International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 6, 2025
https://theaspd.com/index.php

Institutional Governance Framework For Sustainable Mangrove Management: A Multi-Dimensional Analysis Of Jakarta Bay, Indonesia

R Budiono Subambang[1*], Ario Damar[2], Taryono[3], Rahmat Kurnia[4], Dietriech G. Bengen[5]
1 Study Program of Coastal and Marine Resources Management, Department of Aquatic Resources Management, Faculty of Fisheries and Marine Sciences, IPB University.
2,3,4 Department of Aquatic Resources Management, Faculty of Fisheries and Marine Sciences, IPB University.
5.Department of Marine Sciences, Faculty of Fisheries and Marine Sciences, IPB University.
Email: budionosubambang@apps.ipb.ac.id[1*], adamar@apps.ipb.ac.id[2], taryono@apps.ipb.ac.id[3], rahmatku@apps.ipb.ac.id[4], dietriechbe@apps.ipb.ac.id[5]

Abstract

Background: Metropolitan coastal ecosystems face unprecedented governance challenges from institutional fragmentation and multi-jurisdictional complexities. Jakarta Bay exemplifies these challenges with continuing mangrove degradation despite multiple conservation initiatives across three provinces.

Objective: This study develops a comprehensive institutional governance framework for sustainable mangrove management by integrating stakeholder analysis, sustainability assessment, and structural modelling to identify governance gaps and optimal institutional arrangements. Methods: We employed sequential mixed-methods combining stakeholder power-interest matrix analysis (n=23 institutions), Multidimensional Scaling (MDS) sustainability assessment across four dimensions (institutional, ecological, social, economic), and Interpretative Structural Modelling (ISM) for hierarchical governance relationships. Data collection involved structured interviews, focus groups, and policy analysis across Banten, DKI Jakarta, and West Java provinces (October 2023-January 2024). Results: Stakeholder analysis revealed significant power imbalances with 75.8% government dominance, while local communities remain marginalized despite high ecosystem dependence. MDS demonstrated moderately sustainable status: social (72.24%), institutional (60.33%), ecological (59.60%), and economic (55.61%). Leverage analysis identified inter-institutional coordination, regulatory effectiveness, and policy integration as critical factors. ISM revealed hierarchical dependencies requiring foundational institutional arrangements before effective implementation. Conclusions: Current governance arrangements inadequately support sustainable mangrove management in metropolitan coastal zones. Achieving sustainability requires: (1) enhanced multi-stakeholder coordination mechanisms, (2) inclusive governance structures bridging power-interest gaps, and (3) hierarchical institutional development prioritizing foundational elements. This integrated framework provides actionable insights for coastal governance transformation in similar multi-jurisdictional contexts globally.

Keywords: *coastal governance, institutional analysis, mangrove conservation, multi-stakeholder management, sustainability assessment, Jakarta Bay.*

INTRODUCTION

Coastal mangrove ecosystems provide critical ecosystem services valued at $194,000 per hectare annually, yet continue declining at rates of 0.13% per year globally due to governance failures rather than purely biophysical pressures (Worthington et al., 2020; Friess et al., 2019). Metropolitan coastal zones amplify these challenges through institutional fragmentation, jurisdictional overlaps, and competing development pressures that overwhelm traditional conservation approaches (Glaser et al., 2018; Newton et al., 2020).

Jakarta Bay represents a paradigmatic case of metropolitan coastal governance complexity, spanning three provinces with over 30 institutions claiming authority over 110,000 hectares of mangrove ecosystems supporting 10 million coastal residents (Rusdianti & Sunito, 2012; Marfai & King, 2008). Despite Indonesia's National Mangrove Management Strategy (Presidential Regulation 73/2012) and substantial restoration investments exceeding $50 million annually, mangrove coverage continues declining at 2.1% per year, twice the global average (Giri et al., 2011; Murdiyarso et al., 2015).

Contemporary coastal governance theory emphasizes polycentric institutional arrangements and adaptive co-management, yet empirical applications in metropolitan contexts remain limited (Ostrom, 2010; Armitage et al., 2009). The social-ecological systems (SES) framework provides conceptual foundations for understanding complex governance challenges, but lacks operational frameworks for institutional transformation in multi-jurisdictional contexts (McGinnis & Ostrom, 2014; Partelow, 2018).

Critical research gaps identified through systematic review include: (1) limited integration of stakeholder power dynamics with sustainability assessment, (2) absence of hierarchical institutional modelling for complex coastal systems, (3) insufficient focus on metropolitan coastal governance, and (4) weak empirical foundations for institutional transformation pathways (Thomas et al., 2021; Glaser & Glaeser, 2014).

This study addresses these gaps through methodological innovation combining stakeholder analysis matrices, multidimensional sustainability assessment, and structural institutional modelling. We develop and test an integrated governance framework that: (1) quantifies stakeholder power-interest dynamics, (2) assesses multi-dimensional sustainability status, and (3) identifies hierarchical institutional relationships for transformation pathways.

