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Cost Estimation for Blasting and Painting Repair Work on KMP. Kormomolin

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Abstract

One of the stages in the ship hull maintenance and repair process is the blasting and painting process. Parts of the ship hull that do not fulfill classification standards will be repaired to extend the ship's operational life. This study aims to estimate the material requirements and costs of blasting and painting in the ship hull repair process, so that the calculation of material requirements and repair costs can be used as a reference for ship owners in future repair activities. The methods used include data collection and repair of the KMP Kormomolin ship, as well as calculations of material usage efficiency based on the area worked on. Estimates of the requirements for each material are calculated based on the surface area of the ship and the efficiency of use per liter, then converted to cans or kilograms. The analysis results show that the main material requirements consist of copper slag as a blasting medium, as well as various types of coat such as primer, anti-corrosion (AC), anti-fouling (AF), and finishing coat. The total cost is calculated from the number of requirements multiplied by the unit price of the material. From the calculation results, it is known that the highest costs come from anti-fouling coat.

Keywords: Blasting, Cost, Materials, Painting, Ship Repair

1. INTRODUCTION

Maritime transportation is one of the oldest modes of transportation and remains a major pillar of the global economy. This mode plays an important role in international trade because most goods, particularly heavy and bulk commodities, are transported by sea [1]. Ship repair is a periodic activity carried out when a vessel experiences functional failure or is no longer suitable for operation. Repairs are conducted on components that no longer meet classification standards or have suffered damage. The parts that are commonly repaired include hull structures, outfitting, machinery, and piping systems [2].

Along with the increasing intensity of shipping and trade activities, the need for ship maintenance and repair has become increasingly important. Ship repair cost is one of the main aspects that must be considered by ship owners and operators. This cost includes material costs, labor costs, and the time required to complete the repair work. Therefore, estimating ship repair costs is crucial for ship owners in budget planning and expenditure optimization [3].

Ship repair cost analysis does not only focus on cost calculation, but also considers the factors that influence the cost, such as the type of damage, type of vessel, repair location, and technology used [4]. Through comprehensive analysis, ship owners can make better decisions regarding maintenance and repair methods, as well as plan more efficient maintenance schedules. This can reduce vessel downtime and increase productivity, which ultimately has a positive impact on company competitiveness in the maritime industry [5].

In the global shipbuilding and shipping industry, ship repair cost plays a crucial role in operational expenditure structure and long-term asset management. Ship repair refers to a series of repair and maintenance activities carried out to maintain the optimal condition and performance of a vessel, including structural repair, machinery maintenance, and navigation system renovation [6]. Delays in ship repair activities can cause losses for ship owners due to disruption of shipping service schedules. Therefore, network planning needs to be reviewed to identify the workflow and critical path of repair activities [7].

Based on the background above, this study aims to estimate the material cost of blasting and painting work on KMP. Kormomolin during docking at PT. XYZ. The estimation of blasting and painting material costs is expected to assist the shipyard in preparing a more efficient repair cost plan and help the ship owner in planning the repair budget for blasting and painting work.

2. RESEARCH METHOD

This study used a descriptive quantitative approach to estimate the material requirements and repair costs for blasting and painting work on KMP. Kormomolin. The research was conducted at PT. XYZ shipyard, where the vessel underwent docking and repair activities. The object of this study focused on hull maintenance work based on the repair list of KMP. Kormomolin.

The research began with the collection of the KMP. Kormomolin repair list, followed by direct observation at PT. XYZ shipyard and interviews with relevant staff and management. The observation was carried out to obtain data related to the actual condition of the vessel, repair workflow, material management, and interaction among divisions during the repair process. Interviews were conducted to obtain more detailed information regarding work handling procedures, material planning, material usage standards, and unit prices applied by the shipyard. Furthermore, the estimation of hull maintenance material requirements was carried out, covering sandblasting and painting activities, followed by the overall material cost recapitulation. The condition of KMP. Kormomolin during docking at PT. XYZ shipyard is shown in Figure 1.

Figure 1. KMP. Kormomolin on the slipway of PT. XYZ shipyard

2.1 Ship Repair Cost

Ship repair cost refers to the total expenditure required to repair and maintain a vessel so that it remains operational and complies with established safety standards. This cost includes several components, such as material cost, labor cost, facility cost, equipment cost, and testing and certification cost. A clear understanding of ship repair cost components is important for shipping companies and shipyards in managing budgets, controlling material usage, and improving operational efficiency.

