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Assessing Economic Resilience of Wetland Villages as a Foundation for Rural Investment: An Index-Based Study in Bengkalis Regency, Indonesia

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ABSTRACT

Purpose – This study analyzes the economic resilience of wetland villages as a basis for promoting rural investment in Siak Kecil Subdistrict, Bengkalis Regency, Indonesia. The study focuses on the importance of aligning rural investment strategies with local strengths and wetland ecosystem characteristics to support sustainable development.

Design/methodology/approach – Economic resilience is measured using indicators such as production diversity, access to basic economic infrastructure, presence of local financial institutions, and regional accessibility. A scoring method (0–5) is applied, and the results are compiled into an Economic Resilience Index (ERI) ranging from 0 to 1.

Findings/Results – Applying a 12-indicator ERI framework across 17 wetland villages, the findings reveal that production diversity is high and nearly uniform across villages, so that differences in overall resilience are driven mainly by credit access, market/retail infrastructure, and regional accessibility. Using a mean ± 0.5 SD classification rule, four villages (Lubuk Muda, ERI = 1.00; Sungai Nibung, 0.9167; Sungai Siput, 0.90; Sungai Linau, 0.8833) fall into the High resilience category, seven fall into the Medium category, and six villages (including Lubuk Garam, the lowest at 0.65) fall into the Low category, with credit facility access and public transportation identified as the main constraints separating lower- from higher-tier villages.

Originality/Value – This study contributes a transparent, rule-based 12-indicator Economic Resilience Index (ERI) for Southeast Asian wetland village contexts, where village-level investment readiness remains undermeasured relative to social- or ecological-resilience approaches; full replicability and objectivity of the index depend on continued validation and reporting of the underlying scoring rules and raw indicator data. By combining IDM secondary data (2024) with field-verified primary data across all 17 villages of a wetland sub-district and applying a transparent, rule-based classification of resilience tiers, the study offers a planning foundation rather than a direct measurement of investment outcomes; improving infrastructure, strengthening local institutions, and expanding financing access are identified as the priority levers for inclusive and sustainable rural development in Riau's coastal wetland areas.

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1. Introduction

Weak economic resilience is seen in locations with limited access to basic supplies, especially in rural wetland areas. Household socioeconomic level has an impact on village economic resilience, although infrastructure quality and availability are also important factors (Xu, 2025; Usman et al., 2023). In this regard, investment is a crucial factor that can boost economic expansion and produce cross-sectoral knock-on effects that increase village resilience (Zhou & Gu, 2025). As an adaptive response, communities frequently take charge of managing public services in villages when they decline or are threatened. However, such locally driven substitution can also be seen as indirect support for neoliberal policy frameworks that encourage self-reliance and shift responsibility, whether deliberate or not (Lundgren & Nilsson, 2023). Since rural regions are typically more susceptible to internal pressures and external shocks than metropolitan areas, the resilience of rural settlements is a key factor in determining the long-term viability of villages (İzgi, 2022).

Siak Kecil Subdistrict's wetland settlements are a part of the Gerbang Laksamana strategic corridor, which is Bengkalis Regency's growing economic growth pole. Through (i) religious tourism industries, (ii) export-import port facilities positioned as a regional logistics hub, and (iii) community-based agriculture, plantation, and livestock initiatives aimed at empowerment and improved household welfare, development in this corridor leverages local potential. The combined goal of these initiatives is to turn Gerbang Laksamana into a driving force behind sustainable and equitable rural economic growth in the coastal area of Riau. From the standpoint of regional development, villages with great economic resilience are crucial to the success of critical locations like the Gerbang Laksamana corridor (Lu & Qian, 2023; Yang et al., 2022). The key to ensuring sustainable growth and reducing the likelihood of instability brought on by internal or external shocks is village economic resilience. Strong economic resilience enables villages in the coastal region of Riau to quickly embrace opportunities and adjust to challenges, so promoting equitable progress.

The ability to diversify production is a defining characteristic of village economic resilience. Siak Kecil Subdistrict's wetland villages, which are a part of the Gerbang Laksamana corridor, have a lot of potential for the growth of religious tourism as well as for agriculture, plantations, and cattle. In order to lessen reliance on a single commodity and the risks of price swings or crop failure, diversification is crucial. Creating integrated farming systems that incorporate cattle, oil palm plantations, and food crops, for instance, can be a useful tactic to raise household income. Another important component of enhancing village economic resilience is dependable market access. As one of Bengkalis Regency's new growth centers, the Gerbang Laksamana area features integrated export-import port facilities to facilitate the delivery of regional goods to larger markets. For agricultural and processed goods from villages to compete in regional and national markets, marketing networks must be strengthened with adequate transportation and logistics infrastructure.

The availability of financial services also has a significant role in bolstering local economies. Access to banks and cooperatives enables communities to access business finance for the development of local potential. When micro, small, and medium-sized businesses (MSMEs) receive enough funding, they can expand, provide jobs, and enhance the welfare of their households. The fundamental infrastructure supporting local economic activity is another important consideration. The efficiency of manufacturing and distribution will be improved by the availability of enough roads, energy, internet networks, and clean water facilities. The development of villages into more contemporary and competitive economic centers will also

be accelerated by adequate infrastructure. In strategic locations like Gerbang Laksamana, villages can become catalysts for equitable and sustained regional economic growth by fulfilling three requirements: varied production, dependable market access, accessible financial services, and sufficient infrastructure (Cai et al., 2023). In addition to enhancing the well-being of rural people, this achievement will solidify Bengkalis Regency's standing as one of the coastal region of Riau's economic hubs.

However, field observations reveal a significant gap between macro-level policy objectives and micro-level realities in villages, particularly those situated in wetland ecosystems (Hidayat et al., 2022). These villages continue to experience multiple constraints, including limited access to public transportation, poor road quality, inadequate trade and financial facilities, and weak interregional economic integration (Agrawal et al., 2022). In contrast, theories of village economic resilience underscore the critical role of economic infrastructure and access to basic services as essential prerequisites for the success of area-based development initiatives (Yadav & Verma, 2024; Zhang et al., 2018; Gangwar et al., 2022).

This gap highlights a disconnect between the regional development vision and the readiness of wetland villages that form part of Gerbang Laksamana. Therefore, an empirical study is needed to systematically assess village economic resilience using objective indicators such as production diversity, availability of shops and markets, financial services, and regional infrastructure. This study is expected to fill the data and analysis gap and provide strategic input for the formulation of more adaptive, locally grounded development policies for wetland villages. Accordingly, this study pursues three specific objectives: (1) to measure the economic resilience of 17 wetland villages in Siak Kecil Subdistrict using a 12-indicator Economic Resilience Index (ERI); (2) to identify spatial variations in production diversity, infrastructure access, financial inclusion, and regional accessibility across villages; and (3) to generate evidence-based recommendations for targeted investment and development policy in the Gerbang Laksamana strategic corridor.

2. Literature Review and Hypothesis Development

2.1 Conceptual Framework of Rural Economic Resilience

Rural economic resilience the capacity to withstand, recover from, and adapt to shocks is a multidimensional construct shaped by institutional capacity, livelihood diversity, and access to infrastructure (Martin & Sunley, 2015; Yang et al., 2022). Yang et al. (2022), in the International Journal of Environmental Research and Public Health (Scopus Q1), showed that resilience is unevenly distributed across rural space, while Cheng et al. (2022) confirmed that villages with diversified incomes and better infrastructure score higher on livelihood resilience indices directly resonating with the scoring-based Economic Resilience Index (ERI) applied in this study. In the Indonesian context, Hidayat et al. (2022) in Sustainability demonstrated that cultural embeddedness and community governance significantly modulate resilience in floodplain wetland areas, underscoring the ecological dimension of resilience in Bengkalis Regency.

2.2 Production Diversity as a Driver of Economic Resilience

Production diversity reduces rural vulnerability to income shocks and is widely recognised as a prerequisite for investment readiness. Related evidence from the food-security literature reinforces this logic from a different angle: Nguyen and Qaim (2025) in Nature Food found that household- and regional-level production diversity is positively associated with dietary

diversity, and Liu et al. (2023) in PLOS ONE documented a comparable link between agricultural production diversity and children's nutritional status in poor rural households; while these two studies measure dietary and nutritional outcomes rather than economic stability directly, they indicate that diversified production systems generate household-level benefits beyond income alone. At the village level, Sun et al. (2023) in Ecological Indicators incorporated production diversity as a core dimension of their rural resilience indicator system for coastal villages, and Cai et al. (2023) in Sustainability found that investment-readiness was stronger in areas with existing production variety. For wetland villages specifically, Angge et al. (2023) showed that BUMDes development in Indonesia effectively leveraged multi-commodity platforms to reduce economic vulnerability. In a related rural Indian context, Saha and Bhadana (2022) similarly documented how diversified agricultural work experience shapes household socio-economic conditions, reinforcing the broader link between production-related diversification and rural livelihood resilience. Together, this evidence supports the hypothesis that higher production diversity scores correspond to stronger ERI values.

2.3 Access to Basic Economic Infrastructure and Market Connectivity

Basic economic infrastructure markets, retail outlets, food stalls, and logistics is a foundational pillar of rural economic resilience. Kishor et al. (2025) found that limited market access forces farmers to sell below market price due to poor logistics, while Agrawal et al. (2022) noted that even resource-rich villages remain economically marginal without adequate trade facilities. In Indonesia, Hariyanto et al. (2024) confirmed that villages with diversified economic service clusters demonstrated superior development outcomes. Transportation infrastructure amplifies these effects: Aleschenko et al. (2022) in Transportation Research Procedia documented that transport accessibility reduces transaction costs and enables goods movement a finding especially critical for wetland villages in Siak Kecil, where flooding, swampy terrain, and river barriers structurally constrain market integration.

