Equivalent : Journal Of Economic, Accounting and Management
Vol. 4, No. 2, 2026, Page : 2451-2462
Publisher: CV. Doki Course and Training
E-ISSN: 2985-8089 | P-ISSN: 2986-8777

ARRANGEMENT OF COASTAL SLUMS IN PAGURAWAN VILLAGE, BATU BARA REGENCY

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ARTICLE INFO

Article History
Submission :07/06/2026
Received : 13/06/2026
Revised : 25/06/2026
Accepted : 27/06/2026

Keywords
coastal slums;
slum upgrading;
fishermen community;
WASH;
collaborative governance

ABSTRACT

This study examines the existing conditions of a coastal informal settlement in Pagurawan, Batu Bara Regency, with emphasis on housing quality, basic infrastructure, and environmental sanitation, and formulates an appropriate, context-sensitive upgrading strategy for a fishermen community. A qualitative case-study design was used, combining field observations, document review, and community/stakeholder inputs. The findings indicate multiple, interacting drivers of deprivation: limited access to safe water and sanitation, inadequate drainage and solid waste services, high exposure to coastal hazards (tidal flooding and abrasion), insecure tenure, and constrained household livelihoods. Building on recent evidence from community-based sanitation and slum-upgrading practices in Batu Bara and North Sumatra, the paper proposes a staged upgrading framework: rapid WASH improvements and waste management, climate-adaptive access infrastructure, incremental tenure arrangements, ecosystem-based coastal protection, and livelihood strengthening through cooperative-based value addition. The proposed strategy highlights the need for collaborative governance that aligns municipal programs, community organizations, and private/CSR support to ensure both technical suitability and long-term operation.

Introduction

Coastal settlements often face double vulnerabilities: low housing quality, limited basic services (drinking water, sanitation, drainage, and waste), and exposure to coastal hazards such as flash flooding and abrasion. In Indonesia, the slum management agenda is linked to the national target of 100–0–100 and various collaborative platforms, including the Slum-Free City Program (KOTAKU) as part of the National Slum Upgrading Program (The Global Platform for Sustainable Cities, 2020; World Bank, 2020). Technical

Equivalent : Journal Of Economic, Accounting and Management
Vol. 4, No. 2, 2026, 2451-2462

regulations also emphasize the importance of profiling slums, determining locations, and preparing prevention and quality improvement plans (Permen of PUPR No. 14/PRT/M/2018).

Pagurawan Village in Batu Bara Regency is one of the coastal fishing settlements that face various problems of slums, especially related to the quality of houses, limitations of basic services (clean water, sanitation, drainage), and waste management. Studies in Batu Bara show that slum management will be more effective if it strengthens aspects of community participation, concern, and social control in sanitation and environmental management (Harmoko et al., 2024a; Harmoko et al., 2024b; Hidayat et al., 2023; Sipayung et al., 2025). In addition, the issue of uninhabitable houses and tenure issues in coastal areas are often obstacles to housing improvement programs and access to assistance (Aprianto et al., 2025).

On a global scale, informal settlements in coastal areas are growing rapidly in line with the pressures of urbanization, land-use change, and limited access to decent housing. At the same time, coastal areas are experiencing increased risks due to climate change (sea level rise, extreme weather) which increases the frequency of inundation, infrastructure damage, and environmental health risks. Therefore, the agenda for handling coastal slums cannot only be understood as a physical problem of buildings, but also as an issue of resilience and equity in access to basic services (UN-Habitat, 2020; World Bank, 2020).

In the Indonesian context, improving the quality of slums requires a reliable profiling process, evidence-based prioritization, and a management plan that can be operated across sectors. The Minister of Public Works and Public Works Regulation No. 14/PRT/M/2018 emphasizes the prevention and improvement of the quality of slums through indicator assessment, planning, and measurable implementation. However, in coastal areas, technical challenges are often more complex due to water-saturated soil conditions, stilt houses, and tidal dynamics that affect the feasibility of sanitation and drainage technologies.

