

The Fuzzy Cognitive Mapping of Stakeholders Related to the Measured Fishing Policy (In Southeast Sulawesi)

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ABSTRACT

The issuance of the Measured Fishing Policy (PIT) has sparked controversy among fishing communities, particularly due to its mechanism, which is seen as granting greater opportunities for the fishing industry to exploit marine resources. In contrast, small-scale and traditional fishers are perceived to be at a disadvantage in the long run. This study aims to examine the perceptions of fisheries stakeholders regarding the implementation of PIT, with research conducted in Fisheries Management Area (WPP) 714, especially in Southeast Sulawesi. A mixed-methods approach was applied, combining primary data from Focus Group Discussions (FGD), questionnaires, and in-depth interviews, alongside secondary data sourced from scientific articles, research reports, online media, and other references. The analysis using fuzzy cognitive mapping indicates that the PIT policy is negatively associated with fishermen's income, fish stock sustainability, conservation efforts, and community involvement. Furthermore, the study reveals stakeholder perspectives on seven key characteristics of measurable fishing policies, with the quota system emerging as the most prominent concern among fisheries practitioners and observers. In conclusion, the fuzzy cognitive mapping results highlight that PIT is largely perceived as having adverse impacts on small-scale fisheries.

Keywords: fuzzy cognitive mapping, measured fishing policy, stakeholder perceptions

INTRODUCTION

In the 1990s, Indonesia faced a serious crisis in fisheries management. The main problems were overfishing, illegal fishing practices, and marine environmental degradation. Heazle & Butcher (2007), noted that from the 1970s to the early 2000s, many fish populations in Indonesian waters experienced a drastic decline, such as the depletion of fish stocks in the Arafura Sea and the sharp decline in small pelagic catches using purse seines in the Java Sea. Suman et al., (2018), also revealed that the level of fish resource utilization across Indonesia's Fisheries Management Areas (WPP) was generally overfished, fully exploited, or moderately developed, with fully exploited and overfished status dominating at 44% and 38% respectively. The fish groups most heavily affected by overfishing were shrimp and other crustaceans.

The Indonesian government has attempted to implement various fisheries management approaches to restore national fishery resources. Muawanah et al., (2018), explained that the government is committed to implementing ecosystem-based fisheries management by adopting the FAO Code of Conduct for Responsible Fisheries and applying the Ecological Approach to Fisheries Management (EAFM). The government also initiated the establishment of Fisheries Management Councils in various WPPs and updated aquaculture potential estimates to improve fishery resource management. However, these policy changes still leave major questions about the success of fisheries resource management and the contribution of the fisheries sector to the national economy. Consequently, in 2021, the government introduced another breakthrough by combining the ecosystem-based approach with quota-based fisheries management (QBFM). This combined policy is known as *Measured Fishing* or *Penangkapan Ikan Terukur (PIT)* (Aprian et al., 2023). Fishing practices in Indonesia have generally relied on conventional input-based approaches through licensing without catch quotas, which has triggered a race to fish and created potential unfairness in non-tax state revenue (PNBP) collection since actual catches were not considered. As an alternative, the government introduced output-based measured fishing with specific catch quotas and post-production PNBP, as well as pre-post production options. This approach is considered fairer and allows more accurate state revenue projections based on allocated fishery resource.

The issuance of PIT-related policies has sparked resistance among communities and fisheries observers. PIT is seen as part of the blue economy program, which, according to Schutter et al., (2021) represents a metamorphosis of global capitalism. The NGO coalition for fisheries and marine affairs (KORAL) regards PIT as a form of privatization of fisheries resources that could potentially deprive coastal communities of their rights, particularly concerning the plan to contract out 11 Indonesian Fisheries Management Areas (WPPNRI). They argue that this plan lacks clear and objective justification since many WPPNRI are already fully exploited or overexploited, especially WPP-NRI 711, 713, and 718. Beyond governance issues at the national level, the implementation of PIT at the regional level has also faced criticism, particularly regarding how to align the policy with local needs in PIT zones. Critics argue that this policy may overlap with local marine and fisheries management authorities, thereby requiring special strategies or approaches for its application.

