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Analysis of key Factors in Collaborative Governance Models Between Navy and Maritime Industry using Delphi - Interpretive Structural Modeling (ISM)

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ABSTRACT

Mapping research direction on collaborative governance within the maritime industry is crucial for developing a comprehensive review. Many maritime companies currently employ traditional and outdated approaches to collaborative governance management, showing resistance to adopting more advanced methods. This research aims to explore these factors and their impact on improving operational effectiveness through collaboration between the Navy and the maritime industry. The study utilizes the Delphi technique and Interpretive Structural Modeling (ISM). Eight collaborative governance factors were identified from the literature and validated through assessments by twelve experts. These factors are: Budget (C1), Capability Building (C2), Leadership Commitment (C3), Trust Building (C4), Regulatory Framework (C5), Technology (C6), Resource Availability (C7), and Goals and Objectives (C8). The ISM approach was employed to develop contextual relationships and hierarchical structural models, resulting in a six-level digraph. The analysis revealed that Capability Building (C2) has a low driving force, while Resource Availability (C7) exhibits the highest dependence. Technology (C6) and Capability Building (C2) were identified as dependent variables with weak driving force but strong dependence. Goals and Objectives (C8) emerged as the only independent variable with a strong driving force but weak dependence. The linkage variables include Budget (C1), Leadership Commitment (C3), Trust Building (C4), Regulatory Framework (C5), and Resource Availability (C7).

1. Introduction.

The maritime industry's contribution to global trade is substantial, with approximately 90% of goods being transported by sea (Okumus et al., 2023). In this context, "shipping" denotes the oceanic transit of cargo by vessels (Shahbakhsh, Emad and Cahoon, 2022). This reliance on maritime transport underscores the shipping industry's pivotal role as a cornerstone of the global economy. Nonetheless, the industry confronts a range of challenges including social issues, climate change, economic pressures, and notably, rapid technological advancements. These factors necessitate that the shipping sector views these challenges as opportunities rather than threats, with particular attention to security considerations (Mouschoutzi and Ponis, 2022). Additionally, the maritime industry is profoundly influenced by various aspects of the industrial revolution (Ichimura et al., 2022).

Both the shipping sector and the broader maritime industry are heavily reliant on seaworthy vessels, which require routine maintenance. Historically, shipbuilders and owners have depended on dry docks for the construction, inspection, maintenance, and repair of ships (Armoo, Franklyn-Green and Braham, 2020). For naval vessels, routing can often be determined at the last moment (Mouschoutzi and Ponis, 2022). Early case studies in the naval sector highlight the critical need for rapid manufacturing to enhance naval capabilities (Singh and Verma,

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2015; Wibawa and Suharjo, 2021). Enhancing naval capabilities may be achieved through collaboration with the maritime industry (Zulkifli et al., 2020). Consequently, it is essential to continuously anticipate rapid technological changes and strategic shifts through collaborative governance between the maritime industry and naval forces (Wibawa and Suharjo, 2021).

Mapping the direction of research on collaborative governance within the maritime industry is crucial for developing a comprehensive review (Kaštelan et al., 2024). There is a recognized need for a structured framework within maritime companies to guide sustainable development stages and foster collaboration in achieving Sustainable Development Goals (SDGs) (Bolton, Landells and Roberts, 2020). Mouschoutzi and Ponis (2022) highlight that naval military operations offer a comprehensive perspective on existing challenges. Many maritime companies currently employ traditional and outdated approaches to collaborative governance management, showing resistance to adopting more advanced methods. Van den Oever, Fjeld, and Sætrevik (2023) argue that future research should focus on maritime operational tasks to uncover cognitive and collaborative challenges. Consequently, research is needed to identify factors of collaborative governance that could enhance naval operational capabilities. This research aims to explore these factors and their impact on improving operational effectiveness through collaboration between the Navy and the maritime industry.

This research is significant for several reasons. Firstly, it enhances National Security and Defense Capabilities by examining key collaborative factors, which could lead to improved strategies for threat detection, response capabilities, and resource allocation. Secondly, analyzing collaborative governance models can drive innovation through the exchange of knowledge and resources between the Navy and private sector companies, potentially leading to the development of advanced technologies that benefit both naval operations and commercial shipping practices. Thirdly, this research offers insights into how these entities can collaborate to navigate regulations effectively, ensuring compliance while promoting innovation. Lastly, understanding collaborative governance between national defense entities, such as the Navy, and the commercial industry is vital for strengthening the domestic maritime industry and fostering international partnerships.

This research is grounded in collaborative theory, collaborative governance, and the maritime industry context. Employing a descriptive statistical qualitative research method, the study utilizes the Delphi technique and Interpretive Structural Modeling (ISM) to analyze data. It draws on insights from twelve expert panels with expertise and experience in developing the capabilities of the Indonesian Navy and the maritime industry. The focus is on various maritime industries in Indonesia, as the collaboration between the Indonesian Navy and the national maritime sector is crucial for aligning security strategies, enhancing economic benefits, and improving operational efficiency.

The research offers several contributions. Firstly, it presents a framework that provides a structured approach to strengthening collaborative factors within the maritime industry. This framework integrates management principles with levels of analysis relevant to both maritime and naval sectors. Secondly, it lays the groundwork for developing a theoretical model on how collaborative governance can enhance naval capabilities and maritime industry performance, an area currently underexplored in the literature. Thirdly, the research contributes new insights for maritime industry stakeholders by offering a collaborative factor structuring model that fosters synergy in maritime development. Finally, the research's findings have significant implications for achieving Sustainable Development Goal, which focuses on the conservation and sustainable use of oceans, seas, and marine resources. This relevance stems from the integration of economic approaches with broader stakeholder interests, promoting sustainable practices in both maritime and naval sectors.

