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Analysis of the Effectiveness of Agile Supply Chain in Indonesia's Largest Shipbuilding Industry

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***Abstract*— The shipbuilding industry is currently facing increasingly complex challenges, particularly related to market demand dynamics, global competition, and production timeliness. The implementation of Agile Supply Chain (ASC) is expected to be a strategic solution to address these challenges because ASC can increase flexibility and response to rapid changes and high demand variability. This study aims to analyze the Supply Chain Management (SCM) process in the largest shipbuilding industry in Indonesia, with a focus on identifying challenges in ASC implementation and examining the role of information technology in supporting this framework. A mixed methods approach is employed to investigate these issues by collecting data through questionnaires, in-depth interviews, direct observation, and analysis of relevant documents. The research findings indicate that ASC implementation, with collaboration and integration technology as the most dominant variables, can significantly improve operational flexibility, accelerate production timelines, reduce reliance on inventory, ensure timely material arrivals, and improve coordination among stakeholders in the supply chain. In addition, the adoption of ASC can result in faster ship construction compared to the initial planning stage. Challenges faced in implementing ASC include the need for investment in technological infrastructure, workforce training, and organizational culture transformation. Training, effective communication, and investment in supply chain digitalization systems are essential to improve the effectiveness of ASC implementation, thereby supporting the competitiveness and efficiency of the Indonesian shipbuilding industry in the future.**

Keywords— *Agile Supply Chain, Supply Chain Management, Shipbuilding Industry, Flexibility.*

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I. INTRODUCTION

In the era of globalization and rapidly shifting market dynamics, Agile Supply Chain (ASC) has become a critical strategy for enhancing organizational flexibility and responsiveness. The shipbuilding industry plays a strategic role in supporting the maritime sector. The prosperity of this industry has the potential to significantly boost the economy and lay the groundwork for advancing the maritime sector. However, innovative solutions are needed to address challenges such as volatile market demand, global competition, and the need for efficient production times [46].

Even though Indonesia has a lot of chances to grow its shipbuilding industry, it still has some serious problems, particularly in supply chain fulfillment. One key issue is the industry's reliance on raw materials and components, which are often subject to delayed deliveries. Limited supply of key components, such as high-quality steel plates and ship equipment, further exacerbates the situation. Another major concern is ineffective coordination between suppliers and manufacturers, which frequently results in production schedule delays. Uncertainty in the supply chain has a significant impact on production efficiency and overall project costs [36]. Therefore, a more robust supply chain management strategy is required, including supplier diversification and the enhancement of local manufacturing capabilities, to reduce reliance on imports [35]. Currently, supply chain control in the shipbuilding industry still relies heavily on the capacity of cross-sector resources within the company.

ASC is implemented to enhance flexibility and responsiveness to changes in market demand within the context of manufacturing industries. Reference [48] highlights that ASC implementation helps manufacturing companies achieve strategic goals by reducing production cycle time and strengthening collaboration with supply chain partners. This study emphasizes that companies adopting ASC tend to be more competitive, as they are able to respond to changes more swiftly

Study [17] adds that ASC is highly relevant in dynamic manufacturing environments, where market demand frequently shifts rapidly. Through the integration of digital technologies such as real-time data analytics, ASC enables manufacturing companies to optimize the procurement of raw materials and the distribution of finished products. The study demonstrates that ASC not only improves operational efficiency but also helps companies reduce logistics costs.

Research [10] states that large investments in technology and human resource training are required to implement ASC in the shipbuilding industry. The implementation of ASC is considered a strategic approach because it can increase cost efficiency and improve adaptability to customer demands.

Empirical evidence shows that ASC implementation has a positive effect on manufacturing

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industry growth. Several research findings also indicate that ASC adoption can increase operational flexibility, resulting in accelerated production schedules, reduced reliance on inventory, timely material arrivals, and improved coordination among supply chain stakeholders. In the shipbuilding industry, ASC implementation has resulted in faster shipbuilding completion than initially planned. However, there is still limited research addressing the specific mechanisms through which ASC generates these positive outcomes, including the supporting factors involved and the challenges faced by the industry in its implementation.

The adoption of innovative concepts has become essential for the shipbuilding industry to overcome supply chain challenges. The ASC concept offers flexibility and responsiveness in supply chain management, enabling companies to be more adaptive to shifts in customer demands and market conditions. The results of previous research [19] show that this approach can accelerate response to market demand and enhance operational efficiency by optimizing the flow of materials and information. However, there are many challenges that must be overcome by the shipbuilding industry in implementing this concept, especially in terms of investment in technological infrastructure, human resource development, and organizational culture transformation which significantly affect the success of integrating the ASC concept into the company's operational processes.

