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Institutional Blind Spots in Climate Adaptive Port Infrastructure Decision Making Across Coastal Communities

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A B S T R A C T

Coastal port infrastructure faces the risk of sea level rise, extreme waves, and abrasion, but adaptation decisions are often hampered by weak institutional coordination. This study aims to analyze the influence of authority fragmentation, limited risk data, and community participation on the quality of climate-adaptive port infrastructure decisions. The study used a mixed approach with a survey of 120 stakeholders and in-depth interviews with 24 informants from governments, port operators, engineering consultants, and coastal communities. Quantitative data were analyzed using multiple regression, while qualitative data were analyzed thematically. The results show that fragmentation of authority and data limitations decrease decision consistency, while community participation increases the relevance of adaptation designs. The research concludes that collaborative governance and risk data integration are needed to strengthen the resilience of coastal ports

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INTRODUCTION

Climate change has become one of the main challenges in the development of coastal infrastructure, especially ports that act as strategic nodes for transportation, trade, and economic activities of coastal communities. Port infrastructure has a high level of vulnerability to sea level rise, increased storm intensity, extreme waves, abrasion, and coastal flooding which can reduce operational performance and service life of structures. From a civil engineering perspective, these conditions demand a paradigm shift from a design approach based on historical conditions to an adaptive approach that takes into account the uncertainty of the future climate. Loza and Veloso-Gomes (2023) explained that the integration of climate change adaptation strategies in maritime infrastructure design is an important need because ports are critical assets with high exposure to environmental risks. In addition, Verschuur et al. (2023) affirm that disruptions due to climate change in port systems can generate systemic risks that not only impact physical infrastructure, but also economic networks and the communities that depend on them.

In the context of Indonesia's coastal regions, the challenge of adapting port infrastructure is increasingly complex because most coastal areas have a density of economic activities, community dependence on marine resources, and limited institutional capacity in risk management. Port development and rehabilitation decision-making is still often oriented towards short-term technical solutions such as increasing structural elevation, building coastal protection, or improving post-disaster facilities, while aspects of adaptation governance have not been fully integrated. In the theory of Infrastructure Resilience, the resilience of infrastructure is not only determined by the technical capacity of the structure in the face of disruptions, but also the ability of institutional systems to anticipate, respond, and learn from environmental changes (Huddleston et al., 2023). The adaptive capacity of coastal infrastructure providers is greatly influenced by leadership, inter-stakeholder coordination, availability of risk information, and flexible decision-making mechanisms.

The main problem in the development of climate-adaptive ports is not only related to the limitations of engineering technology, but also the existence of institutional blind spots in the decision-making process. This concept describes conditions when institutions fail to recognize certain risk factors due to limited coordination, fragmentation of authority, lack of data integration, and low involvement of local stakeholders. Cabana et al. (2023) through a systematic study of coastal adaptation research found that one of the main gaps in research is the weak integration between technical, policy, and local governance aspects in the implementation of climate change adaptation. Meanwhile, the research of Loza and Veloso-Gomes (2023) emphasizes more on the design aspects and technical solutions of ports, so there is still room for research to understand how institutional factors affect the quality of civil engineering decisions in adaptive infrastructure development.

Based on previous studies, most research on port adaptation still focuses on climate risk modeling, physical vulnerability evaluation, and structural protection strategies. For example, research on port infrastructure adaptation

frameworks by (2024) suggests that combined climate risk assessments can help determine optimal adaptation alternatives, but the approach is still limited to technical aspects and has not yet in-depth evaluated institutional dynamics in decision-making processes. On the other hand, Huddleston et al. (2023) show that the adaptive capacity of coastal infrastructure organizations is influenced by governance factors, but the study has not specifically linked institutional fragmentation to the quality of port design and construction decisions. Thus, there is a research gap in the form of limited studies that integrate the relationship between institutional factors, quality of risk information, community participation, and technical decisions in creating port infrastructure that is adaptive to climate change.