2. Literature Review.

2.1. Theory of Collaboration.

Collaboration is widely recognized as a mechanism for enhancing competitiveness and ensuring survivability in turbulent environments (Romero, Galeano and Molina, 2008). It is defined as ongoing interpersonal interaction aimed at achieving a common goal (Colbry, Hurwitz and Adair, 2014). Scholars of collaborative governance generally describe collaboration as a cyclical and nonlinear interaction involving communication, trust, commitment, shared understanding, and outcomes (Kim, 2016). Effective collaboration can be instrumental in resolving conflicts or advancing a shared vision (Jamal and Getz, 1995). The impact of collaboration on business performance is evident, as organizations increasingly adopt various collaborative models to navigate the complexities of a highly competitive global landscape (Romero, Galeano and Molina, 2008). The success of these collaborative processes often hinges on the perceptions of the participants, given that collaboration involves coordinated efforts among multiple stakeholders (Kim, 2016).

The literature reveals that government agencies often resort to collaboration to secure agreements that are initiated and implemented by the agency (Cheng and Sturtevant, 2012). However, successful collaboration can be jeopardized by members who are socially reluctant, uncooperative, or part of counterproductive alliances. Conversely, collaboration can be facilitated by strong team members who offer diverse perspectives, help negotiate conflicts, assign roles, foster communication, and guide the team through challenges (Graesser et al., 2018). Effective collaboration involves sharing control and responsibility based on trust, distributing financial responsibility and risk, and coordinating interests and actions, which can lead to significant synergistic effects (Tolstykh et al., 2023). To design a robust collaboration strategy, it is crucial to understand why existing governance arrangements may be exclusive, exhibit limited stakeholder participation, and address stakeholder concerns (Woldesenbet and Kebede, 2021).

2.2. Collaborative Governance.

Collaborative governance represents an innovative strategic model of government that engages various stakeholders and government officials in a joint decision-making forum to address complex problems that cannot be solved independently (Tando, Sudarmo and Haryanti, 2020). This approach involves collaboration between public and private actors through specialized processes, rule-setting, and policy development aimed at making effective public decisions (Ansell and Gash, 2008; Lindholst and Torjesen, 2024). Collaborative governance provides a framework for understanding the challenges of enhancing and institutionalizing collaboration among organizations (Gordon et al., 2020). In the literature, political capital within collaborative governance often refers to the commitment and willingness of stakeholders to collectively shape goals, agendas, and actions (Ansell and Gash, 2008; Kim, 2016).

Despite its increasing prominence in public administration literature, the definition of collaborative governance remains ambiguous, and its application varies (Emerson, Nabatchi and Balogh, 2012). The approach is gaining importance as a strategy for achieving sustainability goals due to its multi-sectoral and bottom-up problem-solving orientation (Mah and Hills, 2012). When applied, collaborative governance identifies three key categories of actors involved in state asset management efforts: (1) the government, which formulates and enforces regulations related to state asset management and public services; (2) the private sector, which utilizes state assets and contributes as taxpayers; and (3) the general community, which provides oversight and input in state asset management (Jiwando and Juwono, 2019). Collaborative governance theory integrates elements of synergistic and governance theories, where diverse governance subjects within a complex social system leverage their distinct abilities and roles to create a collective governance force, thereby enhancing governance efficiency (Yao, Luo and Zhao, 2022).

2.3. Maritime Industry.

Maritime industry is crucial to global trade and economic development, characterized by its complex supply chain involving numerous interconnected players, systems, and networks (Nguyen et al., 2023). The sea has historically been integral to civilization and development, forming the foundation of the maritime industry (Armoo, Franklyn-Green and Braham, 2020). Traditionally, innovation within this sector has progressed slowly and incrementally (Munim et al., 2020). While technological advancements are essential, their impact on the maritime industry is contingent upon widespread adoption and integration.

Maritime industry has undergone significant changes through various stages of the industrial revolution. Initially, the steam engine supplanted wind power as the primary energy source for large seagoing vessels (Ichimura et al., 2022). This transition has influenced not only individual stakeholders but also the maritime industry as a whole, affecting legislation, culture, commercial structures, trust, collaboration, and other ”softer” aspects of institutional change (Munim et al., 2020). Additionally, the maritime industry is subject to stringent regulations, necessitating compliance with a multitude of technical and operational specifications and guidelines imposed by different countries (Mouschoutzi and Ponis, 2022).To navigate these complexities, the industry can leverage experiences from past technological innovations to develop roadmaps, strategic plans, and training programs that enhance the application of technology across various maritime sectors (Shahbakhsh, Emad and Cahoon, 2022).

3. Methodology.

The primary objective of this paper is to investigate and develop a hierarchical process for understanding the contextual relationships among collaborative governance factors between the Navy and the national maritime industry using interpretive modeling. The research employs a two-phase sequential exploration research methodology, incorporating both the Delphi and Interpretive Structural Modeling (ISM) methods. Initially, the qualitative Delphi technique is utilized to identify relevant collaborative governance factors. Subsequently, the ISM multi-criteria decision-making (MCDM) tool (Susilo, U. Ciptomulyono, et al., 2019; Susilo, Udisubakti Ciptomulyono, et al., 2019) is applied to establish reciprocal relationships among these factors. To complement the ISM findings, MICMAC analysis is conducted to explore indirect relationships.