In addition to the technical aspects, the sustainability of slum management programs is largely determined by local institutional capacity, operation and maintenance (O&M) mechanisms, and the level of citizen participation. Studies in North Sumatra show that the success of sanitation and wastewater services increases when communities are involved from the initiation, development, to routine supervision and financing stages (Hidayat et al., 2023; Harmoko et al., 2024a; Sipayung et al., 2025). These findings are relevant for fishing settlements that have seasonal work patterns and strong social networks, so behavior change strategies and service management need to be designed according to the context.

The gap that often arises in coastal slum management practices is a strategy that is still generic: focusing on physical development without adequately integrating coastal risks, tenure issues, and strengthening livelihoods. In fact, the problem of tenure and uninhabitable houses can hinder access to assistance and affect household incentives to invest in housing and sanitation improvements (Aprianto et al., 2025). Therefore, this study places Pagurawan as a case study to formulate a gradual restructuring framework that combines WASH improvement, adaptive access and drainage, strengthening collaborative governance, and strengthening the local economy.

Problem Formulation and Objectives

The formulation of this research problem includes: (1) how the existing conditions of the coastal slums of Pagurawan from the physical aspects of housing, basic infrastructure, and environmental sanitation; (2) the factors causing slums are reviewed from socio-economic, behavioral, and policy/institutional aspects; and (3) appropriate and sustainable structuring strategies according to the characteristics of the fishing community.

The objectives of this research are: (a) to prepare a profile of existing conditions and priority issues of structuring; (b) identify the main causative factors and their linkages; and (c) formulate a framework for a phased restructuring strategy that promotes service sustainability, coastal risk mitigation, and improved well-being

CONCEPTUAL FRAMEWORK

Slums are generally characterized by limited access to basic services, inadequate housing quality, high density, and vulnerability to health risks and disasters. The practice of slum upgrading emphasizes a gradual and participatory approach—combining infrastructure improvements, institutional strengthening, and livelihood improvement—so that physical investments can be operated and maintained in the long term (Cities Alliance, 2022; UN-Habitat, 2020).

Based on the literature review and field results, the chosen structuring strategy needs to be incremental but measurable, combining physical interventions (basic infrastructure) and non-physical (institutional, behavioral, and financing strengthening), and placing the community as a key actor. Strengthening the role of the community has been proven to have an effect on the sustainability of environmental infrastructure management, especially for wastewater and sanitation (Hidayat et al., 2023; Sipayung et al., 2025), as well as relevant for sustainable water resource governance in rural–coastal contexts (Alfala & Nuraini, 2024).

The main contribution of this manuscript is to develop an operational strategy for the arrangement of Pagurawan's coastal slums (easily reduced to a program) through a combination: (1) mapping of environmental infrastructure priorities; (2) institutional strengthening and participation schemes; and (3) recommendations for gradual implementation based on risks and regional resources. This strategy framework is in line with the findings of the evaluation of the sustainability of slum management programs in similar contexts (Kuntari et al., 2025) and the practices of handling uninhabitable houses in coastal slums (Aprianto et al., 2025).

Research Methodology

This study uses a qualitative case study design to understand the condition of the coastal slums of Pagurawan contextually and formulate an structuring strategy that can be operationalized by the local government and the community. The case study approach was chosen because it allows for an in-depth exploration of the spatial dynamics, behaviors, and institutions in one specific location (Yin, 2018; Nuraini et al, 2024; Nuraini, 2024).

Equivalent : Journal Of Economic, Accounting and Management
Vol. 4, No. 2, 2026, 2451-2462

Location and Scope

The location of the research is in Pagurawan Village, Batu Bara Regency, which is a fishing settlement in the coastal area. The scope of the study includes: (a) the physical condition of the settlement (building quality, road access, drainage, clean water); (b) sanitation and waste conditions; (c) socio-economic and tenure aspects; and (d) slum management governance (programs, actors, and cross-sector coordination). The issue of drainage and its management is an important concern because it intersects directly with inundation, environmental health, and settlement quality (Hartini et al., 2023).