This study employs Conflict Theory as the grand theoretical lens, complemented by three middle-range theories to analyze stakeholder perceptions of the measured fishing policy in Indonesia. Conflict Theory, rooted in Karl Marx's thought, views society as an arena of competition over limited resources, where public policies often reflect the interests of dominant groups and influence the distribution of benefits and access among social groups. In the context of capture fisheries, quota policies and PNBP mechanisms based on actual catches can be seen as regulatory instruments with implications for power relations, economic access, and potential conflicts of interest between small-scale fishers, large-scale operators, and the government. The operational analysis is further strengthened by Stakeholder Theory (Freeman, 1984), which maps stakeholder perceptions based on levels of interest, power, and support; the Theory of Planned Behavior (Ajzen, 1991), which explains the influence of attitudes, subjective norms, and perceived behavioral control on intentions and compliance; and Social Exchange Theory (Homans, 1958; Blau, 1964), which views decisions to support or oppose a policy as outcomes of perceived cost-benefit evaluations. The combination of macro and operational frameworks provides a holistic foundation for understanding the structural, behavioral, and interest-exchange dynamics influencing the acceptance of quota-based policies in Indonesia's fisheries sector.

From the explanations above, it is evident that significant gaps remain for the Ministry of Marine Affairs and Fisheries to address before fully implementing the Measured Fishing policy so that it truly benefits

society. The purpose of this study is to map and analyze stakeholder perceptions in the fisheries sector, the legislature, academia, fishing communities, and other relevant stakeholders.

METHOD

Data collection was carried out over a three-month period in Fisheries Management Area (WPP) 714, particularly in Southeast Sulawesi Province. Primary data were obtained directly from respondents and informants through surveys, observations, and in-depth interviews. The research was complemented by Focus Group Discussions (FGDs) and expert verification to strengthen arguments derived from quantitative data. A total of 31 participants representing various stakeholders took part in the FGD, and additional expert opinions were gathered from mass media and online news portals. Meanwhile, secondary data were obtained from literature studies and regional monographs, such as company documents, government regulations, regional regulations, ministerial regulations, online sources, the Central Statistics Agency (BPS), academic journals, and research reports relevant to this study.

Data Collection

Measurement of Perception Dimensions and Fuzzy Cognitive Mapping

Fuzzy Cognitive Mapping. This research approach aims to facilitate the adaptation of the measured fisheries policy at the local level through a broader conceptual framework. Therefore, the analytical method employed was specifically tailored to generate outputs aligned with subsequent stages of planning and management within the adaptation process, following the pattern suggested by Gray et al. (2014). Data collection was conducted to support issue detection and formulation in fisheries management among key decision-makers (stakeholders) of coastal management and the wider community of coastal governance actors. This included stakeholder surveys and data collection using the Mental Modeler tool through Fuzzy Cognitive Mapping (FCM).

To better understand the structural and functional aspects of knowledge systems regarding the Measured Fishing policy, we developed Fuzzy Cognitive Maps of stakeholder groups involved in small-scale fisheries in Southeast Sulawesi, with respondents as presented in Table 1.

Table 1. Composition of fisheries stakeholder respondents and informants

No	Stakeholder Groups	Number	Description	Status
1	Legislative Members	3	Member of the Indonesian House of Representatives regarding measured fisheries policies.	Informant/ Respondent
2	Academia and Fisheries Experts	10	Lecturers and researchers in Southeast Sulawesi including some statements from lecturers and researchers outside the region	Informant/ Respondent
3	Group of Fishers	10	The Indonesian Fishermen's Association, including ship owners	Respondent
4	Ministry of Maritime Affairs and Fisheries	2	Directorate General of Capture Fisheries, Head of Kendari Ocean Fishing Port	Informant/ Respondent
5	Local Government	5	Fisheries Service of Kendari City, South Konawe, Konawe and Provincial Fisheries Service	Informant/ Respondent
6	NGO	1	Rare Indonesia	Respondent

Stakeholders are key actors whose support plays a strategic role in determining the success of adapting the Measured Fishing policy at the local level. Analyzing stakeholder perspectives particularly their views on fisheries management in the context of small-scale fisheries as well as identifying specific fisheries issues that require adaptive responses constitutes a crucial step in understanding the socio-ecological dynamics of fisheries governance. Such information is essential for identifying potential barriers that may hinder the adaptation process and for formulating effective facilitation strategies to support the implementation of the new policy at both local and regional scales.

Stakeholder Perception Dimensions. Data collection was carried out using in-depth interviews to analyze the perception dimensions of stakeholders. The data obtained were analyzed descriptively and quantitatively to provide an overview of the urgency level of each variable in the Measured Fishing

(PIT) policy. To identify these perceptions, the variables analyzed referred to Government Regulation No. 85 of 2021 and Government Regulation No. 11 of 2023. Seven variables were measured based on their level of importance or urgency, namely: (1) PIT zoning dimension, (2) quota system, (3) fisheries crew dimension, (4) landing ports, (5) transportation of catches, (6) administrative sanctions, and (7) non-tax state revenue (PNBP) levies. The interview data were processed and presented using Microsoft Excel 2021.