This research was conducted between 2023 and 2024, focusing on six major maritime industries in Indonesia involved in the development and construction of naval capabilities. The research targets experts from academia and practice who possess substantial experience in defense, industry, maritime affairs, and maritime technology. Experts were selected based on their relevant research or professional experience in developing naval capabilities and the national maritime industry. Purposeful sampling was used for data collection. A total of 12 experts were surveyed using the Delphi technique, with a questionnaire distributed via Google Forms and email.

Expert selection criteria included: (1) prior research in naval and maritime affairs, (2) a doctoral degree in the field of industry, and (3) more than ten years of maritime work experience. The questionnaire, designed to evaluate the importance of various collaborative governance factors, employed a 5-point Likert scale ranging from ”not important” to ”very important” (Qureshi et al., 2022). During the pre-Delphi phase, the experts rated the factors, and the Content Validity Index (CVI) was calculated to assess the level of agreement among the judges regarding the classification of items. If the CVI fell below 0.75 or if revisions were suggested, a revised form incorporating feedback was redistributed to the judges.

3.1. Conceptual Framework.

The conceptual research framework is divided into two phases. Phase 1: Factor Identification involves using the Delphi method survey to determine the factors influencing collaborative governance between the maritime industry and the Navy. Validation and finalization of the Delphi rounds are supported by the Content Validity Index (CVI). A panel of experts from both industry and academia is initially assembled to provide input. The insights gained through Delphi analysis are critical for addressing existing challenges.

Phase 2: Analysis of Relationships focuses on examining the relationships among the identified collaborative governance

Table 1: Demographic information of the experts.

Expert	Field	Position
E1; E2; E3	PhD in Maritime Industries	Academic and Professional
E4; E5; E6; E7	Master in Naval	Academic and Professional
E8; E9; E10	PhD Student in Maritime Management	Academic
E11; E12	Master in Defense industries	Professional
E1; E2; E3	PhD in Maritime Industries	Academic and Professional
E4; E5; E6; E7	Master in Naval	Academic and Professional

Source: Authors.

factors using the ISM-MICMAC methodology, incorporating expert panel opinions. This phase categorizes the factors into sections such as dependency, drivers, linkages, and autonomy. This analysis aids managers in effectively managing collaborative governance factors and supports the development of naval capabilities in conjunction with the national maritime industry.

3.2. Delphi Technique.

The Delphi technique was designed to facilitate focus group discussions on complex issues to achieve consensus through iterative rounds and guide future directions (Chand, Thakkar and Ghosh, 2020). This method involved careful planning and execution, including defining the problem, selecting panel members, determining the panel size, and conducting Delphi rounds (Munasinghe et al., 2023). Clearly defining the problem and its objectives ensured that the research was methodologically sound and aimed at achieving the desired outcomes (Jannat et al., 2020).

The Delphi technique aimed to gather expert opinions and address various barriers through in-depth questioning of experts and stakeholders within a practical context. The process typically involved several steps: (1) constituting a panel of experts, (2) identifying barriers and formulating a feedback system, and (3) executing the research in three rounds (Venkatesh, Rathi and Patwa, 2015). Given that the Delphi technique often included multiple rounds of feedback, it was crucial to secure the commitment of panel members to participate throughout the process, ensuring the stability and consistency of responses (Rathore et al., 2022) (Ullah et al., 2021).

To assess item validation, the Content Validation Index (CVI) was employed. CVI was calculated by summing the relative frequencies of responses indicating agreement (04) and strong agreement (05), then dividing by the total number of items to determine the level of expert consensus on the adequacy of the assessment (Mahran et al., 2021). A CVI value of 0.75 or higher indicated that the items met the criteria for adequacy in the overall evaluation of the instrument (Coimbra et al., 2021). The CVI was applied to analyze the results from each Delphi round to ensure the reliability and validity of the findings