Data collection techniques

Data were collected through: (1) field observations to identify indicators of coastal slums and vulnerability; (2) review of policy documents and related programs (e.g. determination of slum sites and technical guidelines); and (3) limited interviews/FGDs with key informants (representatives of fishermen, village officials, and related OPDs) to explore problem perceptions, sanitation practices, and opportunities for strategy implementation. The use of interviews and FGDs to capture the dynamics of participation and institutions is relevant to studies that emphasize the role of communities in the management of environmental infrastructure and water resources (Hidayat et al., 2023; Alfala & Nuraini, 2024).

Data Analysis Techniques

The analysis was carried out through thematic analysis to summarize the main themes related to existing conditions, causes of slums, and structuring strategy options. The stages include data familiarization, initial coding, theme development, theme review, and narrative preparation of findings (Braun & Clarke, 2021). To maintain credibility, triangulation between sources (observations–documents–interviews) and confirmation of key findings to informants is carried out.

Results and Discussion

Existing Conditions of Pagurawan Coastal Slums

Field findings show that the physical condition of settlements is still dominated by semi-permanent buildings with high density, narrow road access, and drainage that does not function optimally, triggering inundation during high tide or high rainfall. This condition is consistent with the problem of managing urban/peri-urban drainage networks which are influenced by channel capacity, network patterns, and community maintenance behavior (Hartini et al., 2023).

From the aspect of sanitation and waste, some houses still dispose of domestic wastewater directly into the surrounding environment, while waste sorting and transportation practices have not gone well. In the context of wastewater management, the success of infrastructure development and operations is highly determined by the

suitability of technology, management organizations, and community participation commitments (Hidayat et al., 2023; Sipayung et al., 2025). The absence of environmental green open space also reduces the infiltration capacity and micro-environmental quality; strengthening RTH based on ecological functions can be a supporting intervention (Muazro et al., 2025). Table 1 shows the physical condition of the settlement, while table 2 shows the social condition of the community.

Table 1. Summary of the physical condition of the settlement (indicative)

Aspects	Existing conditions (indicative; summary of field observations)
The area of the coastal settlement of Pagurawan	± 15 hectares
Percentage of areas classified as slums	± 45% of the total settlements (based on the classification of light-medium slums)
Building type	60% semi-permanent house, 25% non-permanent (stage on water), 15% permanent
Building density	> 150 units/ha (indication of very high density; need baseline verification and comparison with applicable healthy settlement density standards)
Neighborhood road conditions	70% is in the form of dirt roads/wooden boards, only 30% cement coated
Clean water facilities	55% of people do not have access to PDAM/proper wells
Sanitation system	65% of homes do not have healthy latrines, most of them defecation directly into the sea
Waste management	There is no routine transportation system, 75% of residents throw garbage into the sea / be burned

Table 2. Summary of the socio-economic conditions of the community (indicative)

Variabel	Indicative information (summary of the profile of the local fishing community)
Key livelihoods	72% traditional fishermen, 15% dockworkers, 8% small traders, 5% others
Average monthly income	IDR 1,200,000 – IDR 2,000,000 (Low Income category)
Education level	48% graduated from elementary school, 32% from junior high school, 15% from high school, 5% did not go to school
Land ownership	60% of houses stand on national land / coastal boundaries (not certified)

Source: data processed by the author (2025).

Equivalent : Journal Of Economic, Accounting and Management
Vol. 4, No. 2, 2026, 2451-2462

Housing quality, density, and health-environmental implications

The high density of buildings and the dominance of semi-permanent houses/stilts limit circulation space, increase the risk of fire, and make it difficult to access emergency services and transport garbage. In informal settlements, low density and quality of construction often correlate with increased exposure to water- and vector-borne diseases and decreased quality of life, especially when drinking water and sanitation services are inadequate (UN-Habitat, 2020; World Bank, 2020). In the context of Pagurawan, these conditions have the potential to strengthen the circle of vulnerability: the health burden is increasing, productivity is declining, and households' capacity to invest in housing improvements is increasingly limited.

