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Analysis Of Ship Main Engine Procurement Process In The Shipyard Industry Using Supply Chain Operation Reference Method (SCOR) (Case Study: PT XYZ)

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Abstract

The shipbuilding industry faces significant challenges in material procurement, with materials accounting for a substantial portion of the total project cost. Procuring ship main engines, a crucial material in shipbuilding projects requires effective supply chain management to ensure efficiency and effectiveness. However, research into measuring supply chain performance in procuring ship main engines must improve performance. This study aims to identify relevant performance metrics, analyze critical performance indicators, and provide recommendations based on the SCOR framework to enhance ship main engine procurement. The research results present 24 metrics distributed into four performance attributes based on SCOR 12.0, with 22 selected metrics aligned with the company's context. The AHP method analysis highlights the reliability attribute as the highest priority, emphasizing metrics such as the percentage of procurement received on time as per request. This study offers insights into crucial aspects of the ship's main engine procurement supply chain, supporting companies in enhancing their procurement process performance.

1. Introduction

There are three indicators of the competitiveness of the shipping industry. These indicators are quality, price, and time. Based on previous research, the factors that most influence the competitiveness of shipyards are related to ship components, including price, quality, and availability of goods. The main problem for the domestic shipping industry is that around 70 to 80 percent of the components installed on ships are imported products. Using imported components will be more expensive because imported goods will definitely be subject to import taxes or import duties.

Meanwhile, ordering imported components takes time, so ship production takes longer, especially for main engine components, which take up to 8 months from order. [1,2 and 3]. There are publications related to efforts to increase the percentage of success in the shipping industry–some domestic and foreign publications that make the shipbuilding industry part of maritime development. The countries in question include China, Korea, Japan, Brazil, Turkey, and many others. [4, 5, 6 and 7]. Publications related to supply chains Formation of maritime cluster organizations. Maritime Cluster Organizations are very important for the future development of the Maritime Industry. Some companies produce production technologies within the network scope; others produce the technology in their final product. This cluster also includes many companies, ranging from supporting and related industries to producers of various unique services such as education, research, classification services, and financing. The formation of clusters helps in describing the relationships between companies and other actors and finding the most critical relationships for development [8 and 9].

The shipbuilding industry is a strategic sector that plays a crucial role in the construction of ships. Materials procurement is a vital aspect to consider in building a new ship in this industry. Materials account for a significant percentage, ranging from 50-70% of the total cost of a new shipbuilding project[10]. One of the crucial materials in shipbuilding is the ship's engine. Procuring ship main engines for a shipbuilding project involves a lengthy process and substantial costs. Therefore, effective supply chain management is essential within a company to ensure efficiency and effectiveness in the procurement process of ship main engines. Good supply chain management in procurement provides operational efficiency, cost reduction, and improved responsiveness to customer demand[11]. The effectiveness and efficiency in procuring ship main engines are crucial in ensuring the built ships' quality, reliability, and performance.

To enhance effectiveness and efficiency in the business procurement process, companies need to measure the performance of the supply chain. The SCOR (Supply Chain Operation Reference) method can measure supply chain management performance. SCOR is a model or method used for self-assessment, comparing activities, and evaluating supply chain performance as a standard supply chain management across industries endorsed by the Supply Chain Council (SCC)[12]. SCOR is a systematic method that combines various elements such as business techniques, benchmarking, and best practices to be applied in the supply chain.[13] The benefits of implementing SCOR in a company include cost savings and the ability to evaluate the company's supply chain business processes [14].

More scholarly publications need to be related to supply chain measurement in procuring ship main engine materials. Therefore, the author attempts to analyze the process of procuring ship main engines at one of the shipyards in Indonesia, namely PT XYZ, located in Cirebon, West Java. PT. XYZ has two main focuses in its business: new shipbuilding and ship repair.

This research will analyze each indicator or metric based on the SCOR model, which can be used to measure the company's performance, particularly in the procurement department. Analyzing the ship main engine procurement process using SCOR can help the company identify potential issues in the procurement process. Through this research, supply chain management in shipyards, especially in the procurement of ship main engine materials, can be improved.

2. Methods

The research was conducted at PT. XYZ is located in the city of Cirebon. PT. XYZ is a shipyard company with two main focuses: new shipbuilding and ship repair. The research process began with data collection and data processing stages.

