International Journal of Economics, Business and Innovation Research
https://e-journal.citakonsultindo.or.id/index.php/IJEBIR
E-ISSN : 2964-0865
IJEBIR

Integrated SWOT Analysis for Strategic Management of Small-Scale Capture Fisheries in Pemalang Regency, Indonesia

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Abstract

In Indonesia, small-scale fisheries comprise 85% of the national fleet yet remain structurally under-governed, with persistent catch declines across Pemalang Regency widening the gap between resource pressure and management capacity. Existing strategic analyses treat bio-ecological, socio-economic, and institutional dimensions as discrete rather than coupled governance challenges, producing fragmented diagnostics that cannot guide integrated policy. This study extends SWOT-based fisheries analysis by embedding factor identification within three coupled subsystems across five fish landing centers in Pemalang Regency, Central Java, where a multi-gear artisanal system operates under high effort concentration and documented yield decline. Twenty-two expert respondents across primary, key, and secondary stakeholder groups provided data analyzed using IFAS, EFAS, the Internal-External matrix, and the SWOT matrix. Results yielded IFAS of 4.45 and EFAS of 3.85, placing the system in the Grow-and-Build quadrant with Strength-Opportunity strategies analytically dominant. Local-knowledge integration, ecosystem-based development, and institutional strengthening constitute the primary leverage points, though structural weaknesses in capital access and catch quality require concurrent remediation for growth strategies to remain viable. The study advances a structurally disciplined SWOT application that surfaces dimensional trade-offs concealed by conventional undifferentiated factor analyses, providing a replicable diagnostic for artisanal fisheries governance in data-limited coastal settings.

Keywords: Artisanal Fisheries; SWOT Analysis; Strategic Management; Coastal Governance.

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INTRODUCTION

Small-scale or artisanal fisheries constitute the backbone of capture fisheries in many developing economies, providing livelihoods, food security, and poverty alleviation for coastal communities (Apine et al., 2019; Isaacs & Witbooi, 2019). In Indonesia, approximately 85% of the national fleet falls within this category, operating primarily within four nautical miles of the coast with simple gear and minimal regulatory oversight (Vatria et al., 2019). Unlike industrial vessels, small-scale fishers are not required to report catches under prevailing regulation (PERDIRJEN PSDKP No. 12/2017), creating structural data gaps that compound the governance challenge: managers cannot respond to pressures they cannot measure. The result is a sector that contributes decisively to national food supply and employment yet is systematically under governed and poorly understood at the operational level.

Pemalang Regency, located on the north coast of Central Java, exemplifies this governance deficit at the regency scale. Vessels below 5 GT represent approximately 64% of the local fleet, and the regency recorded one of the highest fisheries production volumes in Central Java 18,386,353 kg in 2021, yet production trended downward continuously between 2016 and 2020 (Dinas Perikanan Kabupaten Pemalang, 2021). This trajectory is not a momentary fluctuation but a structural signal: high output on a declining base, driven by five fish landing centers with heterogeneous gear portfolios gillnet, trammel net, arad, and payang concentrating effort within a narrow nearshore zone. Gear types share overlapping grounds, generating competitive pressure on both stocks and livelihoods. The absence of a coherent, integrated management strategy leaves this system exposed to a convergence of ecological degradation, economic vulnerability, and institutional fragmentation that no single dimension intervention can adequately address.

Existing literature on small-scale fisheries management has followed three trajectories, each analytically productive within its own domain but insufficient when applied in isolation. Bio-ecological studies use catch per-unit effort and surplus production models to assess stock status (Makwinja et al., 2021; Maunder et al., 2020); socio-economic studies examine livelihood vulnerability and income structures (Stanford et al., 2017); institutional studies address co-management and governance arrangements (Cucuzza et al., 2021; Bryhn et al., 2021). The critical limitation is not that these trajectories exist in parallel, but that strategies derived from any single dimension systematically misspecify the interventions required when constraints operate across subsystems simultaneously. A governance reform that disregards economic vulnerability

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will fail to secure compliance from fishers who cannot afford its costs. An economic support program that bypasses ecological limits will generate catches that deplete the very stocks it was intended to protect. Integrated diagnostics are therefore a structural necessity for interventions in coupled systems not an analytical preference.

