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Organizational Innovation and Human Capital Development Through Cooperative-Based Empowerment of Kamoro Fishermen in Mimika Regency

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Abstract

Purpose: This study aims to analyze the impact of the Maria Bintang Laut Cooperative (*Koperasi Maria Bintang Laut*/KMBL) on the economic empowerment, program participation, and income changes of Kamoro fishermen in Nawaripi Village before and after the cooperative's establishment.
Research Methodology: A mixed-method design was used involving 30 fishermen respondents and six key informants. Data were collected through questionnaires, interviews, observation, and documentation (Nov 2025–Jan 2026). Quantitative data were analyzed descriptively using cross-tabulation, while qualitative data were analyzed using Miles-Huberman thematic analysis, supported by triangulation.
Results: KMBL improved fishermen's welfare through subsidized fishing transport, guaranteed market contracts, and higher fish prices, increasing daily income from IDR 75,000–100,000 to IDR 100,000–300,000. Participation was high in operational activities but low in decision-making. However, challenges remain, including limited access to cooperative loans and negative market stigma related to perceived environmental contamination.
Conclusions: KMBL has improved fishermen's economic welfare through better access, market certainty, and higher prices, but it has not fully functioned as a comprehensive empowerment institution due to limited training, low substantive participation, restricted capital access, and dependence on external support.
Limitations: The study is limited to one village with 30 respondents, uses a cross-sectional design, relies on self-reported income data, and covers only a short observation period, which limits seasonal variation analysis.
Contributions: This study provides the first mixed-method analysis of KMBL's empowerment mechanism, identifying participation imbalance and market stigma issues, and offers policy recommendations for improving cooperative-based empowerment in Papua's extractive industry context.

Keywords: *Capital Access, Cooperative, Economic Empowerment, Participation, Tailing Stigma*

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1. Introduction

Indonesia's archipelagic geography endows the nation with enormous fisheries potential; however, traditional fishermen communities continue to occupy the most economically marginal positions in the national development structure. In Papua's coastal zones, the marginalization of indigenous fishing

communities is compounded by the simultaneous presence of one of the world's largest copper and gold mining operations, PT Freeport Indonesia (PTFI), whose activities directly affect the livelihoods, environmental conditions, and market access of Kamoro tribe communities along the Mimika coast (Kompas.id, 2022).

The Kamoro people of Nawaripi Village, Wania District, Mimika Regency, are a coastal fishing community whose livelihood is uniquely constrained by geography: their primary fishing grounds (Tanggul Barat/Yamaima) lie within PTFI's concession area, approximately 40 kilometers from the village—a journey of two hours each way that, without subsidized transportation, makes profitable fishing economically impossible. In response to this geographic and socioeconomic marginalization, the Timika Diocese established the Maria Bintang Laut Cooperative (KMBL) in 2006 through a triple-helix partnership: PTFI provides funding and market access, the Timika Diocese provides management and mentorship, and KMBL implements field operations. The cooperative now has 101 active members from eight coastal villages, including Nawaripi (Melmambessy & Achmady, 2020; Wahadi et al., 2025).

KMBL operates through five primary program channels: subsidized daily transportation to fishing grounds, subsidized fiber-hull boats for members, technical training in net production, outboard motor maintenance, and salted fish processing, collective marketing through a supply contract with PT Pangansari Utama, and cold storage (40-ton capacity) and fish processing facilities. Despite these investments, field observations reveal a fundamental paradox: while transportation access is rated near-universally excellent (96.7% of respondents), access to business capital is near-universally denied (90% cannot access cooperative loans). This access paradox—strong logistical performance alongside failed financial intermediation—constitutes the central analytical puzzle of this study. Similar conditions have also been highlighted in broader cooperative development literature where infrastructure support does not automatically translate into financial empowerment (Paulangan et al., 2025; Rahayu & Hidayah, 2023).

This study addresses three research questions: (1) What is the impact of KMBL's economic empowerment programs on Kamoro fishermen in Nawaripi Village? (2) How do fishermen participate in KMBL empowerment programs? (3) How have fishermen's incomes changed before and after the KMBL's establishment? The answers have both theoretical significance—for the literature on indigenous cooperative empowerment in extractive industry contexts and human capital development frameworks (Buiney et al., 2025; Sofwani et al., 2022)—and practical significance for KMBL governance reform, Mimika Regency fiscal policy, and PTFI CSR strategy.