2.4 Financial Inclusion and the Role of Local Economic Institutions

Financial exclusion undermines rural resilience by limiting productive investment and enterprise diversification (Fan et al., 2025; Effendi et al., 2024). In Indonesia, BUMDes have become the principal instrument of rural financial inclusion: Putri Wardani and Setiawan (2023) found that active BUMDes significantly increased community economic empowerment through savings-and-loan services, while Olivia (2023) documented a positive BUMDes impact on village development indices. Rakib and Syam (2024) further linked strong local institutions to resilience strategies grounded in social capital, echoing Alhadi et al. (2023), who argued that locally embedded coping mechanisms are more durable than externally imposed financial interventions. These findings directly inform the hypothesis that villages with active credit facilities and local economic institutions will exhibit higher ERI scores.

2.5 Regional Accessibility and Transportation as Determinants of Investment Readiness

Regional accessibility encompassing public transport, road quality, and territorial connectivity is a structural precondition for rural investment. Keblawi et al. (2025) found that the absence of fixed-route public transportation severely limits rural participation in regional economies, while Chirisa (2024) documented how poor road infrastructure creates systemic barriers in ecologically exposed areas. Sun et al. (2023) confirmed that villages with paved roads

consistently outperform those with dirt surfaces across development indicators, and Taryono et al. (2023) demonstrated that road accessibility is a prerequisite for community engagement in value-added activities. Lu and Qian (2023) further showed that improved connectivity supported community-driven revitalization and social resilience in a rural Chinese village, illustrating a related mechanism through which accessibility can strengthen a village's broader development trajectory, even though that study did not directly examine investor location decisions. This body of evidence supports the broader expectation that accessibility indicators are positively associated with ERI scores.

2.6 Sustainable Rural Investment and Area-Based Development in Wetland Contexts

Sustainable rural investment must be calibrated to local ecological and institutional conditions. Ma (2025) found that projects accounting for existing production capacities and infrastructure yield higher socioeconomic returns than top-down approaches, while Hailuddin et al. (2024) confirmed that villages with diversified potential and adequate infrastructure attract more lasting investments. For wetland contexts, Hidayat et al. (2022) argued that development strategies must balance economic opportunity with ecological preservation a position consistent with Cai et al. (2023) and Nguyen and Qaim (2025), who collectively frame resilient, diversified economies as both preconditions for and outcomes of sustainable investment. Internationally, Zhou and Gu (2025) and Hua et al. (2024) create durable growth conditions in marginalised villages validating the theoretical framework applied in the Gerbang Laksamana corridor.

2.7 Research Gap and Hypotheses

Three gaps motivate this study. First, most resilience studies focus on social or ecological dimensions, with few proposing objective, infrastructure-based economic resilience indices applicable to Southeast Asian wetland contexts (Sun et al., 2023). Second, the nexus between wetland ecology and economic resilience in Indonesia remains understudied; Hidayat et al. (2022) is among the few references examining this directly. Third, while BUMDes have been extensively studied, their systematic contribution to composite ERI measurement at the sub-district level has not been mapped. This study addresses these gaps through a 12-indicator ERI framework integrating production diversity, economic infrastructure, financial institution access, and regional accessibility across 17 wetland villages. Because production diversity, infrastructure access, financial access, and regional accessibility are themselves the component dimensions from which the ERI is calculated, examining their association with the composite index does not constitute an independent test of these relationships -- by construction, a higher score on any component mechanically raises the composite ERI. Accordingly, this study does not treat these as hypotheses to be confirmed or falsified, but reframes them as descriptive research questions that decompose the index and identify which components account for the observed differences between villages. They are examined qualitatively against the observed ERI and indicator scores in Section 4, and a genuine test of these relationships -- for example, against an external outcome such as investment inflows, enterprise growth, or income stability that is not itself part of the ERI -- is identified as a priority for future research (see Section 6).

RQ1: How do production diversity scores vary across villages, and to what extent are they associated with differences in overall ERI values?

RQ2: How does access to basic economic infrastructure (markets, retail outlets, and logistics services) vary across villages, and how does this variation relate to differences in ERI values?

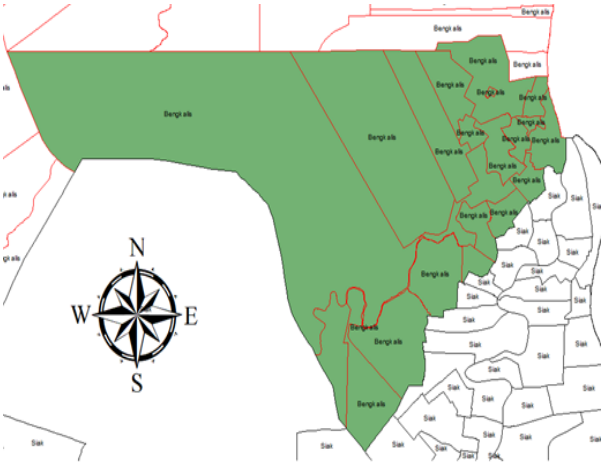
RQ3: How does access to financial institutions and active local organisations (BUMDes, cooperatives) vary across villages, and which of these components -- banking presence or credit access specifically -- tracks the variation in ERI values?
RQ4: How does regional accessibility (public transport, connectivity, and road quality) vary across villages, and how does this variation relate to differences in ERI values?

3. Methodology

3.1 Study Area

This study was conducted in the wetland area of Siak Kecil Subdistrict, Bengkalis Regency, which consists of 17 villages, as shown in Figure 1. This area was selected due to its distinctive geographical and ecological characteristics as a wetland region, as well as the variation it presents in terms of economic infrastructure development, transportation, financial access, and production diversity across villages. These conditions make the area highly relevant for study in the context of local potential-based village development, which is crucial for promoting investment activities in rural wetland areas.

Figure 1. Map of Wetland Villages in Siak Kecil Subdistrict, Bengkalis Regency



3.2 Data Collection

This study utilizes both primary and secondary data to obtain a comprehensive overview of village economic resilience and investment potential in wetland areas. This approach was chosen to integrate empirical field findings with administratively available data sources. Primary data were collected through direct observation at the research sites and in-depth interviews with key informants who possess adequate knowledge of the villages' socio-economic conditions, such as village heads, local officials, business actors, and community leaders (Alkadafi et al., 2025). Observations were conducted to directly assess infrastructure conditions, economic activities, and community interaction with available public facilities and services. Meanwhile, interviews were used to gather qualitative insights not captured in formal statistical data, including barriers, opportunities, and community perceptions of village investment.

For each of the 17 villages, primary data collection drew on a purposive panel of key informants: the village head or village secretary, together with one to two community-level

informants (a BUMDes manager, cooperative administrator, or business or community leader), selected for their direct, first-hand knowledge of local economic activity, infrastructure, and institutional conditions. The number of informants interviewed varied somewhat from village to village depending on local availability, but typically comprised the village head or secretary together with one to two additional community-level informants; a fully itemised roster recording each informant's specific role and the exact date of each interview was not retained in a centralised log during fieldwork, and this gap is acknowledged explicitly as a procedural limitation in Section 6, together with a recommendation for how future applications of the ERI framework should document this information. Informants were selected purposively rather than randomly, on the basis of their institutional role and their first-hand familiarity with the village's economic facilities and infrastructure. Verbal informed consent was obtained from each informant before the interview, and responses were recorded without attributing statements to named individuals in the manuscript. All 17 villages were visited directly by the field team, and a single standardized observation checklist covering the 12 ERI indicators was applied uniformly across villages to ensure comparability, although the checklist's role differed by indicator: physically observable conditions (road surface, presence of market or retail buildings) were directly inspected by the field team, while indicators drawn from administrative counts (e.g., the number of registered credit facilities) were confirmed against IDM records through informant interview rather than independently re-enumerated. Interviews in this study therefore served a verification function -- confirming or correcting the IDM secondary data for each indicator -- rather than constituting an independently coded qualitative dataset; broader qualitative observations volunteered by informants (on barriers, opportunities, and perceptions of investment) informed the interpretation in Section 4 but were not systematically analyzed as a separate qualitative evidence base. Where field observations or interview accounts differed from the IDM secondary data for a given indicator, the discrepancy was recorded, the relevant informant or location was revisited for confirmation, and the field-verified value was adopted; this is the triangulation procedure referred to as “verification through direct confirmation” in this study.

To safeguard scoring consistency across the research team, all field observers were trained on the same scoring rubric shown in Table 1 prior to data collection, and a subsample of villages was independently re-scored by a second observer, with any discrepancies resolved through joint discussion and, where needed, a follow-up site visit. This procedure does not constitute a formal statistical inter-rater reliability test (e.g., Cohen’s kappa or intraclass correlation); it provided a procedural safeguard against idiosyncratic scoring rather than a quantified reliability estimate, and future iterations of the ERI framework should incorporate a formal inter-rater agreement statistic, as noted in the Limitations section.