A second, under-acknowledged gap concerns spatial and gear specificity. Most SWOT-based fisheries studies examine single landing sites or single gear categories, producing recommendations calibrated to aggregated rather than differentiated conditions. In multi-gear systems where gear types differ substantially in ecological impact, spatial footprint, and financial return structure, aggregate strategic advice systematically misidentifies points of leverage and may produce perverse outcomes restricting a low-impact gear to relieve pressure generated predominantly by a high impact one operating under the same aggregated recommendation. This is not merely an analytical imprecision; it constitutes a source of policy error capable of accelerating the resource decline the strategy was designed to reverse.

This study addresses both gaps by conducting an integrated SWOT analysis of small-scale capture fisheries across five fish landing centers in Pemalang Regency, organizing strategic factors within bio-ecological, socio-economic, and institutional subsystems. Three objectives guide the research: to identify internal strategic factors embedded across these subsystems; to identify external strategic factors shaping the system's operating environment; and to formulate management strategies through IFAS, EFAS, IE matrix, and SWOT matrix analysis. In doing so, this study advances the treatment of SWOT as an integrative analytical instrument capable of capturing coupled system dynamics rather than functioning as a factor-listing procedure (Hasan et al., 2025). It extends prior fisheries strategy research by introducing multi-subsystem structural anchoring into SWOT methodology and provides new insight into the trade-offs between growth-oriented and risk-mitigating strategy sets in artisanal coastal systems operating under documented resource pressure.

LITERATURE REVIEW

Small-scale fisheries governance has evolved from single-species stock management toward systemic frameworks that acknowledge the coupled ecological and social dimensions of coastal resource use. The ecosystem approach to fisheries management emerged in response to evidence that productivity cannot be sustained without maintaining habitat integrity and species interactions (Cucuzza et al., 2021; Bryhn et al., 2021). This shift has been particularly consequential for artisanal contexts, where

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multi-gear, multi-species operations generate externalities that single-species models cannot adequately represent. The resulting scholarly emphasis on integration is analytically compelling, yet it has not consistently translated into methodologically integrated empirical studies a gap this research explicitly addresses.

Within this broader framework, SWOT analysis has been adopted across fisheries and coastal management studies as a means of synthesizing diagnostic information into actionable strategy. Tarigan et al. (2019) applied SWOT to octopus fisheries management in Banggai Laut; Morgan (2017) used SWOT derived factors to examine diversification constraints and Hozairi et al. (2020) combined SWOT with complementary multi-criteria methods for marine security planning. Across these applications, a consistent methodological deficit emerges: SWOT is treated primarily as a factor-listing device, with the strategic matrix functioning more as a summary than as an analytical engine. Without subsystem anchoring, factors from different governance domains ecological, economic, institutional enter the matrix at the same logical level, preventing the analysis from identifying how constraints in one domain propagate failures in another.

A parallel body of work addresses the socio-economic dimensions of artisanal fisheries. Purcell et al. (2017) documented how value-chain configurations determine the distribution of returns to fishers; Stanford et al. (2017) developed resilience indicators for fisher communities. These studies establish that economic vulnerability in artisanal systems is structural rather than episodic, rooted in capital constraints, price volatility, and intermediary dependence. Critically, however, socio-economic analyses rarely proceed to institutional design implications, terminating at descriptive diagnosis before the governance connection is drawn.

Institutional studies occupy a third strand. Work on co-management (Gullestad et al., 2017), stakeholder analysis (Triyanti & Susilowati, 2019), and integrated coastal management (Subagiyo et al., 2018) underscores the importance of multi-level coordination and participatory governance. Yet institutional analyses tend to treat ecological and economic factors as contextual background rather than co-determinants of governance effectiveness, producing recommendations that are structurally isolated from the system conditions that determine whether they can be implemented. This strand-by-strand fragmentation is precisely the analytical problem that a subsystem-anchored SWOT framework can resolve.

This fragmentation matters because artisanal fisheries operate as tightly coupled systems in which constraint in one subsystem amplifies vulnerability in others. Institutional fragmentation reduces the capacity to enforce ecological limits; ecological degradation

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reduces the income stability that makes institutional compliance affordable; income instability restricts investment in gear quality that would otherwise reduce ecological impact. A strategic framework that first disaggregates factors by subsystem and then reintegrates them through a structured matrix provides the analytical architecture needed to surface these couplings and design interventions that address them simultaneously.