In general, the main components of ship repair cost are divided into direct costs and indirect costs. Direct costs in ship repair include expenditures that are explicitly related to physical repair activities. Direct ship repair costs are classified into several main categories [8]. The first category is material and spare part cost, which includes the purchase of components, construction materials, replacement equipment, and consumables. This cost is influenced by market price fluctuations and the availability of specific spare parts. The second category is labor cost, which includes the wages of workers directly involved in repair activities, such as shipyard workers, technicians, engineers, and specialists. Labor cost may vary depending on geographical location, required skill level, and work complexity [9]. The third category is facility and equipment cost, which includes the use of dry docks, slipways, special equipment, and testing facilities. The fourth category is testing and certification cost, which includes inspection, testing, and certification processes required to ensure repair quality and compliance with regulatory standards.

In this study, the cost analysis was limited to material costs for sandblasting and painting work. This limitation was applied because the main objective of the study was to estimate material requirements and material costs based on the repair list, material usage standards, and unit material prices applied at PT. XYZ.

2.2 Hull Cleaning Using Sandblasting

Hull cleaning was carried out using the sandblasting process. Sandblasting is a surface cleaning method performed by spraying abrasive material at high pressure onto the surface of the ship plate. This process aims to remove rust, old paint residues, scale, and other impurities attached to the hull surface before repainting.

The material used in the sandblasting process at PT. XYZ is copper slag. Copper slag is an alternative abrasive material that is effective, economical, and environmentally friendly compared to traditional abrasives such as silica sand. Based on previous research, the reuse efficiency of copper slag reaches 75–80%, depending on the application conditions and abrasive recovery system used. This indicates that copper slag can be reused 3–5 times before disposal, resulting in savings of new material usage of up to 80% [10].

The required amount of copper slag material was calculated using Equation (1).

$$\text{Abrasive Requirement } (kg) = \frac{\text{Surface Area } (m^2) \times \text{Abrasive Consumption } \left(\frac{kg}{m^2}\right)}{\text{Abrasive Usage Efficiency}} \tag{1}$$

The implementation of sandblasting on the ship hull is classified into two types, namely dry sandblasting and wet sandblasting. Dry sandblasting is commonly used for metal or iron-based objects, provided that the work area has no risk of sparks during the spraying process. Dry sandblasting activities include full blast, sweep spot blast, spot blast, sweep blast, and light sweep.

Full blast is a process of cleaning the entire hull surface by blasting until all paint layers on the plate are removed and the base metal surface becomes visible. Sweep spot blast is performed on rusty areas of the ship, where the existing anti-corrosion coating must be removed so that the primer paint can properly adhere to the plate surface. Spot blast is the cleaning of specific spots or areas affected by rust, with the main purpose of removing rust only from those areas. Sweep blast is the cleaning of paint on the hull surface that still contains the first layer of red primer before repainting. Light sweep is the roughening process of the first primer layer when the paint has expired or experienced chalking.

Wet sandblasting is applied to metal or iron-based objects that have a risk of fire or are located in areas with potential fire hazards, such as fuel tanks, oil refineries, offshore facilities, or gas stations. In wet sandblasting, silica sand or other abrasive materials are mixed with special anti-rust chemicals to minimize sparks during the blasting process.

2.3 Hull Painting

Painting was carried out after the sandblasting process was completed. According to ISO 4618-1, paint is defined as a pigmented coating material in the form of liquid, paste, or powder which, when applied to a substrate, forms an opaque film with protective, decorative, or specific technical properties [11]. Ship hull painting aims to protect the ship surface from corrosion and marine organism growth. This is important because most ship structural materials are made of metal or steel plates, while the ship operates in a corrosive marine environment.

Before painting work is carried out, the surface to be painted must be cleaned from oil, old paint residues, dust, rust, and other impurities. This stage aims to ensure that the plate surface is ready for painting so that paint adhesion can be optimized. As a water transportation facility, a ship is highly susceptible to corrosion caused by seawater and marine organisms that attach to the submerged hull surface. Therefore, painting is an important part of hull repair work.

In calculating painting requirements, the material loss factor due to environmental conditions during painting was set at 7% according to PT. XYZ standards. The types of marine paint used at PT. XYZ include Primer Anti-Corrosion (AC I) or anti-corrosion paint for underwater areas, Intermediate Anti-Corrosion (AC II), Anti-Fouling (AF), and Finishing Above Water. The material requirement for each paint layer was calculated using Equation (2).

$$\text{Paint Requirement } (ltr) = \frac{\text{Surface Area } (m^2)}{\text{Paint Usage per liter } \left(\frac{m^2}{ltr}\right)} + 0.07 \times \left[\frac{\text{Surface Area } (m^2)}{\text{Paint Usage per liter } \left(\frac{m^2}{ltr}\right)}\right] \tag{2}$$

Based on PT. XYZ standards, 1 liter of primer paint can cover an area of 7 m^2. Meanwhile, 1 liter of AC, AF, and finishing paint can cover an area of 5 m^2. Each paint can contain 20 liters. The paint coverage data and volume per can were used as the basis for calculating the total paint requirement for the painting work on KMP. Kormomolin.

