Adaptive Co-Management In Fisheries Management Based On Local Wisdom: A Systematic Literature Review

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Abstract. The purpose of this study is to assess the implementation of adaptive co-management in fisheries management based on local wisdom as an effort to enhance socioeconomic conditions and preserve marine resources. This research is expected to play an important role in bridging the gap between scientific knowledge and traditional practices in fisheries decision-making. The research method used is a literature review employing the PRISMA protocol, with data drawn from previous studies published in reputable journals. A narrative synthesis approach was applied to present empirical evidence regarding the integration of local wisdom within the adaptive co-management framework. The study reveals an increase in ecological and social effectiveness within the adaptive co-management framework through social learning, community participation, and the role of bridging organizations. It also highlights the incorporation of local wisdom, such as fishing restrictions and consideration of fish biological cycles, which have been proven to contribute to ecosystem sustainability. However, large-scale implementation, conflicting stakeholder interests, and the lack of adequate monitoring systems remain major challenges. The limited existing literature emphasizing the importance of locally based collaborative governance in the fisheries' socio-ecological system implies that strengthening institutional capacity and integrating technological innovation can enhance adaptability and lead toward long-term sustainability.

Keywords: Adaptive Co-Management, Fisheries Management, Local Wisdom, Socio-Ecological Systems, Community Empowerment, Collaboration

1 Introduction

Sustainable fisheries management has become a global necessity amid the challenges of overexploitation, climate change, and environmental degradation. (Béné, C., Bennett, E. L., & Neiland, 2004). The global decline in fish stocks threatens marine biodiversity and the livelihoods of coastal communities, primarily due to unregulated fishing practices and the lack of adaptive responses to dynamic marine ecosystems (Atmaja, S. B., Sadhotomo, B., & Nugroho, 2017b). In traditional fishing communities that depend on local resources, conventional top-down management approaches have proven inadequate in capturing socio-ecological complexities. (Joshua E. Cinner, 2007). In this context, the co-adaptive management approach has emerged as a promising framework as it combines scientific knowledge and local wisdom in decision-making processes (Derek Armitage, 2010); (Sari, D. A. A., & Latifah, 2021).

Local wisdom, which refers to the knowledge, practices, and beliefs rooted in the community and related to the management of natural resources, significantly strengthens socio-ecological resilience and enables long term sustainability. (Wiber, M. G.,

N. Alyani Ishak et al. (eds.), *Proceedings of the International Conference on Cross- Disciplinary Academic Research 2025 - Track 2 Advances in Business & Economics, Social Science, Communications & Media (ICAR-T2 2025)*, Advances in Economics, Business and Management Research 385,
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Charles, A., Kearney, J. F., & Berkes, 2008). An additional process of making the fisheries management policy more effective, legitimate, and acceptable, especially at the grassroots level, is through the integration of local wisdom into the policy (Daniel Stokols 1, 2013). A series of studies have shown that training and empowerment programs using participatory approaches can enhance the adaptive capacity of coastal communities through collaborative efforts among local governments, NGOs, and local communities. (T, N., Puank Parukka, R. A., Husein, S., & Haris, 2024), (Dale & Armitage, 2010).

Nevertheless, there remains a significant research gap regarding how adaptive co-management frameworks are actually implemented in diverse local contexts, particularly within the socio-ecological systems of coastal communities in developing countries. Many studies remain conceptual and have not deeply explored the collaborative practices and power dynamics involved in integrating local wisdom into fisheries policy (Derek R Armitage,2009.); (Chuenpagdee, 2009). For instance, in various regions of Indonesia, such as the coasts of Sulawesi and Nusa Tenggara, local practices like *sasi laut* and *awig-awig* have long been part of traditional resource management systems. However, the implementation of co-adaptive approaches often encounters challenges such as overlapping authorities, limited capacity of local institutions, and resistance from external actors who do not understand local values (Adrianto et al., 2021.).

The above explanation shows that the success of adaptive co-management largely depends on institutional design, equitable participation, and continuous social learning processes. Therefore, this study is essential to address fundamental questions regarding how adaptive co-management based on local wisdom can be effectively implemented in fisheries management, as well as what factors influence the adaptation and collaboration processes within the socio ecological context of coastal communities.