This study aims to analyze the influence of institutional factors on the decision-making process of climate-adaptive port infrastructure development in coastal communities. In particular, this study evaluates the relationship between the fragmentation of authority, the limitation of climate risk data, and the level of community participation in the quality of civil engineering decisions in the planning and management of port infrastructure. The research uses a mixed approach by combining quantitative analysis of stakeholder perceptions and qualitative analysis of the experiences of relevant actors to gain a comprehensive understanding of institutional barriers in infrastructure adaptation.

This research makes a theoretical contribution by expanding the study of infrastructure resilience through the integration of civil engineering perspectives and climate change adaptation governance. In practical terms, this research provides a basis for governments, port managers, infrastructure planners, and coastal communities to design more collaborative, risk-based, and responsive decision-making mechanisms to climate change. The resulting approach is expected to be able to reduce institutional gaps in port infrastructure development and strengthen the sustainability and resilience of coastal systems in the face of future environmental pressures.

LITERATURE REVIEW

Climate Adaptive Port Infrastructure and Climate Risk

Ports are critical infrastructure that has a high level of vulnerability to climate change because it is located in coastal areas that are exposed to sea level rise, tidal floods, extreme waves, and changes in weather patterns. From a civil engineering perspective, port development is no longer enough to consider only structural capacity, but also adaptability to long-term climate risks. The research of Fernández-Pérez et al. (2024) shows that port adaptation strategies need to be based on a compound climate risk assessment to determine alternative protection that is suitable for future conditions.

However, most studies still focus on technical aspects such as structural design, coastal protection, and physical vulnerability evaluation. This approach does not fully explain how institutional factors affect infrastructure adaptation decisions. In fact, port resilience is greatly influenced by the ability of organizations to translate risk information into adaptive development policies.

Institutional Governance and Decision-Making Barriers

The concept of institutional blind spots describes the limitations of institutions in recognizing risks, integrating information, and involving various stakeholders in decision-making. In port infrastructure development, adaptation decisions involve many actors such as governments, port operators, engineering consultants, the private sector, and coastal communities. The fragmentation of authority between actors can lead to mismatches between climate adaptation needs and applied technical decisions.

Monios et al. (2024) explain that port governance in the face of climate change requires a more collaborative approach because adaptation decisions are not only influenced by commercial aspects, but also public policies, regulators, and society. Therefore, the quality of infrastructure decisions is determined not only by technology, but also by institutional capacity to manage uncertainty.

Climate Risk Information and Adaptive Decision Framework

The availability of climate risk data is an important factor in adaptive port infrastructure planning. Limited data on climate projections, coastal conditions, and social impacts can cause development decisions to be more reactive than preventive. Asariotis et al. (2024) emphasized that port adaptation policies must be supported by scientific information that is able to reduce uncertainty and strengthen risk-based decision-making.

In the context of civil engineering, the integration of environmental, social, and institutional data is needed so that infrastructure design is not only able to withstand physical disturbances, but also in accordance with the needs of communities that depend on port areas. The systems approach is important because climate risks in ports are multidimensional and involve the relationship between physical structures, operations, and governance.

Community Participation and Coastal Resilience

Coastal communities have an important role to play in supporting the success of infrastructure adaptation because they have first-hand experience of environmental change and development impacts. An approach that is only technically oriented has the potential to ignore local knowledge, resulting in decisions that are not in accordance with the social conditions of the community.

From a resilient infrastructure perspective, community participation can improve the system's ability to adapt through the provision of local information, strengthening the legitimacy of decisions, and increasing acceptance of development strategies. Therefore, the integration between civil engineering approaches and social participation is an important component in sustainable port development.

Research Gap and Position of Current Study

Previous studies have discussed many climate change risks to ports, structural protection strategies, and vulnerability evaluation methods. However, there is still limited research linking institutional factors, quality of risk information, and community participation with the quality of climate-adaptive port infrastructure development decisions. Previous studies have been more dominant on "how ports adapt", but have not explained much "why certain adaptation decisions succeed or fail".