Specific objectives are to: (1) analyse institutional arrangements and stakeholder dynamics affecting mangrove governance in Jakarta Bay, (2) assess sustainability status across institutional, ecological, social, and economic dimensions, (3) identify critical leverage factors and institutional gaps, and (4) develop an integrated governance framework applicable to similar metropolitan coastal contexts globally.

Research Questions

1. How do current institutional arrangements and stakeholder power dynamics influence mangrove sustainability in Jakarta Bay?
2. What are the critical leverage factors across sustainability dimensions that determine governance effectiveness?
3. What hierarchical institutional relationships must be established for sustainable governance transformation?
4. How can integrated governance frameworks address multi-jurisdictional coastal management challenges?

METHOD

2.1 Study Area and Context

Research was conducted in the Jakarta Bay coastal zone (5°54′S–6°10′S, 106°30′E–107°10′E), encompassing mangrove ecosystems across three provincial jurisdictions: Banten Province (Tangerang Regency), DKI Jakarta Province (North Jakarta Administrative City), and West Java Province (Bekasi Regency). This 110,000-hectare area represents Indonesia's most economically critical coastal zone, generating $12.8 billion annually while supporting diverse ecosystem services (Neumann et al., 2015).

The study area was selected based on: (1) institutional complexity with 33 identified stakeholder organizations, (2) multi-jurisdictional governance challenges, (3) significant ecosystem service values under threat, (4) representativeness of metropolitan coastal governance globally, and (5) availability of historical governance data for temporal analysis.

2.2 Research Design and Methodological Framework

We employed a sequential exploratory mixed-methods design integrating quantitative stakeholder assessment with qualitative institutional analysis and structural modelling. The methodological framework combines three analytical approaches: (1) stakeholder analysis using power-interest matrices (Abbas, 2005), (2) sustainability assessment using Multidimensional Scaling (Fauzi & Anna, 2005), and (3) institutional structural modelling using ISM (Warfield, 1974).

2.3 Data Collection

Primary data collection occurred October 2023-January 2024 through: (1) structured interviews with 47 key informants across institutional categories, (2) focus group discussions with 8 stakeholder groups (6-8 participants each), and (3) participatory workshops with 23 institutional representatives for ISM consensus-building.

Secondary data included policy documents, legal frameworks, planning documents, and institutional reports from 2012-2024. Sampling strategy used purposive sampling, ensuring representation across: government levels (national, provincial, local), sectors (marine, forestry, spatial planning), and stakeholder types (government, private, community, academia, NGO).

2.4 Stakeholder Analysis

Power-interest matrix analysis followed Abbas's (2005) methodology with modifications for coastal governance contexts. Twenty-three key institutions were evaluated across five interest criteria (participation forms, benefits, authority, work programs, dependency levels) and five influence criteria (condition strength, feasibility, compensation, individual capacity, organizational strength). Each criterion was scored 1-5 scale, producing total interest and influence scores (maximum 25 each).

Stakeholder categorization used Reed et al. (2009) framework: Subject (high interest, low influence), Key Players (high interest, high influence), Context Setters (low interest, high influence), Crowd (low interest, low influence). Validation employed expert panel review and respondent feedback.

2.5 Sustainability Assessment using Multidimensional Scaling

MDS analysis evaluated sustainability across four dimensions using RAPFISH methodology (Pitcher & Prescot, 2001). Thirty-one attributes were distributed across dimensions: institutional (8), ecological (8), social (8), and economic (7). Each attribute was scored 0-2 ordinal scale based on field observations and stakeholder assessment. Statistical validation included: (1) Stress testing (acceptable <0.25), (2) R-squared values (acceptable >0.80), (3) Bootstrap analysis (95% confidence intervals), (4) Monte Carlo simulation for robustness testing. Leverage analysis identified sensitive attributes that most influence sustainability scores.

2.6 Interpretative Structural Modelling

ISM methodology developed hierarchical relationships among institutional elements through: (1) Element identification via expert consultation, (2) Structural Self-Interaction Matrix (SSIM) development, (3) Reachability matrix calculation, (4) Level partitioning, and (5) Structural model construction. Three main elements analysed: (A) Enabling conditions fulfilment (4 sub-elements), (B) Action implementation (3 sub-elements), (C) Sustainability strategies (4 sub-elements). Consensus-building used a modified Delphi technique with 15 expert participants across three rounds.

2.7 Data Analysis and Integration

Quantitative analysis used SPSS 26.0 for stakeholder scoring, RAPFISH software for MDS analysis, and R 4.2.0 for ISM calculations. Qualitative analysis employed thematic coding using NVivo 12 for interview transcripts and FGD data. Integration methodology used joint displays and meta-inferences connecting quantitative patterns with qualitative explanations (Creswell & Plano Clark, 2017).

2.8 Validation and Reliability

Multi-level validation included: (1) Internal validation through expert panel review, (2) External validation through cross-case comparison with Sundarbans and Thai coastal governance, (3) Methodological triangulation across data sources and analytical techniques, and (4) Member checking with key stakeholder representatives.

RESULTS AND DISCUSSION

3.1 Institutional Landscape and Stakeholder Configuration

Institutional mapping identified 33 organizations across five categories: national government (36.4%), regional government (39.4%), private sector (3.0%), local communities (6.1%), and other stakeholders (15.2%). This distribution reveals government institutional dominance (75.8%) with limited private sector engagement and marginalized community representation.