2 Research Method

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach is used in this study to conduct a Systematic Literature Review aimed at identifying, evaluating, and synthesizing scientific literature on the implementation of adaptive co-management informed by local wisdom in fisheries management. Through this approach, the scientific literature review becomes more transparent and replicable, while also capable of mapping trends, gaps, and theoretical contributions from previous studies.

The search for previous studies was conducted in the Scopus and ScienceDirect databases using the keywords: adaptive co-management, co-management, fisheries, small-scale fisheries, local knowledge, and traditional ecological knowledge. The inclusion criteria in this study focused on Scopus-indexed journals that contain empirical studies on the implementation of co-management or adaptive co-management in the context of fisheries management and local wisdom, published between 2005 and 2024. The exclusion criteria were: Gray literature (e.g., policy reports, and editorials), Studies focused on non-fisheries development, Not available in full text.
The article selection process, guided by PRISMA, consisted of four stages:

1. **Identification**: 154 articles were identified through initial keyword searches in Scopus and ScienceDirect.
2. **Initial Screening**: 81 articles were eliminated due to duplication and irrelevance based on titles and abstracts.
3. **Eligibility**: 75 articles were fully read to evaluate content relevance to the research topic.
4. **Inclusion**: 37 articles met all criteria and were further analyzed.

Data from the 37 selected articles were analyzed using a **thematic approach** to identify key trends, research gaps, and theoretical contributions in the study of adaptive co-management. The analysis was conducted qualitatively by grouping findings into several major themes, such as the role of local wisdom, bridging organizations, conflicts of interest, and sustainability strategies.

3 Results and Discussion

3.1 Theoretical Development of Adaptive Co-Management

The failure in public administration, reflected in hierarchical and homogeneous governance systems, has proven incapable of accommodating local diversity and systemic change. The dominant top-down, command-and-control approach—often neglecting social dynamics, actor pluralism, and the complex, adaptive nature of ecology—has been deemed ineffective in shaping conventional natural resource management models that are centralized, bureaucratic, and linear. This failure eventually led to the emergence of the Adaptive Co-Management concept.(Berkes, J. and Folke, C., 2003).

Adaptive Co-Management is a conceptual evolution that merges two primary approaches:

a) **Adaptive Management:** Rooted in ecology and complex systems theory, this approach emphasizes experimental governance and feedback learning to handle ecological uncertainty. It focuses on cyclical, reflective, and evidence-based policy processes (Holling & Gunderson, 2023).
b) **Collaborative Management (Co-Management):** Originating from studies on community participation in resource management, this approach highlights power-sharing, deliberation among actors, and inclusiveness in policy processes (Chuenpagdee, 1989); (Lars Carlsson 1, 2005).

Adaptive Co-Management represents an epistemological convergence between ecological learning and social collaboration. It integrates the system's capacity for continuous learning from nature's dynamics with participatory governance mechanisms across scales. Resource management is thus understood as an adaptive process shaped by actor interaction, institutional structures, and environmental dynamics (Plummer & Armitage, 2007).

From a public administration perspective, Adaptive Co-Management marks a shift from the efficiency-centered **New Public Management** paradigm toward a more deliberative and responsive **governance network** model (Obosi, 2019). Effective resource governance is not solely about bureaucratic efficiency, but about the system's

capacity to: Build trust among stakeholders, Provide institutional space for interest negotiation, and Manage uncertainty cooperatively and sustainably.

In community-based fisheries, Adaptive Co-Management serves as a hybrid framework that bridges scientific knowledge with local wisdom (such as *sasi*, *awig-awig*, and the role of *panglima laut*). This reflects a **polycentric governance** model, where authority and responsibility are delegated across government levels and communities simultaneously (Systems, 2010). This study's literature review identifies three main pillars influencing the success of Adaptive Co-Management in fisheries:

1) **Social Learning**
   A process where actors learn from experience, share knowledge, and build collective understanding of socio-ecological issues. This learning is iterative and occurs in deliberative dialogue spaces that generate dynamic consensus (Mark S. Reed, 2010).
2) **Strengthening Local Institutional Capacity**
   Adaptive Co-Management relies on local institutions as drivers of adaptation. However, their capacity must be supported by flexible regulations, sufficient resources, and cross-scale support (Derek R Armitage, 2009). Local institutions are not just implementers, but also producers of norms and knowledge.
3) **Power Redistribution and Governance Justice**
   Adaptive Co-Management promotes power devolution from the state to local communities through collaborative mechanisms, enabling substantive justice in decision-making. Policy legitimacy stems not only from formal legality but also from social acceptance and ecological sustainability (Jentoft & Bavinck, 2014). Adaptive co management is practically associated with the social-ecological systems framework, where this concept is viewed as a form of governance that enables dynamic interactions between social and ecological systems within an adaptive, complex, and non-linear framework (Ostrom, 2009). In principal terms, Adaptive Co-Management does not portray as a method that is simple-technical, but rather, it is contextual, reflective, and an experiment type of adaptive governance which appears most appropriate for the challenges of public administration in the climate change period, ecological uncertainty, and actor pluralism period.

3.2. Main Findings of the Systematic Review (PRISMA)

The systematic review based on the PRISMA approach in this study indicates an increasing recognition of Adaptive Co-Management as a form of transformation in fisheries resource governance based on local wisdom. It is also considered appropriate for addressing the socio-ecological complexities that have not been adequately captured by previous governance models.

a. Integration of Local and Scientific Knowledge

Prior research asserts that the efficiency of adaptive co-management accrues from the integration of SEK and LEK. This integration has proved successful and brought about positive ecological dimensions in terms of:

1) Recovery of fish biomass (Atmaja, S. B., Sadhotomo, B., & Nugroho, 2017a),

2) Enhancement of benthic habitat and coral reef quality,
3) Ecosystem stability through the implementation of seasonal bans and customary zoning [3]; (Joshua E. Cinner, 2007)

These findings reinforce **political ecology theory**, which views knowledge as an arena of power and legitimacy, where local communities are no longer seen as objects of intervention, but as active subjects in the production of knowledge and governance decisions.

b. Strengthening Social Cohesion and Institutional Legitimacy

Adaptive co-management should begin to build social cohesion by gradually building trust among participants and horizontal collaborators while relying on the principles of gotong royong and collective trust. Results from the local study proposed that customary-based institutional legitimacy is more techno-krat and alien to have community accept it than formal rules. The process of community dialogue, consensus meetings, and making decisions together helps to greatly minimize conflicts due to competing interests in conservation, commercialization, and indigenous rights (Chuenpagdee, 2009).

c. Economic Efficiency and Livelihood Sustainability

Livelihood Sustainability and Economic Efficiency. In addition, adaptive co-management has been demonstrated to enhance the economic efficacy of small-scale fisheries. Among the indicators are:
1) Higher yields of sustainable catch (Plummer, 2009)
2) Diversification of employment (Heriawan, F., Susanto, A., & Haryanti, 2021)
3) Improved value-added through community-based innovation (Qonita Rachmah, Junaida Astina, Dominikus Raditya Atmaka, 2023); (Suarnadwipa, N., Adnyana, I. W. B., & Wicaksana, 2018)

These successes are attributed to access to ecosystem information, community-based quota arrangements, and social control over destructive fishing gear. A study by (Wiber, M. G., Charles, A., Kearney, J. F., & Berkes, 2008) even highlights that when local actors are given substantial participatory space, innovations in fisheries practices and local economies tend to grow endogenously and sustainably.

d. Discrepancies Between Ecological Understanding and Conservation Efforts

Despite widespread acknowledgment of the ecological understanding present in coastal communities such as awareness of fish spawning cycles, seasonal migrations, and indicators of environmental degradation research like that of (Amin, M. A., Adrianto, L., Kusumastanto, T., & Imran, 2021b) underscores a disconnect between knowledge and action. In regions experiencing significant economic strain and fragile local governance, conservation efforts frequently fail to operate efficiently. The factors that contribute are as follows: 1) Daily income instability, 2) Absence of immediate economic incentives, 3) Fragmentation of institutions and ineffective community-based enforcement systems.