3.3. Interpretive Structural Modeling (ISM).

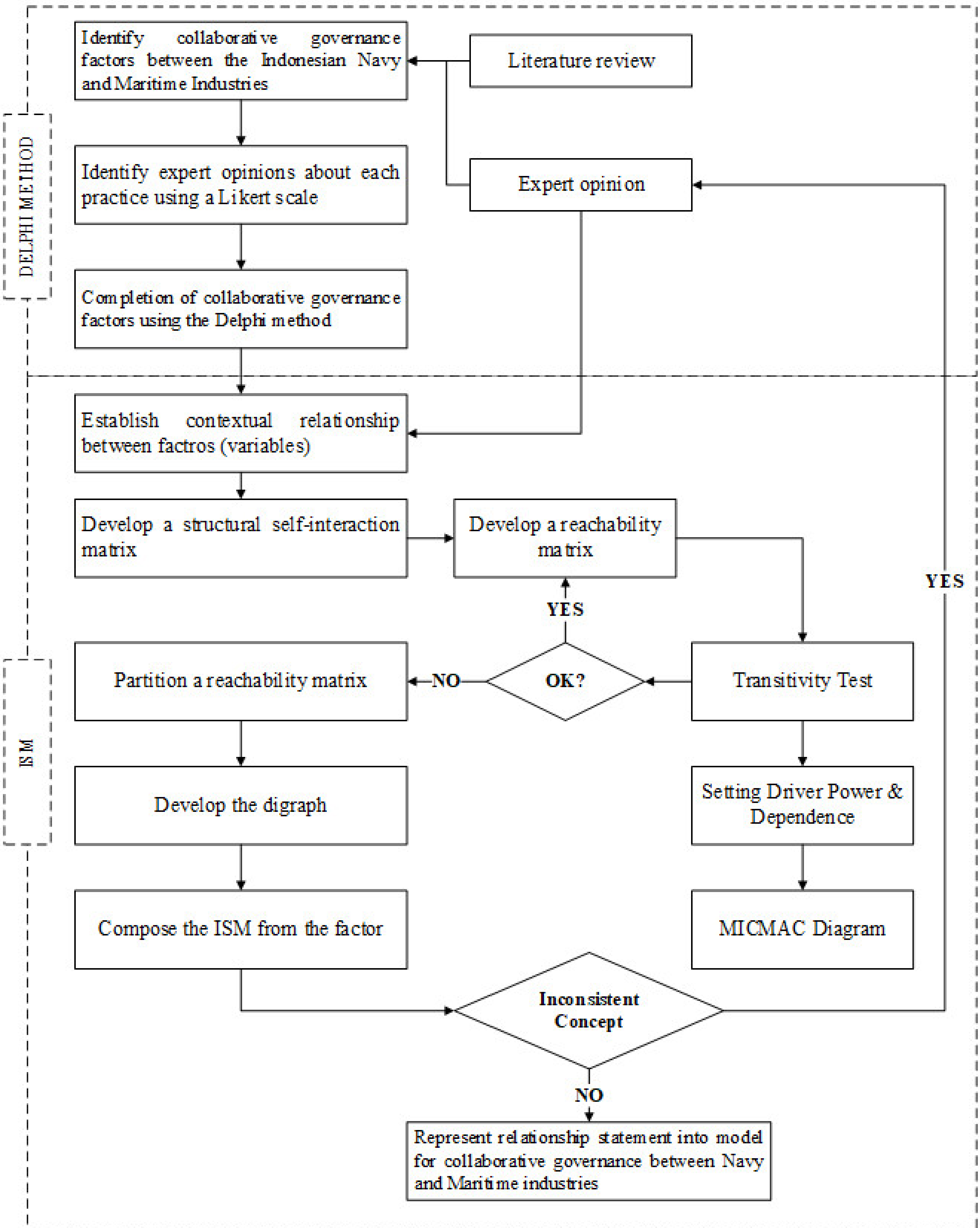
Interpretive Structural Modeling (ISM) is an approach based on group judgment and consensus, utilizing a collaborative learning process to systematically organize connected factors impacting a system into a coherent model (Susilo, Udisubakti Ciptomulyono, et al., 2019; Wu et al., 2023). This technique, first proposed by Warfield (1974), enables the interactive research of how determinants within a complex system are interrelated (Wu et al., 2023). The interpretive nature of ISM arises from its reliance on expert judgment to define the relationships between variables. It is termed "structural" because it constructs a framework that describes these relationships. ISM is considered a modeling technique as it allows for the development of graphical models that visually represent the interconnections between variables (He and Elhami Khorasani, 2022)

The development of an ISM model is detailed through a step-by-step approach. ISM facilitates the identification of structures within a system. The following steps are involved in the ISM methodology (Chand, Thakkar and Ghosh, 2020; Ullah et al., 2021):

- Factors influencing the process are listed. This research identifies factors related to collaborative governance in the maritime industry and the Navy.
- Contextual relationships between the factors studied are established.
- Pairwise relationships between factors are developed with the formulation of a Structural Self-Interaction Matrix (SSIM).
- A Reachability Matrix is created to examine transitivity. The transitivity rule assumes that if A has a relationship with B and B has a relationship with C, then A has a direct relationship with C.
- The final reachability is built through the application of transitivity rules, which are divided into several sections.
- A directed graph is drawn based on the relationships in the final reachability matrix, with transitive links removed.
- The final digraph is converted into ISM by replacing element nodes with statements.
- To ensure valid results, the theoretical Interpretive Structural Model is re-tested for inconsistencies and adjustments must be made as necessary.

The partition levels outlined in Table 5 are subsequently utilized to construct a hierarchical model illustrating the enabling factors that influence collaborative governance between the Navy and maritime industries. The relationships among these factors are plotted accordingly. An interval is applied to the values, with relationships being excluded from the diagram if their mean score is lower than the specified value. The resulting diagram is referred to as a digraph. Following the elimination of transitivity, as detailed in the ISM methodology, the

Figure 1: Proposed research framework.



Source: Authors.

digraph is refined into the final ISM model presented in Figure 3. This ISM model demonstrates the interdependencies among the various enabling factors across the six identified levels.

3.4. MICMAC Analysis.

Matrices d'Impacts Croisés Multiplication Appliquée à un Classement (MICMAC) analysis is a method used to categorize and classify variables into four distinct groups to identify key factors that influence each other directly and indirectly (Moradi et al., 2023). This analysis is performed to reveal the indirect relationships between collaborative governance factors in the maritime industry and the navy by examining the driving forces and dependencies of each barrier (Rathore et al., 2022). Each barrier is assigned a coordinate based on the number of impacts it has in rows and columns, which is then used to position it on a two-dimensional graph. Subsequently, barriers are classified into four quadrants based on their coordinates (Qureshi et al., 2022), as follows:

- Autonomy (Quadrant I) – Factors in this quadrant have low driving power and low dependence. Therefore, they have minimal influence.
- Dependence (Quadrant II) – Factors in this quadrant have weak driving power but strong dependence. Other factors typically influence these factors at a lower level in the ISM model**.**
- Interaction (Quadrant III) – Factors in this quadrant have both strong driving power and strong dependence. They are unstable, and any actions involving these factors will lead to subsequent reactions affecting both these factors and others.
- Independent or Driving (Quadrant IV) – Factors in this quadrant are considered the most important, with strong driving power but weak dependence. This means these factors can significantly impact other factors. Thus, they require immediate attention, as other dependent factors may be affected.