2.1. Data Collection

In this stage, data related to the supply chain business process, particularly the procurement of engines, was collected. The collected data included company profile documents, organizational structure, and procurement business processes. Data collection was carried out through interviews and direct observations with PT. XYZ. This stage also involved a literature review of SCOR from several journals and related research.

2.2. Data Collection Stage

In this stage, the collected data is processed. The initial step involves identifying the procurement business process using the SCOR approach. After the identification of the procurement business process, proposed metrics are developed. PT XYZ then verifies these proposed metrics. The verified metrics are structured into a hierarchy for weighting using the AHP method. Weighting aims to determine the importance of each performance attribute and metric. Once the AHP hierarchy is established, metric weighting can be carried out. The weighting is done through pairwise comparison using the Pairwise Comparison method.

3. Results and Discussion

3.1. Business Process Identification at PT XYZ

Identifying the company's business process aims to determine the attributes and metrics to be used. PT XYZ applies the Source Engineer To Order in procurement activities. The Source Engineer process is a series of procurement activities with product configuration based on customer demand or needs, referring to the SCOR model [15]. Engineer to Order is used considering the actual process of engine procurement at PT XYZ, which is based on customer needs. The procurement activities include the Planning and Execution stages. The procurement activities based on SCOR can be seen in Figure 1 and Figure 2.

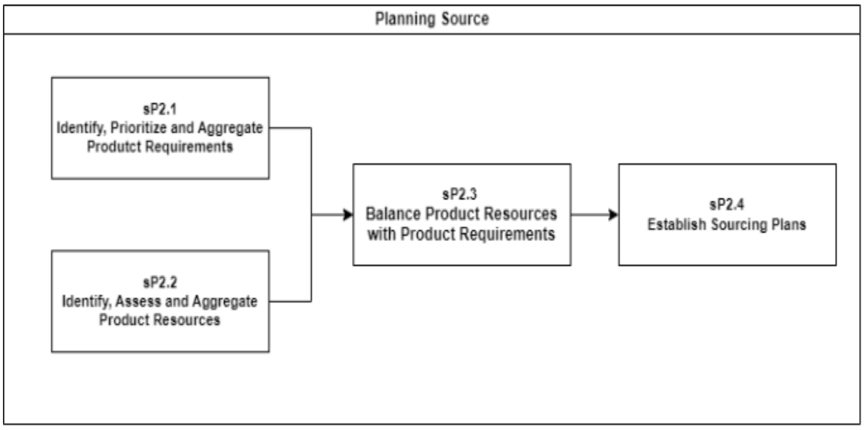

Figure 1. SCOR Model Process Plan Source

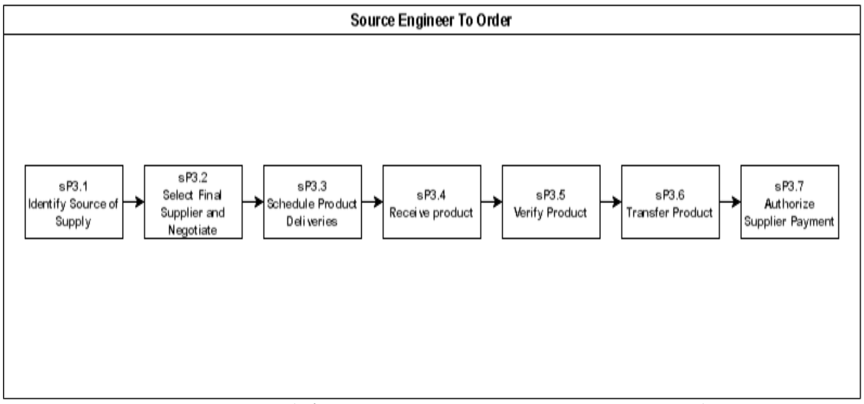

Figure 2. SCOR Model Process Source Engineering To Order

3.2. Metric Development and Verification

The metrics were developed to align with the company's conditions and needs according to the business process mapped based on the SCOR model. The company then verified the structured metrics. Out of the 24 designed metrics, 22 were considered valid after the verification process. The verified metrics can be seen in the Table 1.