These represent significant obstacles to converting ecological understanding into tangible conservation efforts. This underscores the significance of flexible strategies and socio-economic motivations in the framework of adaptive co-management. These findings reinforce the idea that adaptive co-management transcends a simple technical framework; it serves as a governance strategy that reshapes power dynamics, knowledge, and trust in the stewardship of shared resources. The significance of bridging institutions, adaptive governance frameworks, and multi-level integration is crucial for improving the effectiveness and sustainability of this approach.

e. Gaps Between Ecological Literacy and Conservation Practices

Despite broad recognition of the **ecological literacy** of coastal communities—such as knowledge of fish spawning cycles, seasonal migrations, and environmental degradation signals—studies such as (Amin, M. A., Adrianto, L., Kusumastanto, T., & Imran, 2021a) highlight a gap between knowledge and action. In areas facing high economic pressure and weak local institutions, conservation practices often do not function effectively. Contributing factors include:

1) Daily income insecurity,
2) Lack of short-term economic incentives,
3) Institutional fragmentation and weak community-based enforcement mechanism.

The explanation above highlights the main barriers to transforming ecological knowledge into concrete actions, emphasizing the importance of institutional design in adaptive co-management through adaptive mechanisms and socio-economic incentives. Overall, these findings support the premise that adaptive co-management is a governance approach that reconstructs power relations, knowledge, and trust in managing common resources, rather than merely a technical management framework. The effectiveness and sustainability of this approach rely on the role of bridging institutions, adaptive governance structures, and multi-level integration.

3.3. Social Learning and the Role of Bridging Organizations

In the implementation of Adaptive Co-Management, the gaps between the government, local communities, and non-state actors need to be bridged by intermediary organizations. NGOs, research institutions, universities, customary authorities, and other organizations serve as catalysts in building adaptive collaborative governance through three main functions: knowledge mediation, deliberation facilitation, and institutional capacity strengthening.

a. Knowledge Mediation Between Epistemic Systems

Bridging organizations serve as translators and intermediaries between **local ecological knowledge (LEK)** and **scientific ecological knowledge (SEK)** (Amin, M. A., Adrianto, L., Kusumastanto, T., & Imran, 2021a)(David Cash, William Clark, Frank Alcock, Nancy Dickson, 2002). This role is crucial given the frequent mismatch in language, norms, and logic between academic knowledge and community practices. A study by (Beatrice Crona, 2012) shows that NGOs with strong local networks are able

to simplify scientific research findings into formats that are understandable and useful for fishing communities such as participatory zoning maps, simple monitoring tools, or case-based dialogue forums.

b. Facilitators of Deliberation and Actor Inclusion

In community-based fisheries management, bridging organizations function as **facilitators of deliberative processes** decision-making processes based on equal, inclusive, and reflective dialogue. These processes are essential arenas for resolving conflicts of interest, formulating local rules, and building institutional legitimacy (Jessica Blythe, Jennifer Silver, Louisa Evans, Derek Armitage, Nathan J. Bennett, Michele-Lee Moore, Tiffany H. Morrison, 2018). Findings from several studies indicate that the presence of local universities and environmental NGOs helps create **safe deliberative spaces,** especially in regions with a history of intergroup conflict. This supports the theoretical framework of **collaborative governance,** which emphasizes neutral facilitation and recurring interaction structures as prerequisites for successful collaborative governance.

c. Enhancing Adaptive Capacity and Social Learning

The most essential aspect of bridging organizations is their capacity for **social learning.** Social learning is not merely about information transfer, but a collective process of building shared meaning, testing assumptions, and adjusting behaviors to socio-ecological dynamics (Reed, 2010). In practice, bridging organizations initiate: Participatory workshops for resource mapping, Scenario simulations for management planning, and Community-based monitoring and evaluation systems.

These processes lead to **double-loop learning,** in which actors not only change their practices but also revisit the values, norms, and underlying assumptions behind their decisions (Pahl-Wostl, 2009). This shows that adaptive co-management is not just a technical approach, but an institutional process of collective learning and social engineering.

d. Challenges and Tensions in Bridging Roles

However, studies also reveal **tensions** in the role of bridging organizations, especially regarding representation, accountability, and financial sustainability. In some cases, international NGOs are perceived as too dominant in rule-making processes, thereby reducing the autonomy of local communities. Meanwhile, local universities sometimes fall into short-term project logic without a clear **exit strategy,** which disrupts program sustainability (Jessica Blythe, Jennifer Silver, Louisa Evans, Derek Armitage, Nathan J. Bennett, Michele-Lee Moore, Tiffany H. Morrison, 2018). Therefore, it is important for bridging organizations to: Ensure transparency and accountability to the communities they support, Build institutional transition mechanisms to local actors, and Adopt reflective and iterative facilitation approaches.