Secondary data were obtained from the assessment of raw indicator data from the Village Development Index (Indeks Desa Membangun/IDM), developed by the Ministry of Villages, Disadvantaged Regions, and Transmigration. These data include several indicators relevant to village economic resilience and investment potential. The data were then verified through direct confirmation to ensure validity and contextual accuracy. This validation is crucial to

ensure that the secondary data truly reflect actual field conditions and to minimize potential administrative bias.

3.3 Data Analysis

This study employs a scoring approach to assess village economic resilience through various indicators that reflect production diversity and access to basic economic infrastructure. Two main aspects are the focus of this assessment: the diversity of village economic production and accessibility to economic infrastructure and financial institutions. Scoring is conducted by assigning values ranging from 0 to 5 for each indicator based on actual field conditions (Sun et al., 2023). Economic production diversity is assessed based on the ratio of micro-industry units to the total number of households in the village. Indicators of basic economic infrastructure include the presence of markets, shops and convenience stores, food stalls and lodgings, as well as logistics services. Villages with a higher number of such units receive higher scores, as they are considered to have more developed economic infrastructure. Similarly, the presence of financial institutions such as banks, rural credit banks (BPR), cooperatives, and village-owned enterprises (BUMDes) is also scored based on the number of available units. Access to credit facilities and local economic institutions serves as an important indicator of how well villagers can access business financing. In addition to economic aspects, regional accessibility indicators are also considered. These include the availability of public transportation, village openness (assessed by whether the village can be accessed by four-wheeled vehicles throughout the year), and the quality of village roads. Villages with adequate transportation access and good road infrastructure tend to develop more easily economically, as the movement of goods and services becomes more efficient.

Table 1. Scoring of Economic Resilience Indicators for Wetland Villages

Indicator	Scoring Criteria
Production Diversity Score	If the Number of Micro Industries / Number of Households : • ≥ 0.004 → score 5 • 0.001 – 0.003 → score 3 • 0 → score 1
Retail Store Proximity Score	If the distance to the nearest shopping cluster (km): • ≤ 7 → score 5 • 8 – 12 → score 4 • 13 – 17 → score 3 • 18 – 25 → score 2 • > 25 → score 1
Market Score	If Total HH / Number of Markets: • < 250 (fewer households per market, i.e. better market availability) → score 5 • ≥ 250 (more households sharing each market, i.e. weaker market availability) → score 3 • No market present in the village (0 markets; ratio undefined) → score 1
Grocery Shops and Stalls Score	If the number of grocery shops and stalls:

	• > 3 → score 5 • 3 → score 4 • 2 → score 3 • 1 → score 2 • 0 → score 1
Food Stalls and Inns Score	If the number of food stalls and inns: • > 1 → score 5 • 1 → score 3 • 0 → score 0
Postal and Logistic Services Score	If the number of postal and logistic service providers: • > 1 → score 5 • 1 → score 3 • 0 → score 0
Bank and Rural Bank Score	If the number of Banks and BPR (Rural Credit Banks): • > 1 → score 5 • 1 → score 3 • 0 → score 1
Credit Facility Score	If the number of credit facilities: • 4 → score 5 • 3 → score 4 • 2 → score 3 • 1 → score 2 • 0 → score 1
Economic Institution Score	If the number of active cooperatives and village-owned enterprises (BUMDes): • > 1 → score 5 • 1 → score 3 • 0 → score 1
Public Transportation Score	If public transportation is: • Available with a fixed route → score 5 • Available without a fixed route → score 3 • Not available → score 1
Area Accessibility Score	If village roads are passable by motorized four-wheel or larger vehicles: • All year round → score 5 • All year round except certain times → score 3 • Not passable year-round → score 1
Road Quality Score	If the type of village road surface is: • Asphalt/concrete → score 5 • Hardened (gravel, stone, etc.) → score 4 • Dirt → score 3 • Other → score 1

The scoring thresholds in Table 1 are adapted from the operational indicator categories used in the Village Development Index (Indeks Desa Membangun/IDM) issued by the Ministry of Villages, Disadvantaged Regions, and Transmigration, and follow the general scoring logic

proposed by Sun et al. (2023) for rural resilience indicator systems, in which higher scores are assigned to conditions that reduce transaction costs and expand access to markets, finance, and services. Cut-off values that are specific to this study – such as the 0.004 and 0.001 micro-industry-to-household ratio bands for production diversity and the 250-household-per-market threshold – were calibrated during field verification by comparing the distribution of raw IDM values against locally observed conditions in Siak Kecil Subdistrict, so that the resulting score bands separate villages with materially different levels of service availability rather than splitting a statistically homogeneous group. These thresholds therefore combine (i) the IDM's own operational categories, (ii) the general scoring approach of Sun et al. (2023), and (iii) local field calibration; they are not derived from an independent statistical distribution-fitting procedure, which is acknowledged as a limitation of the scoring design (see Section 6).

The Economic Resilience Index (ERI), which ranges from 0 to 1, provides a quantitative measure of the extent to which a village can withstand and adapt to various economic pressures. The ERI is calculated using the following formula: ERI = (Sum of Si) / (n x Smax), where Sum of Si is the sum of scores across all n = 12 indicators for a given village, and Smax = 5 is the maximum possible score for any single indicator. All 12 indicators are weighted equally, reflecting the assumption that each dimension of economic resilience contributes proportionally to overall village capacity; this equal-weighting approach is consistent with the IDM framework from which the indicator structure is derived (Sun et al., 2023). Equal weighting was adopted for three reasons. First, the 12 indicators span four conceptually distinct but complementary dimensions (production, market infrastructure, financial access, and regional accessibility), and no prior theoretical or empirical work on wetland village resilience specifies a differentiated weighting scheme that this study could draw on. Second, equal weighting maximises transparency and replicability, since differential weights derived from expert elicitation or principal component analysis would require additional data collection beyond the scope of this study. Third, equal weighting avoids introducing researcher-driven bias into which dimension of resilience is treated as more important, leaving that interpretation to the reader and to local policymakers. This simplification is, however, a limitation: it assumes that a one-point change in, for example, the credit facility score is substantively equivalent to a one-point change in the road quality score, an assumption that future research could test empirically through participatory or data-driven weighting (see Section 6).

To classify villages into high, medium, and low resilience categories, this study applies a mean ± 0.5 standard deviation interval rule, a standard method for interval classification of composite indices. Across the 17 villages, the ERI has a mean of 0.831 and a standard deviation of 0.078. Villages with ERI ≥ 0.871 (mean + 0.5 SD) are classified as High; villages with 0.792 ≤ ERI < 0.871 (within 0.5 SD of the mean) are classified as Medium; and villages with ERI < 0.792 (mean − 0.5 SD) are classified as Low. This rule is applied consistently to all 17 villages in Table 2 and in the discussion that follows, replacing the more impressionistic high/medium/low language used in earlier drafts of this manuscript.

Because the mean ± 0.5 SD rule is a relative classification defined within this sample of 17 villages rather than an absolute resilience standard, its stability was checked against two

alternative procedures applied to the same 17 ERI values. First, a tertile split (approximately the top, middle, and bottom third of villages by ERI) places Tanjung Belit and Sepotong in the top tier and Langkat in the middle tier, in contrast to their Medium and Low classifications, respectively, under the mean ± 0.5 SD rule; this reclassification occurs because several villages cluster tightly around ERI = 0.7833-0.8667, so small changes in the cut rule shift multiple villages across tier boundaries. Second, a fixed-interval classification applied to the ERI's full theoretical 0-1 range (Low: 0-0.333; Medium: 0.334-0.667; High: 0.668-1.000) places every village except Lubuk Garam in the High band, because the observed ERI values for all 17 villages are compressed within a narrow 0.65-1.00 range. This comparison indicates that the High/Medium/Low labels reported in this study describe each village's resilience relative to other villages in Siak Kecil Subdistrict, not an absolute level of resilience on the ERI's 0-1 scale; even villages classified as Low here score well above the midpoint of the theoretical range. Readers and policymakers should therefore interpret the categories as a within-sample ranking tool for prioritising investment, not as a claim that Low-tier villages are, in absolute terms, economically fragile.

In the context of villages located in wetland areas, a high ERI score carries strategic significance. It serves not merely as an economic indicator but also as the foundation for investment-driven rural development. Wetland regions have unique ecological characteristics that require a more cautious development approach to prevent environmental degradation. Thus, a high ERI score indicates that a village can sustainably leverage its local potential such as agriculture, fisheries, and ecotourism while simultaneously attracting investments that align with its ecological attributes. Strengthening village economic resilience can be achieved by fulfilling several basic indicators, including the availability of economic infrastructure, production diversification, access to markets and financial services, and the reinforcement of local institutions. These efforts will create greater opportunities for achieving rural development that is inclusive, participatory, and sustainable. Inclusive development ensures the involvement of all community groups, while participatory approaches guarantee that decision-making processes actively engage local communities..

4. Result and Discussion

4.1 Production Diversity and Access to Basic Economic Infrastructure

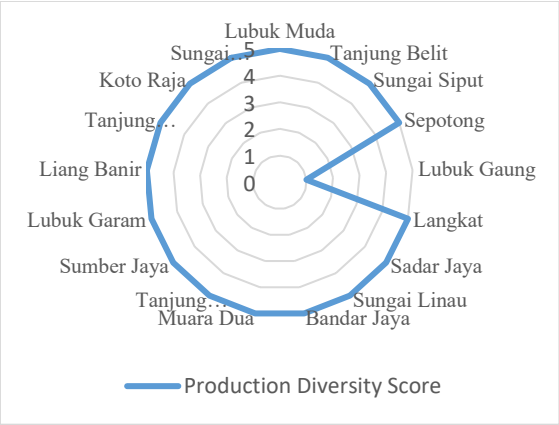
Wetland villages possess highly distinctive ecological characteristics, offering both opportunities and challenges in resource management. These areas hold significant economic potential if managed sustainably. Sustainability is key to ensuring that resource utilization does not compromise the essential ecological functions of wetlands, such as flood control, carbon sequestration, and providing habitats for biodiversity. Therefore, development strategies must be grounded in a balance between economic utilization and ecological preservation.

