Review of the Risk Assessment Methods for Shipbuilding in Indonesia

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Abstract. In the shipbuilding industry, there is still little discussion and analysis of risk management in the shipbuilding process. From previous studies, it is probable that the material/component group has a high percentage of shipbuilding delays, but there are no publications that discuss ship components specifically. Various models have been developed related to risk assessment in shipbuilding, but mostly discussed on shipbuilding construction, company management and work safety in shipyards. This paper discusses the need for planning and risk assessment models for component availability in the construction of new ships in Indonesia. The aim is to review the methods that will be used in risk assessment, combined with quantitative evaluation methods in the procurement of component materials and ship building installations. The development of methods for risk analysis, with a combination of Failure Mode and Effect Analysis (FMEA) and Bayesian Network (BN) approaches, it is hoped that the most critical risks can be identified so that risk evaluation actions can be carried out.

Key word: Ship Equipment; Ship Component; Risk Analysis; Risk Assessment; Shipbuilding.

1. Introduction
For Indonesia, the maritime sector does not only function to increase economic activity, but also as a symbol of the strength and sovereignty of the State. The characteristics of the labor-intensive, capital-intensive and technology-intensive shipping industry require serious handling and attention from the government in order to be able to develop and have competitiveness. The advancement of the independent Indonesian shipping industry to be able to meet the needs of the national fleet of ships. In addition, the multiplier effect that occurs with the rotation of the shipping industry business can have a big impact and be able to move the wheels of the economy in other sectors. [1].

According to the results publication by Prasetyo, et al. showed that the highest priority level in the assessment of industry conformity in all ship components was in the development of components in the hull construction group. In this components groups is dominated by components or plate materials and steel profiles. [2]. Ship production capacity is influenced by facility utilization and asset increase,
but ship delivery time is influenced by production capacity, facilities owned, ship planning design and average level of production. [3] It is known that the shipbuilding industry is a typical Engineering to Order (ETO) type and undergoes several changes at the strategic level for each industry, each shipbuilding is different which is tailored to customer needs. [4][5]

According to Iwan and Rosochacki in their paper, there have been no studies on quantitative methods developed specifically to manage risk in the shipbuilding process. The clustering method of data analysis is based on the number of grouping parameters, so that the case studies are based on actual data at the shipyard which will then be researched and published.. [6]

This paper aims to select the method that will be used in the risk assessment of the availability of material components of new ship construction in Indonesia. In the shipyard industry, there has been no discussion and analysis of risk management in more detail, although the risks faced are no less great than other fields. The shipyard industry is a capital-intensive industry and its rate of return is quite long (slow yielding), so in its operation must use the principle of prudence. From the research of Basuki and Widjaja with research samples taken from PT. Dok and Shipping Surabaya on new ship building activities, risk data related to operations / business using respondents at the manager level and above with a period of five years previously. Data analysis is done using Value at Risk approached by statistical methods. From the results of the analysis with the system management database, it can be identified 21 kinds of potential risks faced by PT. Dok dan Perkapalan Surabaya. The 21 kinds of potential risks are then summarized based on the risk index, which is work delay is the highest risk category and software sometimes error stay at a very low risk category. [7][8].

Failure mode and effects analysis (FMEA) is a technique used for system improvements that have been shown to improve safety. In the presentation of Djasri, 2018 explained that FMEA is a team-based, systematic, and proactive technique used to prevent problems from the process or service before occurring any problem. FMEA can also provide an overview not only of what problems may occur but also about the severity of the consequences caused.[9] This method if applied to the procurement of materials in the construction of new ships, where materials come periodically starting with the keel, hull, etc, it is expected to create a scalable system even though the materials used are sourced from domestic and imported.

FMEA Combined with Bayesian network method. Bayesian Decision Theory is a statistical approach to calculating trade-offs between different decisions, using the probabilities and costs that accompany decision-making. Bayesian network is a combination of probabilistic model and graphical model. Concepts, formulas, and diagrams must be prepared and presented clearly with the aim of being easy to understand. The advantage of Bayesian theory is that it must be understood, only requires simple coding and fast calculations. [10]. BN theory is more suitable for simple decision making. [11] The results of the initial analysis are then taken into consideration for decision making, the order of procurement of new ship construction materials so that they can be completed on time.