2. Literature Review

2.1 Community Empowerment Theory

Mardikanto (2019) and Putra et al. (2025) defines community empowerment through cooperative institutions as a development strategy that positions cooperatives as the primary instrument for improving economic, social, and political capacity of members, operating through three domains: (1) enabling—creating a climate that allows community potential to develop; (2) empowering—strengthening potential through investment, knowledge, and technology; and (3) protecting—safeguarding vulnerable groups from further exploitation. The 'from members, by members, for members' principle ensures that economic benefits return to fishermen rather than flowing to external investors (International Cooperative Alliance, 2015). In the KMBL context, this theory is directly applicable because the cooperative functions as a bridge between the vulnerable indigenous community and the institutional market (PTFI/PT Pangansari Utama).

2.2 Social Capital Theory

Putnam (2018) identifies trust, reciprocal norms, and social networks as components of social capital that increase collective efficiency by facilitating the coordination. For Kamoro fishermen, the values of

gotong royong (mutual cooperation) and community solidarity represent strategic social capital assets that can be optimized through cooperative institutions. However, Cohen and Uphoff (1980) warned that meaningful participation must encompass all four stages—planning, implementation, benefit-taking, and evaluation—not merely the operational implementation stage. Where participation is confined to instrumental economic engagement (using transportation, submitting catch), the cooperative risks developing what Arnstein (1969) and Desmintari and Aryani (2021) terms 'tokenism': members are involved in operational activities without the genuine power to influence institutional policy.

2.3 Welfare and the Capability Approach

Armansyah (2025) and Sitohang and Yusuf (2025) frames welfare not as income per se but as the substantive freedom to achieve valued functionings—including economic security, health, education access, and social participation. Aisyah et al. (2025) and Almakki et al. (2025) operationalized this through multidimensional development encompassing human capacity improvement, inclusive growth, and the reduction of absolute poverty. For Nawaripi fishermen, welfare encompasses (1) daily income stability, (2) safe access to fishing grounds, (3) availability of productive inputs, (4) family healthcare and educational access, and (5) autonomous enterprise management capacity. Income improvement alone—without improvement in access to capital, training, and decision-making participation—represents partial welfare development that risks reproducing dependency rather than building capabilities (Hos & Tunda, 2024; Polii et al., 2023).

2.4 Market Failure and Tailing Stigma

Akerlof (1970) market for lemons model predicts that when buyers cannot verify product quality individually, they apply mass price discounts or exit the market entirely. This dynamic is directly applicable to the Timika fish market, where consumers cannot distinguish between contaminated and uncontaminated fish and apply blanket avoidance to all fish caught locally. Paulangan et al. (2022) and Sofwani et al. (2022) confirmed that heavy metal accumulation exists in fish from Mimika's tailing-affected waters. This creates a market trust crisis that simultaneously compresses fishermen's selling prices in open markets and constrains KMBL's willingness to purchase fish caught in coastal waters near the tailing footprint, driving the cooperative to purchase from non-member migrant fishermen from more distant, 'cleaner' waters (Maluku Sea, Fakfak, Kaimana), constituting a Firdaus et al. (2020) and Sutiyo et al. (2024) economic leakage from the target community.

2.5 Prior Research Synthesis

Fifteen reviewed studies support and contextualize the findings of this research. Sutiyo et al. (2024) found that fishermen's cooperatives along Java's coast significantly stabilize fish selling prices through collective marketing but remain structurally weak in providing business capital—a pattern replicated in KMBL. Sarjito (2024) confirm that indigenous value-based empowerment in Papua increases participation, but that market access remains the primary constraint. Arifandy et al. (2020) establish that cooperative-based programs embedded in indigenous institutions are more sustainable than those directly managed by extractive corporations—validating the PTFI-Diocese-KMBL partnership model while highlighting its dependency risk as PTFI's contract expiration approaches (2041). Indrawarsih and Ratri (2023), in a study of Kamoro economic potential in Mimika, confirmed that the integration of cultural values increases cooperative member participation, but modern management strengthening remains essential, directly anticipating the key conclusions of this study.