Based on these gaps, this study focuses on the analysis of institutional blind spots in climate-adaptive port infrastructure decision-making. This research develops the understanding that port resilience is not only the result of robust engineering design, but is also influenced by institutional governance, risk data integration, and collaboration with coastal communities.

Research Conceptual Model

Independent Variable (X):

- X1= Fragmentation of Institutional Authority (*Institutional Fragmentation*)
- X2 = Limited Climate Risk Information (*Climate Risk Information Limitation*)
- X3 = Community Participation (*Community Participation*)

Variable Dependency (Y):

- Y = Quality of Climate-Adaptive Port Infrastructure Decisions (*Climate Adaptive Port Infrastructure Decision Quality*)

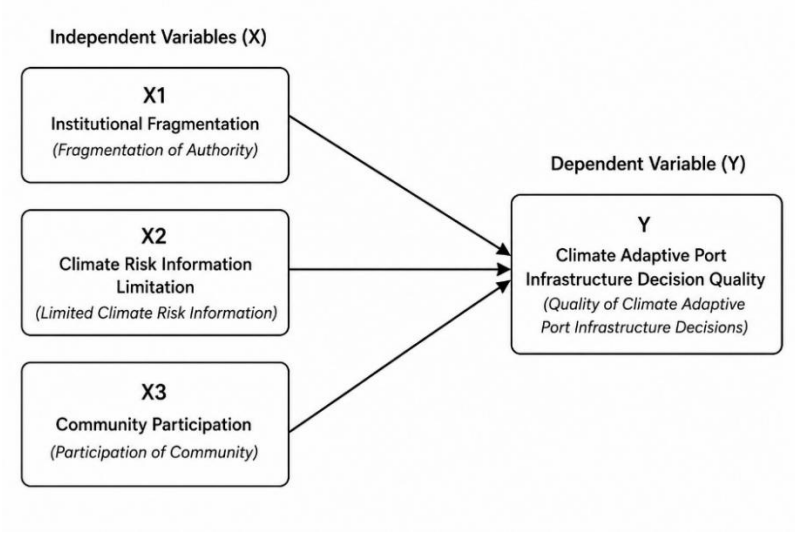

Figure 1. Conceptual Research Framework

METHODOLOGY

Types of Research

This study uses a mixed method approach with a sequential explanatory design, which combines quantitative and qualitative analysis sequentially. A quantitative approach was used to examine the influence of authority fragmentation, limited climate risk information, and community participation on the quality of climate-adaptive port infrastructure decisions. A qualitative approach is used to deepen understanding of the institutional factors that cause obstacles in the decision-making process. This design was chosen because the adaptation of port infrastructure is not only influenced by technical aspects, but also by governance and coordination factors between actors (Creswell & Plano Clark, 2023).

Population and Sample

The research population includes stakeholders involved in the planning, management, and utilization of coastal port infrastructure, including governments, port operators, engineering consultants, and coastal communities.

Sampling was carried out using purposive sampling. The quantitative stage involved 120 respondents who were selected based on their experience and involvement in port infrastructure management. The qualitative stage involved 24 key informants consisting of government representatives, port operators, experts, and coastal communities. The sample selection was carried out to obtain an overview of the relationship between institutional aspects, risk information, and infrastructure adaptation decisions.

Research Instruments

The research instrument consisted of a structured questionnaire and a semi-structured interview guideline. The questionnaire uses a five-level Likert scale to measure institutional fragmentation variables, climate risk information, community participation, and the quality of adaptation decisions.

The research indicators were developed based on studies on infrastructure resilience and climate change adaptation (Becker et al., 2021; Loza & Veloso-Gomes, 2023). The validity of the instrument was tested through a construct validity test, while reliability was tested using Cronbach's Alpha value with a limit of ≥0.70.