One of the primary strengths of wetland villages is production diversity. Communities in these areas generally do not depend on a single economic sector; instead, they engage in a variety of activities such as agriculture, fisheries, livestock farming, and local product processing. This diversification offers substantial benefits by reducing risks associated with economic shocks, commodity price fluctuations, and the impacts of climate change. Through diversification, villages have greater opportunities to achieve economic stability that supports long-term resilience (Nguyen & Qaim, 2025; Liu et al., 2023).

However, harnessing this potential cannot be fully realized without support from village-level economic and financial institutions. The presence of institutions such as village-owned enterprises (BUMDes), cooperatives, and microfinance institutions plays a strategic role in promoting local economic development. These institutions not only provide affordable access to capital but also facilitate value chain management, product processing, and distribution. Such institutional support serves as the backbone of economic strengthening for villages, reducing dependence on external financial institutions that are often inaccessible to rural communities.

Moreover, the role of local institutions in providing savings and loan services and strengthening business capital has a direct impact on community economic empowerment. With improved access to finance, communities can develop productive enterprises, increase household incomes, and create new employment opportunities. These efforts will enhance the competitiveness of villages in facing global challenges while simultaneously improving local welfare. Therefore, the development of local economic institutions must be prioritized as part of a strategic approach to unlock the potential of wetland-based economies (Angge et al., 2023) On the other hand, economic service facilities such as village markets and crop distribution centers are not fully available or functioning optimally in many wetland villages. The lack of such facilities often forces farmers to sell their products at low prices due to limited access to broader markets (Kishor et al., 2025). Therefore, the development and revitalization of local economic facilities are crucial agendas for promoting inclusive economic growth. These economic empowerment efforts will not be effective without adequate accessibility and quality of transportation infrastructure (Chirisa, 2024;Aleschenko et al., 2022). Village roads, bridges, small ports, and waterway access in swamp areas are key factors in the movement of goods, services, and people. In many wetland villages, infrastructure conditions remain poor or damaged due to geographical challenges such as flooding and erosion. Thus, government interventions both local and national are urgently needed to develop infrastructure that is adaptive to wetland conditions (Gangwar et al., 2022).

Figure 2. Production Diversity of Wetland Villages in Siak Kecil Subdistrict, Bengkalis Regency



The production diversity of wetland villages in Siak Kecil Subdistrict, Bengkalis Regency, as illustrated in Figure 2, shows that most villages in this area have achieved the maximum score (5), indicating a very high level of economic production diversity. Villages such as Lubuk

Muda, Sungai Nibung, Koto Raja, Tanjung Datuk, Liang Banir, Lubuk Garam, Sumber Jaya, Tanjung Damai, Muara Dua, Bandar Jaya, Sungai Linau, Sadar Jaya, and Langkat stand out with the highest scores. These scores highlight the strong local economic potential supported by a wide range of economic activities, including agriculture, fisheries, trade, services, and local product processing (Rakib and Syam, 2024). This diversity underscores the need for rural-based investment, which can serve as a strategic advantage for strengthening village economic resilience, creating employment opportunities, and improving community welfare.

However, the chart also highlights a contrasting condition in some areas. The village of Lubuk Gaung recorded the lowest production-diversity score among all 17 villages (1 out of a possible 5, as reported in Table 2), indicating a comparative lack of developed economic activities in the area. This situation may signal structural barriers such as limited accessibility, unfavorable geographic conditions, poor supporting infrastructure, or a lack of human resource capacity and local institutional strength (Rudiansah, 2025). This disparity shows that although most villages possess relatively strong economic competitiveness, there are still villages that require special attention in future development planning. Affirmative interventions such as the provision of basic infrastructure, entrepreneurship training, and market facilitation are essential to encourage economic diversity and growth in lagging villages.

Figure 3. Access to Financial and Economic Institutions in Wetland Villages of Siak Kecil Subdistrict, Bengkalis Regency

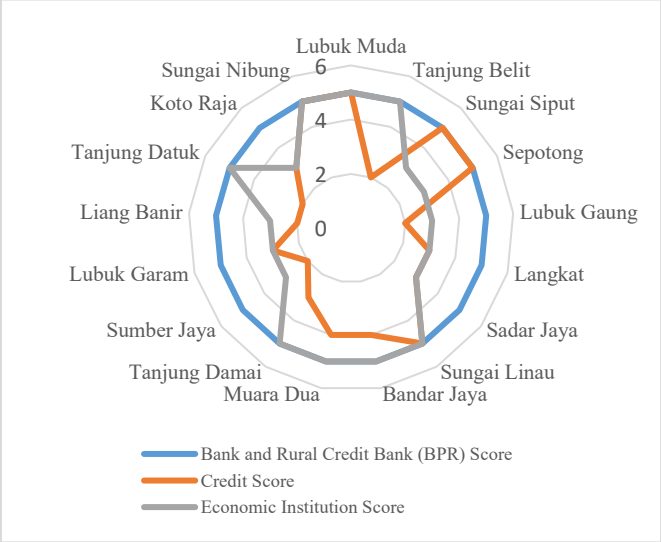
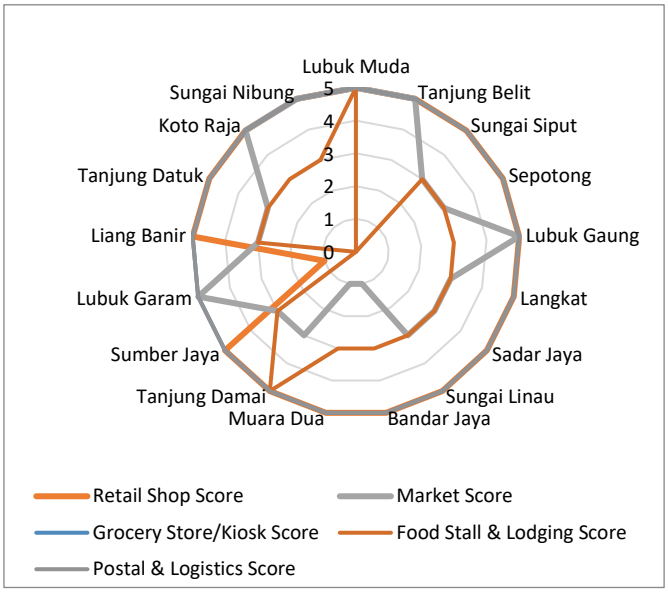


Figure 3 illustrates the level of access that wetland villages in Siak Kecil Subdistrict have to various forms of economic services and institutions, particularly banking, credit, and local economic organizations. Overall, access to banks and rural credit banks (BPR) appears to be relatively widespread, as indicated by the high scores across most villages. This suggests that the presence of formal financial institutions in the area is fairly well established and can serve as an important foundation for stimulating economic activities in rural communities (Effendi et al., 2024). However, access to credit services shows a very different picture, with scores varying significantly. Only a few villages -- Lubuk Muda, Sungai Nibung, Sungai Siput, Sungai Linau, and Sepotong -- reach the maximum credit facility score. In contrast, Tanjung Belit, Liang Banir, Tanjung Datuk, Lubuk Gaung, and Sumber Jaya record the lowest credit facility scores in the sample (2 out of 5, as reported in Table 2). This indicates that although

banking services are present in every village, actual access to credit facilities is not yet optimal. This may be due to administrative barriers, lack of information, or the limited capacity of residents to meet loan requirements (Fan et al., 2025). Meanwhile, the presence of local economic institutions such as cooperatives, business groups, or village-owned enterprises (BUMDes) also shows disparities among villages. Some villages, such as Tanjung Datuk and Liang Banir, score high, reflecting strong local economic institutional roles. However, the majority of other villages still score low to moderate. This suggests the need to strengthen the capacity and role of community-based economic institutions to enhance collective and sustainable participation in economic activities (Olivia, 2023). The economic development of wetland villages cannot rely solely on the presence of formal financial institutions; a more comprehensive approach is needed. This includes financial education, facilitation of inclusive credit access, and the strengthening of local economic institutions. In doing so, the economic potential of wetland villages can be maximized to promote more equitable and sustainable community welfare.

Figure 4. Economic Service Facilities in Wetland Villages of Siak Kecil Subdistrict, Bengkalis Regency



Based on the analysis in Figure 4, markets and grocery kiosks are the most evenly distributed economic facilities across all villages, including those with wetland characteristics. The presence of these two types of facilities reflects a local and traditional trade pattern that heavily relies on accessibility and proximity to residential settlements (Hariyanto et al., 2024). Markets and grocery kiosks serve as vital points in the economic circulation of communities in wetland areas, which are generally dispersed and face infrastructure limitations. However, other economic facilities such as retail shops and lodging are still concentrated in a few specific villages, such as Lubuk Muda and Muara Dua. This concentration indicates that investment has not yet reached all areas evenly, particularly in wetland regions that are often perceived as less profitable due to geographical challenges and high infrastructure costs. In fact, wetland villages hold significant potential in sectors such as fisheries, swamp agriculture, and ecotourism, which could be further developed through the presence of commercial facilities and services such as lodging and modern trade service centers, consistent with the broader

convergence between rural economic development, digital technology, and community engagement identified in the bibliometric literature (Nasution et al., 2025).

