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Crane Derrick Maintenance Strategy for Smooth Loading and Unloading on MV. Blossom Pescadores

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Abstract

The smoothness of loading and unloading operations is strongly influenced by the readiness of onboard cargo-handling equipment, particularly crane derrick systems on general cargo vessels. Although previous studies have examined cargo-handling equipment and shipboard maintenance, research specifically addressing crane derrick maintenance strategies using weighted SWOT analysis remains limited. This study aims to analyze the maintenance strategy for crane derrick cargo-handling equipment to support loading and unloading operations on MV. Blossom Pescadores. A qualitative descriptive approach with a case study design was employed. Data were collected through observation, interviews, documentation, and literature study during sea practice on board the vessel. The data were analyzed using SWOT analysis by identifying internal factors, comprising strengths and weaknesses, and external factors, comprising opportunities and threats, which were then formulated into IFAS and EFAS matrices. The findings indicate that crane derrick maintenance on board was still constrained by internal weaknesses, particularly unstructured maintenance schedules, limited operational supervision, and incomplete spare part availability. However, external opportunities remained available through the continued

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demand for general cargo vessels and knowledge transfer from experienced officers to junior crew members. The SWOT analysis positioned the maintenance strategy in the WO quadrant, indicating that available opportunities should be used to overcome internal weaknesses. This study concludes that structured maintenance schedules, regular wire rope inspection, stronger operational supervision, improved spare part management, and crew competence development are essential to maintain crane derrick readiness. The findings provide practical implications for deck officers and shipping companies in improving the safety, smoothness, and efficiency of loading and unloading operations.

Keywords: Crane Derrick; Cargo-Handling Equipment; Maintenance Strategy; Loading and Unloading Operations; SWOT Analysis

INTRODUCTION

Sea transportation plays a strategic role in supporting the movement of goods between regions, especially in archipelagic countries where shipping connects production areas, distribution centers, and consumer markets. In maritime operations, the effectiveness of loading and unloading activities determines not only the speed of cargo transfer but also vessel turnaround time, port service efficiency, and shipping cost control. Cargo handling activities are therefore closely related to the operational performance of ships and ports. When cargo handling equipment is not ready for use, loading and unloading operations may be delayed, vessel berthing time may increase, and the company may experience additional operational costs.

Cargo handling equipment is an important operational facility used to move cargo from ship to shore or from shore to ship. (Dewa, Uut Dwi Karningsih, et al., 2021) explain that cargo handling equipment, truck waiting time, operator performance, and stevedoring labor influence cargo handling productivity. (Khaldun et al., 2018) also show that loading and unloading activities are closely related to vessel turnaround time. These studies indicate that cargo handling performance is not determined only by cargo volume but also by the readiness of equipment, human resources, and operational coordination. Therefore, shipboard cargo handling equipment must be maintained properly to ensure that loading and unloading activities can be conducted safely and efficiently.

On general cargo vessels, one of the most important cargo handling tools is the crane derrick. This equipment is installed on board and is used to lift and move cargo between the

ship and the quay. A crane derrick consists of several main components, including mast, boom, winch, block, pulley, hook, and wire rope. These components work together to lift and transfer cargo during loading and unloading operations. The readiness of the crane derrick is particularly important for general cargo vessels because such ships may operate in ports where shore-based cargo handling facilities are limited. In this context, the ship's own cargo handling equipment becomes a decisive factor in operational continuity.

However, crane derrick equipment is exposed to various operational risks. Continuous lifting activity, repeated load movement, exposure to seawater, corrosion, friction, and limited rest periods during cargo operations can reduce equipment reliability.(ISO, 2017) emphasizes that wire ropes used on cranes and hoists require proper care, maintenance, inspection, and discard procedures because failure to recognize damage may create safety risks. This is highly relevant to shipboard crane derrick operations because the wire rope is one of the most critical components in the lifting system. When the wire rope experiences wear, broken strands, poor lubrication, deformation, or improper positioning on the block, the risk of operational failure increases.