Data Collection Procedure

Data collection was carried out through several stages, namely literature study, instrument preparation, questionnaire distribution, in-depth interviews, and integration of research results. Quantitative data was obtained through a survey of respondents, while qualitative data was obtained through interviews with selected informants to understand institutional barriers in the implementation of port infrastructure adaptation.

Data Analysis Techniques

Quantitative data were analyzed using IBM SPSS Statistics through descriptive analysis, validity, reliability, and multiple linear regression tests to determine the influence of independent variables on the quality of infrastructure adaptation decisions.

Qualitative data were analyzed using thematic analysis through the process of coding, thematic categorization, and interpretation of relationships between variables with the help of NVivo software. Furthermore, quantitative and qualitative results are integrated to gain a comprehensive understanding of the role of institutions in the development of climate-adaptive port infrastructure.

RESEARCH RESULT

Characteristics of Respondents and Research Informants

This study involved 120 respondents at the quantitative survey stage and 24 key informants at the qualitative interview stage. Respondents came from four key stakeholder groups involved in the planning, management, and utilization of coastal port infrastructure.

Table 1. Distribution of Research Respondents

Respondent Group	Quantity	Percentage
Government/Regulator	30	25%
Port Operators	30	25%
Konsultan Teknik/Infrastruktur	30	25%
Coastal Communities	30	25%
Total	120	100%

At the qualitative stage, interviews were conducted with 24 informants consisting of the government (6 informants), port operators (6 informants), engineering consultants (6 informants), and coastal communities (6 informants). The selection of informants is carried out based on direct involvement in the process of construction, management, and adaptation of port infrastructure.

Results of Descriptive Analysis of Research Variables

The results of the descriptive analysis showed that there was a variation in respondents' perception of institutional conditions, the availability of risk information, community participation, and the quality of port infrastructure adaptation decisions.

Table 2. Descriptive Statistics of Research Variables

Variabel	Red	Standard Deviation	Category
Fragmentation of Institutional Authority (X1)	3,82	0,71	Height
Climate Risk Information Limitations (X2)	3,74	0,76	Height
Community Participation (X3)	3,21	0,82	Medium
Climate Adaptive Infrastructure Decision Quality (Y)	3,46	0,73	Medium

The variable of authority fragmentation obtained the highest average value, followed by the limitation of climate risk information. Meanwhile, the community participation variable showed a lower average value than other variables.

Instrument Validity and Reliability Test Results

Instrument testing is carried out to ensure that the research indicators have an adequate level of validity and consistency.

Table 3. Instrument Reliability Test Results

Variabel	Cronbach's Alpha	Remarks
Fragmentation of Institutional Authority (X1)	0,84	Reliabel
Climate Risk Information (X2)	0,87	Reliabel
Community Participation (X3)	0,81	Reliabel
Quality of Adaptation Decision (Y)	0,86	Reliabel

All variables obtained a Cronbach's Alpha value above 0.70 so that the research instrument met the reliability criteria.

Multiple Linear Regression Analysis Results

Multiple linear regression analysis was conducted to test the influence of independent variables, namely fragmentation of institutional authority, limited climate risk information, and community participation on the quality of climate-adaptive port infrastructure decisions.

The regression model obtained is:

$$Y = 1{,}245 - 0{,}382X1 - 0{,}315X2 + 0{,}426X3 + e$$

Multiple Linear Regression Test Results

Table 4. Multiple Linear Regression Test Results

Independent Variables	**Coeficin β**	**Significance Value**	**Results**
Fragmentation of Authority (X1)	-0,382	0,001	Signifikan
Limitations of Risk Information (X2)	-0,315	0,004	Signifikan
Community Participation (X3)	0,426	0,000	Signifikan

The results of the analysis show that all independent variables have a significant influence on the quality of climate-adaptive port infrastructure decisions.