National-level institutions include 12 ministries/agencies led by the Ministry of Environment and Forestry (KLHK), the Ministry of Marine Affairs and Fisheries (KKP), and the Peat and Mangrove Restoration Agency (BRGM). Regional institutions span three provinces with 21 organizational units, including provincial and district/city governments, plus technical agencies.

3.2 Stakeholder Power-Interest Analysis Results

Power-interest matrix analysis revealed significant stakeholder imbalances across quadrants (Figure 1). Key findings include:

International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 6, 2025
https://theaspd.com/index.php

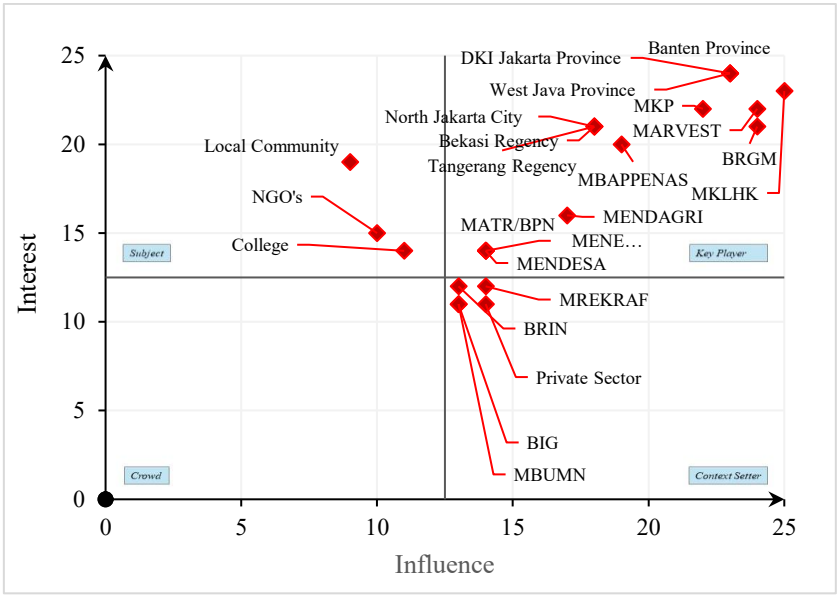


Figure 1 . Stakeholder Interest–Influence Matrix for Mangrove Governance

Subject Quadrant (High Interest, Low Influence): Local communities, universities, and NGOs demonstrate strong commitment but limited decision-making power. Community stakeholders scored 12.0 interest vs. 9.0 influence, highlighting governance exclusion despite direct ecosystem dependence. Key Players Quadrant (High Interest, High Influence): Central and regional governments dominate with 15 institutions (65.2% of total). KLHK achieved the highest combined scores (23.0 interest, 25.0 influence), followed by provincial governments (24.0 interest, 23.0 influence average). Context Setters Quadrant (Low Interest, High Influence): Tourism Ministry, State Enterprises Ministry, BRIN, and BIG, plus private sector actors. These stakeholders scored 13.0-14.0 influence despite 11.0-13.0 interest levels, indicating passive but potentially transformative roles. Crowd Quadrant (Low Interest, Low Influence): No stakeholders identified, suggesting all actors maintain minimum engagement levels with mangrove governance. Statistical validation confirmed matrix reliability (Cronbach's α = 0.847) and inter-rater agreement (Cohen's κ = 0.723).

3.3 Multi-Dimensional Sustainability Assessment

MDS analysis revealed a moderately sustainable status across four dimensions with notable variations (Table 1, Figure 2):