Conversely, some villages such as Sumber Jaya and Lubuk Garam show significant lag in the provision of economic infrastructure. This may be due to the wetland conditions that hinder physical access, as well as the low investment appeal resulting from limited basic infrastructure support. The low scores for economic facilities in these villages indicate an urgent need to promote both public and private investment to break isolation and strengthen the community's economic foundation (Monalisa & Sugiarto, 2022). Therefore, the results of this analysis highlight the importance of developing a rural investment needs map based on ecosystem characteristics, particularly those of wetland ecosystems. Local governments and development partners need to design inclusive investment strategies grounded in local potential. This includes the development of basic infrastructure (roads, bridges, water channels), economic facilities (markets, kiosks, lodging), and the digitalization of services to support trade and logistics. With well-targeted investments, wetland villages can not only overcome isolation but also transform into new centers of economic growth rooted in environmental sustainability.

Figure 5. Accessibility and Quality of Transportation Infrastructure in Wetland Villages of Siak Kecil Subdistrict, Bengkalis Regency

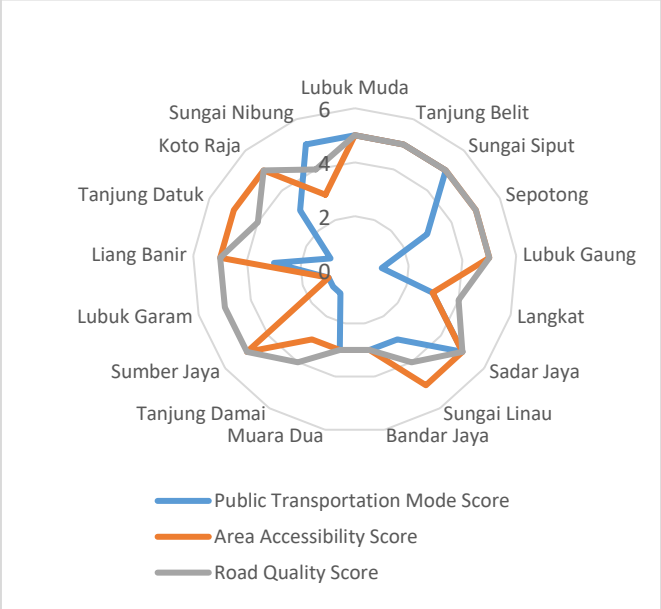


Figure 5 illustrates the accessibility and condition of transportation infrastructure in wetland villages. In general, several villages such as Lubuk Muda, Tanjung Belit, and Sungai Nibung show high scores in public transportation modes, area accessibility, and road quality, indicating that these areas have relatively good connectivity. This can facilitate community mobility, improve the distribution of production outputs, and enhance local economic potential (Taryono et al., 2023). However, there are also villages that record low scores in one or more indicators, such as Muara Dua, Sumber Jaya, and Lubuk Garam. In these villages, the public transportation mode score is as low as 1, indicating that residents rely solely on private vehicles or have limited access to public transport. This condition can lead to difficulties in

accessing markets, healthcare services, education, and the logistics of agricultural and fishery products.

The area accessibility indicator, which reflects the ease of entering and exiting a village, also reveals disparities. Some villages, such as Koto Raja and Liang Banir, score high, while others, like Muara Dua and Tanjung Damai, record low scores. This may indicate the presence of geographical barriers such as rivers, swamps, or a lack of effective inter-village connecting routes. Meanwhile, road quality is generally adequate in most villages, suggesting that although public transportation is not yet evenly distributed, investments in road development have begun to yield results. However, without adequate transportation modes, good road quality cannot be fully utilized by the broader community especially vulnerable groups such as the elderly, women, and students. This highlights that accessibility in wetland areas continues to face inter-village disparities in terms of public transportation availability, territorial connectivity, and road quality (Keblawi et al., 2025). Therefore, future development planning should consider improving local public transportation, strengthening inter-village connectivity, and adapting road infrastructure to the geographic characteristics of wetlands in order to promote equitable development and rural community well-being.

4.2 Village Economic Resilience Index

Table 2. Consolidated Indicator Scores, Total Score, ERI, and Resilience Category for All 17 Wetland Villages

Village	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11	I12	Total	ERI	Category
Lubuk Muda	5	5	5	5	5	5	5	5	5	5	5	5	60	1.0000	High
Sungai Nibung	5	5	5	5	3	5	5	5	5	5	3	4	55	0.9167	High
Sungai Siput	5	5	3	5	3	5	5	5	3	5	5	5	54	0.9000	High
Sungai Linau	5	5	3	5	3	5	5	5	5	3	5	4	53	0.8833	High
Tanjung Belit	5	5	5	5	0	5	5	2	5	5	5	5	52	0.8667	Medium
Sepotong	5	5	3	5	3	5	5	5	3	3	5	5	52	0.8667	Medium
Sadar Jaya	5	5	3	5	3	5	5	3	3	5	5	5	52	0.8667	Medium
Koto Raja	5	5	5	5	3	5	5	3	3	3	5	5	52	0.8667	Medium
Tanjung Damai	5	5	3	5	5	5	5	3	5	1	3	4	49	0.8167	Medium
Liang Banir	5	5	3	5	3	5	5	2	3	3	5	5	49	0.8167	Medium

Tanjung Datuk	5	5	3	5	3	5	5	2	5	1	5	4	48	0.8000	Medium
Langkat	5	5	3	5	3	5	5	3	3	3	3	4	47	0.7833	Low
Bandar Jaya	5	5	1	5	3	5	5	4	5	3	3	3	47	0.7833	Low
Muara Dua	5	5	1	5	3	5	5	4	5	3	3	3	47	0.7833	Low
Sumber Jaya	5	5	3	5	3	5	5	2	3	1	5	5	47	0.7833	Low
Lubuk Gaung	1	5	5	5	3	5	5	2	3	1	5	5	45	0.7500	Low
Lubuk Garam	5	1	5	5	0	5	5	3	3	1	1	5	39	0.6500	Low

Note: I1 = Production Diversity Score; I2 = Retail Store Proximity Score; I3 = Market Score; I4 = Grocery Shops and Stalls Score; I5 = Food Stalls and Inns Score; I6 = Postal and Logistic Services Score; I7 = Bank and Rural Bank Score; I8 = Credit Facility Score; I9 = Economic Institution Score; I10 = Public Transportation Score; I11 = Area Accessibility Score; I12 = Road Quality Score (see Table 1 for full scoring criteria). Category thresholds follow the mean ± 0.5 SD rule defined in Section 3.3 (High ≥ 0.871; Medium 0.792–0.870; Low < 0.792).

Economic resilience in wetland villages plays a crucial role as the foundation for developing investment. Economic resilience reflects the village's ability to endure, adapt, and recover from various pressures, whether environmental, social, or economic. Villages with a high level of economic resilience generally demonstrate stability in productivity, community strength, and the sustainability of local enterprises. This serves as an initial indicator that convinces investors that the village is a viable location for the development of long-term economic activities (Ma, 2025). Wetland villages often possess significant natural resource potential, such as fisheries, agriculture, and ecotourism. However, without strong economic resilience, this potential cannot be optimally utilized. Economic resilience encourages the diversification of community enterprises and reduces dependency on a single sector, consistent with evidence that BUMDes-driven multi-commodity platforms lower rural households' exposure to sector-specific shocks (Angge et al., 2023), and enhances local capacity to manage environmental risks such as flooding or drought. This creates a safer investment climate, as the risk of disruptions to business operations can be minimized.

Moreover, villages with strong economic resilience generally possess adequate basic infrastructure and active local institutions. The availability of reliable roads, access to clean water, electricity, and communications networks is an essential precondition for supporting community economic activity. These facilities not only facilitate the movement of goods and services but also improve the overall quality of life in rural areas. Furthermore, institutional support from village-owned enterprises (BUMDes) and cooperatives serves as a primary driver of local economic strengthening through the management of productive ventures, provision of savings-and-loan services, and development of local value chains (Putri Wardani & Setiawan, 2023).

For investors, the presence of adequate infrastructure and active local economic institutions is a powerful attraction. Such basic facilities help reduce investment risk and lower operating costs. The literature further suggests that investors are more inclined to invest when local communities demonstrate a collaborative spirit and openness to innovation, and that

transparent, responsive village governance provides an additional advantage by ensuring accountability and reducing the risk of social conflict; community collaboration, governance quality, and investor behaviour are not indicators captured by the ERI itself, and these statements should be read as contextual expectations drawn from prior studies rather than findings of the present analysis (Lidya et al., 2024).

Village economic resilience is not only an indicator of well-being; it is also a critical foundation for realizing sustainable investment. The broader literature suggests that villages articulating a long-term vision, prioritising environmental conservation, and implementing inclusive economic development programs are more likely to attract investors seeking dual returns -- financial gain alongside positive social and ecological impact -- consistent with global trends in sustainable investment that integrate economic, social, and environmental dimensions; the present ERI does not directly measure environmental conservation practice or investor motivation, so this connection is offered as a contextual expectation rather than a tested finding (Hailuddin et al., 2024).