4. Results.

4.1. Identification of Collaborative Governance Factors between the Maritime Industry and the Navy.

As discussed in the previous section, a comprehensive list of characteristics related to collaborative governance between the maritime industry and the navy was developed based on a review of the literature. The Delphi method was employed to explore and finalize the identification of these factors. A panel consisting of twelve professionals, academics, and other stakeholders was assembled for this research (see Table 1). These participants were invited to contribute to the survey.

To facilitate their input, detailed information regarding the selected factors, including the rationale for their selection and a general explanation and definition of each factor, was provided to the experts. They were then asked to participate in the first round of the survey. During this initial round, the experts provided their feedback using a 5-point Likert scale questionnaire.

In the first round of the Delphi method, the Item-CVI values ranged from a minimum of 0.67 to a maximum of 1, validating all items of the instrument. Four items were removed based on the results of this round—Cultural Differences, Conflict Resolution Mechanisms, Public Perception and Support, and International Relations—resulting in a reduction from 14 to 10 items. In the second round, the Item-CVI values ranged from a minimum of 0.5 to a maximum of 1. Two additional items, Communication Channels and Stakeholder Engagement, were removed, leading to a final set of 8 items.

Following these revisions, the instrument was sent for a third round of evaluation to assess its final validity. The results indicated that all dimensions were fundamental to the construction of the assessment tool. Nearly all items achieved an I-CVI value of 1, reflecting 100% agreement among the experts, with an S-CVI of 98%. The I-CVI was thus considered very good, completing the overall validity stage (Table 2 and Figure 2).

Table 2: Expert judgment results in the first, second, and third rounds.

No	Factors	Round 1		Round 2		Round 3		Code
		CVI	Result	CVI	Result	CVI	Result	
1	Communication Channels	0.92	Accepted	0.58	Rejected			
2	Budget	0.92	Accepted	0.83	Accepted	1.00	Accepted	C1
3	Capability building	0.92	Accepted	0.83	Accepted	1.00	Accepted	C2
4	Stakeholder Engagement	0.83	Accepted	0.50	Rejected			
5	Cultural Differences	0.67	Rejected					
6	Leadership Commitment	1.00	Accepted	0.92	Accepted	1.00	Accepted	C3
7	Trust Building	1.00	Accepted	0.83	Accepted	1.00	Accepted	C4
8	Regulatory Framework	0.83	Accepted	0.83	Accepted	0.92	Accepted	C5
9	Conflict Resolution Mechanisms	0.67	Rejected					
10	Technology	0.92	Accepted	1.00	Accepted	1.00	Accepted	C6
11	Public Perception and Support	0.67	Rejected					
12	Resource Availability	0.83	Accepted	1.00	Accepted	1.00	Accepted	C7
13	Goals and Objectives	0.83	Accepted	0.92	Accepted	0.92	Accepted	C8
14	International Relations	0.75	Rejected					
Sum of I-CVI		11.75		8.25		7.83		
S-CVI/Ave		0.84		0.83		0.98		
Category		**Accepted**		**Accepted**		**Accepted**		

Source: Authors.

Table 2 presents the eight factors identified through the expert panel evaluation process, each assigned a reference code for use in Interpretive Structural Modeling (ISM). The factors include Budget (C1), Capability Building (C2), Leadership Commitment (C3), Trust Building (C4), Regulatory Framework (C5), Technology (C6), Resource Availability (C7), and Goals and Objectives (C8).

4.2. Analysis of Relationships Among Collaborative Governance Factors between the Maritime Industry and the Navy.

After identifying the key factors of collaborative governance in the navy and maritime industry for strengthening capabilities, the next step is to analyze these factors using the Interpretive Structural Modeling (ISM) technique (Roy Ghatak, 2020). ISM is employed to construct a structural model based on the contextual relationships between the factors, which is then followed by MICMAC analysis to classify the barriers according to their driving forces (Huang et al., 2020).

ISM allows a small group of experts to develop a graphical representation of a complex system. This technique facilitates the creation of a comprehensive structure by considering all possible pairwise interactions among the identified factors. As a modeling technique, ISM maps and illustrates the complete structure and individual relationships of the elements through a digraph, based on expert opinions. Subsequently, MICMAC analysis is used to identify dependent, interrelated, and autonomous elements within the system, providing insight into how these factors interact and influence each other (Moradi et al., 2023).

4.2.1. Structural self-interaction matrix (SSIM).

To detect contextual relationships between factors, the Interpretive Structural Modeling (ISM) approach leverages the insights of experts with extensive experience in the maritime and naval industries. During the expert meeting, the participants assessed the interaction relationships between factors using the contextual relationship of the "influence" type to elucidate these connections. A specially designed questionnaire was employed to establish the relationship paths between pairs of variables (i and j) (Rahman et al., 2022). To describe the nature of these relationships, four alternative symbols were used: 'V' indicates that factor i contributes to the achievement of factor j; 'A' signifies that factor j contributes to factor i; 'X' denotes that both factors i and j contribute to each other's achievement; and 'O' represents that factors i and j have no relationship (Xiao et al., 2022). Based on the analysis in Table 3, the Structural Self-Interaction Matrix (SSIM) was developed, considering the one-to-one relationships among the eight identified factors.

Table 3: Structural self-interaction matrix from factors of collaborative governance between navy and maritime industries.