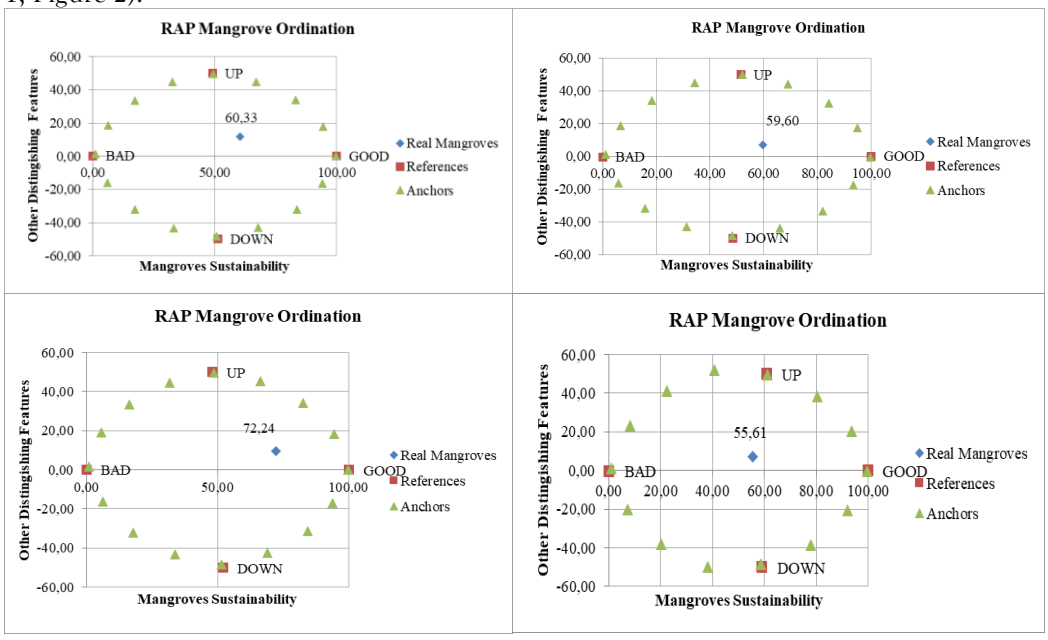


Figure 2. RAP Mangrove Ordination for Mangrove Sustainability Assessment

International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 6, 2025
https://theaspd.com/index.php

Table 1. Sustainability index, stress, determination coefficient, and correlation value

Dimensions	*Sustainability index*	*Stress value*	*RSQ (R^2)*	*r*
Institution	11.59	0.15	0.94	0.97
Ecology	7.1	0.14	0.95	0.97
Social	9.55	0.14	0.95	0.97
Economi	7.17	0.15	0.94	0.97

Social Dimension (72.24%): Highest sustainability reflecting strong community knowledge and cultural connections. However, leverage analysis identified education levels (leverage = 4.82) and community awareness (leverage = 4.13) as critical improvement areas.

Institutional Dimension (60.33%): Moderate sustainability is challenged by coordination gaps. Seven of eight attributes showed high leverage, particularly inter-institutional coordination (leverage = 4.32) and policy integration (leverage = 3.44).

Ecological Dimension (59.60%): Moderate sustainability with rehabilitation effectiveness (leverage = 3.67) and land pressure (leverage = 3.21) as primary leverage factors. Field observations confirmed 65% rehabilitation failure rates due to inadequate institutional coordination.

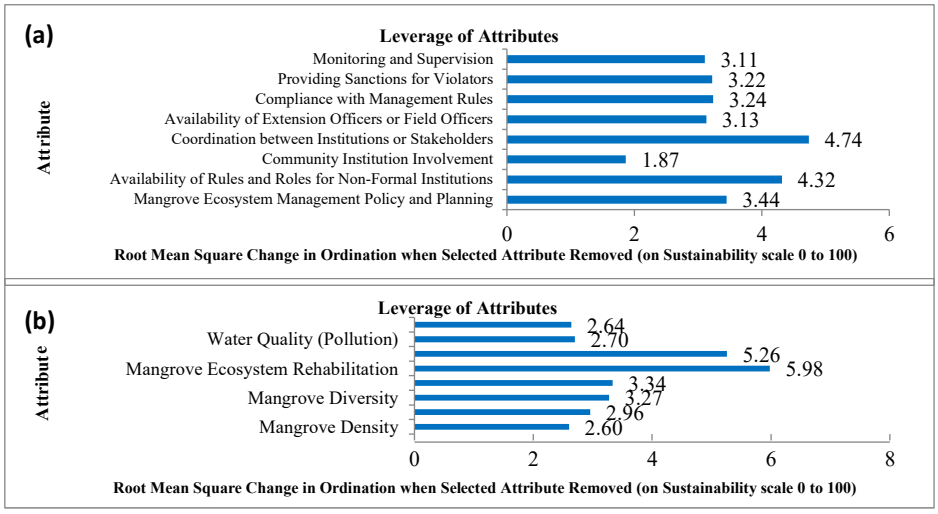
Economic Dimension (55.61%): Lowest sustainability reflecting limited livelihood integration. Stakeholder involvement (leverage = 3.89) and land use zoning (leverage = 3.42) emerged as critical factors for economic sustainability.

Validation results demonstrated high model quality: stress values 0.14-0.15 (all <0.25), R-squared 0.94-0.95 (all >0.80), bootstrap confidence intervals ±2.1-3.4%.

3.4 Leverage Analysis and Critical Factors

Cross-dimensional leverage analysis identified 11 critical attributes most influencing overall sustainability (Figure 3):

1. Inter-institutional coordination (institutional): Primary leverage factor affecting all dimensions
2. Rehabilitation effectiveness (ecological): Technical implementation quality
3. Stakeholder involvement (economic): Economic integration necessity
4. Education levels (social): Foundational capacity building
5. Policy integration (institutional): Regulatory coherence
6. Community awareness (social): Social mobilization potential
7. Land use zoning (economic): Spatial planning effectiveness
8. Land pressure (ecological): Development pressure management
9. Regulatory compliance (institutional): Rule implementation
10. Monitoring systems (institutional): Oversight mechanisms
11. Sanction mechanisms (institutional): Enforcement capacity