Data Processing

Fuzzy Cognitive Mapping (FCM) is a simplified mathematical model of a belief system and has been widely used to represent knowledge systems at both individual and group levels (Özesmi & Özesmi, 2004). Gray et al. (2012) demonstrated that FCM can serve as an effective tool to structure complex relationships between social and ecological concepts within highly intricate ecosystems. When applied to all stakeholder groups, FCM not only helps identify mechanisms where shared understanding exists but also highlights areas or mechanisms where additional resources should be directed to gain deeper insights into system operations. Zhang et al. (2013) further indicated that FCM analysis can provide valuable information for the development of fisheries management plans.

In this study, observational data were illustrated using the web-based software **MentalModeler**, including the construction of several policy scenarios reflecting diverse stakeholder perceptions. Once the mapping matrices and policy scenarios were developed, the verification process was carried out with stakeholders as a form of validation of the constructed model.

RESULTS AND DISCUSSION

Stakeholder Perception Dimensions

To obtain a comprehensive overview of stakeholder perspectives, a mapping of perception dimensions was carried out on the key variables of the Measured Fishing (PIT) policy. The results of this mapping are presented in Figure 1.

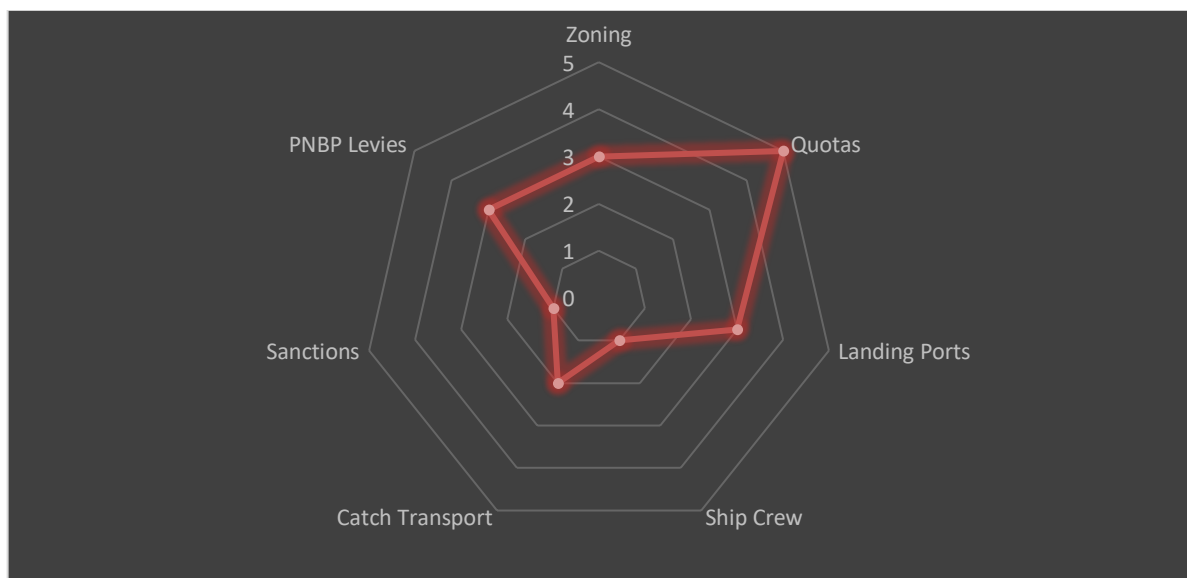


Figure1. The level of importance or urgency of the seven pillars of the Measured Fishing (PIT) policy, based on a scale of 1–5, where higher values indicate greater urgency or importance of the respective variables within the policy framework.

The mapping of stakeholder perception dimensions regarding the seven variables of the Measured Fishing (PIT) policy shows that the fisheries quota system is perceived as having the highest level of urgency, followed by the zoning system, non-tax state revenue (PNBP) levies, and landing ports. Meanwhile, administrative sanctions and crew-related aspects received the lowest urgency scores. These findings indicate that although the fisheries quota system is considered important, perceptions toward it

tend to be negative, as it is feared to bring less favorable outcomes for fisheries management in Indonesia.

