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MARITIME SUPPLY CHAIN RISKS ANALYSIS OF THE INDONESIAN SHIPBUILDING INDUSTRY

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Abstract

In the face of volatile market demand, the shipbuilding industry must focus on enhancing its growth and productivity to ensure its survival, especially in the aftermath of the pandemic. The ETO business model adopted by Indonesian shipyards is complex and vulnerable, necessitating a clear understanding of customer requirements within the ship construction and repair services market. Moreover, addressing the dynamic risks present in the maritime SC is crucial. Identifying effective mitigation strategies requires shipyards to understand the common threats they face comprehensively. To facilitate this, our study employs the HOQ tool within the QFD methodology to analyse the needs of customers and maritime SC risks in the shipbuilding sector, aiming to secure their sustainability over the long term. The findings identified 6 customer needs and 5 maritime supply chain risks affecting the Indonesian shipbuilding industry.

Keywords: *Customer requirement, Maritime supply chain risk, QFD, Shipbuilding industry, Sustainability*

INTRODUCTION

The shipbuilding industry in Indonesia faces unique challenges in meeting production targets, mainly due to the volatile market demands. These challenges have been further exacerbated by the disruptions caused by the pandemic, including supply chain (SC) interruptions, increased costs, changing customer preferences, and a widespread shift towards digitalisation. The sector operates on a highly intricate engineer-to-order (ETO) model, where each construction project is customised to meet the specific requirements of individual clients, often referred to as ship owners. This customisation results in a wide variety of ship types, materials, capacities, and other essential specifications, underscoring the engineering and organisational challenges involved (Willner et al., 2016). Thus, product quality is essential in this industry as it impacts ship owners' loyalty and recommendations to others.

Vol. 03 No. 01 E-ISSN: 2985-3796

Implementing extensive customisation in ship construction introduces significant uncertainty and risk throughout the SC. These risks stem from internal and external sources, encompassing everything from sourcing materials to the final delivery of the ship to the owner. Any disruptions in the SC process can critically impact its performance, notably affecting cost structure and inventory management (Carvalho et al., 2012). These disruptions can also adversely affect overall satisfaction levels within the company, from downstream processes to the end customers, beyond just financial profitability.

To ensure the best service for ship owners, shipyards must actively manage and minimise risks throughout the entire SC process. Collaboration among key stakeholders is vital for creating an integrated SC with enhanced resilience, capable of rebounding from disruptions or adapting to favourable conditions. This includes safeguarding against failures, especially in the maritime SC, to maintain its strength and reliability. Therefore, this study addresses the fundamental research questions as follows:

RQ1. "What customer requirements are essential for enhancing the quality of products and services in Indonesian shipyards?"

RQ2. "Which maritime risks impact the operations of Indonesian shipyards?

The study aims to identify the maritime SC risks that most significantly impact customer satisfaction in the Indonesian shipbuilding industry.

RESEARCH METHODS

A structured survey based on literature is used to gather data on customer needs and maritime risks in shipbuilding. The questionnaire is shared online through specific community groups, targeting 152 shipowners (Trusteddocks, 2017), shipping liners, and logistics firms. Feedback from experienced shipbuilding industry experts with at least 10 years of experience or managerial roles will validate the survey data.

This study uses the House of Quality (HOQ) tool within the Quality Function Deployment (QFD) methodology to address research questions. As outlined in Figure 1, HOQ comprises six fundamental elements and starts with gathering customer requirements and assessing performance against these demands.

Vol. 03 No. 01 E-ISSN: 2985-3796

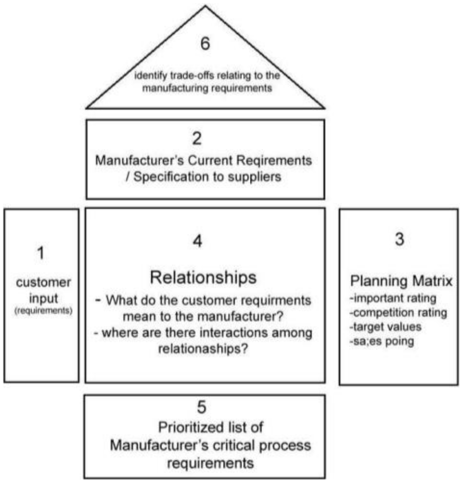

Figure 1. HOQ Structure

ANALYSIS AND DISCUSSION

In Figure 2, 55 respondents were distributed across different company departments. The Operations department accounted for 47.3% of the distribution, Sales/Marketing 16.4%, and Logistics 12.7%. The remaining departments collectively comprised 23.6%. These percentages demonstrate each department's impact on operational efficiency and performance.