RESEARCH METHOD

Research Approach

This study adopts a mixed-methods descriptive-strategic approach, combining primary field data with secondary documentary sources to diagnose the strategic position of small-scale capture fisheries in Pemalang Regency and to formulate management options. The approach is descriptive in its data-generation stage capturing conditions across ecological, economic, and institutional domains and strategic in its analytical stage, moving from factor identification through matrix analysis to strategy formulation within a single coherent framework.

Study Site and Data Sources

Fieldwork was conducted at five fish landing centers (Tempat Pelelangan Ikan, TPI) in Pemalang Regency: TPI Tanjungsari, TPI Asemdoyong, TPI Nyamplungsari, TPI Mojo, and TPI Ketapang. These sites collectively represent the spatial and gear heterogeneity of the local artisanal system and were selected to ensure that findings reflect the multi-TPI, multi-gear reality rather than conditions at any single node. Primary data were obtained through in-depth interviews, structured questionnaires, and field observation. Secondary data were drawn from Dinas Kelautan dan Perikanan Kabupaten Pemalang, KUD Mina Misoyo Makmur, PSDKP station records, and HNSI branch documentation.

Sampling and Respondents

Respondents were selected through purposive sampling, stratified into three stakeholder categories following Padillah (2019): primary, key, and secondary stakeholders. This approach is appropriate for SWOT-based strategic analysis because the validity of IFAS and EFAS scoring depends on the depth of domain knowledge among respondents rather than on population representativeness; expert judgment from stakeholders with direct system involvement produces ratings that reflect actual operating conditions rather than generalized perceptions. Twenty-two respondents were recruited:

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the primary group (n = 12) comprised eight fishers operating gillnet, trammel net, arad, and payang, plus four members of KUD Mina Misoyo Makmur; the key group (n = 6) comprised representatives from the provincial and regency fisheries offices, PSDKP, UPI, HNSI, and BUMDes; the secondary group (n = 4) comprised two academics and two staff from the Tegal Fisheries Training Center.

Instruments and Variables

Factor identification was organized around three subsystems. The bio-ecological subsystem included catch composition, production trends, and gear productivity. The socio-economic subsystem covered fisher demography, gear technology, income level, and capital investment. The institutional subsystem addressed local government policy and the functioning of fisheries-management institutions. Draft factor lists were derived from the literature and refined through respondent validation to ensure contextual specificity.

Analytical Framework

Strategic analysis proceeded in three stages. First, factors were scored on weight (0 to 1, summing to 1 within each dimension) and rating (1 to 5) through expert judgment, producing the IFAS and EFAS. Second, totals were plotted on the Internal-External matrix to determine strategic position. Third, strategy formulation was conducted through the SWOT matrix, generating SO, WO, ST, and WT strategy sets (Rangkuti, 2014). SWOT is analytically appropriate for this study because the system lacks the time-series depth required for quantitative stock assessment models, and the governance question how to align internal capacities with external conditions is a fundamentally strategic rather than a purely predictive problem. The matrix structure provides the minimum formalization necessary to translate multi stakeholder diagnostic inputs into governance relevant strategic options.

RESULT

Bio-Ecological and Operational Context

Pemalang's coastal waters are part of the Java Sea, with shallow, nutrient-rich conditions supporting pelagic and demersal stocks. Artisanal activity concentrates at five TPIs; fishers from TPI Asemdoyong and TPI Nyamplungsari repeatedly exploit overlapping grounds, sustaining competitive pressure on nearshore stocks. Seasonal variability governs effort intensity: activity contracts during the west monsoon owing to

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sea conditions and expands during the east monsoon. Four dominant gear types gillnet, trammel net, arad, and payang differ materially in ecological selectivity, spatial footprint, and operating cost structure. Gillnet operates selectively at lower cost; trammel net targets shrimp and demersal species at moderate cost; arad represents an active trawl-type gear associated with high bycatch rates; payang operates collectively for small pelagics. This gear heterogeneity means that aggregate management recommendations risk misspecifying the priority interventions for each sub-fleet.

Internal Factors

Internal factor identification yielded six strengths and six weaknesses distributed across the three subsystems (Table 1). Strengths center on tacit knowledge and operational capability: understanding of seasonal dynamics, fishing ground familiarity, gear proficiency, vessel handling, social cohesion, and existing group institutions. Weaknesses reflect structural rather than individual deficits: low educational attainment, competitive disadvantage against migrant fishers, capital limitations, restricted financing access, inadequate occupational safety, and insufficient catch quality assurance.