SN	Code	Factors	Factors							
			C8	C7	C6	C5	C4	C3	C2	C1
1	C1	Budget	X	V	V	V	V	V	X	-
2	C2	Capability building	X	V	V	X	X	V	-	
3	C3	Leadership Commitment	A	X	V	X	X	-		
4	C4	Trust Building	A	X	X	V	-			
5	C5	Regulatory Framework	A	V	V	-				
6	C6	Technology	X	X	-					
7	C7	Resource Availability	X	-						
8	C8	Goals and Objectives	-							

Source: Authors.

4.2.2. Final Reachability matrix.

Following the steps of ISM analysis, the reachability matrix was derived from the SSIM formed in the previous step. Then, SSIM was converted into the initial reachability matrix based on the following rules.

- If the entry (i, j) in SSIM is V, entries (i, j) and (j, i) are set to 1 and 0.
- If the entry (i, j) in SSIM is A, entries (i, j) and (j, i) are set to 0 and 1.
- If the entry (i, j) in SSIM is X, entries (i, j) and (j, i) are set to 1 and 1.
- If the entry (i, j) in SSIM is O, entries (i, j) and (j, i) are set to 0 and 0.

Based on the initial reachability matrix, the final reachability matrix was created by applying the transitivity rules. According to these rules, some cells containing 0 must be replaced with 1. The results are shown in Table 4 below.

Table 4: Final reachability matrix from factors of collaborative governance between navy and maritime industries.

Code	Factors	Factors								DP
		C1	C2	C3	C4	C5	C6	C7	C8	
C1	Budget	1	0	0	0	1	0	1	1	4
C2	Capability building	1	1	1	1	1	1	1	1	8
C3	Leadership Commitment	1	0	1	1	0	0	1	0	4
C4	Trust Building	1	0	1	1	0	1	1	1	6
C5	Regulatory Framework	1	0	1	1	1	0	0	1	5
C6	Technology	1	0	1	1	1	1	1	1	7
C7	Resource Availability	1	1	1	1	1	1	1	1	8
C8	Goals and Objectives	0	0	1	0	0	0	0	1	2
	DEPENDENCE	7	3	7	6	5	4	6	7	

*DEP= Dependence Power; DP= Driving Power

Source: Authors.

4.2.3. Level Partitions.

Level partitioning organizes the components into a hierarchical structure, taking into account the relationships among different variables (Warfield, 1974). The final reachability matrix facilitates the calculation of both the antecedent and reachability sets for each component. The top level of the Interpretive Structural Modeling (ISM) table is determined based on reachability and intersection factors. Once the high-level aspects are isolated from the other elements, a similar procedure is applied to classify the remaining factors into each classification level (Moradi et al., 2023). This process contributes to the development of the final ISM digraph and model. The reachability factor set, antecedent set, intersection set, and the initial and final levels of each element are detailed in Table 5. The level assessment process involves five iterations, continuing until each element is properly assigned. The outcome of the level partitioning process results in six distinct levels for the identified drivers.

Table 5: Level partitions from factors of collaborative governance between navy and maritime industries.

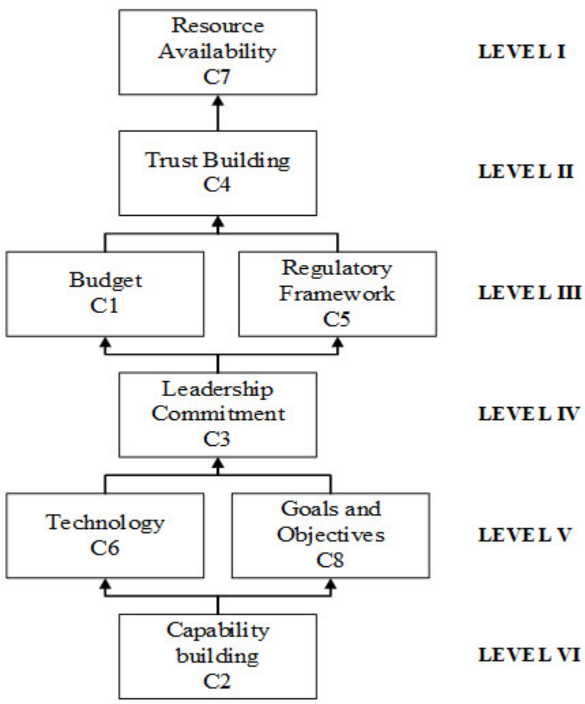
Code	Factors	Reachability	Antecedent	Intersection	Level
C1	Budget	1;5;7;8	1;2;3;4;5;6;7	1;5;7	III
C2	Capability building	1;2;3;4;5;6;7;8	2;7	2;7	VI
C3	Leadership Commitment	1;3;4;7	2;3;4;5;6;7;8	3;4;7	IV
C4	Trust Building	1;3;4;6;7;8	2;3;4;5;6;7	3;4;6;7	II
C5	Regulatory Framework	1;3;4;5;8	1;2;5;6;7	1;5;7	III
C6	Technology	1;3;4;5;6;7	2;4;6;7	4;6;7	V
C7	Resource Availability	1;2;3;4;5;6;7;8	1;2;3;4;6;7	1;2;3;4;6;7	I
C8	Goals and Objectives	3;8	1;2;4;5;6;7;8	8	V

Source: Authors.

4.2.4. Interpretive Structure Modeling (ISM).

The partition levels outlined in Table 5 are subsequently utilized to construct a hierarchical model illustrating the enabling factors that influence collaborative governance between the Navy and maritime industries. The relationships among these factors are plotted accordingly. An interval is applied to the values, with relationships being excluded from the diagram if their mean score is lower than the specified value. The resulting diagram is referred to as a digraph. Following the elimination of transitivity, as detailed in the ISM methodology, the digraph is refined into the final ISM model presented in Figure 3. This ISM model demonstrates the interdependencies among the various enabling factors across the six identified levels.