3. Methodology

3.1 Research Design

This study employed a mixed-method sequential explanatory design (Creswell, 2014) that integrated quantitative and qualitative data into a single cohesive research architecture. The quantitative component measured the prevalence and magnitude of empowerment impact across 30 respondents. The qualitative component explains the mechanisms, barriers, and contextual interpretations that quantitative data alone cannot reveal. Three types of research questions necessitate this integration: 'How large?' (quantitative), 'How and why?' (qualitative), and 'Under what conditions?' (combined). Miles and Huberman (1994) affirm that mixed-method designs are most appropriate for program evaluation in communities with complex social dynamics.

3.2 Research Location and Context

The research was conducted in Nawaripi Village, Wania District, Mimika Regency, Central Papua Province (coordinates: 4°30'–4°45'S; 136°45'–137°00'E) from November 2025 to January 2026. Nawaripi Village was selected based on five strategic criteria: (1) it hosts the largest concentration of KMBL members (101 active members) among the eight coastal villages in KMBL's coverage; (2) it has 85% Kamoro ethnic homogeneity, ensuring cultural consistency in the analysis; (3) KMBL has been present since 2006, providing more than two decades of community experience; (4) the 40-kilometer geographic barrier to fishing grounds creates a measurable, observable transportation access gap; and (5) it provides adequate researcher access without prohibitive administrative barriers. The village encompasses approximately 150 hectares (lowland topography, Arafura Sea coast), with 450 inhabitants in 107 households—71.1% in the productive age bracket (15–64 years)—of whom 80% (101 households) depend on fishing.

3.3 Population and Sampling

The research population comprised all 101 active KMBL members in Nawaripi Village who (1) were registered with valid membership status, (2) were permanent Nawaripi residents, (3) held fishing as their primary occupation, and (4) actively utilized KMBL transportation and marketing services. From this population, 30 respondents were selected through purposive sampling based on the following criteria: minimum five years of Nawaripi residency (enabling pre-post comparison), active membership status, minimum four fishing trips per week (indicating high program engagement), and voluntary participation consent. The 30-respondent sample represented 29.7% of the total population—an adequate proportion for descriptive analysis in a small, bounded community (Sugiyono, 2019). Snowball sampling supplemented the initial sample to identify respondents with atypical experiences (e.g., fishermen who failed to access capital or experienced market rejection due to the tailing stigma). Six key informants were selected for in-depth interviews: the cooperative's management team (Chairman, Secretary, and Treasurer—interviewed as one unit representing the institutional perspective); one Timika Diocese field staff member; one village community leader (traditional Kamoro leader); and one official from the Mimika Cooperative and SME Office.

3.4 Data Collection

Primary data were collected using four methods. Structured questionnaires (30 respondents; average 15–20 minutes per respondent; conducted in informal, relaxed settings to minimize formal bias) measured 11 empowerment impact indicators, four participation indicators, and pre- and post-project income categories. Semi-structured in-depth interviews (six informants; 30–60 minutes; recorded with consent and transcribed verbatim) explored the mechanisms, challenges, and institutional perspectives. Non-participant observation was conducted each morning (05:00–08:00 WIT) when fishermen prepared and departed, and each afternoon (15:00–18:00 WIT) when they returned with their catches, capturing daily

routines, catch submission behaviors, and cooperative infrastructure operations. The documentation included KMBL's Annual Report and Work Program (2020–2025), Mimika Regency statistics, PTFI's CSR reports, government regulations, and environmental assessment reports. Secondary data were obtained from the BPS Mimika, Dinas Perikanan Mimika, Dinas Koperasi Mimika, KMBL institutional documents, and the Timika Diocese.

3.5 Data Anlysis

Quantitative analysis followed four sequential stages: data cleaning and coding, descriptive statistics (frequency distributions, percentages), comparative analysis (pre-post income cross-tabulation), and results interpretation. Qualitative analysis followed Miles and Huberman (1994) three-stage model: open coding (identifying organic themes from transcripts), focused coding (grouping related themes into categories), and axial coding (establishing causal mechanism chains, e.g., cooperative intervention → mechanism → outcome → moderating condition → final impact). Triangulation was conducted across three dimensions: source triangulation (30 respondents vs. 6 informants), method triangulation (questionnaire vs. interview vs. observation data), and temporal triangulation (consistency of patterns across the three months of observation). Ethical standards were maintained through informed consent, data confidentiality (coded identifiers replacing personal information), and beneficence principles, ensuring that the research benefits outweighed any potential harm.