Several industries have adopted ASC to address operational challenges. The results of research [29] indicate that the implementation of this concept in manufacturing industries can enhance responsiveness to market demand and improve operational efficiency. Research findings [35] show that Agile Supply Chain (ASC) significantly contributes to better company performance. Study [8] discusses the implementation of lean, agile, resilient, and green supply chain practices in the logistics sector. The results show that these practices can create a responsive and environmentally friendly supply chain system. In addition, the results of research [34] reveal that integrating information technology with ASC concept can improve coordination efficiency between suppliers and manufacturers. The application of ASC in the shipbuilding industry can strengthen adaptability to market fluctuations, shorten production cycle time, and boost company competitiveness. This study aims to explore the implementation of ASC in Indonesia’s largest shipbuilding industry using a qualitative case study approach

The implementation of ASC in the shipbuilding industry is relatively more complex due to extended production cycles and highly specific customer demands. The results of study [46] reveal that, in the shipbuilding industry in Indonesia, the implementation of ASC can enhance coordination among suppliers, manufacturers, and customers in fulfilling large-scale project requirements. Implementing ASC in this industry enables companies to reduce reliance on extensive material stock while simultaneously accelerating delivery times.

Previous studies have shown that ASC has a positive effect on the manufacturing and shipbuilding industries, particularly in terms of flexibility, efficiency, and adaptability. However, its implementation requires technological infrastructure support, risk management strategies, and closer collaboration across the supply chain.

Research [33] defines Supply Chain Management (SCM) as the process of managing and monitoring the supply chain cycle, starting from raw materials, payments, information flow from suppliers to manufacturers, wholesalers, retailers, and finally to the end consumer. SCM is a mechanism that connects all parties and activities involved in converting raw materials into finished goods. These parties and activities are responsible for delivering finished products to customers at the right time and place and as efficiently as possible [30].

In addition, research [12] states that supply chain management aims to achieve efficient integration among suppliers, manufacturers, distributors, retailers, and customers. This approach ensures that goods are produced in the right quantity, at the right time, and delivered to the correct location, with the primary goal of minimizing overall costs while meeting the expected service level. SCM focuses not only on operational efficiency but also on optimal resource management to strike a balance between cost and service quality. The implementation of SCM requires well designed stages to ensure that all activities within the supply chain operate effectively and efficiently. Research [26] outlines six key stages in the supply chain management process: planning, procurement, production, warehousing, delivery, and return.

Factors that can influence the success of SCM encompass various aspects that must be considered to ensure the smooth flow of the supply chain. Understanding these factors is crucial to ensure that every element within the supply chain can function optimally and support one another. Research [47] outlines several key factors that can affect the SCM process, such as risk management, operational efficiency, business partner collaboration, information technology, and supply chain strategy.

ASC is an approach to SCM that emphasizes flexibility, responsiveness, and adaptability in dealing with dynamic market changes. This approach is increasingly relevant in modern business environments, given the growing complexity of global supply chains. Research [49] states that the ability to respond to change quickly and flexibly provides a significant competitive advantage. Study [18] indicates that ASC can enhance operational efficiency through close collaboration and the use of advanced technologies

According to [9], ASC is a supply chain system designed to rapidly respond to changes in market demand through the optimization of information and material flow, as well as the reduction of production cycle time. This approach aims to create a competitive advantage within highly dynamic business environments. Research [48] adds that ASC emphasizes integration of technology, process innovation, and close collaboration

among supply chain partners. The key elements of this concept include response speed, operational flexibility, collaboration and integration of technology, and risk management, all of which influence adaptability to market demand fluctuations. The main components of ASC can be described as follows:

1. Speed of Response
   According to [49], a rapid response to market changes is the core of ASC. Companies with agile supply chains are able to identify shifts in customer needs more quickly and adjust their operations efficiently.
2. Operational Flexibility
   According to [2], operational flexibility encompasses a company's ability to adapt its production processes, distribution, and resource management in response to changes in demand and market conditions.
3. Collaboration and Integration of Technology
   According to [18], close collaboration between suppliers, distributors, and customers supported by advanced information technology is a success key factor in ASC. The use of technology enables companies to share information in real time and improve decision-making efficiency.
4. Risk Management
   In the context of ASC, effective risk management is essential for addressing market uncertainties. Study [7] shows that well planned risk mitigation strategies can help companies reduce the negative impact of supply chain disruptions.

II. METHOD

Comprehensive, valid, reliable, and objective data are obtained using a mixed methods approach. This research method combines qualitative and quantitative techniques by conducting observations, surveys, interviews, document analysis, and audiovisual materials. According to [39], mixed methods approach is a research strategy designed to generate more comprehensive, valid, reliable, and objective data. The approach involves not only the collection and analysis of two types of data, but also the integrated function of both research paradigms collectively, resulting in a more robust overall outcome.

Specifically, the quantitative approach within this mixed methods study employs descriptive statistics to provide an objective overview of the research subject. Quantitative data are processed using analytical techniques, percentage formulation, or basic statistical methods [43]. The quantitative approach in this study is used to examine the condition of SCM and explore the main challenges and the role of technology in evaluating the effectiveness of ASC in the largest shipbuilding industry in Indonesia.