2.4 Material Cost Recapitulation

After the material requirements for sandblasting and painting were obtained, the next stage was to recapitulate the material cost. The recapitulation was conducted by multiplying the material requirement by the unit price of each material used by PT. XYZ. The sandblasting material cost was calculated based on the required amount of copper slag, while the painting material cost was calculated based on the required amount of each type of paint used in each coating layer.

The result of this method is the estimated total material cost for blasting and painting work on KMP. Kormomolin. This estimation can be used as a basis for material planning, repair cost control, and evaluation of repair work efficiency at PT. XYZ shipyard.

3. RESULTS AND DISCUSSION

The identification of material requirements for blasting and painting in the repair of KMP. Kormomolin was based on the repair list and the repair work standards of PT. XYZ, as presented in Table 1. This identification includes the surface area of blasting and coating work, as well as the types of materials used in the hull maintenance process.

Table 1. Surface area data for hull maintenance work blasting and painting

No	Work area hull maintenance	Area (m^2)
	Sandblasting work	
1	Hull BGA + topside area full blast	637
2	Outer side of bow ramp door	76
3	Outer side of stern ramp door	76
	Painting work	
4	Bottom BGA area: 1 × Primer coat Red-150 µ	538
	Bottom BGA area: 1 × AC coat Light Grey-75 µ	538
	Bottom BGA area: 1 × AF coat Red-150 µ	538
5	Bottop AGA area: 1 × Primer coat Red-150 µ	99
	Bottop AGA area: 1 × AC coat Light Grey-75 µ	99
	Bottop AGA area: 1 × Finishing coat Caribbean Blue-150 µ	99
6	Bow ramp door outer side: 1 × Primer coat Red-150 µ	76
	Bow ramp door outer side: 1 × Finishing coat Caribbean Blue-75 µ	76
7	Stern ramp door outer side: 1 × Primer coat Red-150 µ	76
	Stern ramp door outer side: 1 × Finishing coat Caribbean Blue-75 µ	76

3.1 Estimation of Sandblasting Material Requirements

The requirement for copper slag material in the sandblasting process of KMP. Kormomolin repair work was calculated using Equation (1). In estimating the copper slag requirement, the PT. XYZ shipyard standard was used, in which every 1 m^2 of blasting work requires 50 kg of copper slag abrasive material. The sandblasting work area includes the hull below the waterline BGA plus the topside area, as well as the outer sides of the bow and stern ramp doors.

Based on Table 2, the total copper slag requirement was 493 kg. Since one sack of copper slag contains 25 kg, the total copper slag requirement was calculated as 493/25, or approximately 20 sacks.

Table 2. Work area and surface area for blasting repair

No	Sandblasting work area	Surface area (m^2)	Total abrasive requirement (kg)
1	Hull BGA + topside area full blast	637	398
2	Outer side of bow ramp door	76	48
3	Outer side of stern ramp door	76	48
	Total		493

3.2 Estimation of Painting Material Requirements

The painting material requirement for KMP. Kormomolin repair work was determined based on the type of paint and the surface area of each work section. The material requirement was calculated using Equation (2). The total paint requirement for each type of paint is presented in Table 3.

Table 3. Total paint material requirement for each type of coating

No	Paint coating	Bottom	Bottop	Bow ramp door	Stern ramp door	Total paint requirement cans
1	Primer coat	4.1	0.8	0.6	0.6	6.1 ≈ 7
2	AC coat	5.8	1.1	-	-	6.9 ≈ 7
3	AF coat	5.8	-	-	-	5.8 ≈ 6
4	Finishing coat	-	1.1	0.8	0.8	2.7 ≈ 3

3.3 Material Cost of Blasting and Painting

Based on the estimated material requirements for sandblasting and painting, the total material cost for the overall work was calculated, as shown in Table 4. The total material cost was obtained by multiplying the total material requirement by the unit price of each material.

Table 4. Total material cost of blasting and painting

No	Material type	Unit	Total requirement	Unit price (Rp)	Total cost (Rp)
1	Copper slag	Sack	20	55,000	1,100,000
2	Primer paint	Can	7	1,035,000	7,245,000
3	AC paint Anti-Corrosion	Can	7	1,650,000	11,550,000
4	AF paint Anti-Fouling	Can	6	4,440,000	26,640,000
5	Finishing coat paint	Can	3	3,167,000	9,501,000
	Total				56,036,000

The total material cost required for the blasting and painting work was Rp 56,036,000. The distribution of material costs used in the blasting and painting work during the repair process of KMP. Kormomolin is shown in Figure 2. Each segment represents the contribution of each material cost to the total material cost. Based on the total cost, the largest cost component was anti-fouling paint, followed by anti-corrosion paint, finishing coat paint, primer paint, and copper slag.