The previous transformation of fisheries policy gained significant momentum during the leadership of Susi Pudjiastuti (2014–2019) through her “radical” policy to combat Illegal, Unreported, and Unregulated (IUU) fishing, which was claimed to have increased capture fisheries stocks from 6.5 million tons to 12.5 million tons per year (Aryo & Wiswayana, 2023; Elisafira & Usmaedi, 2023). In the subsequent period, Minister Wahyu Sakti Trenggono introduced PIT based on zones and quotas to maintain resource sustainability while boosting economic circulation in the fisheries sector. However, this policy has been widely criticized by legislators and regional governments regarding the potential marginalization of small-scale fishers, inequitable allocation of quotas and PNBP, weak monitoring, risks of quota trading, limited infrastructure and subsidized fuel, as well as the shift in regional revenue schemes from direct levies to shared PNBP revenues—perceived as reducing direct economic benefits for local governments (Brief Report of the DPR RI Hearing with the Ministry of Marine Affairs and Fisheries, 2022; Uluputty, 2023; Interview with Imam Botji, 2023).

Globally, quota systems have long been implemented as instruments for fish stock management. Anderson et al. (2019) emphasized that such systems can ensure stock sustainability in response to uncontrolled fishing activities, with restrictions applicable to individuals, communities, companies, or access rights in designated areas. The primary objective of quota-based fisheries is to enhance sustainability and economic performance, particularly when applied alongside Total Allowable Catch (TAC), which limits overall harvests and prevents overfishing. Australia is one of the pioneering countries, introducing quotas in the Southern Bluefin Tuna fishery as early as 1984, and this policy has been in place for more than 35 years (Pascoe et al., 2022).

However, international practices reveal that quota systems are not universally applicable. Pascoe et al. (2022) noted that although quotas have been applied across various Australian fisheries and elsewhere, undesirable economic and social impacts still emerge, particularly for small-scale fishers. An Australian Senate inquiry in December 2020 highlighted that individual fishers tended to express negative responses to quota policies across environmental, social, and economic aspects, while industry organizations responded more positively. A recurring issue is quota ownership by non-fisher actors or investors, which has been criticized for creating inequities. Santiago & Surís-Regueiro (2018) and Aprian et al. (2023) also confirmed that quota-based policies in various countries often generate adverse social and economic impacts, while placing excessive pressure on certain target species.

Several scholars have cautioned that quotas are not a one-size-fits-all solution. Sumaila (2010) asserted that this system can only function as one instrument within a comprehensive ecosystem-based management framework, which should integrate the three goals of modern fisheries management: ecological, economic, and social sustainability. A study by Liu et al. (2022) on capture fisheries in China demonstrated that although the country accounts for 15% of global fisheries production, the adoption of rights-based fisheries could generate bioeconomic losses if not supported by adequate management systems.

Potential conflict also emerges as a critical issue in implementing quota systems. Inequitable distribution of quotas, resource limitations, and competition between traditional fishers and large-scale industries can trigger rule violations and social tensions. Weak enforcement and regulatory ambiguities exacerbate the situation, particularly when small-scale fishers feel disadvantaged by policies perceived to benefit larger capital owners. This condition is consistent with the findings of Hapsari et al. (2020), who reported that fishing communities tend to respond firmly to any policy that threatens their livelihoods.

Fuzzy Cognitive Mapping

Fuzzy Cognitive Mapping (FCM) was developed through a series of *Focus Group Discussions* (FGDs) with key stakeholders in the fisheries sector. This process aimed to elicit, interpret, and visualize their perceptions regarding the implementation of the Measured Fishing Policy (*Penangkapan Ikan Terukur*, PIT). The resulting cognitive map is presented in Figure 2, which illustrates the interrelationships among policy variables as well as the perceived level of influence attributed by stakeholders.