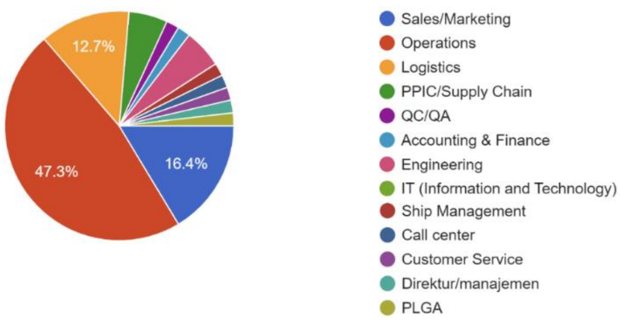

Figure 2. Respondents' Department (Percentage)

House of Quality Construction

Determining *What's* and Discussion

Vol. 03 No. 01 E-ISSN: 2985-3796

Before progressing to the development stage in HOQ, the VOC questionnaire results were ranked to identify the top five essential items from the original 25. Table 1 presents the ranked CR from the questionnaire, pinpointing critical service quality factors in shipbuilding services.

Table 1
Ranking of Customer Requirements' Attributes

Attributes	Item Code	Score	Weight/Importance (%)	Rank
Safety management during construction-repair	CR21	204	3.71	1
Service alignment with customer needs	CR20	198	3.60	2
Construction accuracy	CR4	197	3.58	3
Providing best solutions	CR8	196	3.56	4
Fast service	CR5	195	3.55	5
Efficient operation with qualified equipment	CR19	195	3.55	5

In response to *Research Question 1*, the top-ranking CR attributes are "Safety management during construction and repair" (CR21) with a relative weight of 17.22%, followed by "Service alignment with customer needs" (CR20) at 16.71%, and "Construction accuracy" (CR4) at 16.62%. The fourth-ranked attribute is "Providing the best solution" at 16.54%, while two attributes share the fifth position: "Fast service" and "Efficient operation with qualified equipment".

Relationship Matrix

After analysing maritime risks, a matrix was created to map these risks to customer requirements, as shown in Figure 5.

Vol. 03 No. 01 E-ISSN: 2985-3796

Problem Characteristics (a.k.a. "*Maritime Risks*" or "Hows") / **Demanded Quality** (a.k.a. "*Customer Requirements*" or "Whats")	Natural disasters	Commodity prices	Dearth of financing	Bank loan portfolio choice	Limited industry connections & shifting regulations	Inter-shipyard rivalry	Financial policies of global ship-owning companies	Late customers' requests and rework	Port operational risks	Highly customised ship design	Limited infrastructure and dry-docking capacity	Import-dependent raw materials	Supplier uncertainty	Inadequate management, planning, and unskilled employees	Down IT system and network	Poor cash flow forecasting and budget evaluation	HSE issues	Technical failures and machine shortage	Operational issues
Safety management during construction-repair	▲										▲			Θ	O		Θ	Θ	Θ
Service alignment with customer needs		O	▲		▲	Θ	▲	Θ		Θ	O	▲	Θ	O		▲	O		
Construction accuracy					O			O		Θ	Θ	Θ	▲	Θ			Θ	O	O
Providing best solutions		Θ	▲	▲	O								O		▲	▲	▲	▲	▲
Fast service	▲					Θ			▲	▲	Θ	O	O	O				▲	O
Efficient operation with qualified equipment			O		▲	O		▲	▲	Θ	Θ			Θ	Θ		▲	Θ	Θ

Figure 5. Relationship Matrix HOQ 1

The study found minimal impact of natural disasters on construction safety management. It also observed a moderate correlation between service alignment with customer needs and commodity prices in shipbuilding, as well as a strong connection between construction accuracy and the customisation level of ship designs.