Accordingly, strengthening the economic resilience of villages especially those in wetland areas is a strategic step toward opening investment opportunities with broad and long-term impacts. This resilience can be achieved through reinforcing local institutions, building community capacity, providing adequate infrastructure, and implementing transparent, participatory governance. When pursued consistently, wetland villages will not only be able to attract investment but also ensure inclusive, sustainability-oriented rural development that advances community well-being.

Figure 6. Economic Resilience Index of Wetland Villages in Siak Kecil Subdistrict, Bengkalis Regency

Applying the mean ± 0.5 SD classification defined in Section 3.3, four villages fall into the High resilience category (ERI ≥ 0.871): Lubuk Muda (ERI = 1.0000), Sungai Nibung (0.9167), Sungai Siput (0.9000), and Sungai Linau (0.8833). These villages combine near-maximum production diversity with strong scores on market access, credit facility access, and road quality, which together explain their position at the top of the index; Lubuk Muda in particular records the maximum possible score on all 12 indicators. A further seven villages fall into the Medium category (0.792 ≤ ERI < 0.871): Tanjung Belit, Sepotong, and Sadar Jaya (each 0.8667), Koto Raja

(0.8667), Tanjung Damai and Liang Banir (each 0.8167), and Tanjung Datuk (0.8000). These Medium-tier villages are strategically important: their composite scores are held back by specific, addressable gaps for example, Tanjung Belit and Sumber Jaya-adjacent villages show comparatively weak credit facility and food-stall/lodging scores rather than by broad-based underdevelopment, which makes them realistic near-term targets for investment acceleration through moderate, targeted policy intervention rather than large-scale infrastructure investment. These villages have the potential to become the driving force for economic growth in surrounding areas as their remaining gaps are closed, and can serve as models for development planning based on village competitive advantages.

The remaining six villages fall into the Low resilience category (ERI < 0.792): Langkat, Bandar Jaya, Muara Dua, and Sumber Jaya (each 0.7833), Lubuk Gaung (0.7500), and Lubuk Garam (0.6500, the lowest ERI recorded in the study). Their low ERI scores reflect underlying structural problems that weaken village economic robustness, ranging from limited access to basic services to inadequate infrastructure. Under these conditions, villages are highly vulnerable to economic shocks and natural hazards, making sustainable development difficult to achieve without timely, well-targeted interventions.

One of the principal challenges is the shortage of basic infrastructure reliable roads, electricity networks, clean water systems, and other facilities that support economic activity. This situation directly constrains inter-village and regional connectivity, limits the distribution of goods and services, and drives up logistics costs. Dependence on a single economic sector (for example, agriculture or fisheries) further heightens exposure to commodity price volatility and climate change. Weak institutional support whether from microfinance providers, cooperatives, or village-owned enterprises (BUMDes) worsens the problem because households and producers lack affordable capital to diversify.

Comparing the indicator profiles in Table 2 across tiers clarifies which mechanisms drive these differences rather than simply restating the ranking. The High-tier villages (Lubuk Muda, Sungai Nibung, Sungai Siput, Sungai Linau) are distinguished less by production diversity, which is near-uniform across almost all 17 villages, than by consistently strong scores on market access, credit facility access, and road quality; together with public transportation, these are the indicators that show the greatest inter-village variation and therefore carry the most weight in separating villages within the index. Bank and rural-bank presence (I7) is not among these differentiating indicators: every village in the sample records the maximum score of 5 on this item, so while formal banking institutions are evidently well established across Siak Kecil Subdistrict, this indicator has no discriminatory value within the ERI and should not be read as explaining differences between villages. By contrast, the Low-tier villages (Langkat, Bandar Jaya, Muara Dua, Sumber Jaya, Lubuk Gaung, Lubuk Garam) are pulled down primarily by low credit facility and public transportation scores, and, in the cases of Lubuk Gaung and Lubuk Garam, by an additional deficit in production diversity or retail proximity that compounds the transport and credit gap. Lubuk Garam, the lowest-ranked village overall, combines a minimum retail proximity score with an absent food-stall/lodging sector and the lowest possible area accessibility score, indicating that its resilience deficit is geographically rooted in physical isolation rather than in a single institutional weakness. This pattern suggests that credit access and transportation connectivity, more than production diversity per se, are the binding constraints separating Medium- and Low-tier villages from

the High tier, and should therefore be prioritised in targeted investment planning for the Gerbang Laksamana corridor.

Addressing these constraints requires adaptive, needs-based strategies. Local governments should prioritize infrastructure investments that not only meet basic needs but also enable long-term economic development for instance, constructing all-weather access roads to market centers, extending internet connectivity to support digital transformation, and strengthening village economic institutions so they can manage resources more autonomously. In parallel, support for micro and small enterprises and local agribusiness should be expanded through improved access to finance, technical assistance, and wider marketing channels.

Findings from the ERI analysis can serve as an important evidence base for designing more targeted, data-driven village development strategies. Interventions must be calibrated to each village's level of economic resilience, recognizing that every village has distinct characteristics, potentials, and constraints. Uniform policy packages (one-size-fits-all) are unlikely to be effective and may even create new disparities.

Collaboration is key. Local governments, development partners, and village communities must work in synergy to craft policies that are responsive to local challenges. Active community participation in planning and decision-making builds ownership and improves program sustainability. Policy priorities should focus on strengthening self-reliance and economic resilience so that these villages not only withstand pressure but also grow into inclusive and sustainable rural development hubs.

Wetland villages in Siak Kecil Subdistrict face unique challenges, including dependence on the primary sector and limited access to infrastructure. However, studies indicate that economic resilience can be strengthened through the development of local institutions, enhanced community capacity for resource management, and the promotion of community-based initiatives to foster local enterprises (Hua et al., 2024). These conditions send a positive signal for investment, as villages are not only capable of surviving but are also proactive in shaping social and economic structures that support sustainable investment (Sharma et al., 2024).

Recognizing spatial and temporal dynamics is crucial in designing economic resilience strategies (Yang et al., 2022). Village transformation is neither a linear nor uniform process; thus, applying a "one-size-fits-all" policy approach risks overlooking the ecological and institutional conditions that differentiate wetland villages from other rural settlements (Hidayat et al., 2022). This aligns with the context of Siak Kecil, where investment and village development policies must consider the unique characteristics of wetland villages in terms of ecology, social structures, and local culture. Such an approach is essential to ensure that the internal capacity of villages, as the foundation of economic resilience, remains strong.

In Siak Kecil, the strength of community organizations such as cooperatives, farmer groups, and traditional institutions can serve as a bridge between investment interests and community needs. This reinforces the argument that investment in villages will be more sustainable if built upon a bottom-up foundation of economic resilience, rather than relying solely on top-down structural approaches (Arvanitis et al., 2023). Therefore, the economic resilience of wetland villages is not only technical in nature but also encompasses social and spatial complexities that form a critical foundation for successful investment (Nugraha et al., 2024; Widodo & Singgalen, 2025).

Descriptive Research Question Summary

Based on the descriptive ERI analysis across 17 wetland villages, the following observations answer RQ1-RQ4; because production diversity, infrastructure access, financial access, and regional accessibility are themselves components of the ERI, these are descriptions of which components account for the observed differences between villages, not tests of an independent relationship, and the discussion below should be read accordingly. For RQ1, production diversity contributes almost nothing to the observed differences: 16 of the 17 villages recorded the maximum production diversity score of 5, so this component does not vary enough to distinguish High- from Low-tier villages; the single exception, Lubuk Gaung, combines a low diversity score with a below-average ERI (0.7500), but this is one observation and not a general pattern. For RQ2, basic economic infrastructure access accounts for a meaningful share of the differences between villages: the High-tier villages (Lubuk Muda, Sungai Nibung, Sungai Siput, Sungai Linau) show stronger market and retail-proximity scores than the Low-tier villages, and Lubuk Garam, the lowest-ranked village, records the minimum retail proximity score. For RQ3, banking presence is constant across all 17 villages (a score of 5 in every case) and therefore contributes nothing to the differences between villages, but credit facility scores vary considerably and are consistently lower in the Medium- and Low-tier villages than in the High-tier villages; it is credit access specifically, not financial-institution presence in general, that tracks the ERI pattern. For RQ4, regional accessibility accounts for part of the difference between tiers: three of the four High-tier villages record public transportation scores of 3 or 5, while five of the six Low-tier villages record scores of 3 or below, though Lubuk Garam's very low ERI is driven more by market and food-stall deficits than by transportation alone. Overall, credit facility access, market/retail infrastructure, and regional accessibility are the components that differentiate villages within the index, while production diversity and banking presence do not; because these components are definitionally part of the ERI rather than external variables, this decomposition should be read as identifying which levers explain the ranking, not as a validated causal claim, and a genuine external test of these relationships remains a priority for future research (Section 6).

5. Conclusion and Suggestion

This study emphasizes that village economic resilience is a crucial foundation for promoting sustainable investment in wetland areas. By using an approach based on objective indicators such as production diversity, the presence of basic economic infrastructure, access to financial institutions, as well as regional quality and accessibility, this research successfully maps the variations in economic resilience among villages in Siak Kecil Subdistrict, Bengkalis Regency. The analysis shows that nearly all villages exhibit high economic production diversity, reflecting strong local potential that can be developed through village-based investment strategies; because this indicator varies little across villages, however, differences in the composite ERI are driven mainly by credit access, market and retail infrastructure, and regional accessibility rather than by production diversity itself. Gaps remain in access to financial institutions, credit services, and local economic organizations such as cooperatives and village-owned enterprises (BUMDes), posing challenges for many villages to optimally grow their enterprises. In addition, uneven economic and transportation infrastructure further

exacerbates development disparities, especially for villages located in geographically challenging areas.