The sample represents and reflects the characteristics and nature of the population. Quantitative research samples are drawn from individuals who work in and are responsible for sustaining the supply chain within Indonesia's largest shipbuilding industry. Sampling is conducted using purposive sampling technique, where research subjects are deliberately chosen by the researcher based on specific criteria or considerations. Research [24] states that qualitative research does not use random sampling, but rather purposive sampling. Therefore, this study focuses on individuals who have worked for more than one year. The sample determination in this study refers to the Slovin formula as explained in [38]:

$$n = \frac{N}{1 + Ne^2}$$

Where:
n = sample size
N = population size
e = margin of error

Data processing is conducted through the steps outlined by [31] as follows:

1. Data Coding
   This is the process of systematically organizing raw data from the questionnaire into a format that is easily read by both researchers and data processing software.
2. Transferring Data to the Processing Software.
   This is done by transferring the coded data into a data processing machine. This study uses Statistical Package for the Social Sciences (SPSS) version 29.0.
3. Data Accuracy
   This is done to ensure that all data entered into the data processing system accurately corresponds to the original values.
4. Data Processing and Presentation
   The next step is data processing and presentation, which can be displayed in numerical form, graphs, and other formats.

The research method can be described using a flowchart as follows:

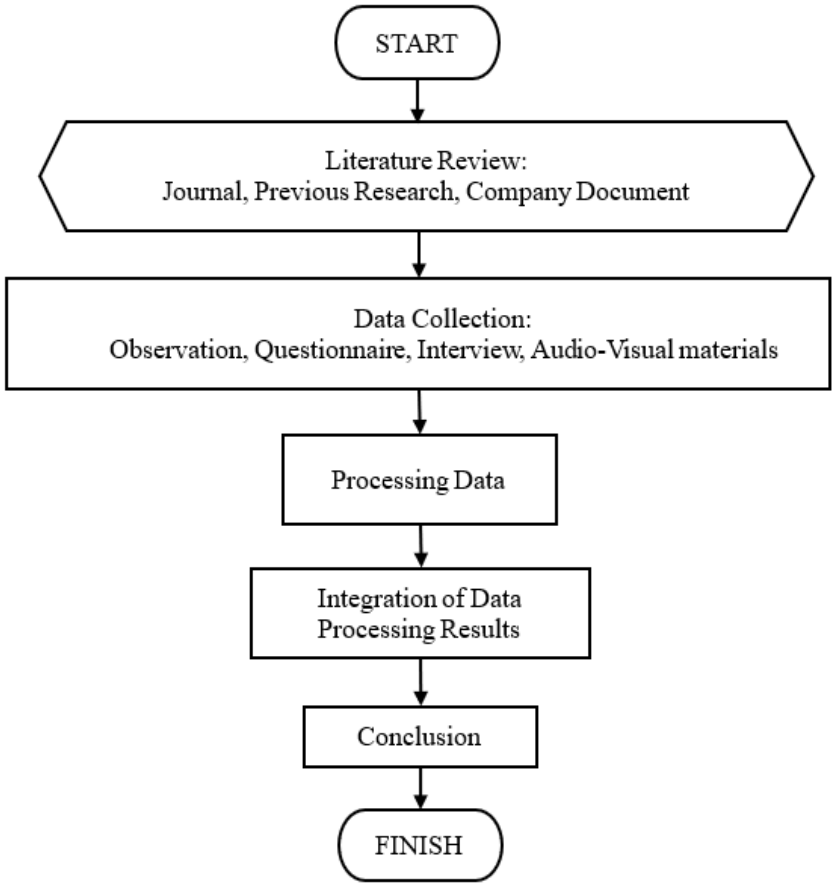


Figure. 1. Research Flowchart

III. Results and Discussion

The presence of the shipbuilding industry plays a vital and strategic role in supporting the development of the national maritime sector. As a downstream company, the Indonesia's largest shipbuilding industry functions as a Tier-1 entity within the supply chain system. Support in the form of materials and services from various contributing companies, such as Tier-2, Tier-3, and Tier-4, is essential. Operational agility in procurement is critically needed to meet production demands. The current research subject relies on the capabilities of cross-sector resources to manage the supply chain. The implemented supply chain model can be mapped out as shown in Table 1 below.