These findings reinforce the argument that bridging organizations are not merely technical intermediaries, but **key institutional actors** in shaping the architecture of transformative adaptive governance. From a public administration perspective, they ex-

pand the meaning of governance toward a more **horizontal, participatory, and learning-based** approach. Their role becomes increasingly crucial in the context of ecological crises and institutional fragmentation that require governance innovations based on networks and **coevolution.**

4 Research Gaps

Theoretical and empirical gaps remain significant in previous studies that have legitimized adaptive co-management as an alternative to conventional natural resource governance. The limitations of earlier research not only create these gaps but also open strategic opportunities, particularly in the fields of public administration, collaborative governance, and adaptive environmental policy. Three major gaps identified are as follows:

a. Scalability and Institutionalization in Multi-Level Governance

The majority of adaptive co-management studies are still limited to **small- to medium-scale case studies,** often rooted in specific socio-ecological systems (Plummer & Armitage, 2007); (Berkes, 2009). Although local context is crucial, there has not been a comprehensive review exploring how adaptive co-management principles can be **replicated, scaled, and institutionalized** within multi-level governance frameworks involving central government, regional authorities, and communities. So far, vertical-horizontal coordination mechanisms across governance levels and integration between formal policies and customary rules remain underdeveloped areas in the literature (Wiber, M. G., Charles, A., Kearney, J. F., & Berkes, 2008). The absence of a conceptual model explaining the transition from local practices to national or regional policies presen(Plummer & Armitage, 2007)ts both methodological and normative challenges in advancing adaptive co-management in a more systemic and sustainable direction.

b. Conflict Resolution and Management of Trade-Offs Between Interests

Previous studies have shown that the system's ability to manage both latent and overt conflicts of interest whether involving the government, local communities, small-scale fishers, large-scale fisheries industries, or the balance between ecological conservation and subsistence economic needs serves as a key determinant of success in the implementation of Adaptive Co Management(Chuenpagdee, 2009). However, most studies still tend to describe conflicts **descriptively**, without exploring the institutional mechanisms used for conflict resolution through deliberation, mediation, or institutional reconciliation. Moreover, the concept of **institutional trade-offs** has not been widely integrated into analyses. For example, how the strengthening of one objective (such as conservation) might weaken another, or how customary laws may conflict with formal decentralized policies. This highlights the need for studies that explore institutional design frameworks that are responsive, inclusive, and capable of dynamically managing conflicts.

c. Adaptive Monitoring and Evaluation Based on Social-Ecological Systems

Monitoring and Evaluation (M&E) is a **key component** of adaptive co-management, yet current literature remains limited to **sectoral indicators** such as catch volume, rule violations, or actor participation (Prudence Plummer, 2015). The main objective of adaptive co-management has not been sufficient to enhance the long-term resilience of social-ecological systems through these indicators. There is still no integrated evaluation framework capable of measuring the ecological, social, institutional, and economic dimensions in a holistic and adaptive manner. The lack of iterative evaluation systems based on social learning causes many adaptive co-management projects to stagnate after the initial intervention, due to the absence of feedback loops that support continuous adaptation. Further studies need to develop **complexity-based evaluation methodologies** such as systems thinking approaches, adaptive indicators frameworks, or real-time participatory monitoring.

This research contributes by addressing these gaps through **theoretical synthesis** and the **integration of local wisdom,** with a focus on:

1) Developing **conceptual institutional models** that allow context-based replication and cross-site learning,
2) Analyzing **institutional design** capable of navigating value conflicts and interest trade-offs among actors in fisheries social-ecological systems,
3) Formulating an **adaptive evaluation framework** based on integrated social-ecological indicators that considers institutional dynamics, participation, and collective capacity.