Neighborhood road access and basic service connectivity

Narrow environmental road access or the use of temporary materials (boards/wood) not only affects the mobility of residents, but also determines the ease of basic services: garbage transportation, fecal vacuuming services, clean water distribution, to ambulance and fire brigade access. A study of transportation infrastructure at the district level shows that improving the quality of access networks can strengthen local economic activity and improve the affordability of public services (Rambe & Nuraini, 2024). Therefore, improving access to coastal slums needs to be positioned as key infrastructure that enables WASH and waste interventions to function more effectively.

Drainage, inundation, and tidal dynamics (rob)

In coastal areas, inundation problems are often triggered by a combination of limited channel capacity, sedimentation, garbage blockage, and backwater effects due to tides. Studies on drainage characteristics and management show that the performance of drainage networks is greatly influenced by maintenance behaviors, network patterns, and channel capacity according to the context (Hartini et al., 2023). The implication is that the handling strategy is not enough with momentary normalization; tidal adaptive drainage design is required (e.g., elevation of access lines, control points/small ponds, and community-based O&M reinforcement) as well as integration with coastal land management to reduce the risk of recurrent inundation (Saifullah et al., 2025).

WASH and waste as a foundation for improving the quality of settlemen

Findings on the limitations of healthy latrines, the discharge of wastewater into the environment, and the absence of a stable waste system show that WASH is the most urgent basic need. The experience of implementing wastewater infrastructure confirms that success is not only in physical development, but also in the selection of appropriate technology (e.g. for stilt houses/high-rise groundwater), the availability of management organizations, and citizen participation in contributions and supervision (Hidayat et al., 2023; Sipayung et al., 2025). In coastal communities, sustainable domestic wastewater management is also directly related to water quality and livelihood sources (catches), so increasing WASH has the potential to provide dual benefits: public health and fishers' economy (Sembiring et al., 2025).

Green open space, infiltration and protection of coastal ecosystems

The limited environmental RTH and the lack of catchment areas strengthen the risk of inundation and reduce the quality of the residential microclimate. Remote sensing-based RTH studies in Coal show the importance of RTH for the ecological function and quality of residential environments (Muazro et al., 2025). In the coastal context, this step needs to be combined with ecosystem protection (e.g. vegetation/mangrove rehabilitation) and coastal land management as part of a risk reduction strategy (Saifullah et al., 2025).

Factors Causing Slums

Slums in Pagurawan are not solely caused by physical factors, but are the result of an interaction of social-economic, behavioral, and institutional factors that reinforce each other.

Socio-economic factors: Fishers' low and fluctuating household income limits their ability to repair homes, build healthy toilets, or pay for basic services. The relatively low level of education also has an impact on access to program information and environmental health literacy.

Behavioral and cultural factors: The practice of dumping garbage and waste into the sea is often seen as a long-standing habit because there are no alternative services available. Behavior change requires a combination of education, appropriate facilities, and community social control mechanisms.

Factors that cause slums identified include: (1) economic pressure and limited housing investment (many houses are unlivable and do not meet health standards); (2) land limitations and tenure issues; (3) low access to basic services; and (4) weak coordination of cross-sector programs. In terms of infrastructure, accessibility and quality of road networks affect economic activities and the ease of basic services (Rambe & Nuraini, 2024). An integrated rejuvenation-based handling pattern (physical-social-environment) as applied in several other areas can be a reference for the preparation of program stages (Pakpahan et al., 2025; Saputra et al., 2025). Studies in Batu Bara show that strengthening community concern/sympathy and citizen involvement from initiation to supervision of facility use can improve the sustainability of sanitation services and reduce dependence on external interventions (Harmoko et al., 2024a).