TABLE 1.
OBJECT MAPPING ASC MODEL

Stage	Object	Detail	Impact
Design	Design Unit	Design Drawing Production Drawing	High
Production Planning	Corporate Strategic Planning	Production Schedule	High
Procurement	Supply Chain Unit	Procurement Process Material Arrival Labor Supply Readiness	High
Construction	Production Unit	Ship Unit	High
Quality Assurance	QA Unit	Quality Acceptance	Medium
Deliver	Maarketing Unit	Ship Product	Low

The visualization of this mapping is illustrated in Figure 2 below:

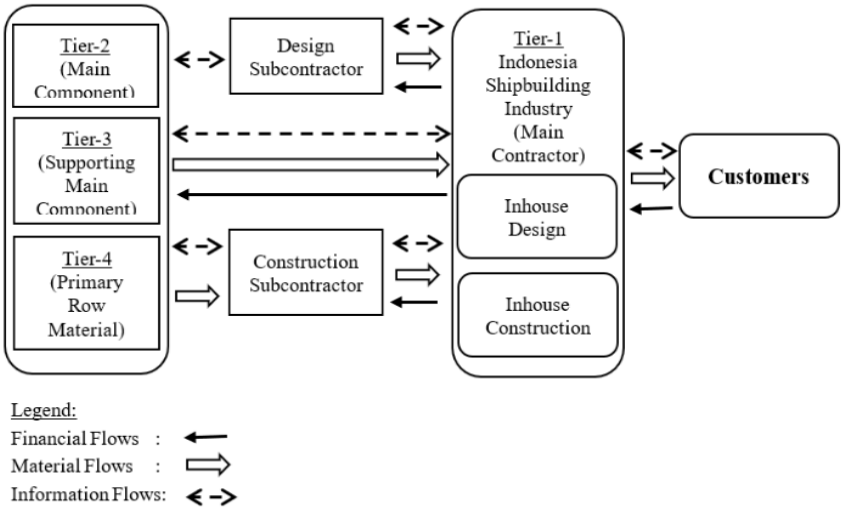


Figure. 2. ASC Model (Source: [6])

Respondent The criteria for respondents in this study are as follows: • Employees of the Indonesia's largest shipbuilding industry whose duties and functions are related to procurement activities; • Having work experience of more than one year. Of the total 45 respondents targeted in this study, 41 respondents are willing to fill out the questionnaire, while 4 others decline to participate. Of the 41 respondents, 24 have more than 6 years of work experience, 12 have between 4 and 6 years of experience, and 5 have between 1 and 3 years of experience.

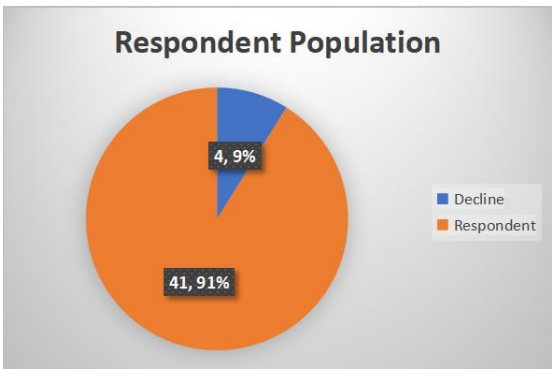


Figure. 3. Respondent Population Chart

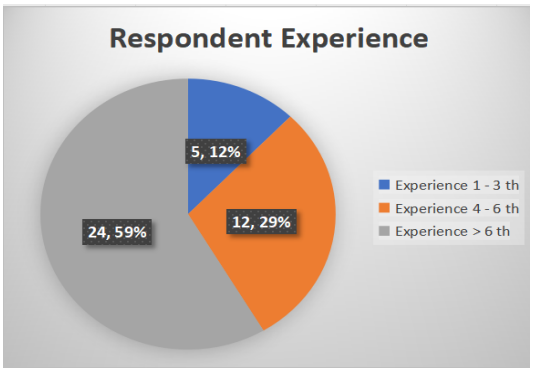


Figure. 4. Respondent Experience Chart

B. Sampling Test.

According to [38], the sampling test is conducted using Slovin's formula as follows:

$$n = \frac{N}{1 + Ne^2}$$

The results obtained are as follows:

$$= \frac{45}{1 + 45\ (0.05)(0.05)}$$

$$= \frac{45}{1.1125}$$

$$= 40.45$$

The n sample size calculated is 40.45, which is rounded up to 41 respondents.

C. Validity Test

Research [14] states that a validity test is used to measure whether a research questionnaire is valid. A questionnaire is considered valid if its questions are capable of revealing what the questionnaire intends to measure. In this study, the validity test is conducted using a statistical tool, SPSS version 29.0. Table 2 presents the results of the validity test conducted on a sample of 41 respondents. Each main component of ASC consists of 10 statements, bringing the total to 40 statements overall.