Thus, this study not only complements the existing literature but also provides both theoretical and practical contributions to strengthening collaborative and adaptive natural resource governance in response to the complex challenges of climate change and ecological crisis.

5. Theoretical Contributions

This study provides significant theoretical contributions to the discourse in **public administration**, **environmental governance**, and **social-ecological systems theory**, by positioning adaptive co-management as a dynamic framework for fisheries resource management rooted in local wisdom. There are three primary domains of theoretical contribution emerging from this review:

a. Reframing Local Wisdom as an Epistemic Asset in Governance

The first contribution lies in the **redefinition of local wisdom**, not merely as traditional knowledge, but as an **epistemic asset** that is equal and complementary to scientific knowledge in decision-making processes. This study expands the perspective that local communities are not merely objects of intervention, but **epistemic subjects** capable of generating governance mechanisms based on collective experience and long-term relationships with ecosystems.

In the framework of adaptive co-management, local wisdom such as *sasi* in Maluku, *awig-awig* in Bali, or the role of *panglima laut* in Aceh's coastal areas, holds not only

normative value but also functions as an **ecological governance instrument**, contributing to the formation of norms, social sanctions, and adaptive mechanisms. This expands the discourse of **collaborative governance** by integrating epistemic-communitarian dimensions that have often been marginalized in formal governance models (Berkes, 2009); (Plummer & Armitage, 2007).

b. Integration of Social Learning and Trust as Pillars of Adaptive Institutions

The second contribution is the **integration of social learning and social capital**, such as inter-actor trust, into the adaptive institutional framework. Unlike classical institutional approaches, which are static and hierarchical, adaptive co-management demonstrates that governance success relies on the ability of actors to **continually learn, engage in deliberative interaction**, and build cross-sectoral and cross-scale trust.

This study affirms that **trust is not only a prerequisite for participation**, but also an **institutional capital** that enables collective decision-making under ecological uncertainty. Thus, this study strengthens the argument that institutional designs must be **flexible, open to experimentation, and responsive** to socio-ecological dynamics as core requirements for sustaining adaptive co-management systems (Carl Folke, Thomas Hahn, Per Olsson, 2005); (Andreas Olsson, Katherine I Nearing, 2007).

c. Refinement of Adaptive Co-Management Theory in the Global South Context

The roots of adaptive co-management presented in various pieces of literature largely originate from the context of Global North countries, which possess relatively stable institutional systems and well-established policy infrastructures. This study addresses that gap by developing an adaptive co-management framework tailored to **developing countries**, particularly Indonesia, which is characterized by legal pluralism, hybrid institutions, and complex socio-ecological-economic pressures. Through this approach, the study enriches adaptive co-management theory by proposing a **contextualized adaptive governance model**, one that accounts for: Heterogeneity of actors and norms (customary, religious, governmental), The fragility of asymmetric power dynamics and local institutions in facing climate change and market forces.

Hence, this contribution is not only conceptual but also **normative**, advocating for governance that is **ecologically effective, socially just,** and **culturally meaningful.** These theoretical contributions have broad implications for **public administration**, particularly in developing governance approaches that are **responsive, participatory, and transdisciplinary.** This study deepens the understanding of how: Local and scientific knowledge can interact in deliberative platforms, Social learning functions as a mechanism for institutional adaptation, And how formal state structures can synergize with informal institutions through the mediation of bridging organizations. By proposing the **Adaptive Collaborative Governance** conceptual framework, this study contributes to the **paradigm shift** in public administration—from managerial-hierarchical approaches to **reflexive, co-evolutionary, and dual-knowledge-based** approaches.

6. Practical Implications and Technological Innovation

The findings of this review demonstrate that the **adaptive co-management** approach not only requires institutional reform but also opens substantial opportunities for **technological innovation** and **contextual governance design**. The integration of social, ecological, and digital dimensions becomes the foundation for transforming community-based fisheries resource governance.

a. Hybrid Governance Design: Synergy Between Digital Technology and Local Knowledge

The importance of developing hybrid governance systems and utilizing digital technologies, remote sensing, and artificial intelligence represents one of the key practical implications, serving as supportive tools to enhance the adaptive capacity of fishing communities rather than replacing traditional knowledge systems. Sensor-based monitoring systems can be utilized to support: Early detection of environmental degradation, Efficient planning of fishing times, and Community-based fisheries surveillance.