Maintenance is therefore a central element in ensuring crane derrick reliability. Maintenance is not only a technical activity carried out after damage occurs but also a strategic process to prevent failure, extend equipment life, reduce downtime, and improve operational safety. (Jardine et al., 2006) explain that condition-based maintenance relies on condition monitoring to support maintenance decisions.(Quatrini et al., 2020) also emphasize that condition-based maintenance can help organizations identify equipment conditions before failure occurs. In the maritime context, planned maintenance systems are used to support technical reliability, documentation, and safety assurance on board (Stazić et al., 2017). These concepts show that effective maintenance should be preventive, systematic, documented, and supported by competent personnel.

Previous studies have addressed various aspects of cargo handling and maintenance. (Bahari et al., 2025) discuss the optimization of cargo securing equipment to support cargo safety on board. (Deril Cornelis Maturbongs, 2025) analyzes document handling and loading-unloading obstacles in passenger vessel operations. (Dewa, Karningsih, et al., 2021) highlight the influence of cargo handling equipment and operational variables on coal handling productivity. (Sugiarto, 2023) specifically discusses crane maintenance optimization on board and shows that insufficient continuous maintenance and late availability of critical spare parts

may disrupt cargo operations. Meanwhile, (Ningrat et al., 2024) evaluate container crane performance and show that equipment malfunction and idle time may affect loading and unloading productivity. These studies confirm that equipment readiness is a recurring issue in maritime and port operations.

Although these studies provide useful insights, research specifically focusing on crane derrick maintenance strategy on a general cargo vessel through weighted SWOT analysis remains limited. Previous studies tend to discuss cargo handling productivity, port equipment performance, or maintenance practices in general. Few studies have combined field-based shipboard findings with strategic internal and external analysis to determine which maintenance strategy should be prioritized. This gap is important because crane derrick maintenance is not only a technical problem but also a strategic issue involving crew competence, officer supervision, spare part availability, operational demand, vessel competitiveness, and company support.

The novelty of this study lies in the use of weighted SWOT analysis to formulate crane derrick maintenance strategy on MV. Blossom Pescadores. By using IFAS and EFAS matrices, this study identifies the internal strengths and weaknesses as well as external opportunities and threats affecting crane derrick maintenance. This approach allows the study to determine the most suitable strategic position and formulate practical actions based on the actual condition of shipboard operations. SWOT analysis is considered appropriate because it helps organizations identify strategic alternatives by combining internal and external factors (David, 2017; Gurel & Tat, 2017; Rangkuti, 2016).

Based on this background, this study aims to analyze the maintenance strategy of crane derrick cargo handling equipment to support the smoothness of loading and unloading operations on MV. Blossom Pescadores. The study is expected to contribute theoretically to maritime operational studies, particularly in the field of shipboard cargo handling equipment maintenance. Practically, the findings may serve as a reference for deck officers, ship crews, and shipping companies in improving maintenance scheduling, operational supervision, spare part management, and crane derrick readiness.

METHODS

This study employed a qualitative descriptive approach. This approach was selected because the study aimed to describe the actual condition of crane derrick maintenance on

board and analyze the factors influencing the smoothness of loading and unloading operations. The qualitative approach enabled the researcher to examine shipboard maintenance practices, operational disturbances, and crew responses based on real field conditions.

The research design used in this study was a case study. The case focused on the crane derrick maintenance system on MV. Blossom Pescadores, a general cargo vessel equipped with four crane derricks. The case study design was considered appropriate because the research investigated a specific operational phenomenon in a real shipboard context. The research was conducted during the author's sea practice on MV. Blossom Pescadores from August 2024 to August 2025.

The informants were selected purposively based on their direct involvement in crane derrick operation, inspection, supervision, and maintenance. The informants included deck officers and deck crew members who were responsible for cargo handling activities. They were selected because they had practical experience in operating and supervising the crane derrick during loading and unloading operations. The use of purposive informants allowed the researcher to obtain relevant and focused information related to the maintenance problem.

