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Optimizing Shipyard Assembly Facilities in Indonesia Using a Multi-Criteria Decision-Making Approach

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Abstract: As the world's largest archipelagic nation, Indonesia relies heavily on maritime transportation, positioning its national shipbuilding industry as a strategic sector. This study aims to determine the optimal strategy to accelerate ship construction by optimizing production facilities, with a specific focus on the assembly workshop. A Multi-Criteria Decision Making (MCDM) approach is applied to evaluate three alternative facility development strategies based on five key criteria: investment, production capacity, human resource requirements, design/layout efficiency, and space utilization. The analysis identifies Alternative 2—efficient adjustment in the number of facility units—as the most favorable option, achieving the highest performance score (0.98). These findings offer a strategic foundation for enhancing the production capacity of national shipyards from 35 to 50 blocks per month.

Keywords: *Production Facility Optimization, Shipbuilding Efficiency, Strategic Planning, Multi-Criteria Decision Making (MCDM).*

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I. INTRODUCTION

As the world's largest archipelagic nation, Indonesia relies heavily on maritime transportation to ensure inter-island connectivity and national stability. In this context, the national shipbuilding industry plays a vital role in both new ship construction and fleet maintenance, supported by strategic government policies such as the cabotage principle and the Sea Toll program. Despite this support, Indonesia's shipyard industry holds a relatively small share in the global market. Increasing production capacity and efficiency is therefore essential. One major challenge is the optimization of existing production facilities, particularly in large-scale shipyard assembly workshops facing rising workloads due to market demand. This study aims to identify an optimal strategy to accelerate ship construction by analyzing the utilization of current production facilities, focusing on the assembly process, with the goal of increasing output from 35 to 50 blocks per month.

II. LITERATURE REVIEW

The literature review in this study draws from ship production research and direct experience in large-scale national shipyards. Shipbuilding is a complex process involving multiple technical stages, from design to final assembly. Production technology plays a critical role in productivity and cost-efficiency [1]. Innovations such as modular construction and the Full Outfitting Block System (FOBS) allow for pre-equipped block assembly, enhancing time and cost efficiency [2]. In Indonesian shipyards, production begins with material processing and continues through block erection using cranes and large transporters, involving cutting, welding, painting, and system installation.

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International comparisons reveal varying approaches: Helsinki Shipyard emphasizes layout efficiency, Just-in-Time material management, RFID use, and smart distribution algorithms, while Dalla Shipyard faces challenges with outdated equipment and inefficient layouts. These highlight the importance of facility optimization in enhancing productivity.

This study adopts a Multi-Criteria Decision Making (MCDM) approach to identify optimal production strategies based on factors such as time, cost, and quality. Common shipbuilding issues include material delays, weak coordination, and technical disruptions [3]. Human resources, particularly skills and training, significantly impact outcomes [4], and process innovation is key to improving efficiency [5]. A case study from South Korea shows that applying digital twin technology can boost productivity by up to 35% [6].

Unlike broader production studies, this research specifically focuses on assembly workshops, using existing conditions to identify bottlenecks, design strategies, and evaluate impacts to support capacity optimization in national shipyards.

III. METHODOLOGY

This study aims to optimize Indonesian shipyard facilities by applying a Multi-Criteria Decision-Making (MCDM) approach. A case study was conducted at a large-scale national shipyard in Indonesia to evaluate three alternative development strategies for the assembly workshop. The MCDM methods employed include Simple Additive Weighting (SAW) and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS).

- Five key criteria were used for evaluation:
- Investment cost (non-beneficial)
- Production capacity (beneficial)
- Human resource requirements (non-beneficial)
- Design/layout efficiency (beneficial)
- Land area requirements (non-beneficial)

Data were collected through technical documentation, direct field observations, and interviews with production management personnel. Each alternative scenario was assessed based on its ability to meet the target of increasing production capacity from 35 to 50 blocks per month while maintaining investment efficiency and operational effectiveness..

IV. RESULTS AND DISCUSSIONS

A. Existing Facility

Large-scale national shipyards play a crucial role in meeting both domestic and export shipbuilding needs. To achieve a production target of 50 blocks per month or two Landing Dock class ships per year, a complete and efficient production facility is required. Key facilities include stationary machines (±350 units), lifting and transporting equipment (±85 units), and welding machines (±400 units), which support the ship fabrication and assembly process.

The assembly process is a critical stage in shipbuilding, where the ship blocks are assembled into a complete structure. Accuracy in assembly and synchronization between parts is essential, as errors can affect the ship's quality and safety. Therefore, the proper use of production facilities is necessary to ensure technical standards and production efficiency.

Ten main facilities in the assembly process are grouped into four main categories. First, material handling and transportation facilities (e.g., 10T Transverser, Chain Conveyor, Overhead Crane) facilitate the movement of blocks. Second, material cutting and forming facilities (e.g., NC Plasma Cutting, Press Bending Machine, Hydraulic Press) ensure components are made according to design. Third, drilling and structural preparation facilities (e.g., Radial Drilling Machine, Shot Blasting Machine) ensure joint precision and material durability. Fourth, material finishing and protection facilities (e.g., Sandblasting, Abrasive Vacuum System) enhance material resistance to marine environments and create a safer and cleaner working environment.

B. Alternative Facility

The three alternatives are: (1) maintaining existing facilities as they are, (2) adjusting the number of facilities with better efficiency without significant cost increases, and (3) significantly increasing the number of facilities with a larger investment to support higher production capacity. Each alternative is compared based on the number of facility units and the total investment required to achieve optimal ship production targets.