TABLE 2.
VALIDITY RESULTS

Item	Significance Value	Correlation Value	r_{Table} Value	Remark
Statement 1	0.000	0.604	0.3008	Valid
Statement 2	0.000	0.782	0.3008	Valid
Statement 3	0.000	0.704	0.3008	Valid
Statement 4	0.000	0.689	0.3008	Valid
Statement 5	0.000	0.721	0.3008	Valid
Statement 6	0.000	0.693	0.3008	Valid
Statement 7	0.000	0.778	0.3008	Valid
Statement 8	0.000	0.720	0.3008	Valid
Statement 9	0.000	0.658	0.3008	Valid
Statement 10	0.000	0.728	0.3008	Valid
Statement 11	0.000	0.713	0.3008	Valid
Statement 12	0.000	0.617	0.3008	Valid
Statement 13	0.000	0.677	0.3008	Valid
Statement 14	0.000	0.628	0.3008	Valid
Statement 15	0.000	0.789	0.3008	Valid
Statement 16	0.000	0.743	0.3008	Valid
Statement 17	0.000	0.604	0.3008	Valid
Statement 18	0.000	0.611	0.3008	Valid
Statement 19	0.000	0.747	0.3008	Valid
Statement 20	0.000	0.727	0.3008	Valid
Statement 21	0.000	0.673	0.3008	Valid
Statement 22	0.000	0.695	0.3008	Valid
Statement 23	0.000	0.723	0.3008	Valid
Statement 24	0.000	0.801	0.3008	Valid
Statement 25	0.000	0.775	0.3008	Valid
Statement 26	0.000	0.690	0.3008	Valid
Statement 27	0.000	0.701	0.3008	Valid
Statement 28	0.000	0.739	0.3008	Valid
Statement 29	0.000	0.799	0.3008	Valid
Statement 30	0.000	0.708	0.3008	Valid
Statement 31	0.000	0.773	0.3008	Valid
Statement 32	0.000	0.767	0.3008	Valid
Statement 33	0.000	0.691	0.3008	Valid
Statement 34	0.000	0.808	0.3008	Valid
Statement 35	0.000	0.799	0.3008	Valid
Statement 36	0.000	0.760	0.3008	Valid
Statement 37	0.000	0.802	0.3008	Valid
Statement 38	0.000	0.812	0.3008	Valid
Statement 39	0.000	0.777	0.3008	Valid
Statement 40	0.000	0.745	0.3008	Valid

Validity measurement in this study is conducted using Pearson correlation at a threshold of 0.05 ($\alpha = 5\%$). The relationship between two variables is considered significant when the p-value is less than or equal to the predetermined significance level. Based on the validity test results, the significance values are presented in the second column of Table 2 above. All statements show a significance value of 0.000, or less than 0.05, so they are considered statistically significant.

TABLE 3.
R - TABLE FOR DF = 1 - 50

df = (N-2)	Significance level for a one-tailed test				
	0.05	**0.025**	**0.01**	**0.005**	**0.0005**
	Significance level for a two-tailed test				
	0.1	**0.05**	**0.02**	**0.01**	**0.001**
1	0.9877	0.9969	0.9995	0.9999	1.0000
2	0.9000	0.9500	0.9800	0.9900	0.9990
3	0.8054	0.8783	0.9343	0.9587	0.9911
4 - 39	------	------	------	------	------
40	0.2573	0.3044	0.3578	0.3932	0.4896
41	0.2542	0.3008	0.3536	0.3887	0.4843
42	0.2512	0.2973	0.3496	0.3843	0.4791
43 - 50	------	------	------	------	------

(Source: Junaidi http://junaidichaniago.wordpress.com, 2010).

The application of correlation interpretation in this study is based on the (r) value, as in Pearson correlation coefficient. The validity test is conducted by comparing the (r) count value obtained with the (r) table value as shown in Table 2 above. The (r) count value must be greater than the (r) table value for the research instrument to be considered valid. The (r) table value is determined based on the (n) sample value. This study uses (n) sample = 41 respondents.

Based on the results of the validity test described in Table 2, third column, all statement items have (r) table value of 0.3008, so it can be concluded that all statement items compiled in this study are declared valid.

D. Reliability Test

The purpose of reliability testing is to determine the consistency of each questionnaire item used in the study. Table 4 shows the results of the reliability test based on the correlation of each individual statement.

According to [41], a construct is considered reliable if it has a Cronbach's Alpha value greater than 0.70. Based on Table 4 above, the reliability test results show a Cronbach's Alpha value of 0.976. Therefore, the statement items for each variable are deemed reliable as measurement instruments.

TABLE 4.
RELIABILITY TEST RESULT

Cronbach's Alpha	N of Item
0.976	40

E. Description of Research Findings

The variation of statements is arranged based on the main components of the study consisting of speed of response, operational flexibility, collaboration and integration of technology, and risk management. The statements are formulated in the form of a questionnaire and then respondents provide their feedback using a Likert scale ranging from 1 to 5. The collected data are presented in the form of a frequency table and evaluated using a rating interval.

The results of data processing for statements one to 10 with the main component of "speed of response" can be seen in Table 5 below.

TABLE 5.
CUMULATIVE SCORE FOR SPEED OF RESPONSE

	NSA	DA	N	A	SA	Cumulative Score
Statement 1	0	1	7	27	6	161
Statement 2	0	4	12	20	5	149
Statement 3	0	4	9	22	6	153
Statement 4	0	7	16	12	6	140
Statement 5	0	2	4	27	8	164
Statement 6	0	4	14	16	7	149
Statement 7	0	4	5	26	6	157
Statement 8	0	1	6	22	12	168
Statement 9	0	0	10	23	8	162
Statement 10	0	2	14	19	6	152
Total	0	29	97	214	70	1555

Data processing is carried out using the same method for statements 11 to 20 for the main component of "operational flexibility." The results are presented in Table 6.