Data were collected through observation, interviews, documentation, and literature study. Observation was conducted by directly observing the condition of crane derrick equipment, wire rope movement, block and pulley system, lubrication condition, operational supervision, and cargo handling activities. Semi-structured interviews were conducted with ship personnel to obtain information about maintenance practices, causes of equipment disturbances, spare part availability, and crew competence. Documentation was used to collect supporting evidence such as ship particulars, maintenance notes, inspection records, photographs of crane components, and records of operational disturbances. Literature study was used to strengthen the theoretical foundation related to cargo handling equipment, maintenance strategy, crane safety, planned maintenance systems, and SWOT analysis.

Data trustworthiness was maintained through source triangulation and technique triangulation. Source triangulation was carried out by comparing information from different informants, including officers and deck crew. Technique triangulation was conducted by comparing interview results with observation findings and ship documentation. This process

was used to ensure that the interpretation of the data was consistent with actual shipboard conditions.

The data were analyzed using descriptive qualitative analysis supported by weighted SWOT analysis. The first stage was data reduction, in which the researcher selected information related to crane derrick maintenance, operational disturbances, and supporting or inhibiting factors. The second stage was data display, in which the findings were organized into internal and external factors. The third stage was SWOT identification, consisting of strengths, weaknesses, opportunities, and threats. The fourth stage was the preparation of IFAS and EFAS matrices by assigning weights and ratings to each factor. The fifth stage was the calculation of SWOT coordinates and the formulation of strategic alternatives to determine the most appropriate crane derrick maintenance strategy for MV. Blossom Pescadores

Ethical consideration was applied by using the data only for academic purposes. The findings were presented descriptively without disclosing sensitive operational information beyond the research focus. The identities of informants were not emphasized in the presentation of findings to maintain confidentiality and to ensure that the analysis focused on the operational problem rather than personal responsibility.

RESULTS

The findings show that the crane derrick maintenance system on MV. Blossom Pescadores had not been implemented optimally. The main problem was related to the absence of a consistently structured maintenance schedule, limited supervision during cargo handling operations, and incomplete spare part availability. These weaknesses increased the risk of crane derrick disturbance during loading and unloading operations.

During the research period, two important operational incidents were recorded. The first incident occurred on December 2, 2024, at Badas Port, Sumbawa, when crane derrick number 1 experienced wire jumping. This condition occurred when the wire rope came off the block track during cargo handling operations. The incident required repair activity and caused loading and unloading operations to stop temporarily. The second incident occurred on March 27, 2025, at Celukan Bawang Port, Bali, when the wire ropes on crane derrick numbers 2 and 4 broke during unloading activities. The incident occurred during the handling of cement bags using nets, which caused repeated load swing and continuous stress

on the wire rope. The failure required wire rope replacement and resulted in operational delay.

These incidents indicate that crane derrick maintenance on board was still more reactive than preventive. Maintenance tended to be carried out after signs of damage appeared or after equipment failure occurred. This finding is consistent with the main problem stated in the thesis, namely that crane derrick maintenance and supervision had not been optimal, as shown by wire rope disturbances, limited inspection before and after use, and the absence of consistent maintenance scheduling.

1. Internal Factor Analysis

The internal factors consisted of strengths and weaknesses. The strengths identified in this study included the presence of experienced deck officers, good cooperation between officers and deck crew, and discipline among deck crew members. These strengths supported repair and maintenance activities when crane derrick problems occurred. Meanwhile, the weaknesses included infrequent crane derrick maintenance, insufficient supervision during crane operation, and incomplete spare part availability.

