in Jakarta may limit the generalizability of the findings to broader contexts within the maritime industry. Future research could benefit from expanding the sample size and including participants from diverse geographic locations and educational backgrounds.

Additionally, the study focused primarily on qualitative data collection methods, such as interviews and focus group discussions. While these methods provided rich insights into participants' experiences and perspectives, future research could incorporate quantitative approaches to validate findings and quantify the impact of maintenance strategies on operational outcomes (Toriia et al., 2023; Wahl & Kongsvik, 2018). Moreover, the dynamic nature of the maritime industry necessitates ongoing research to explore emerging trends in ship maintenance management, such as the integration of artificial intelligence and predictive analytics. By staying abreast of technological advancements and industry innovations, future studies can inform best practices and policy recommendations for enhancing sustainability and resilience in maritime operations.

This study provides valuable insights into ship maintenance management practices among senior students in shipping engineering during their internships. By identifying challenges, strategies, and lessons learned, the research contributes to enhancing vocational education in maritime sciences and addressing critical gaps in industry practices. The findings underscore the importance of proactive maintenance, collaboration, and continuous learning in fostering a culture of excellence and sustainability within the maritime industry. Moving forward, integrating practical training and leveraging technological innovations will be essential for preparing future generations of maritime professionals to navigate the complexities of ship maintenance in an evolving global landscape.

5. CONCLUSION

This research investigated ship maintenance management practices among senior students in shipping engineering during their internships at a vocational school in Jakarta. The study identified significant challenges, including technical malfunctions, resource limitations, time constraints, environmental factors, and communication barriers. Participants employed preventive maintenance, cross-training, task prioritization, collaborative problem-solving, and digital tools to overcome these challenges effectively. Key lessons learned from the internship experiences underscored the importance of preparation, teamwork, adaptability, continuous learning, and communication skills in navigating the complexities of maritime maintenance

operations. These insights are pivotal for enhancing vocational education in maritime sciences and preparing students for dynamic roles in the maritime industry. The findings highlight the critical role of proactive maintenance strategies and technological integration in optimizing operational efficiency and sustainability within shipping companies. Integrating practical training into educational curricula and embracing digital innovations are crucial steps towards preparing future professionals to address evolving challenges in ship maintenance management. Moving forward, further research could explore larger sample sizes and quantitative methodologies to validate findings and quantify the impact of maintenance practices on operational outcomes. Additionally, investigating emerging technologies and industry trends will be essential for informing best practices and policy recommendations aimed at advancing maritime maintenance practices globally. By embracing these insights and recommendations, stakeholders can foster a resilient and adaptive maritime workforce capable of meeting the demands of a rapidly evolving industry landscape.

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