Figure 2: ISM-based model from factors of collaborative governance between Navy and maritime industries.



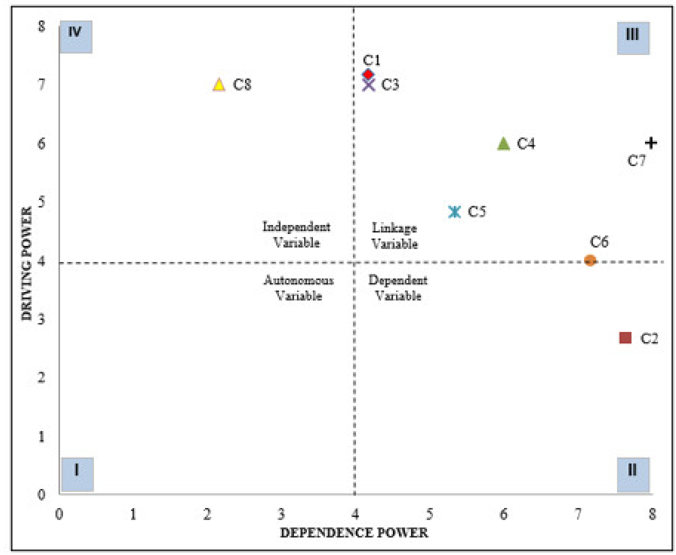
Source: Authors.

Based on the partition levels described, a hierarchical structural model is developed, as depicted in Figure 3. This diagram arranges drivers in a hierarchical structure from level 1 to level 6, where drivers at the lower levels influence those at higher levels. Generally, drivers with high driving power are positioned at the lower levels, while those with significant dependency are placed at the higher levels. In this research, capability building (C2) exhibits low driving power, whereas resource availability (C7) is identified as the factor with the highest dependency.

4.2.5. MICMAC Analysis.

MICMAC analysis is designed to evaluate the driving force and dependency force of elements within the Interpretive Structural Modeling (ISM) framework. This analysis involves plotting the driving force on the X-axis and the dependency force on the Y-axis to assess the influence of various drivers in collaborative governance. Utilizing the final affordance matrix, a simplified MICMAC analysis is conducted to examine the impact of the eight influential drivers identified in this research. Based on their driving and dependency forces, the drivers are classified into four categories: autonomous, independent, linkage, and dependent, as illustrated in Figure 4.

Figure 3: Driving power and dependency diagram from factors of collaborative governance between Navy and maritime industries.



Source: Authors.

Figure 4 categorizes the variables based on their driving and dependency forces. The dependent variables, Technology (C6) and Capability Building (C2), exhibit weak driving forces but strong dependency. Goals and Objectives (C8) are identified as the sole independent variable, characterized by a strong driving force and weak dependency. The linkage variables, which include Budget (C1), Leadership Commitment (C3), Trust Building (C4), Regulatory Framework (C5), and Resource Availability (C7), demonstrate both strong and dynamic driving forces and dependencies. These linkage variables are interconnected, meaning that changes in one variable can affect the others, highlighting their significant role in collaborative governance. Notably, no autonomous variables are present in this research, indicating that all variables are crucial for the collaborative governance between the Navy and maritime industries.

4.3. Discussion.

In this research, the final model for collaborative governance between the Navy and maritime industries was developed using an integrated approach, which involved three rounds of Delphi and Interpretive Structural Modeling (ISM). This model was crafted based on two primary selection indices that received unanimous agreement from the experts. Content analysis, employing both open and axial coding, was utilized to identify factors from qualitative interviews and Delphi data, resulting in the identification of eight key factors for further investigation.

To minimize errors, the expert panel reviewed the interpretative structural model and the results from the MICMAC analysis. The experts confirmed that the model effectively addressed the factors relevant to the current scenario. The results are discussed in terms of the factor levels identified through the ISM model. The ISM technique was employed to develop a structured model identifying and modeling the factors influencing collaborative governance between the Navy and maritime industries. The developed model consists of six levels. Figure 3 illustrates that Resource Availability (C7) is positioned as the sole level 1 factor. Despite this, the MICMAC analysis reveals Resource Availability (C7) as a linkage variable with both high dependency and driving force. The fundamental nature of collaboration revolves around resource availability (Wang et al., 2023). Resource Availability is crucial for stakeholders, providing incentives and facilitating cooperation (Ain et al., 2021). Imbalances in resources among parties can lead to manipulation of weaker parties by those with more resources, posing a challenge to effective collaborative governance (Ammirato et al., 2021). Addressing these imbalances can be achieved through face-to-face dialogue, trust-building, and establishing shared values, thereby correcting disparities in power and knowledge (Baek and Zhang, 2022).

Figure 3 indicates that Capability Building (C2) is positioned at a lower level within the hierarchy. However, the MICMAC analysis (Figure 4) reveals that Capability Building (C2) has a weak driving force but high dependency. Developing collaborative capabilities is challenging and heavily reliant on resources. Collaborative capabilities alone are rarely sufficient to have a significant positive impact without strategic capacity development, which acts as a catalyst for strategic renewal (Wang et al., 2023), (Ayu, Maharani and Ahlstrom, 2023). From the perspective of capability development, increased resource commitments can enhance performance by improving expected positive outcomes (Li and Fleury, 2020). Therefore, leaders and representatives who influence core services, strategic orientation, and innovation capabilities play a central role in collaborative governance due to their comprehensive interaction across all areas (Bichler and Lösch, 2019).