Table 1. IFAS Matrix

No.	Internal Factors	Weight	Rating	Score
A	**Strengths**			
1	Experienced and professional deck officers on board	0.13	4	0.52
2	Good cooperation between officers and deck crew	0.10	3	0.30
3	Deck crew discipline in carrying out duties	0.08	3	0.24
	Total Strengths	**0.31**		**1.06**
B	**Weaknesses**			
1	Infrequent maintenance of crane derrick	0.26	4	1.04
2	Lack of supervision during cargo handling equipment operation	0.24	4	0.96
3	Incomplete spare part availability	0.19	3	0.57
	Total Weaknesses	**0.69**		**2.57**
	Total Internal Factors	**1.00**		**3.63**

As shown in Table 1, the total strength score was 1.06, while the total weakness score was 2.57. This result indicates that internal weaknesses were more dominant than internal strengths. The most influential weaknesses were infrequent maintenance and insufficient supervision during crane derrick operation. Therefore, the internal condition of MV. Blossom Pescadores still required improvement, particularly in maintenance scheduling, operational supervision, and spare part readiness.

2. External Factor Analysis

The external factors consisted of opportunities and threats. The opportunities identified in this study included the high demand for general cargo vessels equipped with crane derricks and the opportunity for knowledge transfer from experienced officers to junior crew members. Meanwhile, the threats included competition with other vessels that had more structured maintenance systems and better spare part availability.

Table 2. EFAS Matrix

No.	External Factors	Weight	Rating	Score
A	**Opportunities**			
1	High demand for general cargo vessels equipped with crane derrick	0.28	3	0.84
2	Knowledge transfer from experienced officers to junior crew members	0.22	4	0.88
	Total Opportunities	**0.50**		**1.72**
B	**Threats**			
1	Other vessels have more structured maintenance systems and more modern cargo handling equipment	0.29	3	0.87
2	Other vessels have more complete spare part availability	0.21	3	0.63
	Total Threats	**0.50**		**1.50**
	Total External Factors	**1.00**		**3.22**

Table 2 shows that the total opportunity score was 1.72, while the total threat score was 1.50. This means that external opportunities were slightly greater than threats. The largest opportunity was knowledge transfer from experienced officers to junior crew members, followed by the demand for general cargo vessels equipped with crane derrick. This finding indicates that MV. Blossom Pescadores still had opportunities to improve operational performance if its internal weaknesses could be addressed properly.

3. SWOT Coordinate and Strategy Position

After calculating the IFAS and EFAS scores, the SWOT coordinates were determined by subtracting total weaknesses from total strengths for the X-axis and subtracting total threats from total opportunities for the Y-axis.

Table 3. SWOT Coordinate Calculation

Axis	Formula	Result
X	Total Strengths – Total Weaknesses = 1.06 – 2.57	-1.51
Y	Total Opportunities – Total Threats = 1.72 – 1.50	0.22

The coordinate result was (-1.51; 0.22). This position places the crane derrick maintenance strategy of MV. Blossom Pescadores in Quadrant III, which represents the WO strategy. This quadrant indicates that internal weaknesses are greater than internal strengths,

but external opportunities are still greater than threats. Therefore, the most appropriate strategy is to minimize internal weaknesses by utilizing available external opportunities.

4. Priority Strategy

To strengthen the SWOT analysis, alternative strategies were calculated by adding the total scores of each factor group. The results are presented in Table 4.

Table 4. Priority Strategy Calculation

No.	Alternative Strategy	Formula	Score	Priority
1	SO Strategy	Total Strengths + Total Opportunities = 1.06 + 1.72	2.78	III
2	WO Strategy	Total Weaknesses + Total Opportunities = 2.57 + 1.72	4.29	I
3	ST Strategy	Total Strengths + Total Threats = 1.06 + 1.50	2.56	IV
4	WT Strategy	Total Weaknesses + Total Threats = 2.57 + 1.50	4.07	II

Table 4 shows that the WO strategy obtained the highest score of 4.29. This score was higher than the WT strategy with 4.07, the SO strategy with 2.78, and the ST strategy with 2.56. Therefore, the WO strategy became the main priority in improving crane derrick maintenance on MV. Blossom Pescadores. The WO strategy includes preparing a structured maintenance schedule, improving supervision during loading and unloading operations, managing spare parts more systematically, applying crane derrick inspection checklists, and strengthening crew competence through knowledge transfer from experienced officers.