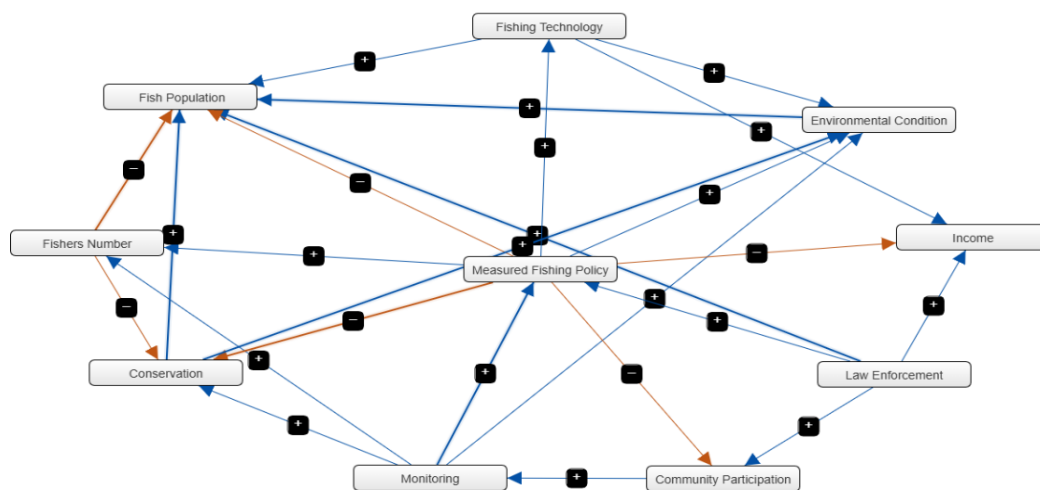


Figure 2. Fuzzy Cognitive Mapping (FCM) of fisheries stakeholders in Fisheries Management Area (FMA) 714, Southeast Sulawesi.

Based on the analysis of inter-variable relationships using the Fuzzy Cognitive Mapping (FCM) approach, the Measured Fishing Policy (PIT) was identified as having negative linkages with four main aspects: fisher income, fish population, conservation efforts, and community participation. Stakeholders perceived that the policy could potentially reduce small-scale fishers' income due to restricted fishing grounds and increased competition with industrial fishers operating within PIT zones. This perception was reinforced by interviews with fisher groups, who generally criticized the implementation of non-tax state revenue (PNBP) levies as stipulated in Government Regulation No. 85/2021, which imposes a pre-production fee of 5% for vessels ≥ 5 gross tonnage (GT). Such provisions are considered to increase the financial burden on traditional and small-scale fishers, thereby potentially reducing their competitiveness and the sustainability of their fishing enterprises.

Although Government Regulation No. 11/2023 comprehensively outlines the provisions regarding PIT, public perception still reflects concerns about its adverse impacts on traditional fishers. Johan Rosihan, a member of Commission IV of the Indonesian House of Representatives (DPR RI), urged the Ministry of Marine Affairs and Fisheries (MMAF) to provide detailed clarification on PNBP obligations, and proposed exemptions for small-scale fishers. This issue is further complicated by the ambiguity surrounding the definition of "small-scale fishers," which, according to Halim et al. (2019), has undergone frequent revisions. Currently, the definition includes vessels < 10 GT, whereas it was previously < 5 GT. This expanded definition could increase the risks of unregulated and unreported fishing, while simultaneously creating inequities by legitimizing support for industrial fishers with stronger financial capacities.

In addition, PIT is perceived as potentially accelerating the exploitation of fish resources if not accompanied by adequate mechanisms for controlling industrial fisheries investment. Increased investment may drive fleet expansion and the adoption of high-capacity fishing technologies within PIT zones. Yet, in principle, rights-based or quota-based fisheries management aims to address stock depletion, enhance efficiency and equity in resource utilization, and prevent overexploitation of key species (Halimatusaadia et al., 2023). While the MMAF asserts that PIT is designed to slow the rate of exploitation through quota systems, DPR RI through its oversight function may recommend policy reassessment, particularly concerning opportunities for foreign investment. From a budgetary perspective, DPR RI can also advocate for sufficient funding allocations for supporting infrastructure to ensure PIT implementation remains aligned with its intended objectives (Adhiem, 2023).

Management Scenarios

In this study, two fisheries management scenarios were developed based on cognitive mapping conducted with fisheries sector stakeholders. The analysis presented in Figure 3 indicates that the full implementation of the Measured Fishing Policy (*Penangkapan Ikan Terukur*, PIT) potentially has negative implications for fish populations, community participation, conservation efforts, and fishers' income. This perception stems from concerns that PIT implementation could open the door to liberalization of fishing activities, with industry and investment orientation becoming the primary benchmarks of national fisheries policy. The lack of community participation in the decision-making process is also perceived as a risk that may lead to centralization of fisheries management in the hands of the government, thereby diminishing the role and autonomy of coastal communities.