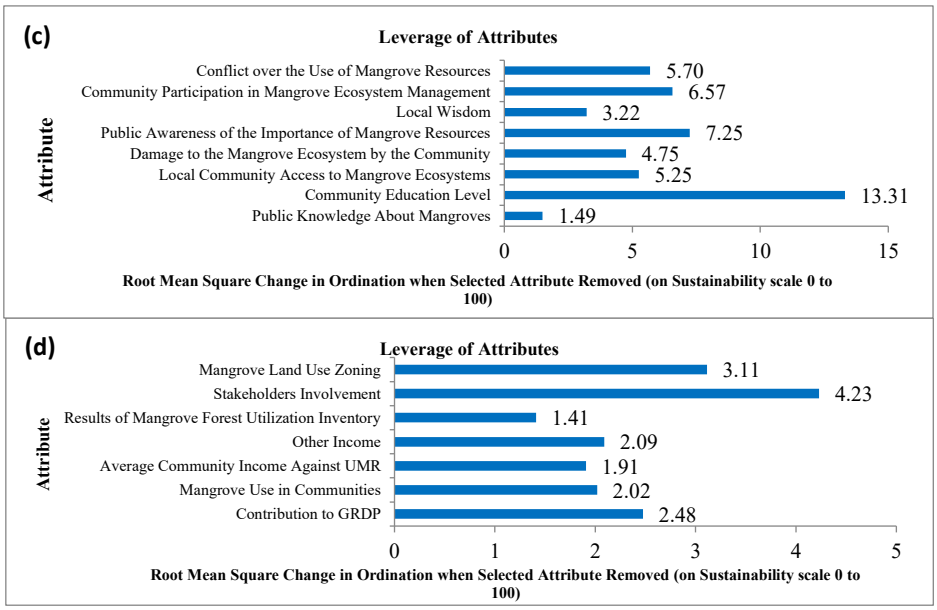


Figure 3. The results of leverage analysis in four dimensions: a) Institution; b). Ecology; c). Social; and d). Economy

3.5 Interpretative Structural Modelling Results

ISM analysis revealed hierarchical institutional relationships across three main elements (Figure 4):

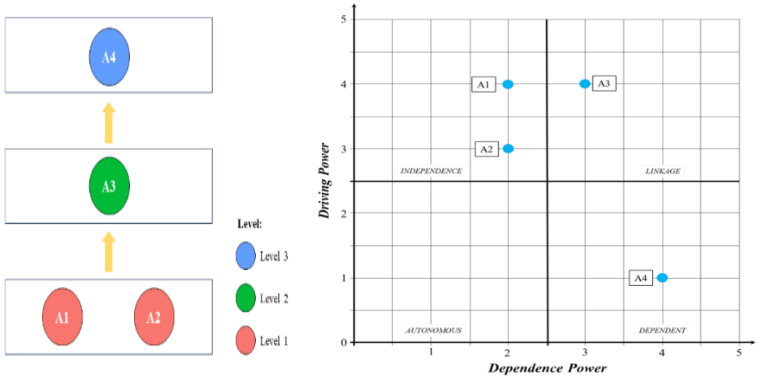


Figure 4. Structural Model of Enabling Conditions Elements

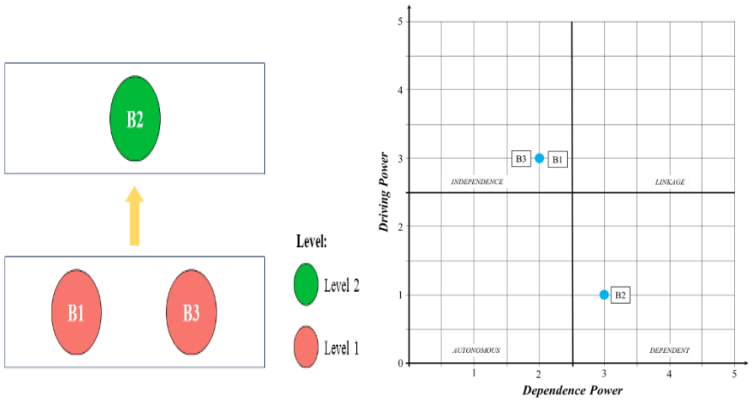


Figure 5. Structural Model of Action Implementation Elements

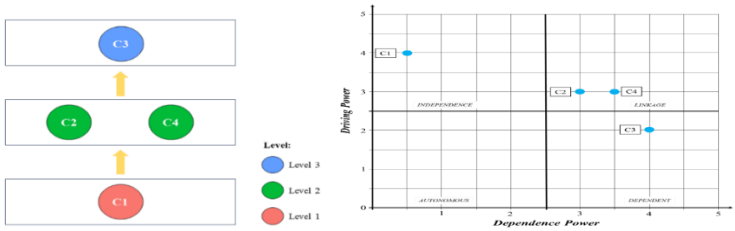


Figure 6. Structural Model of Sustainability Strategies

3.6 Enabling Conditions Fulfilment

Level 1 (Foundation): Institutional consensus (A1) and data/planning adequacy (A2) form the base level with the highest driving power (4.0 each) and lowest dependence. Statistical analysis confirmed these as independent variables essential for higher-level achievements.

Level 2: Effective institutional frameworks (A3) emerge from foundational elements with linkage characteristics (driving power 3.0, dependence 3.0), requiring careful management due to high interdependence.