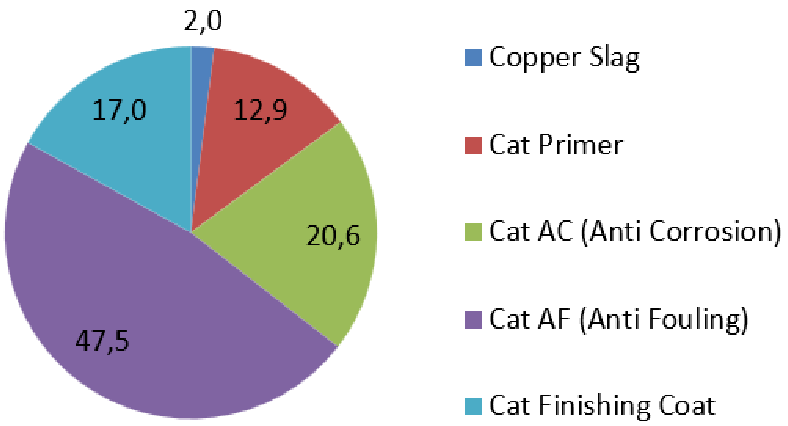

Figure 2. Distribution of blasting and painting material costs

This cost composition indicates that underwater hull protection is the main priority in hull maintenance work. The cost distribution was dominated by anti-fouling paint at 47.5%, showing that protection of the submerged hull area requires special attention. Meanwhile, copper slag contributed only around 2% of the total cost. This indicates that although blasting is an initial and essential process, the largest cost burden is found in hull coating materials. It can also be concluded that the hull area requires the highest level of protection, both in terms of material technology and budget allocation. Therefore, the selection of material type and quality in this work has a significant influence on the durability and operational efficiency of hull maintenance.

4. CONCLUSION

The hull repair activities for blasting and painting work on KMP. Kormomolin covered the bottom, bottop, topside, bow ramp door, and stern ramp door areas. These activities were carried out to extend the service life of the vessel and maintain the condition of the hull structure. The blasting material used in this work was copper slag, which functions to remove rust, old paint residues, and other impurities from the hull surface before painting. The painting work was applied in several coating layers, consisting of primer coat, anti-corrosion coat, anti-fouling coat, and finishing coat in accordance with classification requirements. The total material cost required for the blasting and painting work was Rp 56,036,000. Of this total cost, the largest contribution came from the use of anti-fouling paint, accounting for 47.5%. This finding indicates the importance of protecting the submerged hull area from corrosion and marine organism growth.

DAFTAR PUSTAKA

[1] United Nations Conference on Trade and Development. Review of Maritime Transport 2024. Geneva: United Nations, 2024.

[2] Nurwanti, R., and Pribadi, T. W. “Analisa Peningkatan Kualitas Layanan Jasa Reparasi Kapal di Galangan Kapal Jawa Timur.” Institut Teknologi Sepuluh Nopember, 2016.

[3] Purnomo, H. “Analisis Biaya Perawatan Kapal pada Galangan Nasional.” Jurnal Teknik Perkapalan, vol. 5, no. 2, pp. 101–110, 2017.

[4] Wibowo, T., and Lestari, N. “Ship Maintenance and Safety: Ensuring Operational Efficiency.” Marine Engineering Journal, 2022.

[5] Kurniawan, A. “Cost Analysis of Ship Repair and Maintenance: A Case Study.” Maritime Economics & Logistics, 2019.

[6] Dinu, O., and Ilie, A. M. “Maritime Vessel Obsolescence, Life Cycle Cost and Design Service Life.” IOP Conference Series: Materials Science and Engineering, 2015.

[7] Idsan, M. A., and Rachman, T. “Estimasi Waktu Reparasi KM. Wilis Menggunakan Critical Path Method.” Riset Sains dan Teknologi Kelautan, vol. 7, no. 2, pp. 105–112, 2024. doi: 10.62012/sensistek.v7i2.41687.

[8] Stopford, M. Maritime Economics, 4th ed. London: Routledge, 2020.

[9] Hunt, E. C., and Butman, B. S. “Marine Commercial Ship Maintenance and Repair.” In Marine Engineering. Jersey City: Society of Naval Architects and Marine Engineers, 2018.

[10] Rao, M. V., and Reddy, K. S. “Utilization of Copper Slag as a Sustainable Abrasive Material for Surface Preparation in Shipbuilding.” Journal of Hazardous Materials, vol. 310, pp. 287–295, 2016.

[11] International Organization for Standardization. Paints and Varnishes Vocabulary, ISO 4618:2014. Geneva: ISO, 2014.