The MICMAC analysis categorizes variables into four main clusters based on their interdependence and driving force (see Figure 4). The Autonomous Cluster includes factors with both low driving power and low dependency, indicating minimal influence on the overall system. In this research, no factors fall into the autonomous category, suggesting that all identified factors are important.

The Dependent Cluster comprises variables with weak driving power but strong dependency. This group includes Technology (C6) and Capability Building (C2), which depend heavily on other factors but exert limited influence themselves.

The Linkage Cluster contains variables with both high dependency and strong driving force, demonstrating significant interconnections. Changes in these factors affect other elements and result in feedback effects. The linkage cluster includes Budget (C1), Leadership Commitment (C3), Trust Building (C4), Regulatory Framework (C5), and Resource Availability (C7). These factors are dynamic and unstable due to their interconnected nature.

The Independent Cluster includes variables with high driving power and low dependency, marking them as critical factors. Goals and Objectives (C8) is the only variable in this category, emphasizing its importance in successfully developing collaborative governance between the Navy and maritime industries.

Implications.

This research offers a novel perspective on the sequence and interrelationships of factors influencing collaborative governance in the maritime and naval industries, enhancing the understanding of this area. The findings are beneficial from various viewpoints, particularly for government authorities, policymakers, maritime practitioners, and researchers. The research presents several theoretical and practical implications, as outlined below.

Theoretical Implications: First, this research identifies and examines the factors affecting collaborative governance in the maritime and naval industries, particularly in the context of increasing shipbuilding. The identified factors can serve as a basis for evaluating collaborative governance among other stakeholders in different sectoral logistics. The literature reviewed in this research offers a foundation for future research, and the developed model, which highlights driving factors and dependencies, can be used as a framework for categorization studies. Second, this research addresses a gap in the empirical research concerning factors influencing collaborative governance from various perspectives. The research design presented here analyzes these factors hierarchically and develops a model for collaborative governance. The research's findings offer valuable insights into the implementation of collaborative governance in the maritime and naval sectors, providing significant implications for academics and researchers in this field.

Practical Implications: First, the findings of this research provide valuable information for professionals in the maritime industry and naval policymakers. Given the influential factors identified, managers should focus on collaborative governance-oriented strategies to enhance naval capabilities. The research highlights critical areas related to capability building and resource availability, which are essential for improving the performance of the maritime industry and advancing the development of weapon systems. By addressing these areas, the government can take targeted actions to strengthen the maritime sector and foster the development of robust and independent naval capabilities.

Second, managing collaborative governance factors between the Indonesian Navy and the maritime industry can help overcome barriers and encourage industry-related service organizations to develop effective joint naval systems. This can be achieved through resource integration and capability enhancement. Analyzing the hierarchical factors of collaborative governance at various levels can provide insights into their relevance at different stages of the collaborative value-creation process.

Third, identifying collaborative governance factors in the maritime and naval industries can help establish a coherent framework for guiding the development of naval and defense industry capabilities. Collaborative management should focus on creating stable policies that support and promote common goals. Potential outcomes include institutional development to attract more investment, capability building, technology advancement, and the creation of regulatory frameworks through trust building and leadership commitment.

Conclusions.

This research aims to identify and analyze factors influencing collaborative governance between the maritime and naval industries through a hierarchical development process using interpretive modeling. This process integrates a combined approach utilizing Delphi and ISM-MICMAC methods. The research validates and categorizes collaborative governance factors into four groups and assesses these factors' contextual relationships using the ISM technique. While the analysis does not claim to be exhaustive, the proposed framework identifies a set of potential factors impacting collaborative governance in these industries. The research concludes by describing the interrelationships between these factors to develop a structural hierarchy model.

Eight collaborative governance factors were identified from the literature and validated through assessments by twelve experts using the Delphi method. These factors are: Budget (C1), Capability Building (C2), Leadership Commitment (C3), Trust Building (C4), Regulatory Framework (C5), Technology (C6), Resource Availability (C7), and Goals and Objectives (C8). The ISM approach was employed to develop contextual relationships and hierarchical structural models, resulting in a six-level digraph. The analysis revealed that Capability Building (C2) has a low driving force, while Resource Availability (C7) exhibits the highest dependence.

Additionally, MICMAC analysis categorized the eight collaborative governance factors into independent clusters, linkage factors, and dependent factors, with no variables falling into the autonomous category, indicating that all factors are significant. Specifically, Technology (C6) and Capability Building (C2) were identified as dependent variables with weak driving force but strong dependence. Goals and Objectives (C8) emerged as the only independent variable with a strong driving force but weak dependence. The linkage variables include Budget (C1), Leadership Commitment (C3), Trust Building (C4), Regulatory Framework (C5), and Resource Availability (C7).

Limitation and Future Work.

This research has several limitations. First, the exploratory nature of the analysis, driven by the Delphi approach, means that the findings are based on expert opinions rather than empirical data. Future research could utilize questionnaire-based surveys to gather responses from a broader range of stakeholders and experts, thereby providing a more comprehensive analysis of factors that act as barriers and risks in collaborative governance between the maritime industry and the navy.

Second, the ISM model developed to establish the hierarchy of barrier factors relies on insights from a limited set of experts. This limitation introduces the possibility of response bias, which may affect the research's results. Future studies could incorporate the Analytical Network Process (ANP) method to enhance consistency and provide weighting values for the factors identified by experts.

Third, the model developed is based on expert opinions, necessitating further empirical validation. Future research should include statistical validity testing of the proposed ISM model. Techniques such as Structural Equation Modeling (SEM) and Data Envelopment Analysis (DEA) could be employed to validate and refine the model, ensuring its robustness and applicability.

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