Table 1. Verified Mertrics

Atribut	Metrik	Kode
Reliability	% of suppliers with an EMS or ISO 14001 certification	RL.3.17
	%Scedule Changed within Supplier's Lead Time	RL.3.27
	% Orders/Lines Processed Complete	RL.3.18
	% Orders/Lines Received On-Time To Demand Requirement	RL.3.20
	% Orders/Lines received with correct packaging	RL.3.22
	% Orders/Lines Received with Correct Shipping Documents	RL.3.23
	Receiving Product Cycle Time	RL.3.113
	% Orders/Lines Received With Correct Content	RL.21
	% Orders/Lines Received Damage-Free	RL.24
	% Product Transferred On-Time to Demand Requirement	RL.3.25
	% Product Transferred without Transaction Errors	RL.3.26
Responsiveness	Identify Sources of Supply Cycle time	RS.3.35
	Select Supplier and Negotiate Cycle Time	RS.3.125
	Average Days per Engineering Change	RS.3.9
	Average Days per Schedule Change	RS.3.10
	Schedule Product deliveries Cycle Time	RS.3.122
	Verify Product Cycle Time	RS.3.140
	Transfer Product Cycle Time	RS.3.139
	Authorize Supplier Payment Cycle Time	RS.3.8
Cost	Cost to Authorize Supplier Payment	CO.3.6
	Cost to Transfer Product	CO.3.9

3.3. AHP Hierarchy Development

One publication uses the AHP method in the supply chain of bamboo materials for ship hulls [16]. Before weighting using AHP, the metrics are verified and arranged into an AHP hierarchy [17]. The verified metrics are organized into three hierarchical levels, with Level-1 representing the company's procurement performance, Level-2 representing the performance attributes obtained from the SCOR mapping results, and Level-3 representing the related metrics of each SCOR performance attribute. The structured structure of the AHP hierarchy can be seen in Figure 3.

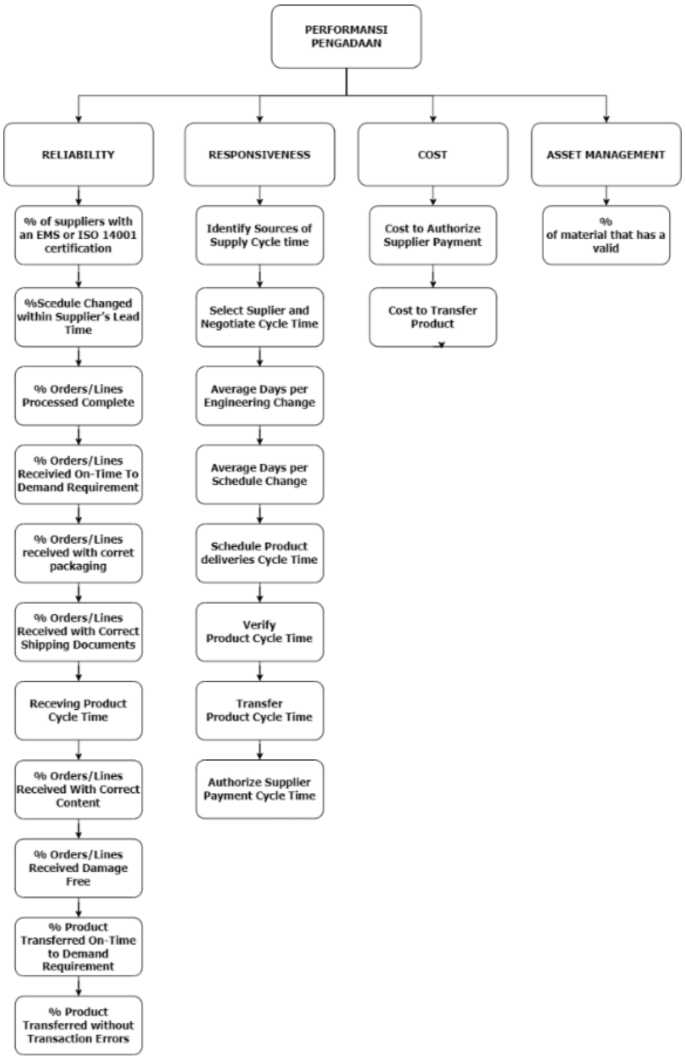

Figure 3. AHP Hierarchy

3.4. Metric Weighting with AHP

The weighting process is carried out using the Analytical Hierarchy Process (AHP) method with the assistance of expert choice software. The calculation of weighting values is obtained by distributing pairwise comparison questionnaires to three respondents from the company. The data obtained from the questionnaire distribution will be processed by calculating the weighting values based on the Analytical Hierarchy Process (AHP) method. The criteria weights must be obtained, subject to the consistency requirement CR ≤ 0.1. If CR is more significant than 0.1, each element is not correctly compared, so a reevaluation of the question aire is needed until consistent weights are obtained [18]. The results of the weighting values for each attribute can be seen in Figure 4 and Table 2.