TABLE 6.
CUMULATIVE SCORE FOR OPEATIONAL FLEXIBILITY

	NSA	DA	N	A	SA	Cumulative Score
Statement 11	0	2	12	21	6	154
Statement 12	0	1	12	23	5	155
Statement 13	0	0	8	26	7	163
Statement 14	0	0	10	26	5	159
Statement 15	0	2	10	25	4	154
Statement 16	0	3	12	22	4	150
Statement 17	0	6	12	18	5	145
Statement 18	0	3	11	20	7	154
Statement 19	0	0	14	21	6	156
Statement 20	0	2	4	30	5	1161
Total	0	19	105	232	54	1551

The results of data processing using the same method for statements 21 to 30 for the main component of "collaboration and integration of technology" are presented in Table 7.

TABLE 7.
CUMULATIVE SCORE FOR COLLABORATION AND INTEGRATION OF TECHNOLOGY

	NSA	DA	N	A	SA	Cumulative Score
Statement 21	0	1	4	25	11	169
Statement 22	0	1	10	21	9	164
Statement 23	0	1	7	23	10	165
Statement 24	0	3	7	26	5	156
Statement 25	0	2	7	25	7	160
Statement 26	0	1	10	23	7	159
Statement 27	0	3	15	17	6	149
Statement 28	0	5	12	20	4	146
Statement 29	0	5	12	20	4	146
Statement 30	0	3	7	25	6	157
Total	0	25	91	225	69	1568

Next, the results of data processing using the same method for statements 31 to 40 for the main component of "risk management" are presented in Table 8.

TABLE 8
CUMULATIVE SCORE FOR RISK MANAGEMENT

	NSA	DA	N	A	SA	Cumulative Score
Statement 31	1	1	10	22	7	156
Statement 32	1	3	9	20	8	154
Statement 33	1	6	9	21	4	144
Statement 34	1	4	14	18	4	143
Statement 35	0	3	7	23	8	159
Statement 36	1	1	8	25	6	157
Statement 37	1	3	10	22	5	150
Statement 38	0	2	9	23	7	158
Statement 39	1	0	8	26	6	159
Statement 40	1	1	7	23	9	161
Total	8	24	91	223	64	1541

F. The Most Influential Factors

Based on the trend of respondents' answers related to the questionnaire results, it is found that the most influential factor in this study, as shown in Table 7, statement No. 21, is "the company has open and effective communication with all partners in the supply chain", with the highest cumulative score of 169. This indicates that communication with supply chain partners plays a very dominant role in overcoming common challenges, especially the need for speed in real-time data exchange. This kind of communication is very important in making fast and accurate decisions.

Table 9 below shows the cumulative scores of the main component assessment factors.

TABLE 9.
CUMULATIVE SCORE OF MAIN COMPONENT ASSESSMENT FACTORS

Main Component		NSA	DA	N	A	SA	Cumulative Score
A.	Speed of Response	0	29	97	214	70	1555
B.	Operational Flexibility	0	19	105	232	54	1551
C.	Collaboration & Integration of Technology	0	25	91	225	69	1568
D.	Risk Management	8	24	91	223	64	1541
	Total	8	97	384	894	257	6215

The interval calculation is based on the cumulative scores of the main component assessments. The total score for each answer is then multiplied by the predetermined answer weight based on the Likert scale. The results are presented in Table 10.

TABLE 10.
INTERVAL CALCULATION

Main Component		NSA (1)	DA (2)	N (3)	A (4)	SA (5)
A.	Speed of Response	0	29	97	214	70
B.	Operational Flexibility	0	19	105	232	54
C.	Collaboration & Integration of Technology	0	25	91	225	69
D.	Risk Management	8	24	91	223	64
	Total	8	97	384	894	257
Score Weight		8	194	1.152	3.576	1.285
Cumulative Score				6.215		
Highest Score				8.200		
Lowest Score				1.640		
Interval				1.640		

From the calculation results, the interval criteria are obtained as shown in Table 11.

TABLE 11.
INTERVAL

Interval	Criteria
1.640 – 3.280	Very Low
3.281 – 4.920	Low
4.921 – 6.560	High
6.561 – 8.200	Very High

The cumulative score for the principal components was 6.215. This score is considered high because it falls within the range of 4.921 to 6.560. Therefore, it can be concluded that ASC implementation plays a significant role in supporting an effective and efficient production process.