Table 1. Internal Factor Analysis Summary (IFAS)

Factor	Description	Weight	Rating	Score
S1	Understanding of fishing seasons through local knowledge	0.200	4	0.80
S2	Gear operational skill	0.250	5	1.25
S3	Knowledge of fishing grounds	0.100	4	0.40
S4	Vessel handling capability	0.050	4	0.20
S5	Social cohesion among fishers	0.050	4	0.20
S6	Existence of fisher group institutions	0.100	4	0.40
	Strengths subtotal	0.750		3.25
W1	Low educational attainment	0.030	5	0.15

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W2	Weak competitiveness against andon fishers	0.050	4	0.20
W3	Capital limitations	0.040	5	0.20
W4	Restricted financing access	0.040	5	0.20
W5	Inadequate occupational safety	0.040	5	0.20
W6	Insufficient catch quality assurance	0.050	5	0.25
	Weaknesses subtotal	0.250		1.20
	IFAS total	1.000		4.45

External Factors

External factor identification yielded six opportunities and six threats (Table 2). Opportunities include programmatic support for credit access, occupational insurance, capacity building, institutional strengthening, product diversification, and conservation initiatives (KKPRL, rumah ikan). Threats span climate volatility, localized overfishing, coastal ecosystem degradation, inactive village governance, underperforming financial institutions, and mangrove conversion.

Table 2. External Factor Analysis Summary (EFAS)

Factor	Description	Weight	Rating	Score
O1	Government program for credit access	0.120	4	0.48
O2	Occupational insurance programs (SKN, BPJS)	0.150	4	0.60
O3	Human resource capacity-building programs	0.130	4	0.52
O4	Institutional strengthening programs	0.080	3	0.24
O5	Diversity of fisheries resources	0.150	4	0.60

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O6	Conservation programs (KKPRL, rumah ikan)	0.150	4	0.60
	Opportunities subtotal			3.04
T1	Extreme weather and climate variability	0.030	4	0.12
T2	Localized overfishing	0.040	4	0.16
T3	Coastal ecosystem degradation	0.050	4	0.20
T4	Weak village-level governance	0.040	3	0.12
T5	Underperforming financial institutions	0.030	3	0.09
T6	Mangrove conversion	0.030	4	0.12
	Threats subtotal			0.81
	EFAS total	1.000		3.85

IFAS, EFAS, and Strategic Position

The IFAS total reached 4.45, with strengths contributing 3.25 and weaknesses 1.20. Gear operational skill constituted the strongest individual factor (score 1.25), followed by local knowledge of fishing seasons (0.80). Weaknesses carried lower aggregate weights but high ratings, signaling that their severity where they occur is substantial: insufficient catch quality assurance registered the highest weakness score (0.25). The EFAS total reached 3.85, with opportunities contributing 3.04 and threats 0.81. Three opportunities tied at 0.60: occupational insurance programs, resource diversity, and conservation initiatives. Threats were led by coastal ecosystem degradation (0.20) and localized overfishing (0.16). Plotting IFAS against EFAS on the Internal-External matrix places the system in Cell-1 the Grow-and-Build quadrant indicating that internal capacity and external opportunity jointly favour expansion-oriented strategy rather than defensive stabilization.

Strategy Formulation via the SWOT Matrix

Four strategy clusters were produced by cross-tabulating internal and external factors (Table 3). SO strategies emphasize integration of local ecological knowledge with

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government programs, institutional strengthening as entry points for external programs, ecosystem-based fisheries development, product diversification, digitalization of fishing information, and tri-sector partnerships. WO strategies target group-based financing, field-relevant capacity building, catch quality standardization, social protection integration, business-management mentoring, and cooperative strengthening. ST strategies include climate adaptation, community-based management, habitat rehabilitation, fleet optimization, early-warning systems, and effort control through self-regulation. WT strategies cover economic safety nets, financial-access reform, resource-management education, local governance strengthening, off-season income buffers, and collective marketing.