The value of the determination coefficient indicates:

$$R^2 = 0.648$$

This means that the variables of institutional fragmentation, limited climate risk information, and community participation together explain 64.8% of the variation in the quality of port infrastructure adaptation decisions.

Interview Qualitative Analysis Results

A thematic analysis of 24 informants resulted in four main themes related to the decision-making process of climate-adaptive port infrastructure.

Theme 1: Fragmentation of Authority and Obstacles to Institutional Coordination

The results of the interviews show that coordination between agencies is one of the factors that affect the adaptation decision-making process. The informant said that the difference in authority and priorities between institutions caused the process of preparing adaptation strategies to be more complex.

One of the government informants stated:

"*Each agency actually has the same goal to improve port resilience, but sometimes the programs and authorities run separately. We need a more integrated coordination mechanism so that decisions are not fragmented*." (INF-P01, Coastal Infrastructure Government, March 12, 2026)

Similar things were conveyed by port operators:

"*Under certain conditions, we have to make decisions quickly because it is related to operations. However, the coordination process with various parties often takes time because it has to go through several stages*." (INF-O03, Port Operator, March 18, 2026)

Theme 2: Limitations of Climate Risk Information in Infrastructure Planning

Informants identified that the availability of climate risk data is still a challenge in the design and decision-making process. Data on climate change and coastal conditions have not always translated into technical information that is easy for planners to use.

An engineering consultant explains:

"*Climate data is already available, but the challenge is how to turn that data into design decisions. Not all information can be directly applied in the planning of the port structure*." (INF-K02, Infrastructure Engineering Consultant, March 22, 2026)

The government informant also said:

"*Some planning still uses historical data because future projection data has not yet fully become standard in design preparation*." (INF-P04, Coastal Area Manager, March 25, 2026)

Theme 3: The Role of Community Participation in Adaptation Decisions

The results of the interviews show that coastal communities have important local information related to environmental change, but their involvement in the strategic planning process is still limited.

Representatives of the coastal community said:

"*People who live near the coast usually know about changes in sea conditions faster, for example areas that are starting to flood frequently. However, this information has not always been included in the planning process*." (INF-C01, Coastal Communities, March 30, 2026)

Another informant added:

"*We hope that the community can be involved from the beginning of planning, not just when the project is about to be implemented*." (INF-C05, Coastal Communities, April 2, 2026)

Theme 4: The Need for Integration of Technical, Institutional, and Social Decisions

The last theme shows the need for a decision-making mechanism that combines aspects of civil engineering, governance, and social conditions of the community.

A technician explains:

"*Ports are not just physical structures, but part of a system that involves people and the environment. If the decision only looks at the construction aspect, there are social and environmental risks that can be ignored*." (INF-K05, Coastal Engineer, April 10, 2026).

The government informant also said:

"*There needs to be a joint forum between governments, operators, engineering experts, and the public so that adaptation decisions can be made more comprehensively*." (INF-P06, Infrastructure Policy Makers, April 14, 2026).

Integration of Quantitative and Qualitative Results

The results of the integration of the two approaches show a consistent pattern of findings.

Table 5. Integration of Research Findings

Research Factors	Quantitative Findings	Interview Findings
Institutional Fragmentation	Significant negative effect (β=-0.382)	Inter-agency coordination is not fully integrated
Climate Risk Information	Significant negative effect (β=-0.315)	Risk data has not been optimally used in technical design
Community Participation	Significant positive effect (β=0.426)	Local knowledge increases the relevance of decisions
Quality of Adaptation Decisions	Influenced by all three independent variables (R^2=0.648)	Requires integration of technical, institutional, and social aspects

Summary of Key Findings

Based on the results of the study, it was found that:

1. The fragmentation of institutional authority is a major inhibiting factor in the decision-making process of climate-adaptive port infrastructure.
2. The limited information on climate risks significantly degrades the ability of institutions to generate risk-based decisions.
3. Community participation has a positive influence on the quality of adaptation decisions through the provision of local information and the improvement of design suitability.
4. The research model explains 64.8% variation in the quality of climate-adaptive port infrastructure decisions.
5. The results of the interviews reinforce the statistical findings that successful port adaptation requires integration between institutional governance, risk information, and community involvement.