The Economic Resilience Index (ERI), calculated from 12 indicators and classified using a mean ± 0.5 SD interval rule, shows that four villages Lubuk Muda, Sungai Nibung, Sungai Siput, and Sungai Linau fall into the High resilience category and hold potential to become drivers of regional economic development. Seven villages (Tanjung Belit, Sepotong, Sadar Jaya, Koto Raja, Tanjung Damai, Liang Banir, and Tanjung Datuk) fall into the Medium category and represent realistic near-term targets for moderate, targeted investment. The remaining six villages Langkat, Bandar Jaya, Muara Dua, Sumber Jaya, Lubuk Gaung, and Lubuk Garam fall into the Low category and require affirmative interventions from the government, such as the development of adaptive infrastructure, strengthening of economic institutions, and facilitation of market access and microenterprise financing. It should be emphasized that the ERI provides an evidence base for identifying villages that may be better prepared for targeted rural investment; it does not directly measure investment readiness or investment outcomes as separate constructs, since these would require indicators beyond the economic, infrastructural, and institutional dimensions captured here. Likewise, while wetland ecological characteristics motivate and contextualize this study, the ERI itself measures economic resilience rather than full socio-ecological resilience; it does not include direct ecological indicators such as flood exposure, wetland degradation risk, or land-use pressure (cf. Abouaiana, 2025, on constructed wetlands as green infrastructure), and future work should consider integrating such indicators. With this caveat, wetland villages that close their credit-access and connectivity gaps can not only withstand economic and environmental pressures but also transform into new centers of economic growth in Indonesia's coastal regions.

6. Limitations and Future Research

This study has several limitations that should be acknowledged. First, the cross-sectional design of the ERI analysis means that results reflect a single point in time (2024 IDM data), limiting the ability to draw causal inferences or track changes in village resilience over time. Second, the study relies primarily on secondary data from the Village Development Index (IDM); as described in Section 3.2, physically observable conditions (e.g., road surface, presence of market or retail buildings) were directly inspected by the field team in all 17 villages, but indicators drawn from administrative counts (e.g., the number of registered credit facilities) were confirmed against IDM records through informant interview rather than independently re-enumerated on site. This means that field verification, while applied consistently across all 17 villages, did not constitute independent original measurement for every indicator, which may introduce some residual administrative bias for the count-based indicators in particular. Third, the analysis is restricted to Siak Kecil Subdistrict, which limits the generalizability of findings to other wetland sub-districts in Riau Province or comparable contexts in Southeast Asia. Fourth, the descriptive nature of the ERI framework does not support inferential statistical testing; as a result, the four propositions were evaluated descriptively rather than through formal regression or correlation analysis, which constrains the strength of causal claims. Fifth, equal weighting of the 12 indicators assumes equal importance across all dimensions of resilience, a simplification that future studies may wish to revisit using expert-weighted or data-driven approaches. Relatedly, although every

indicator is scored on the same 1-5 (or, for two indicators, 0-5) scale and weighted equally in the ERI formula, the indicators do not share a common floor: most indicators assign a minimum of 1 for the complete absence of a facility, while the Food Stalls and Inns and Postal and Logistic Services indicators assign a minimum of 0. This means the complete absence of these two facilities is penalised more heavily in the composite index than the complete absence of, for example, a bank. This was retained in the current version because it mirrors the underlying IDM operational categories, but it is an inconsistency in the scoring design rather than a deliberate weighting choice, and future revisions of the ERI framework should either normalise all indicators to a common floor and ceiling or explicitly justify why these two indicators are treated differently. Sixth, while procedural safeguards for scoring consistency were applied during fieldwork (Section 3.2), no formal statistical inter-rater reliability coefficient was computed, and the scoring thresholds in Table 1 were calibrated through field observation and adaptation of the IDM framework rather than through an independent distribution-fitting or expert-panel procedure; both should be strengthened in future applications of the ERI framework. Seventh, two further documentation gaps are acknowledged directly rather than reconstructed after the fact. An itemised roster of informants -- recording each informant's specific role and the exact date of each interview -- was not kept in a centralised log during fieldwork; Section 3.2 therefore describes the informant composition in general terms only, and future applications of the ERI framework should maintain a complete, dated informant log to support full auditability. Separately, the Market Score (I3) criterion in Table 1 was corrected during this revision to reward a lower household-to-market ratio (better market availability) rather than a higher one, as the original scoring direction was inverted; because the underlying raw household and market counts for each village were not retained in a form that allows re-computation at this stage, the I3 values reported in Table 2 have not yet been re-verified against the corrected rule, and the resulting village rankings -- particularly for villages near the High/Medium and Medium/Low boundaries -- should be treated as provisional pending that re-verification in a future dataset release or erratum.

Future research should address these limitations in several ways. First, longitudinal studies tracking ERI values over multiple years would enable analysis of how village resilience evolves in response to policy interventions, natural shocks, and investment inflows. Second, the ERI framework developed in this study could be extended to other coastal wetland sub-districts in Riau Province and beyond, enabling comparative analysis and greater generalizability. Third, future studies should complement the IDM-based secondary indicators with original field-based measurement using standardized survey instruments, improving data independence and validity. Fourth, incorporating inferential statistical methods such as spatial regression or multivariate analysis would allow formal hypothesis testing and deepen understanding of which indicators most strongly predict ERI outcomes. Fifth, participatory approaches involving village communities in indicator weighting could improve the contextual relevance and acceptance of the index framework among local stakeholders.

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Declaration of AI and AI-assisted technologies in the writing process (if author[s] utilize AI)

During the preparation of this work, the authors used ChatGPT, an AI-assisted language tool developed by OpenAI, to support language refinement, improve sentence clarity, enhance academic readability, and assist in checking the consistency of the manuscript structure. The tool was not used to generate research data, conduct statistical analysis, interpret findings independently, or replace the authors' scholarly judgment. After using this tool, the authors carefully reviewed, verified, and edited the content as needed and take full responsibility for the accuracy, integrity, and final content of the publication.

Reference

Abouaiana, A. (2025). Constructed wetlands as green infrastructure to improve quality of life. In A. Battisti, M. U. Hensel, & D. Sunguroğlu Hensel (Eds.), *Urban-rural dialogue in green city design: Designing environments*. https://doi.org/10.1007/978-3-031-88318-7_11

Agrawal, A., Awasthi, S., & Vishnoi, S. (2022). Transformation from model village to model tourist village: The missing link. *Journal of Rural Development, 41*(2). https://doi.org/10.25175/jrd/2022/v41/i2/154752

Aleschenko, V. V., Aleschenko, O. A., Petrov, Y. V., & Ryumkin, S. V. (2023). Transport accessibility of rural territories of the Siberian Federal District. *Transportation Research Procedia, 68*, 389–394. https://doi.org/10.1016/j.trpro.2023.02.052

Alhadi, Z., et al. (2023). The coping strategies patterns based on local wisdom and resilience capital in facing natural disaster risk in Nagari Mandeh, Indonesia. *International Journal of Sustainable Development and Planning, 18*(1), 315–325. https://doi.org/10.18280/ijsdp.180133

Alkadafi, M., Susanti, Wasistiono, S., & Broto, M. F. (2025). Does village funds impact village development index and achievement of sustainable development goals in rural areas, Indonesia: A case study in Kampar District. *Journal of Lifestyle and SDGs Review, 5*(3), e04903. https://doi.org/10.47172/2965-730x.sdgsreview.v5.n03.pe04903

Angge, K., Pardiman, P., & Farida, E. (2023). Development of BUMDesa to increase the economic resilience of the community in Au Wula Village. *International Journal of Entrepreneurship and Business Development, 6*(5), 859–868. https://doi.org/10.29138/ijebd.v6i5.2322

Arvanitis, K. A., Holenstein, M., & Schriber, L. (2023). Bottom-up resilience: How civic bottom-up initiatives contribute to community resilience. *Swiss Yearbook of Administrative Sciences, 14*(1), 58–72. https://doi.org/10.5334/ssas.191

Cai, Z., Li, S., & Cheng, D. (2023). Has digital village construction improved rural family resilience in China? Evidence based on China Household Finance Survey. *Sustainability, 15*(11), 8704. https://doi.org/10.3390/su15118704

Cheng, S., Yu, Y., Fan, W., & Zhu, C. (2022). Spatio-temporal variation and decomposition analysis of livelihood resilience of rural residents in China. *International Journal of Environmental Research and Public Health, 19*(17), 10612. https://doi.org/10.3390/ijerph191710612

Chirisa, H. (2024). Rural accessibility under siege: Extreme climate events and road infrastructure damage in Southern Africa. *The Review of Rural Resilience Praxis, 3*(1&2). https://doi.org/10.71458/0tmwyy91

Effendi, S. A., Sukoharsono, E., Purwanti, L., & Rosidi. (2024). Village economic institutions partnership: Towards rural business community sustainability. *Indonesian Journal of Accounting and Business Society, 32*(3). https://doi.org/10.21776/ijabs.2024.32.3.757