Analytically, the above factors form the feedback loop. Tenure uncertainty and income limitations reduce the incentives for household investment to improve housing and build decent sanitation. When basic services are not available, the health burden and indirect costs (e.g. lost working days) increase, which in turn perpetuates economic vulnerability. This pattern explains why a single intervention (e.g. just road repairs or just housing assistance) is often not enough to sustainably transform slum conditions, as emphasized in slum upgrading practices that demand an integrated physical-social-institutional package (Cities Alliance, 2022; UN-Habitat, 2020).

In terms of tenure, the proportion of housing on state land/coastal borders has direct implications for the eligibility of aid recipients and investment certainty. Studies on the handling of uninhabitable houses in coastal slums show that the legality/tenure aspect is often an administrative as well as technical obstacle, so a more realistic approach is an incremental tenure certainty scheme (e.g. data collection, limited recognition, or

Equivalent : Journal Of Economic, Accounting and Management
Vol. 4, No. 2, 2026, 2451-2462

consolidation) that is mutually agreed upon and aligned with the spatial plan (Aprianto et al., 2025).
At the institutional level, a common challenge is the fragmentation of programs across OPDs (housing-settlements, PU, environment, health, social) and limitations of post-construction O&M mechanisms. Evaluation of the sustainability of slum management programs in a similar context confirms that social (ownership, contributions, maintenance SOPs) and ecological aspects (pollution load reduction, infiltration, coastal protection) need to be designed from the outset as part of the intervention package, rather than added after the project is completed (Kuntari et al., 2025; Hidayat et al., 2023).
The vulnerability of coastal hazards (rob/abrasion) also strengthens slums through repeated infrastructure damage and increased maintenance costs. Therefore, slum management in Pagurawan needs to combine the improvement of basic services with coastal land management and ecosystem strengthening as a risk reduction strategy (Saifullah et al., 2025), as well as considering the principle of adaptive housing development in disaster-prone areas (Pangathousands et al., 2025).

Sustainable Coastal Slum Planning Strategy

The proposed restructuring strategy emphasizes the principle of incremental upgrading with priority on basic infrastructure, improving housing quality, and strengthening governance. This recommendation is in line with the findings of the evaluation of the sustainability of slum management programs that require a combination of physical interventions and socio-institutional strengthening (Kuntari et al., 2025), as well as practices to handle uninhabitable houses in coastal slums (Aprianto et al., 2025). The integrated rejuvenation pattern—which combines infrastructure improvement, building improvement, and increased environmental awareness—can be adapted to Pagurawan (Pakpahan et al., 2025; Saputra et al., 2025). In addition, aspects of disaster mitigation/coastal vulnerability need to be integrated in the design of home and infrastructure improvements, referring to the study of residential conditions in disaster-prone areas (Pangathousands et al., 2025). Strengthening environmental green open space and catchment is also recommended as part of improving environmental quality (Muazro et al., 2025).

Table 3. A step-by-step structuring strategy matrix

Time horizon	Focus of the intervention	Examples of priority activities	Key actors & funding schemes
0–12 bulan (quick wins)	Quick repair of WASH and waste	Mapping of critical points; communal latrines/septic or biofilter systems that are suitable for stilt houses; strengthening	Kelurahan–DLH–Perkim Office; KSM/fishermen's groups; CSR support and village funds/DAU (initial operation)

		waste collection services (schedules, collection points/TPS); Community-based behavior campaigns	
1–3 years (consolidated)	Tidal access and adaptation infrastructure	Improvement of modular/rob-resistant environmental roads; drainage and connectivity of evacuation routes; increased access to clean water; dues-based O&M management system and SOPs	Public Works and Public Works Office; PDAM; community; KOTAKU/DAK program collaboration; CSR (material)
3–5 years (sustainability)	Coastal spatial planning, tenure, and economic strengthening	Incremental tenure certainty scheme/safe zone arrangement; incentive-based limited relocation for high-risk zones; mangrove rehabilitation/coastal vegetation and coastal protection; Strengthening cooperatives and the value chain of marine products	Related Regional Governments-BPN-OPDs; fishermen's cooperatives; coastal rehabilitation programs; business partnerships/CSR and grants

Note: the strategy needs to be adjusted to the results of technical verification and citizen agreement. Coastal land management and ecosystem strengthening have been highlighted as important factors in risk reduction and improvement of the quality of coastal settlements (Saifullah et al., 2025).