Absolute Importance (AI) and Relative Importance (RI) Calculation

Results of AI and RI are detailed in Figure 6, with Table 2 showing the AI and RI scores for each maritime risk. Complete HOQ was constructed in Figure 7.

	Natural disasters	Commodity prices	Dearth of financing	Bank loan portfolio choice	Limited industry connections & shifting regulations	Inter-shipyard rivalry	Financial policies of global ship-owning companies	Late customers' requests and rework	Port operational risks	Highly customised ship design	Limited infrastructure and dry-docking capacity	Import-dependent raw materials	Supplier uncertainty	Inadequate management, planning, and unskilled employees	Down IT system and network	Poor cash flow forecasting and budget evaluation	HSE issues	Technical failures and machine shortage	Operational issues
Difficulty (0=Easy to Avoid, 10=Extremely Difficult)	8	7	5	3	5	6	7	3	4	3	6	7	6	5	7	3	2	2	4
Max Relationship Value in Column	9	3	3	1	3	9	1	9	9	9	9	3	9	9	9	1	9	9	9
Absolute Importance	33.67	198.99	82.62	16.54	132.66	347.85	16.71	216.71	32.91	464.56	513.16	215.70	265.99	552.15	216.29	33.25	387.68	385.91	418.82
Relative Importance	0.74	4.39	1.82	0.36	2.93	7.68	0.37	4.78	0.73	10.25	11.32	4.76	5.87	12.18	4.77	0.73	8.55	8.51	9.24

Figure 6. Technical Priorities

Table 2. Maritime Risks' Importance

Vol. 03 No. 01 E-ISSN: 2985-3796

Attributes	Item Code	Absolute Importance (%)	Relative Importance (%)
Natural disasters	MR1	33.67	0.74
Commodity prices	MR2	198.99	4.39
Dearth of financing	MR3	82.62	1.82
Bank loan portfolio choice	MR4	16.54	0.36
Limited industry connections and shifting regulations	MR5	132.66	2.93
Inter-shipyard rivalry	MR6	347.85	7.68
Financial policies of global ship-owning companies	MR7	16.71	0.37
Late customers' requests and rework	MR8	216.71	4.78
Port operational risks	MR9	32.91	0.73
Highly customised ship design	MR10	464.56	10.25
Limited infrastructure and dry-docking capacity	MR11	513.16	11.32
Import-dependent raw materials	MR12	215.70	4.76
Supplier uncertainty	MR13	265.99	5.87
Inadequate management, planning, and unskilled employees	MR14	552.15	12.18
Down IT system and network	MR15	216.29	4.77
Poor cash flow forecasting and budget evaluation	MR16	33.25	0.73
HSE issues	MR17	387.68	8.55
Technical failures and machine shortage	MR18	385.91	8.51
Operational issues	MR19	418.82	9.24