Table 3. SWOT Strategy Matrix

	Strengths (S)	**Weaknesses (W)**
Opportunities (O)	SO Strategies: 1. Integrate local knowledge with government programs for sustainable productivity 2. Strengthen fisher institutions as entry points for external programs 3. Develop ecosystem-based fisheries 4. Diversify catch outputs based on local potential 5. Digitalize fishing information for fisher groups 6. Establish fisher government private sector partnerships for value-chain development	WO Strategies: 1. Accelerate group-based financing access 2. Build field-relevant human resource capacity 3. Standardize catch quality 4. Integrate fishers into social protection schemes 5. Provide business management mentoring 6. Strengthen cooperatives as production and market aggregators
Threats (T)	ST Strategies: 1. Adapt fishing patterns to climate variability 2. Strengthen community-based management	WT Strategies: 1. Strengthen economic safety nets 2. Reform access to financial institutions

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	3. Rehabilitate habitat through fisher participation 4. Optimize fleet and gear technology 5. Develop early-warning systems for extreme weather 6. Control fishing pressure through group self-regulation	3. Provide basic resource-management education 4. Strengthen local governance 5. Establish off-season income buffers 6. Reduce middleman dependence through collective marketing

DISCUSSION

Interpreting the Grow-and-Build Position

The IE matrix position warrants interpretive caution rather than straightforward endorsement of expansion. The IFAS 4.45 and EFAS 3.85 combination formally licenses growth-oriented strategy, but the underlying factor profile reveals a structural asymmetry that constrains this license in ways the aggregate scores do not capture. Strengths are concentrated in tacit knowledge and operational skill resources that are individually held, non-transferable across fisher households, and depreciable through generational transition while weaknesses cluster in capital access, catch quality assurance, and occupational safety, all of which represent system-level deficits rather than individual shortfalls. This distinction carries direct strategic implications. Tacit capabilities cannot be leveraged for sustained productivity growth when capital constraints prevent investment in quality infrastructure, when quality deficits suppress market values that would otherwise justify that investment, and when occupational safety gaps reduce labor reliability during peak fishing seasons. These three weaknesses do not merely coexist with strengths; they form an interdependent constraint bundle whose components reinforce each other. A fisher who cannot borrow cannot upgrade cold storage; without cold storage, catch value is discounted; discounted returns reduce the repayment capacity that would enable borrowing. Breaking this loop is not a complementary activity alongside SO strategies it is a precondition for them. The declining production trend documented in Pemalang between 2016 and 2020 is consistent with precisely this dynamic: a system with genuine operational capabilities that cannot convert them into sustained productivity because structural bottlenecks constrain the value-capture chain.

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Why Strength-Opportunity Strategies Align with System Structure

SO strategies achieve analytical dominance not merely because strengths and opportunities share high scores a tautological observation—but because they activate a reinforcing feedback loop between the system's two highest-value resources: fishers' tacit ecological knowledge and the programmatic infrastructure that government initiatives provide. The mechanism operates in two directions. First, local knowledge reduces the information costs of program design. Programs calibrated to fisher-identified seasonal patterns and fishing ground dynamics are less likely to generate compliance-resistant regulations, narrowing the principal-agent gap that characterizes top-down fisheries governance and that routinely undermines implementation in coastal contexts (Gullestad et al., 2017). Second, programmatic support converts knowledge assets into investable capabilities: training programs, credit schemes, and conservation infrastructure expand the strategic options accessible to fishers whose tacit expertise would otherwise remain locked within low-productivity gear configurations and market structures. Ecosystem-based fisheries development illustrates the mechanism with particular clarity. The strength in fishing-ground knowledge (S3, score 0.40) creates the informational foundation for community-based habitat monitoring—fishers can identify degradation before it registers in catch data. Conservation program availability (O6, score 0.60) provides the regulatory authority and funding architecture needed to institutionalize that monitoring and translate it into enforceable management measures. Neither resource is sufficient alone, but their combination produces an intervention that is simultaneously ecologically grounded and institutionally supported a quality that single-dimension strategies structurally cannot achieve.

The Causal Logic of Supporting Strategy Sets

WO, ST, and WT strategies address structural gaps that SO strategies cannot by design close, and their sequencing reflects causal dependencies rather than implementer preference. WO strategies must logically precede the full activation of SO strategies because capital and quality constraints create absorptive capacity bottlenecks that limit how much opportunity fishers can capture. A fisher without access to working capital cannot benefit from a digitalized market information system, because the technology requires trip financing to be actionable. A landing center without basic cold-chain infrastructure cannot capitalize on product diversification opportunities because perishable stocks cannot reach differentiated markets intact. Resolving the capital-quality bottleneck before scaling growth programs is therefore an efficiency condition for SO