C. Alternative Facility

The three production facility alternatives are compared based on efficiency and investment needs. Alternative 1 (existing) requires a total investment of 300 billion but is not yet optimal due to limited facilities such as sandblasting and NC Plasma Cutting. Alternative 2 improves efficiency by adding one unit of NC Plasma Cutting and sandblasting, with a total investment of 312 billion. Meanwhile, Alternative 3 provides the highest production capacity through the addition of NC Plasma Cutting, sandblasting, and a Press Bending Machine, but with the highest investment of 337 billion.

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Table 1 Alternative Facility

NO	EQUIPMENT	QUANTITY		
		ALTERNATIVE 1 (EXISTING)	ALTERNATIVE 2	ALTERNATIVE 3
1	10 T Transverser & Chain Conveyor	2	2	2
2	Shot Blasting Machine	1	1	1
3	NC Plasma Cutting	1	2	4
4	NC gas Cutting Machine	1	1	1
5	500 – 1000 T Hydraulic Press	2	2	2
6	Overhead Crane	29	29	29
7	Radial Drilling Machine	1	1	1
8	Sandblasting	1	2	3
9	Abrasive Vacuum System / AVS	1	1	1
10	Press Bending Machine	1	1	2
TOTAL INVESTMENT (**IDR BILLION**)		300	312	337

D. Multi-Criteria Decision Making (MCDM) Criteria

The evaluation of alternatives is based on five main criteria: investment (non-beneficial), production capacity (beneficial), human resource requirements (non-beneficial), design/layout (beneficial), and area requirements (non-beneficial). The design assessment uses a Likert scale from 1 to 5, with higher scores indicating better, safer, and more efficient facility conditions.

E. Multi-Criteria Decision Making (MCDM) Analysis

The evaluation results show that Alternative 2 has the highest performance with a score of 0.98, making it the best option due to its balance between investment efficiency, production capacity, and facility design. Alternative 3 offers the highest production capacity but requires a higher investment and has a less optimal design. Alternative 1 is the least recommended due to its relatively low capacity and design.

Alternative 1 received a performance score of 0.89. While it requires the lowest investment, it offers limited production capacity and low operational efficiency, making it the least favorable option. Alternative 2 achieved the highest score of 0.98, indicating that it provides the most balanced solution with efficient investment, improved capacity, and the best overall design, making it the most recommended choice. Alternative 3 scored 0.93 and offers the highest production capacity among the three; however, it is less balanced due to higher investment needs and suboptimal facility design, placing it in second rank. as shown in Table 2.

Table 2 Results MCDM Analysis

No	Attribute of Criteria	Investment	Capacity	HR	Design	Area	Performance Score	Rank
1	Alternative 1	0.20	0.13	0.20	0.16	0.20	0.89	3
2	Alternative 2	0.19	0.19	0.20	0.20	0.20	0.98	1
3	Alternative 3	0.18	0.20	0.19	0.16	0.19	0.93	2

F. Main Facility Recommendations

Based on the analysis, the main facilities required to support a production target of 50 blocks per month at the national shipyard are as follows :

Table 3 Recommendation Facility

NO	EQUIPMENT	Quantity	Investment (Billion)	Required Investment (Billion
1	10 T Transverser & Chain Conveyor	2	15	30
2	Shot Blasting Machine	1	30	30
3	NC Plasma Cutting	2	8	16
4	NC gas Cutting Machine	1	3	3
5	500 – 1000 T Hydraulic Press	2	4	8
6	Overhead Crane	29	7	203
7	Radial Drilling Machine	1	5	5
8	Sandblasting	2	4	8
9	Abrasive Vacuum System / AVS	1	4	4
10	Press Bending Machine	1	5	5
TOTAL INVESTMENT (**IDR BILLION**)				312

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V. CONCLUSION

This study concludes that optimizing existing production facilities—particularly within assembly workshops—is crucial for increasing shipbuilding capacity in national shipyards. By applying the MCDM approach, the research identifies Alternative 2 as the most effective strategy, achieving near-target output (49 blocks/month) with a modest increase in investment and optimal facility design.

The findings provide a practical reference for shipyard planners and policymakers aiming to scale up production from 35 to 50 blocks per month. Strategic and selective enhancement of facility units, rather than large-scale investment, is shown to deliver the best return in terms of cost-efficiency and production output.

Future studies are encouraged to explore digitalization strategies, such as the integration of digital twin technologies and real-time production monitoring, to further enhance shipyard productivity and competitiveness.

REFERENCES

[1]. Ma'ruf, A. (2014). Teknologi Produksi Kapal: Teori dan Praktik. Jakarta: Penerbit Galangan.
[2]. Bruce, A. (2003). Lean Production for the Shipbuilding Industry. New York: Marine Press.
[3]. Huang, Y. & Shih, H. (2005). Challenges in Shipbuilding. Journal of Marine Engineering, 37(2), 123-134.
[4]. Kaplan, R. S., & Norton, D. P. (1996). The Balanced Scorecard: Translating Strategy into Action. Harvard Business Review Press.
[5]. Tidd, J., & Bessant, J. (2009). Managing Innovation: Integrating Technological, Market and Organizational Change. Chichester: Wiley.
[6]. Kim, S.W., & Lee, Y.H. (2015). Shipyard Production Capacity Optimization Using Simulation-Based Scheduling. International Journal of Production Research, 53(4), 1023-1035.