4. Results and Discussion

4.1 Respondent Profile

Table 1. Demographic Profile of Respondents (N = 30 KMBL Members, Nawaripi Village)

Variable	Category	N	%	Note
Gender	Male / Female	19/11	63.3/36.7	Male dominant
Age (dominant)	41–50 years	12	40.0	Mature workforce
Education (dominant)	Elementary School (SD)	14	46.7	No college graduates
Fishing tenure (dominant)	11–15 years	11	36.7	63.4% > 10 yrs
Residence tenure (dominant)	11–15 years	12	40.0	93.3% > 5 yrs
Ethnicity	Kamoro (indigenous Papuan)	~26	~85	Culturally homogeneous

Source: Primary Data, 2026

Based on Table 1, the 63.3% male dominance reflects the gender division of labor in Kamoro culture: men (moane) perform offshore fishing, and women (emawe) manage processed products and local sales. Juniarsih and Ramdani (2025) and Yuniarti et al. (2022) describes this as a deeply embedded cultural-ecological knowledge system, not merely a statistical artifact. The 46.7% with only elementary education and zero with tertiary education confirm a structural human capital deficit directly limiting both technical skill adoption and financial literacy—issues identified by Khairuddin et al. (2025) and Malihah et al. (2024) as the primary barriers to cooperative capital utilization. The 63.4% with over ten years of fishing tenure validates respondents' ability to provide reliable pre-KMBL retrospective income comparisons.

4.2 Empowerment Impact Results

Table 2. Empowerment Impact: Respondent Assessment of KMBL Program Dimensions (N = 30)

No.	Indicator	Agree (%)	Disagree (%)	Category
1	Accessibility to fishing grounds (Tanggul Barat)	96.7	3.3	Excellent
2	Family welfare improvement	96.7	3.3	Excellent
3	Market certainty and elimination of fish selling risk	90.0	10.0	Strong
4	Competitive and transparent fish buying prices	90.0	10.0	Strong
5	Fishing and processing infrastructure quality	86.7	13.3	Strong
6	Reduction of dependency on exploitative middlemen (tengkulak)	86.7	13.3	Strong
7	Daily income improvement	86.7	13.3	Strong
8	Creation of new business opportunities outside primary fishing	83.3	16.7	Moderate
9	Skills enhancement (general)	66.7	33.3	Moderate
10	Business management capacity improvement	63.3	36.7	Moderate
11	Technical training adequacy and effectiveness	53.3	46.7	Critical
12	Business capital access (simplest function of a cooperative)	10.0	90.0	Failure

Source: Primary Data, 2026

Based on Table 2, the results reveal a striking hierarchical pattern: physical access and market dimensions achieve near-universal approval (90–96.7%), while human capital dimensions decline progressively (skills: 66.7%; management capacity: 63.3%; training effectiveness: 53.3%), and financial intermediation fails catastrophically (capital access: 10%). This pattern confirms Lestari et al. (2021) enabling-empowering-protecting framework: KMBL has achieved 'enabling' (access creation) with high effectiveness, is achieving 'protecting' (market security) adequately, but is failing to achieve 'empowering' (capacity building and financial inclusion) (Ifanda & Sisdianto, 2024). The 90% capital access failure was the most significant finding. It documents that KMBL has essentially abandoned its raison d'être as a financial intermediary—the foundational economic function that distinguishes cooperatives from mere logistics contractors.

Qualitatively, two structural factors explain the low performance in the training and capital dimensions. First, KMBL's training curricula were designed without adequate adaptation for the 83.4% of members with below-SMA education—using formal instruction formats rather than the Berkes (2018) Traditional Ecological Knowledge-informed, practice-based, vernacular-language approaches proven more effective for indigenous communities (Mustari et al., 2023; Ningtyas et al., 2022). Second, the cooperative's lending function has effectively collapsed due to insufficient cooperative capital reserves, the absence of a microcredit partnership with BRI or other financial institutions, and the cooperative's prioritization of operational sustainability over member financial services.