This phenomenon is consistent with the views of Liu et al. (2022), who argue that rights-based fisheries can, in principle, serve as an effective instrument to address the weaknesses of open-access fisheries systems. However, if not carefully designed and implemented, such policies may create imbalances in management that disproportionately benefit certain groups. From a sociological perspective, Habermas (1984) emphasizes the importance of communicative rationality in policymaking, where inclusive participation is essential to prevent domination by specific actors and to ensure the social legitimacy of public policies. Similarly, Ostrom (1990) underscores that community-based resource management requires recognition of the active role of local communities in formulating rules and governance mechanisms, so that policies are not only economically efficient but also socially equitable.

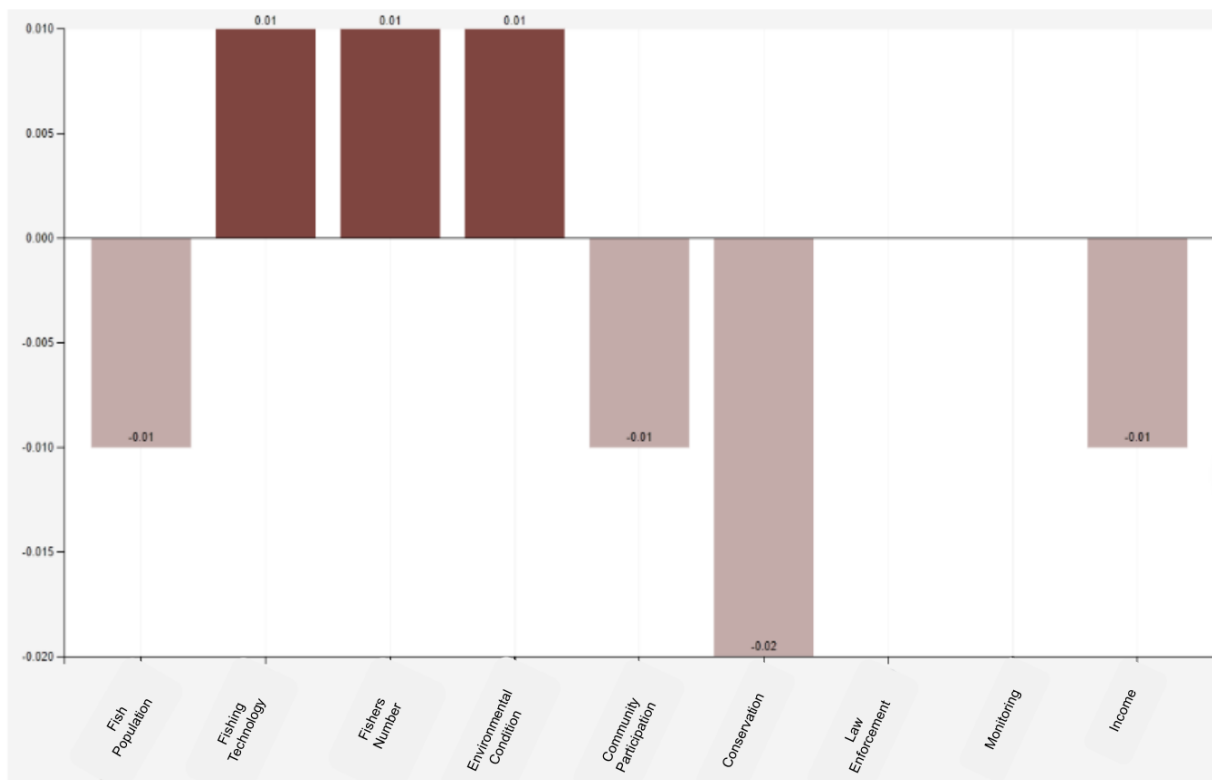


Figure 3. Scenario 1: Fuzzy Cognitive Mapping (FCM) of the implementation of the Measured Fishing Policy (PIT).

Based on the modeling results using Fuzzy Cognitive Mapping (FCM), as illustrated in Figure 3, the scenario of the Measured Fishing Policy (PIT) indicates four main indicators with negative relationships, namely fish population, community participation, conservation efforts, and fishers' income. These negative values reflect that these four aspects are the most vulnerable components likely to be adversely affected if PIT is implemented without adequate mitigation strategies. This finding is consistent with various studies emphasizing that top-down fishery policies may generate social resistance, reduce fishers' welfare, and weaken support for conservation efforts if not accompanied by strong participatory mechanisms.

Therefore, strengthening the PIT framework comprehensively requires the optimization of each policy pillar as formulated in the conceptual framework (Figure 1). This optimization includes enhancing the effectiveness of monitoring and law enforcement, developing quota systems based on the most recent scientific data, empowering fisher institutions, and integrating local wisdom into planning and implementation. Such an approach is expected to reduce the potential negative impacts identified through the FCM analysis, while ensuring that PIT achieves the objective of sustainable fish resource management without sacrificing the socio-economic dimensions of coastal communities.