Level 3: Community empowerment (A4) represents dependent outcomes (driving power 1.0, dependence 4.0) achievable only after foundational and institutional elements are established.

3.7 Action Implementation

Level 1: Ecosystem restoration (B1) and degraded area improvement (B2) function as independent driving factors (driving power 3.0 each), enabling higher-level conservation.

Level 2: Ecosystem protection (B3) emerges as a dependent outcome requiring successful restoration and improvement activities.

3.8 Sustainability Strategies

Level 1: Multi-level policy integration (C1) provides the foundational requirement (driving power 4.0) for all sustainability strategies.

Level 2: Business sector involvement (C2) and access area institutions (C4) represent linkage elements requiring careful coordination.

Level 3: Sustainable silviculture systems (C3) emerge as dependent outcomes requiring all foundational elements.

Institutional Fragmentation and Governance Challenges

Results confirm severe institutional fragmentation characterizing Jakarta Bay mangrove governance, consistent with global metropolitan coastal governance challenges (Thomas et al., 2021). The identification of 33 institutions with overlapping authorities validates theoretical predictions about polycentric governance complexity in social-ecological systems (Ostrom, 2010).

Government dominance (75.8% of institutions) reflects Indonesia's centralized governance legacy despite decentralization policies, creating legitimacy deficits identified by Jentoft (2000) when communities lack meaningful participation. Local community marginalization in the Subject quadrant (high interest, low influence) demonstrates power-interest misalignment fundamental to governance failures.

Inter-institutional coordination emerging as the primary leverage factor (4.32) supports collaborative governance theory, emphasizing coordination mechanisms as prerequisites for effective natural resource management (Ansell & Gash, 2008). The high leverage across seven of eight institutional attributes suggests systemic institutional weakness requiring comprehensive reform rather than incremental improvements.

Sustainability Assessment and Multi-Dimensional Interactions

Moderate sustainability status (55.61-72.24% across dimensions) indicates system resilience despite governance challenges, but reveals vulnerability thresholds requiring immediate attention. The social dimension's highest performance (72.24%) reflects strong traditional ecological knowledge and cultural connections documented in Indonesian coastal communities (Glaser & Glaeser, 2014).

Economic dimension weakness (55.61%) highlights livelihood-conservation tensions endemic to mangrove governance globally (Friess et al., 2019). The critical leverage of stakeholder involvement (3.89) and land use zoning (3.42) supports ecosystem service valuation approaches and payment for ecosystem services (PES) schemes demonstrated in Costa Rica and Thailand (Börner et al., 2017).
Cross-dimensional leverage patterns reveal institutional primacy, with 6 of 11 critical factors located in the institutional dimension. This validates institutional theory predictions that governance structures determine social-ecological system outcomes (Young, 2002; Cash et al., 2006).

Structural Modelling and Hierarchical Dependencies
ISM results provide actionable hierarchical pathways for governance transformation, addressing the implementation gap between governance theory and practice (Biermann et al., 2010). The identification of institutional consensus and data/planning adequacy as foundational requirements validates evidence-based policy advocacy and collaborative planning approaches (Reed, 2008).
Community empowerment as a dependent outcome (Level 3) challenges bottom-up governance assumptions, suggesting that foundational institutional arrangements must precede meaningful community participation. This finding supports staged approaches to participatory governance rather than immediate full participation (Arnstein, 1969; Pretty, 1995).
Multi-level policy integration as the foundation for sustainability strategies validates polycentric governance requirements while providing specific sequencing for institutional development (McGinnis & Ostrom, 2014).

International Comparative Context
Jakarta Bay results show convergent patterns with Sundarbans (Bangladesh-India) co-management challenges, Thai community-based management evolution, and Great Barrier Reef adaptive governance transformations (Islam & Berkes, 2016; Lebel et al., 2006; Day, 2008). Common elements include institutional fragmentation, community marginalization, and coordination as primary constraints.
Divergent patterns reflect metropolitan complexity unique to Jakarta Bay, particularly the density of institutional actors and economic pressures exceeding traditional coastal governance contexts. The 33-institution configuration surpasses Sundarbans (8 primary institutions) and Thai coastal governance (12-15 institutions), suggesting scaling challenges for governance mechanisms.

Theoretical Contributions and Framework Innovation
This study advances three theoretical contributions: (1) methodological integration of stakeholder analysis, sustainability assessment, and structural modelling provides comprehensive governance analysis; (2) hierarchical institutional modelling offers actionable transformation pathways; (3) metropolitan coastal governance theory development addresses knowledge gaps in urban SES research.
The integrated framework demonstrates that sustainable coastal governance requires simultaneous attention to power dynamics, sustainability dimensions, and institutional sequencing. This multi-dimensional approach advances beyond single-factor governance analyses toward systems-level understanding.