4.3 Participation Results

Table 3. Fishermen's Participation in KMBL Programs (N = 30)

Participation Indicator	Highest Response	%	None (%)	Type
Use of cooperative transportation	Always use (28)	93.3	0.0	Instrumental
Submission of full catch to cooperative	Always submit (27)	90.0	0.0	Instrumental
Training participation	Active (18)	60.0	16.7	Moderate
Active decision-making participation	Active (8)	26.7	33.3	Substantive

Type: Instrumental = operational service utilization; substantive = governance and policy participation.
Source: Primary Data, 2026

Based on Table 3, the data reveal a participatory paradox: universal operational-instrumental participation (0% non-users for both transportation and catch submission) alongside critically deficient substantive democratic participation (only 26.7% are active in decision-making; 33.3% never attend cooperative meetings). Arnstein (1969) classifies this pattern as tokenism: members are involved in cooperative activities without possessing the genuine power to influence cooperative policy. Cohen and Uphoff (1980) and Maf'ulla and Rachmawati (2024) specify that meaningful participation requires involvement across all four program stages: planning, implementation, benefit-taking, and evaluation. KMBL currently engages members effectively only at the implementation and benefit-taking stages of the program.

The 0% non-use of transportation reflects complete penetration—a genuinely remarkable institutional achievement confirming that the transportation service has become inseparably integrated into the daily work rhythm of all fishermen. The equally compelling 0% non-submission of catch to KMBL reflects the daily trust-based economic decision to accept KMBL's price over open-market alternatives—a decision that, in Putnam (2018) social capital framework, demonstrates high institutional trust. The contrast between this operational trust and the 33.3% who have never attended a cooperative meeting documents a fundamental governance gap: members trust the cooperative economically but feel excluded from or uninterested in its political-institutional dimension—a condition that Friedmann (1992) and Mukmin and Fallz (2024) identifies as an absence of political power (participation in decision-making) despite the presence of social power (access to economic resources).

4.4 Income Comparison: Before and After KMBL

Table 4. Fishermen's Daily Net Income: Pre-KMBL and Post-KMBL (N = 30)

Income Category	Pre-KMBL (N)	%	Post-KMBL (N)	%	Change
< IDR 75,000	16	53.3	0	0.0	–53.3pp
IDR 75,000–100,000	10	33.3	3	10.0	–23.3pp
IDR 100,001–150,000	3	10.0	0	0.0	Reference
IDR 100,000–300,000	4	13.3	18	60.0	+46.7pp
IDR 200,000–300,000	0	0.0	9	30.0	+30.0pp
> IDR 300,000	1	3.3	0	0.0	–3.3pp

Note: Post-KMBL income brackets drawn from the questionnaire; overlap in ranges reflects the original instrument design.
Source: Primary Data Processed (Retrospective Recall Method), 2026.

Based on Table 4, the distributional shift was dramatic. The lowest income group (< IDR 75,000), which previously dominated at 53.3%, has been completely eliminated in the post-KMBL distribution,

while the IDR 100,000–300,000 group expanded from 13.3% to 90% of all respondents. Cumulatively, 86.6% of respondents previously earned below IDR 100,000 per day; post-KMBL, only 10% remained in that category. This shift was driven primarily by cost elimination (transportation subsidy removing a daily fixed cost of IDR 100,000–150,000 per round trip), not by increased production volume, a finding consistent with Fauzi (2010), who demonstrated that in small-scale fisheries, market access and distribution cost reduction frequently generate larger income effects than technology investment (Kospa, 2020).

However, these improvements must be read alongside three critical caveats. First, income improvements undercount losses from fish that cannot be sold due to tailing stigma—fish caught by Kamoro fishermen that are rejected by Timika market consumers, spoiled, and discarded. Second, the improvements depend entirely on PTFI's continued support and Timika Diocese management—a dependency relationship that will become structurally precarious as PTFI's contract approaches its expiration (2041). Third, income stability remains vulnerable to seasonal weather variations without micro-insurance or savings mechanisms that would provide buffers during low-catch periods.