2. Literature Review
The Ministry of Industry noted that the national shipping industry has made some progress, including an increase in the number of shipyards to more than 250 companies with production capacity reaching around 1 million deadweight tonnage (DWT) per year for new buildings and up to 12 million DWT per year for ship repairs. [12]

There are three indicators of the competitiveness of the shipbuilding industry, which are related to quality, price, and time. Based on previous research, it is stated that the most influential factors on the competitiveness of shipyards are factors related to ship components including price, quality, and availability of goods. The main problem with the domestic shipping industry is that around 70 to 80 percent of the components installed on ships are imported components. In terms of price, using imported components will certainly be more expensive because imported goods will be subject to import taxes. Meanwhile, in terms of time, the process of ordering imported components takes time so
that the ship's production time becomes longer, especially the main engine components which take up to 8 months from the time the order is placed.[13][2].

Exposure from the ministry of industry regarding matters that will be followed up by the government, including the shipbuilding industry and operators having financing schemes with interest and tenors that are in accordance with the nature of the ship industry. Propose ships as infrastructure facilities in Presidential Regulation No. 122/2016 concerning acceleration of availability of priority infrastructure, standardization of ship series so that the component industry achieves economies of scale. Integrated ship procurement planning for the Government and State-Owned Enterprises (BUMN). Immediate implementation of a special scheme for the supply of goods and materials for shipbuilding industry companies for shipbuilding and enforcement of audited domestic component level values (TKDN) by Government and BUMN projects (Customs, Ministry of Transportation, KKP, Pertamina, Pertamina Trans Continental, ASDP and Pelni).[12]. Efforts to fulfill TKDN and ship construction on time and handover need to be carried out risk assessment and model availability of ship components as an effort to achieve the goal.

Continuation of the publication The analysis of the potential development in the component industry that was enabled to be developed in the domestic area by considering the readiness of the industry, including the availability of resources (human resources and raw materials), the existence of the industry, government policies, and economies of scale that could be achieved by developing the component industry. [14]. Technological innovation must continue to be developed to support timely development programs, reduce costs related to delays in development time and realize the ideals of the state, equitable development and social justice of the community.

2.1. Risk Assessment at the Shipyard

Risk assessment in the shipyard area found several publications which are generally divided into shipbuilding, system and construction reviews. In general, previous research in the risk identification section used a lot of data that had existed before (historical data) as in the previous paper [15][16][17][18][19][20][21][22][23][24][25][3][26] and [27].

Risk assessment using the Analytic Hierarchy Process - AHP method in publications [12][14][2], [17][2] risk analysis by the Bayesian Network-BN method in paper [28][29][25][30]and [31].

Risk assessment using the F-MEA method, among others, in the publications of [32][22] [23] Meanwhile, other published papers use dynamic systems, fuzzy-logic, risk matrix, modeling-simulation and clustering. More details can be seen in the publication table of the risk assessment. From the existing data table, a combination method of FMEA and BN was chosen to analyze risks in the procurement and availability of ship components in Indonesia.

| Author                  | Year  | Area Shipyard | Risk Identification | Metode Risk Analysis & Evaluation |
|-------------------------|-------|---------------|---------------------|----------------------------------|
| YAO Hui-li              | 2009  | √             | √                   | √                                |
| Eunchang Lee           | 2009  | √             | √                   | √                                |
| Celeste Jacinto        | 2010  | √             | √                   | √                                |
| F. C. M. Pires Jr      | 2010  | √             | √                   | √                                |
| Kadir Cicik            | 2010  | √             | √                   | √                                |
| Barlas                 | 2012  | √             | √                   | √                                |
| N.G. Fragiadakis       | 2014  | √             | √                   | √                                |
| Minto Basuki           | 2014  | √             | √                   | √                                |
| Iwan Kowicz           | 2014  | √             | √                   | √                                |
| Murat Ozkok            | 2014  | √             | √                   | √                                |
| Christiansen and Thrane| 2014  | √             | √                   | √                                |
| Wei-Shing Wu           | 2015  | √             | √                   | √                                |
| Francesco Camastra    | 2015  | √             | √                   | √                                |
3. Proposed Framework & Discussion