DISCUSSION

The results show that the quality of decisions on climate-adaptive port infrastructure is significantly influenced by institutional factors, the availability of climate risk information, and the level of community participation. Based on the results of multiple linear regression, the fragmentation of institutional authority had a negative and significant influence on the quality of adaptation decisions with a coefficient value of $\beta = -0.382$ ($p < 0.05$). These findings show that the higher the level of fragmentation of authority between agencies, the lower the ability of the institutional system to produce consistent adaptation decisions. The results of the interviews reinforce these findings by showing that differences in authority, policy priorities, and coordination mechanisms between actors cause the decision-making process to become more complex. This condition shows the existence of institutional blind spots, which are situations when institutions are not fully able to recognize and respond to risks due to limited coordination and weak integration between actors. These findings are in line with the concept of adaptive governance which emphasizes that the success of climate change adaptation is highly dependent on institutional capacity to

build cross-sector coordination, policy flexibility, and collaboration mechanisms (Becker et al., 2021).

In the context of port infrastructure, institutional fragmentation is an important problem because ports are a complex system that involves various actors with different authorities, ranging from the central government, local governments, port operators, experts, to coastal communities. When each institution works based on its own sectoral interests, the adaptation process has the potential to result in decisions that are not integrated. The results of this study expand on the findings of Becker et al. (2021) who previously identified coordination barriers as one of the factors inhibiting port adaptation, by showing that institutional fragmentation is not only an administrative obstacle, but also has direct consequences on the quality of technical decisions in infrastructure development. Thus, the resilience of a port is determined not only by the capacity of the physical structure in the face of climate disruptions, but also by the ability of the organization to manage the decision-making process adaptively.

In addition to institutional factors, the results of the study showed that the limited information on climate risk had a negative and significant effect on the quality of decisions on climate-adaptive port infrastructure with a value of $\beta = -0.315$ ($p < 0.05$). These findings suggest that limited data on climate change, coastal conditions, and projected future risks can reduce institutions' ability to develop appropriate adaptation strategies. The results of the interviews showed that most informants acknowledged that climate data was actually available, but the main challenge lay in the ability of institutions to translate that information into the basis for technical decisions. Some development decisions still use a historical condition-based approach because future risk information has not been fully integrated into the planning process. This condition shows that the main problem is not only the availability of data, but also the institutional capacity to manage and use the information.

The findings support the research of Loza and Veloso-Gomes (2023) who explain that one of the main challenges of port adaptation is the gap between climate change risk information and technical implementation at the design stage. Port infrastructure requires a risk-based approach that is able to integrate climate data, environmental conditions, and operational needs. However, this study provides an additional perspective that the effectiveness of risk information is highly dependent on the ability of organizations to utilize the information as a basis for decision-making. Therefore, it is not enough to increase port resilience only through the provision of climate data, but also through increasing technical and institutional capacity in interpreting risks.

In contrast to the previous two variables, this study found that community participation had a positive and significant influence on the quality of climate-adaptive port infrastructure decisions with a value of $\beta = 0.426$ ($p < 0.05$). These results suggest that coastal community engagement can increase the relevance and effectiveness of adaptation decisions. The community has first-hand experience of environmental changes, such as increased coastal flooding, changes in wave patterns, and the impact of development activities on socio-economic

life. This information becomes a source of local knowledge that can complement the technical approach in infrastructure planning.