The results of the cumulative score calculations and interval assessment can be seen in the chart shown in Figure 5 below:

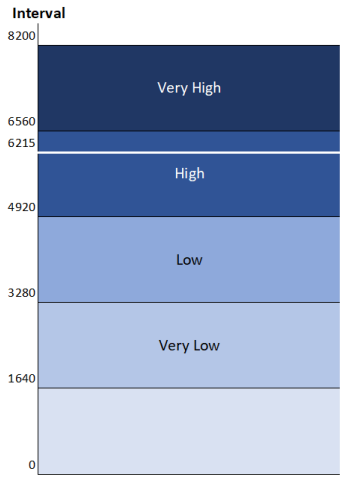


Figure. 5. Interval Graph

G. Implementation of Agile Supply Chain (ASC)

Based on field observations, it is found that the dependency of shipbuilding industry, as downstream industries, is heavily influenced by upstream industries that support their production processes. More than 60%-70% of the main components required for shipbuilding are still imported. The domestic ecosystem of supporting industries for shipbuilding remains relatively underdeveloped, resulting in a high level of dependence on foreign suppliers.

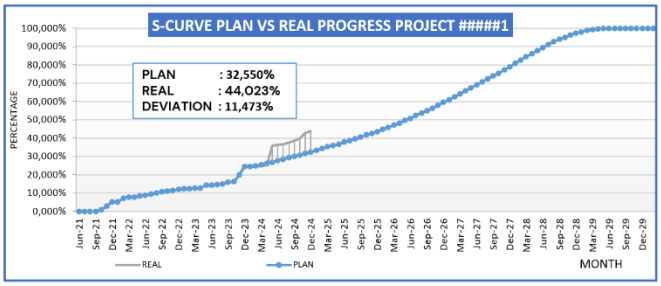
Delays in material delivery can significantly impact ship construction, both in terms of cost and completion time. Several factors contributing to material delays include geopolitical conditions, global economic conditions, and cross-border transportation issues.

A strategic procurement planning approach is necessary to anticipate potential obstacles and ensure the continuity of the supply chain. The implementation of Agile Supply Chain (ASC) in the shipbuilding process

can accelerate production progress by up to 10% of the scheduled time.

Progress Project #####1 (Desember 2024)

NO	WORK GROUP	PERCENT STANDARD	REAL	PROGRESS
1	A. Design Outsource	3,482%	100,000%	3,482%
	B. Design Inhouse	6,518%	55,475%	3,616%
2	A. Procurement Platform	12,444%	56,240%	6,999%
	B. Procurement Combat System	47,556%	50,000%	23,778%
3	Production	30,00%	20,496%	6,149%
	OVERALL PROGRESS	100%		44,023%



Progress Project #####2 (Desember 2024)

NO	WORK GROUP	PERCENT STANDARD	REAL	PROGRESS
1	A. Design Outsource	3,482%	100,000%	3,482%
	B. Design Inhouse	6,518%	55,475%	3,616%
2	A. Procurement Platform	12,444%	34,927%	4,346%
	B. Procurement Combat System	47,556%	50,000%	23,778%
3	Production	30,00%	3,906%	1,172%
	OVERALL PROGRESS	100%		36,394%

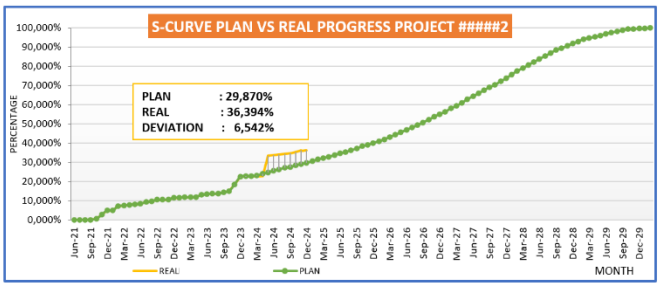


Figure. 6. Project Completion Progress Report

Collaboration with local suppliers is essential to anticipate potential bottlenecks in the supply chain. Long term contract models such as Umbrella Agreements or Consignment Arrangements serve as alternatives to mitigate supply chain disruptions, while also aiming to improve the local component and accelerate the growth of the domestic maritime industry ecosystem. One of the strategies currently being implemented to develop a national maritime industry ecosystem is through the local component enhancement program as shown in Figure 7.