4.5 Two Critical Structural Findings

4.5.1 The Tailing Stigma Market Crisis

The most complex structural finding is the tailing contamination stigma that suppresses market demand for Kamoro fishermen's catches. Aguslan et al. (2024) scientifically confirmed heavy metal accumulation in fish from Mimika's tailing-affected waters, and AEER (2024) documented tailing sediment dispersal reaching coastal and river mouth ecosystems. While individual fish catches may not be uniformly contaminated, Akerlof (1970) 'market for lemons' mechanism operates: because consumers cannot verify individual catch safety, they apply blanket rejection to all locally caught fish at Timika's Pasar Lama and Pasar Sentral. This creates dual income suppression: direct market rejection drives prices below survival margins and causes catch spoilage. KMBL's institutional response—preferring to purchase fish from non-member migrant fishermen from the Maluku Sea, Fakfak, and Kaimana—constitutes economic leakage from the target community (Hirschman, 1958). Fish caught by Kamoro fishermen in near-shore Timika waters are purchased by KMBL at discounted rates or not at all, with premium supply contracts with PT Pangansari Utama serviced predominantly by migrant fishermen with superior technology. This is a form of inadvertent distributional failure: the cooperative's market success benefits the already-advantaged (migrant fishermen with larger vessels) more than the intended beneficiaries (Kamoro small-boat fishermen) (Todaro & Smith, 2020; Wahadi et al., 2025).

4.5.2 Capital Access Failure: The 90% Paradox

The 90% capital access failure is the single finding that is most at variance with the cooperative's institutional mandate. Cooperatives are defined in Indonesian law (Law No. 25/1992) Pemerintah Republik Indonesia (1992) as economic institutions that provide credit and other financial services to members; financial intermediation is not optional but definitional. The finding that 90% of Nawaripi KMBL members cannot access cooperative loans—despite two decades of operation—documents a fundamental institutional dysfunction. Three mechanisms explain this phenomenon. First, KMBL's capital reserves are insufficient to operate a meaningful lending portfolio due to inadequate member savings contributions (partly driven by members' low incomes and high daily consumption demands). Second, no formal partnership with Bank Himbara (BRI, BNI, Mandiri, BTN) or other microcredit institutions has been established to leverage KMBL's operational credibility into expanded credit capacity. Third, cooperative management has prioritized operational service delivery (transportation and marketing) over financial service development—a rational short-term choice given the immediate member value of transportation subsidies–but one that has perpetuated members' inability to invest in larger boats, better engines, and more productive fishing equipment. Without access to capital, Kamoro fishermen remain

locked in technological inferiority relative to migrant fishermen, unable to increase production volume to meet KMBL's supply quotas, perpetuating the cycle in which the cooperative must purchase from outside the community.

4.5.3 Key Informant Perspectives

The three key informants converged on recognizing KMBL's success in improving fishermen's income and reducing middlemen dependency, while diverging on the assessment of participation quality and institutional sustainability issues. The Mimika Cooperative and SME Office official characterized participation as 'high and directly motivated by tangible benefits, a view consistent with the operational participation data (93.3% transportation use) but inconsistent with the governance data (33.3% never attending meetings). This divergence reveals that institutional stakeholders perceive operational engagement as equivalent to substantive participation, a definitional conflation that masks the governance deficit. The cooperative management (Chairman, Secretary, Treasurer) acknowledged the capital access failure and identified it as the cooperative's primary development priority, noting that the absence of a simpan-pinjam (savings and loan) unit, functional since 2020, represents an institutional gap requiring urgent resolution. The Kamoro community leader provided the most culturally nuanced perspective, observing that cooperative meetings conflict with customary social obligations and that the formal governance format is culturally alienating for community members who prefer informal, relationship-based deliberation over structured, parliamentary procedures. This finding requires KMBL to redesign its governance processes to be culturally appropriate and not merely formally compliant.

5. Conclusions

This mixed-method study finds that KMBL significantly improves fishermen's welfare through strong access and market security, but remains weak in financial intermediation and capacity building, indicating achievement of the "enabling" stage but not yet the "empowering" stage in the empowerment framework. Fishermen's participation shows a paradox between near-universal operational use of services and low substantive involvement in governance, reflecting both economic dependence on cooperative services and cultural barriers to formal decision-making processes. Income levels increased substantially from IDR 75,000–100,000 to IDR 100,000–300,000, mainly due to cost reduction rather than productivity gains, while long-term sustainability is constrained by capital access failure, tailing stigma in fish markets, and dependency on external institutional support.

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Author Contributions

EG contributed to conceptualization, data collection, data analysis, manuscript drafting, and final approval. HH was responsible for research design, theoretical framework, methodology, manuscript revision, and final approval. JAM handled supervision, methodology, manuscript revision, and final approval.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this study. This research was conducted independently, and no financial or personal relationships influenced the results

or interpretation of the findings.

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