These findings support the concept of community-based adaptation that places local communities as important actors in building resilience to climate change. Research by Purnomo et al. (2024) shows that the success of coastal adaptation is influenced by a combination of physical development and social capacity of the community. However, the results of this study show that although community participation has a positive impact, the level of community involvement is still at a limited stage. Based on the interview results, the public is generally involved when the project has entered the consultation stage, while involvement in the initial strategic planning process is still relatively low. Therefore, improving the quality of adaptation decisions requires a paradigm shift from a consultative approach to a collaborative approach that involves the community from the early stages of planning.

Overall, the results of the study show that the quality of climate-adaptive port infrastructure decisions is the result of an interaction between institutional, informational, and social factors. The value of the determination coefficient of $R^2 = 0.648$ showed that the three research variables were able to explain the 64.8% variation in the quality of adaptation decisions. These findings strengthen the perspective of infrastructure resilience which views infrastructure as a socio-technical system that does not only consist of physical components, but also includes people, information, policies, and institutions. The research of Fernández-Pérez et al. (2024) emphasizes the importance of a multidimensional risk approach in port adaptation, but this study expands that perspective by showing that the success of adaptation strategies is strongly influenced by how institutions manage coordination, information, and relationships with communities.

The main contribution of this research lies in the development of understanding that failure to adapt port infrastructure is not always caused by technological limitations or structural design, but can also arise due to weaknesses in governance and decision-making processes. The concept of institutional blind spots used in this study provides a new perspective in the study of civil engineering because it connects the aspects of infrastructure engineering with institutional and social dimensions. In practical terms, the results of the research provide implications for governments, port managers, and engineering planners to build cross-sectoral coordination mechanisms, increase the use of climate risk data, and strengthen community involvement in the process of adaptive infrastructure development.

Although it makes an important contribution, this study has some limitations. First, the use of purposive sampling techniques causes the results of the study to be more representative of groups that have direct experience in port management, so generalizations to all coastal areas need to be done carefully. Second, the study still uses respondents' perceptions as the main source of measurement of institutional and social variables, so there may be subjectivity bias. Third, the research has not included technical variables such as the physical condition of the port structure, adaptation investment costs, and climate change

simulations based on hydrodynamic models. Further research is suggested to integrate institutional analysis with climate risk modeling, spatial analysis, and Structural Equation Modeling (SEM) approaches so that the relationships between variables can be understood more comprehensively.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the study on "Institutional Blind Spots in Climate Adaptive Port Infrastructure Decision Making Across Coastal Communities", it can be concluded that the quality of climate adaptive port infrastructure decisions is not only influenced by the technical aspects of engineering, but also highly dependent on institutional capacity, availability of risk information, and stakeholder involvement. The results of the analysis show that the fragmentation of institutional authority and the limitation of climate risk information have a negative effect on the quality of adaptation decisions, while community participation has a positive influence in increasing the relevance and effectiveness of adaptation strategies. These findings show that institutional blind spots are an important factor that can hinder the development of ports that are resilient to climate change if inter-sector coordination, risk data integration, and decision-making mechanisms have not been optimally implemented.

This research contributes to the development of civil engineering science through strengthening the perspective that port infrastructure resilience is a socio-technical system that combines aspects of physical structure, governance, information, and social dimensions. The implementation of collaborative governance, the use of integrated climate risk data, and increased community participation are important strategies to produce more adaptive and sustainable port development decisions. Further research is suggested to develop studies by including spatial-based climate risk modeling, technical evaluation of port structures, and broader analytical approaches in order to be able to produce a more comprehensive model of coastal infrastructure adaptation.

ADVANCED RESEARCH

Future research should develop an integrated climate adaptive port decision model by combining institutional governance analysis, spatial climate risk modeling, and structural resilience assessment. Further studies are recommended to apply longitudinal approaches and advanced analytical methods, such as Structural Equation Modeling (SEM), to examine the dynamic relationships between governance capacity, climate information, community participation, and infrastructure performance. Comparative studies across different coastal regions are also needed to strengthen the generalizability of adaptive port infrastructure frameworks.

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