Literature study, library material collection and collection of all primary data are required for calculation and analysis. The data used in this study include general data about the technical specifications of all equipment components on the ship, as a reference is the 500GT ferry data built by the national shipyard, the collected data will be grouped according to the parameters that will be used in the assessment risk. Data for the group of components of machinery, electrical and other equipment components. Arrival data and install equipment on board. It is also necessary to complete the design and construction drawing data (engineering specifications, engine room layouts, etc.) which are used to determine in detail the condition of the ferry being built and process data (operational procedures) used to support the assessment combined with the above data. knowing the operating limits applied to the construction of the ferry.

In data processing, the initial step taken is component clustering, then risk identification and continued with the risk analysis stage. The grouping of mechanical, electrical and other fitting materials is obtained from a shipyard that build a new ship. Data on equipment components is divided into mechanical, electrical and outfitting groups. The data is adjusted to the arrival at the shipyard and the installation of materials on the ship. Machinery components consist of the main engine group and its equipment, auxiliary motors, pumps, pipe systems and spare parts. Electrical components in the panel-cables, electrical equipment and lights. Other equipment groups are grouped into safety equipment, communication & navigation equipment and firefighting equipment. The procurement group for domestic and imported components is also classified separately. The imported component group consists of machinery components which include machinery components including: main engine & gear box, shaft and propeller, main generator, boiler, pump, purifier, oil water separator, sea water treatment, fresh water generator, air condition unit. Electrical and electrical components include: main emergency switch board, navigation & radio equipment (radar, auto pilot, gyro & magnetic compass, echo-sounder, speed log, GPS, radio comm GMDSS, UHF, Immarsat-c, Navtex), communication system (public addressor, telephone sound power, fire alarm, whistle horn, electric clock), electric cable, lighting.
This method consists of the following main steps: identifying potential failures (seriousness of the problem) that may occur from each stage of the process (severity), identifying the frequency with which problems occur (occurring), identifying existing control systems (detection), calculating RPN (Priority Number Risk) = Severity x Occurrence x Detection and determine corrective steps to be taken. Risk assessment and evaluation using the Bayesian Network approach method includes the following: building a Bayesian Network-BN, determining parameters, making a Conditional Probability Table (CPT), making a Joint Probability Distribution (JPD) and calculating the Posterior Probabilistic.

Data obtained from shipyard X which is located in Central Java and West Java during the construction of the 500GT ferry. Procurement of sustainable slab material from keel laying, block construction to hull construction is complete. Procurement of machinery, electrical and equipment components is made on a time schedule by the building shipyard and approved by the ship owner. The time to order and the arrival of the ingredients except the plate that was tried were analyzed by combining the FMEA and BN methods.

Domestic components already available include: steel plate, electrodes, gas, insulation, main switch board, air conditioner, paint, deck machinery, clothing, etc. Many other materials are imports that need to arrive at the shipyard.

The following is an overview of the steps that will be carried out in the risk assessment:

Start

System Definition & Data
- Ship production technology

Risk Identification

Risk Analyst
Developing an adjusted risk

Risk Evaluation & Treatment
- Simulate and rate mitigation

Verification & Validation
Valid
No snakes
Yes

Conclusions and suggestions

Figure 1. Research Flow Plan. Source: Ariany Z, etl, 2021
4. Conclusion
Risk assessment and evaluation with the Failure Mode and Effect Analysis Approach method – FMEA combination Bayesian Network method is selected. The results of risk assessment with FMEA and BN methods, comparison and combination of results are then created risk matrix to validate risk evaluation and mitigation or treatment that can be done.

The results of the risk assessment using the FMEA and BN methods in the context of procurement of component materials are carried out by comparing and combining the results to further create a risk matrix to validate risk evaluation and mitigation or treatment that can be carried out. The end goal is to get on time for the completion of the construction of a new ship, no longer being constrained by the procurement of materials.

By considering the use of fuzzy grouping methods or other methods, which will be the outline of the subject of further research/development.

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