DISCUSSION

The findings indicate that the main problem affecting the smoothness of loading and unloading operations on MV. Blossom Pescadores was not the absence of cargo handling equipment but the lack of structured maintenance and supervision of the crane derrick. The incidents of wire jumping and wire rope failure show that the maintenance system tended to be corrective. In other words, maintenance was carried out after damage occurred rather than through preventive inspection and scheduled maintenance. This condition supports the concept that unplanned maintenance may increase the risk of operational delay, equipment failure, and safety hazards.

The dominance of internal weaknesses in the IFAS matrix shows that the problem was mainly rooted in shipboard maintenance management. The weakness score of 2.57 was greater than the strength score of 1.06, indicating that the availability of experienced officers

and cooperative deck crew had not been fully supported by an effective maintenance system. This finding is consistent with maintenance management literature stating that maintenance should be aligned with organizational objectives, operational reliability, safety, and performance indicators (Muchiri et al., 2011; Tsang, 2002). In shipboard operations, the objective of maintenance is not merely to repair damaged equipment but to ensure that critical equipment remains ready for safe and efficient operation.

The largest weakness was infrequent crane derrick maintenance. This indicates that the maintenance schedule had not yet become a consistent working reference on board. Without a structured schedule, inspection and lubrication may be delayed or overlooked, especially when the vessel has a tight operational schedule. This condition may lead to the accumulation of damage on wire rope, block, pulley, or other lifting components. (Jardine et al., 2006) and (Quatrini et al., 2020) emphasize that condition monitoring is important in maintenance decision-making because equipment problems can be detected before failure occurs. In the case of MV. Blossom Pescadores, the wire jumping incident and wire rope failure were closely related to insufficient inspection, lubrication, and supervision. Therefore, a shift from corrective maintenance to preventive and condition-based maintenance is necessary.

The second major weakness was insufficient supervision during crane derrick operation. Supervision is important because crane derrick operation involves dynamic loads, wire movement, load swing, and communication among the crane operator, deck crew, and port workers. When the load swings excessively or the wire rope is not properly positioned on the block, the risk of wire damage increases. ISO 4309:2017 provides general principles for the care, maintenance, inspection, and discard of crane wire ropes. In this context, supervision should focus on the stability of cargo, wire rope movement, Safe Working Load compliance, and early signs of abnormal operation such as friction noise, vibration, or unstable load movement.

The third weakness was incomplete spare part availability. Spare parts such as wire rope, grease, block, bearing, shackle, and hook are critical components in crane derrick maintenance. When spare parts are not available on board, repair work cannot be carried out immediately after damage occurs. This condition may extend downtime and delay cargo operations. (Sugiarto, 2023) found that delayed availability of critical spare parts may disrupt crane operation and cargo transfer. This finding is consistent with the condition on

MV. Blossom Pescadores, where spare part readiness became one of the internal weaknesses. Therefore, spare part management must be integrated into the maintenance strategy. Spare part inventory should be checked periodically, and procurement requests should be submitted before stock is depleted.

The EFAS matrix shows that external opportunities were still greater than threats. The opportunity score of 1.72 exceeded the threat score of 1.50. This means that MV. Blossom Pescadores still had opportunities to improve its operational performance, especially because general cargo vessels equipped with crane derricks remain useful in ports with limited shore-based cargo handling facilities. In addition, knowledge transfer from experienced officers to junior crew members can be used to improve maintenance awareness and technical competence. This finding is consistent with strategic management theory, which states that organizational improvement can be achieved by using external opportunities to overcome internal weaknesses (David, 2017; Rangkuti, 2016).

The SWOT coordinate positioned the strategy in Quadrant III, which indicates the WO strategy. The WO strategy is appropriate because the vessel still has operational opportunities, but internal weaknesses must be addressed first. The WO strategy in this study includes five main actions. First, the vessel should prepare and implement structured crane derrick maintenance schedules. These schedules should include daily inspection before and after cargo operations, weekly lubrication and component checking, monthly evaluation, and periodic inspection of high-risk components such as wire rope and block systems.