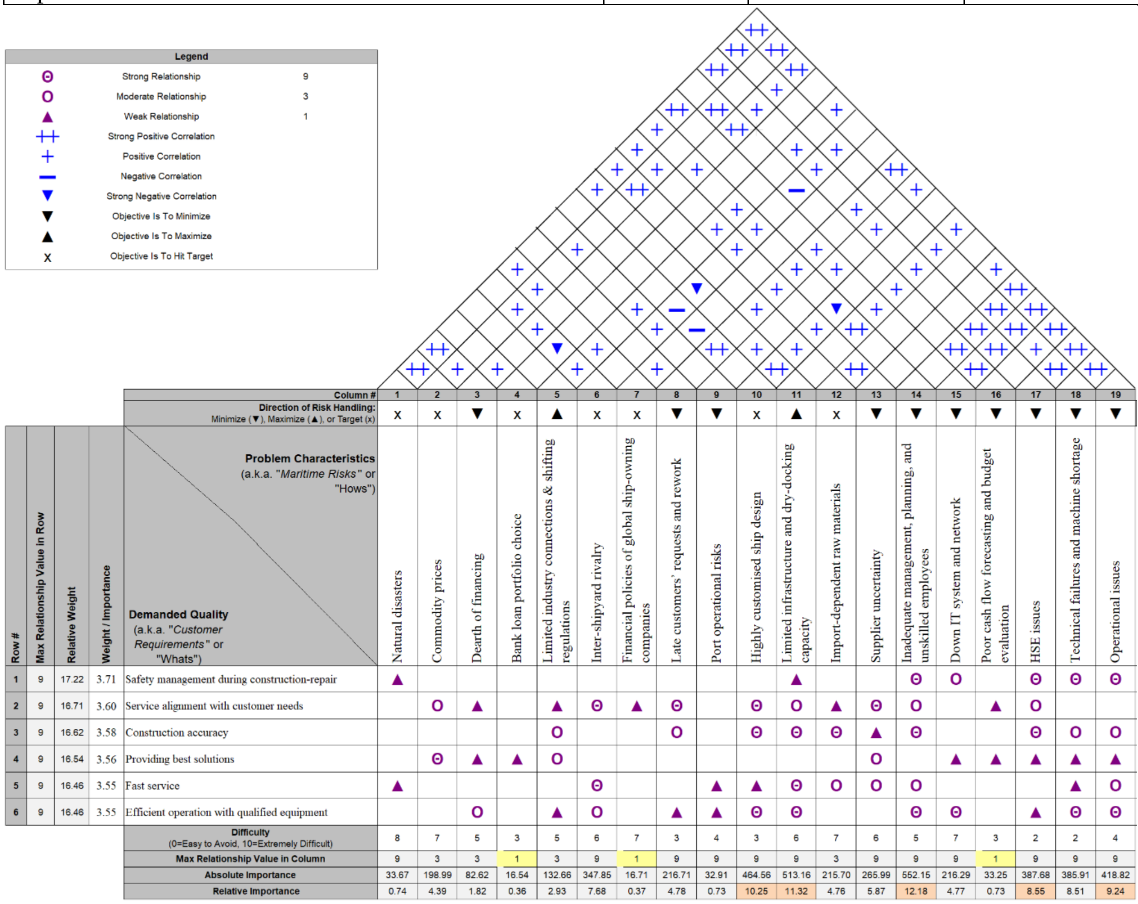

Figure 7. Complete HOQ

Vol. 03 No. 01 E-ISSN: 2985-3796

Maritime Risks Analysis and Discussion

Addressing *Research Question 2*, Table 3 presents the top five most important attributes of maritime risks, ranked in descending order, from a list of 19 potential items. Further insights and analysis are provided in the table.

Table 3. Five-Priorities Maritime Risks

Attributes	Item Code	Absolute Importance (%)	Relative Importance (%)
Inadequate management, planning, and unskilled employees	MR14	552.15	12.18
Limited infrastructure and dry-docking capacity	MR11	513.16	11.32
Highly customised ship design	MR10	464.56	10.25
Operational issues	MR19	418.82	9.24
HSE issues	MR17	387.68	8.55

This study highlights underlying risks similar to those of prior related studies. The primary risk in the ETO business model, particularly in the shipbuilding industry, stems from “inadequate management, poor planning, and unskilled employees” (MR14). Yin (2011) found the same underlying risk around organisation and management issues. Shipbuilding requires detailed planning and strong management to meet specific product demands. Variance in shipbuilding times due to factors like gross tonnage and specific functions can lead to quality assurance issues, potentially resulting in refusal of payment or legal action against the shipyard for not meeting contractual obligations.

The second significant risk involves the “inadequate infrastructure and limited dry-docking capabilities” (MR11) within shipyards. Despite their strategic locations near seas or ports for easier ship deployment, a large number of Indonesian shipyards are hampered by a lack of infrastructure necessary for undertaking large-scale shipbuilding projects. This limitation is particularly evident in smaller-scale businesses. For instance, the traditional shipyard in Lamongan, highlighted by Praharsi et al. (2022), exemplifies the obstacles posed by these constraints. Moreover, the scarcity of dry-docking facilities notably hampers ship repair processes, making them less efficient and effective. This situation poses a severe issue for ship owners needing maintenance services.