Equivalent : Journal Of Economic, Accounting and Management
Vol. 4, No. 2, 2026, 2451-2462

In implementation, a community-based sanitation approach that places residents as the main actors—from initiation, development, to supervision—can strengthen a sense of belonging and ensure the sustainability of services (Harmoko et al., 2024a).

Principles of risk-based staging and prioritization

A phased approach was chosen to reduce the risk of project failure in the context of informal settlements. The 0–12 months (quick wins) phase is focused on services whose impact is felt quickly (drinking water, sanitation, waste, and basic access) in order to build trust and institutional readiness of citizens. The 1-3 year phase is directed at the consolidation of the access and adaptive drainage network of rob, because this infrastructure is a prerequisite for the proper functioning of waste services and wastewater management. The 3–5-year phase emphasizes incremental tenure certainty, coastal protection, and economic strength—components that determine the long-term sustainability of physical investment (World Bank, 2020; Kuntari et al., 2025).

Specifications of realistic WASH and waste strategies for coastal settlements

Because some dwellings are stilt houses and have limited land resources, WASH technology options need to be adjusted: (i) the development of healthy latrines through individual units in possible clusters, and (ii) communal solutions (communal septic/biofilters, or environmental-scale centralized systems) in densely populated locations. Successful implementation requires the establishment of a management organization, O&M SOP, and a transparent contribution mechanism, in line with the findings of a participation-based wastewater infrastructure management study (Hidayat et al., 2023; Sipayung et al., 2025). For waste, strengthening gathering points/polling stations, transportation schedules, and behavioral campaigns must run in parallel; Without regular service, behavioral changes are less likely to last.

Collaborative governance, financing, and sustainability of services

The implementation of the strategy requires clear collaborative governance: local governments establish program frameworks, technical standards, and budgeting; Technical OPD ensures design and construction quality; urban villages and citizens' organizations (KSM/fishermen's groups) are responsible for daily management and social supervision; while private/CSR support can close the funding gap for materials, equipment, and capacity building. Community-based research in Batu Bara shows that citizen involvement from the initiation stage to supervision of the use of facilities strengthens a sense of belonging and increases the sustainability of services (Harmoko et al., 2024a).

Monitoring indicators and further research agenda

In order for the strategy to be evaluated, minimum indicators need to be established from the outset, for example: the percentage of households with access to decent drinking water; the percentage of households with healthy latrines/wastewater management services; the frequency of inundation at a critical point; the scope of waste transportation services; as well as the level of compliance with contributions and the implementation of maintenance SOPs. Given that the table of existing conditions is indicative, follow-up studies need to conduct quantitative baseline surveys to validate erosion indicators, map risk points of erosion/abrasion, and develop life-cycle cost estimates for intervention options.

Conclusion

Based on the results of the analysis, the coastal slums of Pagurawan require an arrangement strategy that focuses on improving environmental infrastructure (roads, drainage, sanitation, clean water), improving housing quality, and strengthening participation-based governance. Implementation is recommended to be carried out in stages with priority at the highest risk point, accompanied by maintenance mechanisms and social supervision so that the sustainability of services is maintained. This recommendation is consistent with the research findings of Cut Nuraini and collaborators regarding the sustainability of slum management programs, strengthening the role of communities in environmental infrastructure management, and slum rejuvenation patterns (Hidayat et al., 2023; Kuntari et al., 2025; Pakpahan et al., 2025; Saputra et al., 2025).

The limitation of this study is the use of indicative data for initial mapping. Follow-up research is recommended to conduct quantitative baseline surveys (density, service access, water quality, and coastal risk) as well as technical–cost feasibility tests of priority intervention options.

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Equivalent : Journal Of Economic, Accounting and Management
Vol. 4, No. 2, 2026, 2451-2462

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