Conceptually, PIT is an output-based control instrument, aiming to limit overfishing through licensing regulations, restrictions on vessel size, control of fishing days, and gear limitations. However, the effectiveness of these measures may face obstacles, as fishers may find ways to substitute regulated factors, thereby maintaining the condition of open-access fisheries (Asche et al., 2014). In addition, the accuracy of catch data in Indonesia remains a significant challenge, which has undermined the effectiveness and even led to the failure of various management initiatives.

In this context, monitoring plays a crucial role, not only through passive mechanisms such as vessel tagging systems, but also through the development of integrated surveillance systems at fishing ports. An integrated monitoring system is expected to strengthen data validity, improve compliance, and prevent illegal fishing practices (FAO, 2018).

To further illustrate the potential challenges in the implementation of PIT, an additional scenario was developed as presented in the following figure:

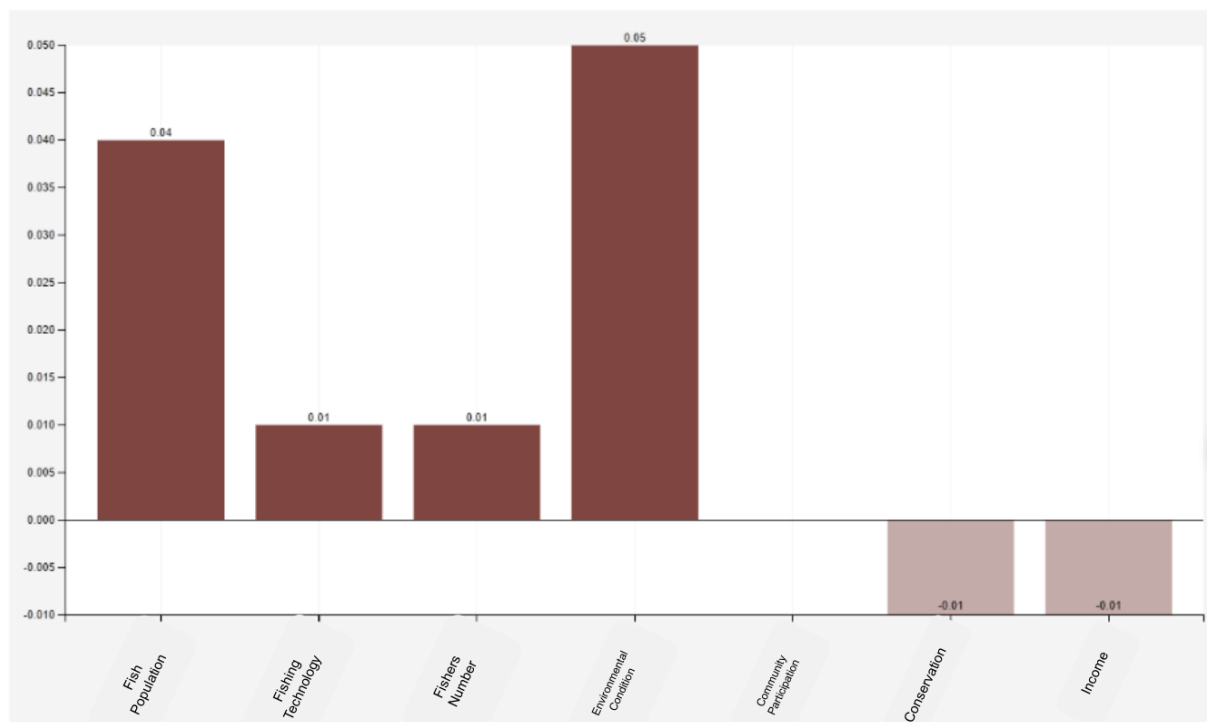


Figure 4. Scenario 2 of the Fuzzy Cognitive Mapping (FCM) of fisheries stakeholders.

Based on the analysis presented in Figure 4, the simulation of the second scenario which prioritizes strengthening law enforcement indicates positive impacts on two key variables: fish population recovery and environmental improvement. This finding highlights that law enforcement is a critical factor in ensuring the sustainability of fisheries resources. The implementation of this policy requires strict monitoring of compliance with the designated zones of the Measured Fishing Policy (PIT) by all licensed operators, centralized landing and data recording of catches at designated ports, and strict control of at-sea transshipment practices that often circumvent official monitoring mechanisms. Accordingly, consistent law enforcement, supported by integrated and data-driven monitoring, can minimize the risk of resource depletion, safeguard ecosystem sustainability, and enhance fisheries governance.