Policy Implications and Management Applications
Immediate policy priorities include: (1) establishing inter-institutional coordination mechanisms through strengthened Mangrove Working Groups with clear authority and resources; (2) implementing inclusive stakeholder processes, elevating community roles from subjects to key players; (3) developing integrated spatial planning addressing land use conflicts across jurisdictions.
Medium-term strategies require: (1) institutional capacity building focusing on foundational elements before advanced coordination; (2) economic incentive alignment through PES schemes and sustainable financing mechanisms; (3) monitoring system establishment enabling adaptive management.
Long-term transformation demands fundamental governance restructuring toward adaptive co-management models incorporating polycentric institutional arrangements with clear authority distribution and accountability mechanisms.

Limitations and Future Research

Methodological limitations include: (1) temporal snapshot analysis requiring longitudinal institutional change assessment; (2) subjective scoring in stakeholder and sustainability assessment despite expert validation; (3) local specificity requiring broader geographic validation.

Future research priorities include: (1) longitudinal governance analysis tracking institutional evolution; (2) comparative metropolitan coastal studies across Southeast Asia and globally; (3) implementation effectiveness assessment of proposed governance frameworks; (4) climate adaptation integration with institutional governance; (5) digital governance platforms for enhanced coordination and transparency.

CONCLUSION

This study demonstrates that current institutional arrangements are fundamentally inadequate for sustainable mangrove management in metropolitan coastal zones, requiring comprehensive governance transformation rather than incremental improvements. The integrated analytical framework reveals systematic institutional weaknesses across stakeholder participation, sustainability dimensions, and hierarchical organization.

Key findings establish that: (1) government institutional dominance (75.8%) marginalizes communities despite high ecosystem dependence; (2) moderate sustainability status (55.61-72.24%) masks critical vulnerabilities requiring immediate intervention; (3) inter-institutional coordination emerges as the primary leverage factor affecting all sustainability dimensions; (4) hierarchical dependencies require foundational institutional development before advanced coordination mechanisms.

The integrated governance framework provides actionable pathways for transformation through: (1) stakeholder rebalancing, elevating community roles while maintaining government leadership; (2) systematic leverage factor addressing prioritizing institutional coordination, policy integration, and economic incentives; (3) hierarchical institutional development establishing foundational elements before dependent outcomes. Broader implications extend beyond Jakarta Bay to metropolitan coastal governance globally, where institutional fragmentation and stakeholder power imbalances create similar challenges. The methodological integration of stakeholder analysis, sustainability assessment, and structural modelling offers replicable approaches for comprehensive governance analysis in complex social-ecological systems.

Successful implementation requires political commitment to fundamental institutional reform, resource allocation for coordination mechanisms, and sustained engagement across stakeholder categories. The urgency of coastal ecosystem degradation demands immediate action, but the hierarchical dependencies identified suggest patient institution-building alongside emergency interventions.

Future coastal governance must embrace adaptive complexity rather than simplified management approaches, recognizing that sustainable outcomes emerge from institutional quality, stakeholder inclusion, and systematic coordination across multiple scales and sectors. Jakarta Bay provides both cautionary evidence of governance failure consequences and hopeful demonstration that comprehensive analysis can guide transformation toward sustainability.

Acknowledgments

We thank the 47 key informants and workshop participants who shared their knowledge and time. Special appreciation to the National and Regional Mangrove Working Groups for facilitating access and providing institutional insights. We acknowledge support from the Ministry of Environment and Forestry, the Ministry of Marine Affairs and Fisheries, and provincial government agencies across Banten, DKI Jakarta, and West Java.

Data Availability Statement

Primary data supporting this research are available upon reasonable request from the corresponding author, subject to ethical approval and institutional agreements. Supplementary materials, including interview protocols, stakeholder scoring matrices, and statistical analysis codes, are provided in online appendices.