This approach also encourages **real-time feedback loops**, where information from sensors is directly correlated with local practices, such as temporal closures or gear bans decided through customary deliberation.

b. Community Digital Literacy as Adaptive Capital

,The adoption of technology cannot be separated from **social readiness**. Therefore, this study recommends enhancing **digital literacy** among coastal communities as part of building **adaptive institutional capacity**. Community-based training on digital data interpretation, participatory spatial mapping, and the use of fisher reporting applications can: Strengthen the community's sense of ownership over technology, Reduce dependence on external actors (state/NGOs), and Facilitate **data-driven social learning**. Thus, technology becomes a **medium for facilitating deliberation**, not a tool for domination.

c. Digital Platforms for Multi-Level and Transparent Governance

At the cross-scale governance level, the development of **collaborative digital platforms** (e.g., GIS-based dashboards, ecological data-sharing applications, and virtual deliberative forums) is crucial. These platforms enable: Integration of information across levels (local, regional, national), Multi-actor coordination in rule-making, and Enhanced transparency and accountability in decision-making (**e-governance in marine resource management**).

This innovation strengthens **networked governance**, where technology acts as an **enabler** of governance structures that are flexible, open, and adaptive to climate and market changes.

d. Risks of Over-Technologization and Mitigation Strategies

The study also notes the risk of **over-technologization**—the tendency to dominate governance processes with technocratic logic, which can marginalize local knowledge and

erode community autonomy. Several potential risks to anticipate include: **Digital alienation** in communities with low literacy levels, **Dependence on technology vendors** or short-term projects, **Data politics**, including access monopolies and bias in ecological data interpretation.

The practical implication is the importance of developing a **technological subsidiarity principle**, where technology is designed, modified, and implemented with a bias toward the local social context. **Transdisciplinary collaboration** among engineers, public administrators, anthropologists, and local communities is key to designing technological systems that are **inclusive and equitable**.

Thus, technological innovation within the adaptive co-management framework is not merely instrumental, but part of a **co-evolutionary strategy** between humans and ecosystems. Appropriate and locally rooted technologies have the potential to **strengthen institutional resilience**, **expand public deliberation spaces**, and **accelerate intergenerational adaptive learning**. This is the convergence point between **community-based public administration** and the **digital transformation** of natural resource governance.

7 Conclusion

A comprehensive mapping of the implementation of adaptive co-management in fisheries management based on local wisdom using the systematic literature review (SLR) approach grounded in the PRISMA framework is presented in this study. The challenges of natural resource governance amid socio-ecological complexity, particularly in the context of developing countries, can be effectively addressed through adaptive co-management as a transformative approach.

This study found that the integration of local and scientific knowledge within the adaptive co-management framework significantly enhances: **Ecological effectiveness** (e.g., fish stock recovery and habitat quality), **Social cohesion and institutional legitimacy** at the community level, **Economic efficiency** at local scales. The main theoretical contribution of this research is the **strengthening of local wisdom** as an **epistemic asset** in governance, along with the development of the **adaptive collaborative governance framework**, which places social learning, inter-actor trust, and institutional innovation as foundational pillars of resilient and adaptive systems.

From the **public administration perspective**, this study offers a new lens for designing governance systems that are **participatory**, **reflective**, and **context-based**. The study also identifies **three major gaps** that remain underexplored in the literature:

1. The absence of **conceptual models** for institutionalizing adaptive co-management within broader multi-level governance systems.
2. The lack of **systematic approaches** in institutional design for managing **conflicts** and **trade-offs** among stakeholders.
3. The unavailability of **adaptive monitoring and evaluation systems** that can holistically and dynamically assess social-ecological success.

Practically, this research emphasizes the importance of synergy between **digital technologies** (such as IoT, e-governance platforms, and participatory mapping) and **con-**

textual local value systems. These innovations not only strengthen institutional capacity and ecological sustainability but also foster governance that is more **just** and **democratic**.

Thus, this study not only enriches the academic landscape in the fields of natural resource governance and public administration but also provides a **conceptual and operational foundation** for designing policies rooted in local strengths, oriented toward sustainability, and resilient in the face of change.

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