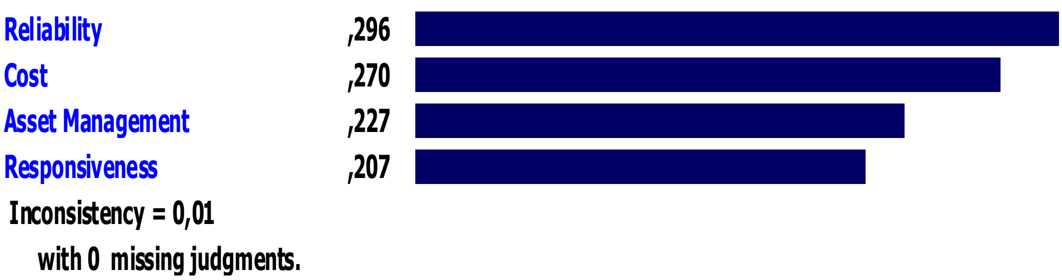

Figure 4. Weighting Results On Performance Attributes

Table 2. Final Results of Performance Attribute Weighting

Performance Attributes	Result
Reliability	0,296
Cost	0,270
Asset Management	0,227
Responsiveness	0,207

The research findings using the Analytical Hierarchy Process (AHP) method revealed a consistency ratio (CR) of 0.01, indicating a high level of consistency as the CR value was within the acceptable range of ≤ 0.1. The weight analysis showed that the reliability attribute received the highest weight of 0.296, underscoring the company's emphasis on reliability in engine procurement, particularly regarding timeliness and order quality. This was followed by the cost attribute with a weight of 0.270, the asset management attribute with 0.227, and the responsiveness attribute with 0.207. The detailed weighting results for the metrics are provided in Table 3.

Table 3. Weigthing Results Of Performance Metrics

Performance Attributes	Metrik	Value Weight
Reliability	% Orders/ Lines Received On-Time To Demand Requirement	0,143
	% Orders/lines received damage free	0,129
	% Orders/ Lines Received with Correct Content	0,117
	% Product Transferred without Transaction Errors	0,109
	% Orders/ Lines Processed Complete	0,106
	% Orders/ lines received with correct packaging	0,104
	% Orders/ Lines Received On-Time To Demand Requirement	0,091
	% Orders/ Lines Received with Correct Shipping Documents	0,082
	Receiving Product CycleTime	0,055
	% of suppliers with an EMS or ISO 14001 certification	0,04
	% Schedules Changed within Supplier's Lead Time	0,025
Responsiveness	Authorize Supplier Payment Cycle Time	0,191
	Verify Product Cycle Time	0,188
	Schedule Product Deliveries Cycle Time	0,136
	Average Days per Engineering Change	0,134
	Select Supplier and Negotiate Cycle Time	0,117
	Identify Sources of Supply Cycle Time	0,095
	Average Days per Schedule Change	0,077
	Transfer Product Cycle Time	0,063
Cost	Cost to Authorize Supplier Payment	0,591
	Cost to Transfer Product	0,409

4. Conclusion

The research conducted in this study identified and developed 24 metrics based on the SCOR framework, with 22 selected metrics tailored to PT XYZ's ship main engine procurement process. These metrics were categorized into four performance attributes: reliability, responsiveness, cost, and asset management. The Analytical Hierarchy Process (AHP) method weighed these metrics, revealing that reliability was the most critical attribute, followed by cost, asset management, and responsiveness.

The prioritized metrics within each attribute, such as the percentage of procurement received on time, costs required for payment to suppliers, and time required for payment processes, provide actionable insights for improving ship primary engine procurement efficiency. By focusing on these critical metrics, companies can enhance their supply chain management practices, reduce costs, and improve operational efficiency in shipbuilding projects. Overall, this study offers practical recommendations for optimizing the ship's primary engine procurement process, ultimately contributing to improved performance and competitiveness in the shipbuilding industry.

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