Fan, Z., Liu, Z., Peng, Y., & Wang, N. (2025). Information frictions, credit constraints, and distant borrowing (SSRN Working Paper No. 5068213) [Preprint, not yet peer-reviewed]. SSRN. http://doi.org/10.2139/ssrn.5068213

Gangwar, R., Agarwalla, A., & Sreekumar, S. (2022). *Infrastructure development—Theory, practice and policy: Sustainability and Resilience 2021 Conference Compendium* (1st ed.). https://doi.org/10.4324/9781003311157

Hailuddin, Suryatni, M., & Irwan, M. (2024). Rural economic development strategy through village tourism development with the exploitation of local potential (Empirical study in Kebon Ayu Village, West Lombok). *Journal of Economics, Finance and Management Studies*, *7*(10), 6337–6348. https://doi.org/10.47191/jefms/v7-i10-28

Hariyanto, A., Saraswati, S., Akliyah, L. S., & Nurhayati, A. (2024). Spatial pattern analysis of rural development success rates based on the new rural development paradigm (NRDP) indicators: A case study of Cimenyan District. *International Journal of Sustainable Development and Planning, 19*(10), 3837–3847. https://doi.org/10.18280/ijsdp.191012

Hidayat, A. S., Rajiani, I., & Arisanty, D. (2022). Sustainability of floodplain wetland fisheries of rural Indonesia: Does culture enhance livelihood resilience? *Sustainability*, *14*(21), 14461. https://doi.org/10.3390/su142114461

Hua, H., Sun, J., & Yang, Z. (2024). Rural self-organizing resilience: Village collective strategies and negotiation paths in urbanization process in the TPSNT framework: A case study of the Hongren Village, China. *Sustainability, 16*(12), 5202. https://doi.org/10.3390/su16125202

İzgi, B. D. (2022). Resilience of rural settlement morphology dynamics: The case of Kargalı district (village). *Journal of Design for Resilience in Architecture and Planning, 3*(1), 112–126. https://doi.org/10.47818/drarch.2022.v3i1047

Keblawi, A., Abdul Sukor, N. S. B., Al-Sahili, K., Sadullah, A. F. B. M., Abdulhussein, S., & Al-Qudsi, A. (2025). Checklist for sustainable public transport service in developing countries: Insights from systematic literature review and experts' judgment. *International Journal of Transport Development and Integration, 9*(2), 271–285. https://doi.org/10.18280/ijtdi.090206

Kishor, V., Kumar, S., Prajapati, S., & Sharma, T. (2025). Empowering farmers: Addressing market access and technological deficiencies in rural agriculture. *International Journal of Research Publication and Reviews, 6*(5), 251–257. https://doi.org/10.55248/gengpi.6.sp525.1934

Lidya, G. M., Mandagi, M., & Tumbel, G. H. (2024). Rural economic development (Management evaluation of village owned enterprises (BUMDes) 'Berkat' in Tulap Village, Kombi District, Minahasa Regency). *Technium Social Sciences Journal*, *53*(1), 96–107. https://doi.org/10.47577/tssj.v53i1.10292

Liu, X., Liu, C., & Chen, K. (2023). Agricultural production diversity, child dietary diversity and nutritional status in poor, rural Gansu Province of China. *PLOS ONE, 18*(6), e0287000. https://doi.org/10.1371/journal.pone.0287000

Lu, Y., & Qian, J. (2023). Rural creativity for community revitalization in Bishan Village, China: The nexus of creative practices, cultural revival, and social resilience. *Journal of Rural Studies, 97*, 183–193. https://doi.org/10.1016/j.jrurstud.2022.12.017

Lundgren, A. S., & Nilsson, B. (2023). 'For the good of the village': Volunteer initiatives and rural resilience. *Journal of Rural Studies, 102*, 103104. https://doi.org/10.1016/j.jrurstud.2023.103104

Ma, R. (2025). Investment evaluation of rural revitalization projects: A case of the B Village rural tourism project in L City as an example. *Asian Journal of Economics, Business and Accounting, 25*(2), 145–156. https://doi.org/10.9734/ajeba/2025/v25i21670

Martin, R., & Sunley, P. (2015). On the notion of regional economic resilience: Conceptualisation and explanation. *Journal of Economic Geography, 15*(1), 1–42. https://doi.org/10.1093/jeg/lbu015

Monalisa, Y., & Sugiarto. (2022). The internal model of default credit for rural banks in Indonesia. *International Journal of Sustainable Development and Planning, 17*(7), 2297–2308. https://doi.org/10.18280/ijsdp.170731

Nasution, M. S., et al. (2025). Bibliometric analysis of rural economic development: Convergence between sustainable agriculture, digital technology, and community engagement for village self-reliance. *International Journal of Sustainable Development and Planning, 20*(1), 245–262. https://doi.org/10.18280/ijsdp.200123

Nguyen, T. T., & Qaim, M. (2025). Local and regional food production diversity are positively associated with household dietary diversity in rural Africa. *Nature Food, 6*(2), 205–212. https://doi.org/10.1038/s43016-024-01096-6

Nugraha, A. T., Fikriyah, Zahara, S., Suhartini, I., Zahid, U., & Hlahla, J. (2024). The role of social capital on community resilience in rural areas: A case study in Ponggok Village, Indonesia. *Regional and Rural Studies, 2*(1), 1–14. https://doi.org/10.21776/rrs.v2i1.27

Olivia, V. (2023). The impact of the existence of village-owned enterprises (BUMDes) business sectors on village development in Indonesia. *International Journal of Current Science Research and Review, 6*(7), 5208–6220. https://doi.org/10.47191/ijcsrr/V6-i7-135

Putri Wardani, R., & Setiawan, T. (2023). Increasing empowerment of rural economic institutions through the village-owned enterprises development program. *International Journal of Current Science Research and Review, 6*(1), 439–448. https://doi.org/10.47191/ijcsrr/V6-i1-49

Rakib, M., & Syam, A. (2024). Application of social capital-based institutional model in formulating village-owned enterprise policy as a resilience strategy for local economic development. *International Journal of Current Science Research and Review, 7*(1), 92–98. https://doi.org/10.47191/ijcsrr/V7-i1-10

Rudiansah, B. (2025). Village infrastructure development supervision model (Study on the optimization of BPD supervision function in village infrastructure development). *Journal of Governance, 10*(1). https://doi.org/10.31506/jog.v10i1.30943

Saha, S., & Bhadana, D. (2022). Rural agricultural work experience: Socio-economic survey in Budha Khera Village, Saharanpur, Uttarpradesh, India. *International Journal of Science and Research, 11*(3), 585–588. https://doi.org/10.21275/mr22310230842

Sharma, N., Nitivattananon, V., Tsusaka, T. W., & Pandey, R. (2024). An application of the stakeholder theory and proactive-reactive disaster management principles to study climate trends, disaster impacts, and strategies for the resilient tourism industry in

Pokhara, Nepal. *International Journal of Sustainable Development and Planning*, *19*(4), 1337–1346. https://doi.org/10.18280/ijsdp.190411

Sun, F., Zheng, Q., Ye, C., & Lin, J. (2023). A rural resilience development indicator system oriented to common prosperity: The case of a coastal village in Zhejiang Province. *Ecological Indicators*, *156*, 111126. https://doi.org/10.1016/j.ecolind.2023.111126

Taryono, Sujianto, Siregar, Y. I., & Indra, M. (2023). Participatory sustainable village development within the Bukit Rimbang Bukit Baling Wildlife Reserve Area in Kampar Regency. *International Journal of Sustainable Development and Planning*, *18*(3), 817–826. https://doi.org/10.18280/ijsdp.180317

Usman, F., Hariyani, S., Kurniawan, E. B., & Sari, I. C. (2023). Measuring resilience of a tourism village against flash flood disaster. *Regional and Rural Studies*, *1*(1), 15–21. https://doi.org/10.21776/rrs.v1i1.4

Widodo, Y. E., & Singgalen, Y. A. (2025). Strategic planning for sustainable development using spatio-temporal analysis. *International Journal of Sustainable Development and Planning*, *20*(3), 1175–1187. https://doi.org/10.18280/ijsdp.200323

Xu, D. (2025). Rural-urban inequality in drinking water accessibility as a socioeconomic outcome in Nigeria. *Utilities Policy*, *93*, 101864. https://doi.org/10.1016/j.jup.2024.101864

Yadav, S., & Verma, S. (2024). Role of Infrastructure Investment Trusts (InvITs) in India's infrastructure development. *European Economic Letters*, *14*(1), 590–602. https://doi.org/10.52783/eel.v14i1.1072

Yang, M., Jiao, M., & Zhang, J. (2022). Spatio-temporal analysis and influencing factors of rural resilience from the perspective of sustainable rural development. *International Journal of Environmental Research and Public Health*, *19*(19), 12294. https://doi.org/10.3390/ijerph191912294

Zhang, Y., Long, H., Ma, L., Tu, S., Li, Y., & Ge, D. (2018). Analysis of rural economic restructuring driven by e-commerce based on the space of flows: The case of Xiaying village in central China. *Journal of Rural Studies*, *63*, 58–67. https://doi.org/10.1016/j.jrurstud.2018.12.001

Zhou, Y., & Gu, H. (2025). Enhancing rural resilience through the rural revitalisation strategy in rural China: Evidence from Wushi Village, Hunan Province. *Journal of Rural Studies*, *114*, 103493. https://doi.org/10.1016/j.jrurstud.2024.103493