Several studies have shown that fisheries policy in Indonesia faces serious challenges in applying community-based and ecosystem-based approaches. Nurani et al. (2018) identified the government's failure to establish an effective monitoring and reporting system, while Rochwulaningsih et al. (2019) emphasized the low competitiveness of Indonesia's maritime economy due to limited technology, weak integration of the marine and fisheries sector, and difficulties in upgrading traditional products into high-value commodities. These conditions necessitate the strengthening of small-scale fisheries performance through participatory processes, cross-sectoral partnerships, and the application of scientific analysis within a co-management framework.

Fisheries stakeholders in the study area generally perceive the PIT policy as highly centralized, despite ongoing government outreach. Findings from focus group discussions (FGDs) and interviews revealed varying levels of public understanding of the policy, reflecting low participation in its formulation process. Yet, participatory decision-making is critical to complement scientific knowledge with local wisdom, thereby increasing legitimacy and implementation effectiveness. In Southeast Sulawesi—one of Indonesia's major tuna-producing regions the imposition of catch quotas, vessel size restrictions, and limits on fishing days under PIT is perceived as potentially restricting fishing space and reducing fisher incomes.

The study further demonstrates that the implementation of PIT in WPP NRI 714, a key spawning and nursery ground for tuna, has the potential to generate complex socio-economic dynamics. From the perspective of Conflict Theory, the policy risks triggering competition over access and tensions among traditional fishers, large-scale industries, and government authorities due to uneven distribution of benefits. From the lens of Stakeholder Theory, the success of PIT depends on the government's ability to manage diverse interests and ensure legitimacy through participatory approaches. Meanwhile, the Theory of Planned Behavior suggests that fishers' compliance with PIT is shaped by their attitudes toward the policy, subjective community norms, and perceived behavioral control related to access, facilities, and licensing. Thus, effective PIT implementation requires the integration of fair regulatory mechanisms, the management of actor relations, and communication and empowerment strategies that encourage behavioral change.

Karr et al. (2017) emphasized that successful fisheries management requires cross-institutional and cross-sectoral partnerships, as evidenced in Cuba and the El Corredor fishery in Baja Sur, California. Similarly, Zhou et al. (2015) demonstrated that co-management enhances fisher compliance and stock recovery, while Romero and Melo (2021) highlighted the importance of integrating local knowledge with scientific expertise to build policy legitimacy and reduce community-level conflicts. Embedding scientific data collection and analysis into fisheries policies, accompanied by incentive-based management mechanisms, is essential to promote compliance with science-based rules (Villasante et al., 2022). In this regard, science-based fisheries management not only ensures resource sustainability but also strengthens trust among fishery actors through transparent decision-making (Fujitani et al., 2017).

This case study underscores that the success of small-scale fisheries reform largely depends on aligning incentives with management objectives, strengthening traditional tenure systems, implementing co-management, and designing effective rights-based systems (Basurto et al., 2016). Well-structured rights-based systems have been shown to reduce overfishing, improve long-term catch yields, and deliver more equitable economic benefits to local communities (Crona et al., 2021). Such measures have the potential to significantly improve the performance of small-scale fisheries, mirroring the outcomes achieved in large-scale fisheries (Free et al., 2022).

CONCLUSION

The results of the Fuzzy Cognitive Mapping (FCM) analysis reveal that fisheries stakeholders perceive the implementation of the Measured Fishing Policy (PIT) as highly complex, particularly regarding the application of fishing quotas, and potentially generating negative correlations with fish population size, fishers' income, conservation efforts, and community participation. Such negative perceptions are largely driven by the proposed quota system and the associated fisheries non-tax state revenue (PNBP) levies, which are considered burdensome. Strengthening PIT policy therefore requires a comprehensive approach, including licensing restrictions, vessel size limitations, regulations of fishing days at sea, and restrictions on fishing gear types. Nevertheless, challenges remain due to fishers' adaptive behaviors, which may reduce regulatory effectiveness and perpetuate open-access fishery conditions, compounded by the inaccuracy of catch data that threatens management success. For this reason, strengthening monitoring becomes crucial, not only through passive measures such as vessel tagging systems but also

through the development of integrated port-based monitoring systems to ensure compliance and enhance the long-term effectiveness of PIT policy.

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