Second, supervision during loading and unloading operations should be improved. The officer on watch and deck crew should monitor wire rope movement, load stability, cargo weight, communication, and signs of abnormal operation. If there are signs of excessive friction, vibration, unstable wire movement, or excessive load swing, the operation should be stopped temporarily for inspection. This preventive decision is important to avoid more serious damage.

Third, spare part management should be improved. The Chief Officer and responsible crew should prepare a list of essential spare parts, update the stock condition, and submit requests to the company in advance. Components with high failure risk, such as wire rope, grease, block, and shackle, should become procurement priorities. Good spare part management can shorten repair time and reduce the possibility of cargo handling delay.

Fourth, an inspection checklist should be applied. The checklist should cover wire rope condition, block and pulley condition, lubrication, hook, boom, winch system, brake system, and signs of wear. The checklist should be filled in before and after cargo handling activities. This documentation can help officers evaluate equipment readiness and provide evidence that inspection has been carried out. (Stazić et al., 2017) emphasize the importance of planned maintenance system databases in evaluating ship maintenance quality. Therefore, checklist documentation can become a practical tool for improving the traceability of crane derrick maintenance.

Fifth, knowledge transfer from experienced officers to junior crew members should be strengthened. Technical guidance may be provided before cargo operations, during maintenance activities, and after operations through evaluation sessions. Junior crew should be trained to identify early signs of wire rope damage, understand proper lubrication procedures, and recognize unsafe load movements. This action is important because maintenance culture depends not only on equipment and procedures but also on crew awareness and competence.

The practical implication of this study is that crane derrick maintenance should be treated as an integrated operational strategy rather than a simple repair activity. Ship officers and shipping companies need to coordinate maintenance schedules, inspection records, spare part procurement, and crew training. If this strategy is implemented consistently, the crane derrick can remain in ready-to-use condition, loading and unloading operations can run more smoothly, and operational delays can be reduced.

This study has several limitations. First, the research was conducted on one vessel, namely MV. Blossom Pescadores, so the findings may not represent all general cargo vessels. Second, the study used a qualitative descriptive approach supported by weighted SWOT analysis; therefore, the findings depend on field observation, interview interpretation, and documentation availability. Third, the study focused on crane derrick maintenance and did not measure the financial impact of loading and unloading delays quantitatively. Future research may expand the study to several vessels, compare different types of cargo handling equipment, or calculate the economic losses caused by crane derrick downtime. \

CONCLUSION

This study concludes that the crane derrick maintenance system on MV. Blossom Pescadores had not been implemented in a fully structured and preventive manner. The occurrence of wire jumping on crane derrick number 1 at Badas Port and wire rope failures on crane derrick numbers 2 and 4 at Celukan Bawang Port shows that maintenance was still dominated by corrective actions. These disturbances caused loading and unloading operations to be stopped temporarily and created operational delays.

The weighted SWOT analysis shows that internal weaknesses were more dominant than strengths, while external opportunities were still greater than threats. The SWOT coordinate of (-1.51; 0.22) placed the strategy in Quadrant III, indicating that the WO strategy was the most appropriate. The priority strategy calculation also confirmed that the WO strategy obtained the highest score of 4.29. Therefore, the most suitable maintenance strategy for MV. Blossom Pescadores is to minimize internal weaknesses by utilizing external opportunities.

The recommended strategy includes preparing a structured maintenance schedule, improving supervision during loading and unloading activities, managing spare parts more systematically, applying crane derrick inspection checklists, and strengthening crew competence through knowledge transfer from experienced officers. These strategies are expected to reduce sudden equipment failure, maintain crane derrick readiness, improve loading and unloading smoothness, and support safer and more efficient ship operations. This study contributes to maritime operational studies by showing how weighted SWOT analysis can be used to formulate practical maintenance strategies for shipboard cargo handling equipment. Future studies are recommended to involve more vessels, apply comparative analysis, and measure the economic impact of crane derrick downtime more quantitatively.

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