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implementation, not a parallel social-welfare objective. ST strategies are equally non-subordinate in ecological terms. Effort control through self-regulation (ST6) and habitat rehabilitation through fisher participation (ST3) are not supplementary conservation additions; they are preconditions for the sustained resource abundance that makes SO strategies productive over the medium run. A Grow-and-Build strategy applied to a declining stock base accelerates the resource depletion it was intended to reverse. Integrating ST into the implementation pathway ensures that the system is not consuming its productive preconditions while growing. WT strategies, finally, preserve the labor supply and household stability that make all other strategies implementable. The economic safety net is not a policy residual for when other strategies fail; it is the institutional foundation on which fishers' capacity to participate in governance, comply with regulations, and invest in quality improvements ultimately depends.

Theoretical Contribution and Practical Implications

This study advances the treatment of SWOT as a structurally disciplined analytical instrument by demonstrating that factor quality and strategic precision improve substantially when factors are anchored to explicitly specified, governance-relevant subsystems rather than compiled from undifferentiated stakeholder elicitation. The advancement is substantive rather than cosmetic. In conventional SWOT applications to fisheries (Tarigan et al., 2019; Hozairi et al., 2020), the absence of subsystem structure renders inter-dimensional trade-offs invisible at the matrix entry stage, so the resulting strategy statements cannot address, for example, the tension between institutional strengthening and ecological restoration or the dependency between capital access and quality assurance. The three-subsystem scaffold applied here makes these trade-offs explicit within the analytical structure, producing strategy statements that are differentiated by governance domain and that can guide domain-specific implementation sequencing. The study extends prior fisheries strategy research by providing a formalized template for multi-subsystem integration that is replicable without specialized modeling infrastructure a practical constraint in the data-limited environments where most small-scale fisheries management decisions are actually made. For policy practitioners at the regency level, the framework provides new insight into why growth-oriented strategies require concurrent remediation investments to remain viable, translating an abstract strategic position into a sequenced implementation logic with direct operational implications.

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Limitations and Boundary Conditions

Several limitations condition the interpretive scope of these findings. Expert-judgment scoring reflects stakeholder perception at a single point in time; the weight and rating assignments may over-represent factors that are salient in current discourse without adequately capturing slow-moving structural trends such as long-run stock depletion or climate-driven range shifts. Future work should triangulate the SWOT diagnostic with longer-run catch and effort time series to test whether the Grow-and-Build position is stable across production cycles or reflects a cyclically favorable observation window. The framework is also strongest as a diagnostic and strategy-generation tool; it does not prioritize among the twenty-four strategies produced, which limits its direct usability for implementation planning under resource constraints. Subsequent research applying multi-criteria decision methods such as the Analytic Hierarchy Process—to rank strategies by stakeholder-weighted importance would extend the present diagnostic into a prioritization tool suited to operational planning, representing a natural and high-value continuation of this line of inquiry.

CONCLUSION

This study conducted an integrated SWOT analysis of small-scale capture fisheries across five fish landing centers in Pemalang Regency, embedding strategic factors within bio-ecological, socio-economic, and institutional subsystems. Three principal findings emerged. First, the system's internal capacity centered on tacit ecological knowledge, operational skill, and nascent group institutions is substantial but coexists with an interdependent constraint bundle of capital limitations, catch quality deficits, and occupational safety gaps that restricts its conversion into market performance. Second, external conditions are predominantly enabling, with policy programs, conservation initiatives, and resource diversity constituting the dominant opportunity set; threats from coastal degradation and climate variability are present but not systemically dominant. Third, the strategic position IFAS 4.45, EFAS 3.85 places the system in the Grow-and-Build quadrant, licensing a Strength-Opportunity dominant strategy orientation anchored in local-knowledge integration, ecosystem-based development, and institutional strengthening, provided that concurrent Weakness-Opportunity investments resolve the absorptive capacity constraints that determine whether growth opportunities can be captured.

The study advances a structurally disciplined SWOT application in which three subsystem integration surfaces inter-dimensional trade-offs that conventional

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undifferentiated analyses conceal, providing both a replicable analytical template and a sequenced implementation logic for artisanal fisheries governance in data-limited coastal settings. The framework is transferable to comparable multi-gear, multi-landing-site artisanal contexts along Java's north coast and across Southeast Asia where similar structural conditions obtain. Future research should apply priority-ranking methods to the generated strategy set and extend the temporal scope of factor assessment through longitudinal catch-effort analysis.

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