REFERENCES

1. Abbas, Z. (2005). Analisis stakeholder pengelolaan wisata alam. Institut Pertanian Bogor.

2. Ansell, C., & Gash, A. (2008). Collaborative governance in theory and practice. Journal of Public Administration Research and Theory, 18(4), 543-571.
3. Armitage, D., Plummer, R., Berkes, F., Arthur, R. I., Charles, A. T., Davidson-Hunt, I. J., ... & Wollenberg, E. K. (2009). Adaptive co-management for social–ecological complexity. Frontiers in Ecology and the Environment, 7(2), 95-102.
4. Arnstein, S. R. (1969). A ladder of citizen participation. Journal of the American Institute of Planners, 35(4), 216-224.
5. Biermann, F., Abbott, K., Andresen, S., Bäckstrand, K., Bernstein, S., Betsill, M. M., ... & Zondervan, R. (2010). Navigating the Anthropocene: improving earth system governance. Science, 331(6014), 1306-1307.
6. Börner, J., Baylis, K., Corbera, E., Ezzine-de-Blas, D., Honey-Rosés, J., Persson, U. M., & Wunder, S. (2017). The effectiveness of payments for environmental services. World Development, 96, 359-374.
7. Cash, D. W., Adger, W. N., Berkes, F., Garden, P., Lebel, L., Olsson, P., ... & Young, O. (2006). Scale and cross-scale dynamics: governance and information in a multilevel world. Ecology and Society, 11(2), 8.
8. Creswell, J. W., & Plano Clark, V. L. (2017). Designing and conducting mixed methods research. Sage Publications.
9. Day, J. (2008). The need and practice of monitoring, evaluating, and adapting marine planning and management—lessons from the Great Barrier Reef. Marine Policy, 32(5), 823-831.
10. Fauzi, A., & Anna, S. (2005). Pemodelan sumber daya perikanan dan kelautan untuk analisis kebijakan. Gramedia Pustaka Utama.
11. Friess, D. A., Yando, E. S., Abuchahla, G. M., Adams, J. B., Cannicci, S., Canty, S. W., ... & Wodehouse, D. C. (2019). Mangroves give cause for conservation optimism, for now. Current Biology, 29(4), R153-R154.
12. Giri, C., Ochieng, E., Tieszen, L. L., Zhu, Z., Singh, A., Loveland, T., ... & Duke, N. (2011). Status and distribution of mangrove forests of the world using Earth observation satellite data. Global Ecology and Biogeography, 20(1), 154-159.
13. Glaser, M., & Glaeser, B. (2014). Towards a framework for cross-scale and multi-level analysis of coastal and marine social-ecological systems dynamics. Regional Environmental Change, 14(6), 2039-2052.
14. Glaser, M., Oliveira, R. S., & Oliveira, A. (2018). Social-ecological systems analysis of coastal zone management in Brazil and Germany. Ocean & Coastal Management, 159, 132-141.
15. Islam, M. M., & Berkes, F. (2016). Can small-scale commercial and subsistence fishers coexist? Lessons from an indigenous community in northern Canada. Maritime Studies, 15(1), 1-18.
16. Jentoft, S. (2000). Legitimacy and disappointment in fisheries management. Marine Policy, 24(2), 141-148.
17. Lebel, L., Anderies, J. M., Campbell, B., Folke, C., Hatfield-Dodds, S., Hughes, T. P., & Wilson, J. (2006). Governance and the capacity to manage resilience in regional social-ecological systems. Ecology and Society, 11(1), 19.
18. Marfai, M. A., & King, L. (2008). Potential vulnerability implications of coastal inundation due to sea level rise for the coastal zone of Semarang city, Indonesia. Environmental Geology, 54(6), 1235-1245.
19. McGinnis, M. D., & Ostrom, E. (2014). Social-ecological system framework: initial changes and continuing challenges. Ecology and Society, 19(2), 30.
20. Murdiyarso, D., Purbopuspito, J., Kauffman, J. B., Warren, M. W., Sasmito, S. D., Donato, D. C., ... & Kurnianto, S. (2015). The potential of Indonesian mangrove forests for global climate change mitigation. Nature Climate Change, 5(12), 1089-1092.
21. Neumann, B., Vafeidis, A. T., Zimmermann, J., & Nicholls, R. J. (2015). Future coastal population growth and exposure to sea-level rise and coastal flooding global assessment. PLoS One, 10(3), e0118571.
22. Newton, A., Harff, J., You, Z. J., Zhang, H., & Wolanski, E. (2020). Sustainability of future coasts and estuaries: A synthesis. Estuarine, Coastal and Shelf Science, 243, 106509.
23. Ostrom, E. (2010). Beyond markets and states: polycentric governance of complex economic systems. American Economic Review, 100(3), 641-672.
24. Partelow, S. (2018). A review of the social-ecological systems framework: applications, methods, modifications, and challenges. Ecology and Society, 23(4), 36.
25. Pitcher, T. J., & Prescot, D. (2001). RAPFISH: a rapid appraisal technique to evaluate the sustainability status of fisheries. Fisheries Research, 49(3), 255-270.
26. Pretty, J. N. (1995). Participatory learning for sustainable agriculture. World Development, 23(8), 1247-1263.
27. Reed, M. S. (2008). Stakeholder participation for environmental management: a literature review. Biological Conservation, 141(10), 2417-2431.
28. Reed, M. S., Graves, A., Dandy, N., Posthumus, H., Hubacek, K., Morris, J., ... & Stringer, L. C. (2009). Who's in and why? A typology of stakeholder analysis methods for natural resource management. Journal of Environmental Management, 90(5), 1933-1949.
29. Rusdianti, N., & Sunito, S. (2012). Conversion of mangrove forest function in Java Island and its impact on fishermen. Jurnal Transdisiplin Sosiologi, Komunikasi, dan Ekologi Manusia, 6(1), 1-17.
30. Thomas, A., Mangubai, S., Beavis, S., Brodie, G., Depledge, J., Lconsensius, L., ... & Morrison, C. (2021). Climate change and mental health: a scoping review. International Journal of Environmental Research and Public Health, 18(22), 11896.
31. Warfield, J. N. (1974). Developing subsystem matrices in structural modeling. IEEE Transactions on Systems, Man, and Cybernetics, 4(1), 74-80.
32. Worthington, T. A., zu Ermgassen, P. S., Friess, D. A., Krauss, K. W., Lovelock, C. E., Thorley, J., ... & Spalding, M. (2020). A global biophysical typology of mangroves and its relevance for ecosystem structure and deforestation. Scientific Reports, 10(1), 1-11.
33. Young, O. R. (2002). The institutional dimensions of environmental change: fit, interplay, and scale. MIT Press.