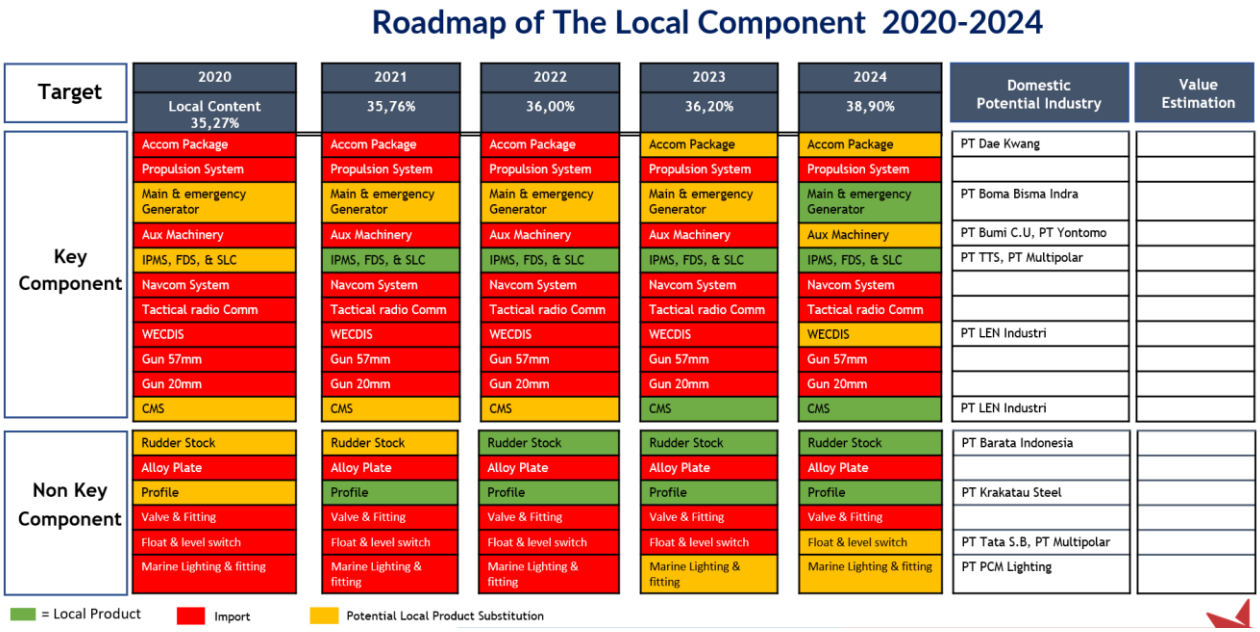


Figure. 7. Road Map of the Local Component

H. Challenges in the Implementation of ASC

A strategic approach in supply chain management that emphasizes adaptability, flexibility, and collaboration among stakeholders is crucial for navigating uncertainty and shifting customer demands in the complex, project-oriented shipbuilding industry. ASC offers a promising solution for overcoming challenges related to high dependency on numerous suppliers and extended lead times. The implementation of ASC in the shipbuilding industry faces a number of challenges that require serious attention. Based on field observations and interviews, these challenges extend beyond financial support and the need for skilled human resources. They also include more dominant barriers such as:

- Reliable technology integration The demand to adapt to the latest technological systems is essential for ensuring flexibility and responsiveness within the supply chain. However, the complexity of production systems and the variation in project requirements often hinder the standardization of integrated information technology systems. Alignment between supplier systems and shipbuilding systems is needed to reduce barriers in real-time data exchange.
- Communication with suppliers

  Smooth communication with suppliers remains a major hurdle, especially when involving various stakeholders within the maritime industry ecosystem who possess different levels of technological capability. Poor communication and limited visibility between shipbuilding industry and suppliers can obstruct collaboration and hinder swift decision-making.

  The inability to overcome these two challenges can hinder the achievement of ASC's primary goals, namely a swift response to customer demands and highly dynamic operational conditions.

I. Implementation of Information Technology that Supports ASC

Information technology plays a critical role in supporting the implementation of ASC. The adoption of the right information systems enables comprehensive monitoring of material, financial, and information flows within an integrated system. Several strategic functions of information technology include:

- Real-time monitoring of processes and material movement. Technologies such as ERP, IoT, and dashboards enable management to track all logistics activities in real time, providing full visibility into the progress of ship component production and distribution.
- Early detection of operational disruptions. Integrated information systems can identify disturbances, obstacles, and delays in the supply flow from the early stages, along with data on their causes. Necessary corrective actions can then be taken swiftly and accurately.
- Collaboration and communication facilities. Information technology serves as a system that facilitates the seamless and often invisible exchange of data between partners in the supply chain, thereby creating efficiencies and increasing adaptability to rapid changes in demand.

Therefore, the success of ASC implementation greatly depends on the readiness of the shipbuilding industry to fully and comprehensively adopt information technology. The availability of reliable information technology and effective communication with suppliers are key factors for achieving a successful transformation toward an ASC.

IV. Conclusion

Using a mixed methods approach, this study combines quantitative analysis to statistically measure supply chain effectiveness, along with interviews and observations to gain deeper insights into the challenges and successes of its implementation. The research findings indicate that the implementation of ASC in the shipbuilding industry has a significant impact on operational efficiency and production flexibility. In addition, the implementation of ASC can improve responsiveness to demand changes and market uncertainty, particularly in the areas of raw material management and stakeholder coordination. Quantitative data demonstrates increased production time efficiency and reduced operational costs, while qualitative findings highlight the importance of collaboration between suppliers, shipyards, and customers in achieving supply chain resilience.

This study also identifies several challenges, such as the complexity of technology integration and resistance to change within organizations. Therefore, strategies that prioritize training, effective communication, and investment in digital supply chain systems are recommended to enhance the successful implementation of ASC in the shipbuilding industry

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