Vol. 03 No. 01 E-ISSN: 2985-3796

On the third list was the risk associated with “highly customised ship design” (MR10). While customisation is a common expectation in shipbuilding, overly complex designs can introduce additional risks. As supported by Yin (2011), issues related to structural design, overlapping responsibilities among personnel, and operational challenges are among the immediate causes of shipping accidents, highlighting the intricate balance required in managing design customisation while ensuring safety and efficiency.

Reaching the fourth list, the maritime SC faced “operational challenges” (MR19). These issues were deeply intertwined with the core activities of the shipbuilding process, highlighting three main areas of concern. Firstly, there was a notable deficiency in effective communication channels, which hindered smooth operations. Secondly, there was an observable gap in the general technical knowledge required for optimal performance. Lastly, there was a significant lack of detailed understanding and knowledge regarding individual ships' specific systems and operations. These challenges collectively contributed to operational inefficiencies within the maritime SC.

The study highlighted "Health, Safety, and Environment (HSE) concerns" (MR17) as the fifth most significant risk factor, showing significant marginal returns. Poor working conditions affect construction and repair processes, according to Ozturkoglu et al. (2019), who emphasise the importance of occupational health and safety management. They recommend that ship recycling companies develop training programs and adopt the Occupational Health and Safety Assessment Series to improve practices. Additionally, focusing on environmental sustainability and green practices not only makes shipyards more eco-friendly but also significantly lowers their environmental impact.

CONCLUSION

Data analysis in this study leads to several conclusions that address the identified research questions as follows:

1. Shipbuilding companies should prioritise customer needs, enhance service quality, and improve efficiency by embracing lean-agile construction practices. Pivotal CRs identified are safety management during construction and repair, alignment of

Vol. 03 No. 01 E-ISSN: 2985-3796

services with customer needs, construction accuracy, providing optimal solutions, quick service, and efficient operation using qualified equipment.

2. The journey to fulfilling these expectations is fraught with risks that could impede achieving CS for ship owners across the SC process. This study highlights the five significant risks: inadequate management, planning, and unskilled labour, limited infrastructure and dry-docking capacity, the complexity of highly customised ship designs, operational issues, and HSE issues.

Future studies should explore additional dimensions of maritime risks for small and medium-sized shipyards and broaden the scope to include companies across different segments of the maritime SC.

REFERENCES

Carvalho, H., Barroso, A. P., MacHado, V. H., Azevedo, S., & Cruz-Machado, V. (2012). Supply chain redesign for resilience using simulation. *Computers & Industrial Engineering*, *62*(1), 329–341. https://doi.org/10.1016/J.CIE.2011.10.003

Ozturkoglu, Y., Kazancoglu, Y., & Ozkan-Ozen, Y. D. (2019). A sustainable and preventative risk management model for ship recycling industry. *Journal of Cleaner Production*, *238*, 117907. https://doi.org/10.1016/J.JCLEPRO.2019.117907

Praharsi, Y., Jami'in, M. A., Suhardjito, G., Reong, S., & Wee, H. M. (2022). Supply chain performance for a traditional shipbuilding industry in Indonesia. *Benchmarking*, *29*(2), 622–663. https://doi.org/10.1108/BIJ-05-2020-0232/FULL/PDF

Trusteddocks. (2017, July 13). *Shipowners / Shipmanagers in Indonesia*. https://www.trusteddocks.com/catalog/managers/101-indonesia?sorting=managedVesselsCount&sortingDirection=DESC

Willner, O., Powell, D., Gerschberger, M., & Schönsleben, P. (2016). Exploring the archetypes of engineer-to-order: an empirical analysis. *International Journal of Operations and Production Management*, *36*(3), 242–264. https://doi.org/10.1108/IJOPM-07-2014-0339/FULL/PDF

Yin, J. (2011). *Quantitative risk assessment for maritime safety management*. https://theses.lib.polyu.edu.hk/handle/200/6085