PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 23 ISSUE 2 (2025), Page 56 – 70

AGILE URBAN DYNAMICS: EXAMINING HOUSING CHARACTERISTICS IN THE SLUMS OF BELAWAN BAHARI, MEDAN-INDONESIA

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Abstract

Rapid urbanisation in Medan, particularly in the Belawan Bahari district, has catalysed the emergence of slum settlements, requiring an in-depth exploration of housing dynamics. This research employs qualitative methods, including site observations, interviews, and community engagement, to examine the structural, infrastructural, and social factors shaping housing conditions in the slum residences of Belawan Bahari. It analyses construction practices, materials, and structural integrity alongside essential amenities such as water, sanitation, and electricity. Additionally, it investigates community structures, social interactions, and shared spaces, providing a comprehensive view of the area's social fabric. This agile approach aims to inform targeted interventions, enhancing residents' quality of life. Expected outcomes include a detailed understanding of housing characteristics, offering insights for urban planners, policymakers, and community organisations. Findings are intended to guide adaptive interventions that address local challenges and utilise existing strengths, contributing to a resilient urban environment in Belawan Bahari, Medan, Indonesia.

Keywords: Agile Urban Dynamics, Housing Characteristics, Slum Residences, Medan-Indonesia

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INTRODUCTION

Rapid urbanisation is transforming cities globally, and Medan, Indonesia, particularly in the Belawan Bahari district, is no exception (Hana & Pujiati, 2023). This swift growth has spurred the development of slum settlements characterised by substandard housing, limited access to essential services, and precarious living conditions, presenting challenges and opportunities for urban planners and policymakers (UN HABITAT, 2020). In response, "agile urban development" emerges as a critical approach, advocating for flexibility, responsiveness, and iterative adjustments to meet urbanization's dynamic and unpredictable nature (Munro, 2015). This model enables planners to implement solutions iteratively, continually integrating stakeholder feedback and adapting strategies to evolving needs. This is particularly pertinent in rapidly growing slum areas like Belawan Bahari, where socio-economic conditions, housing needs, and infrastructure demands shift rapidly (Eren, 2017).

The Belawan Bahari district exemplifies the complexities of informal settlements growth amidst rapid population increases (Rahmad et al., 2017). Its proximity to port and industrial zones has attracted a large migrant population, leading to the spontaneous formation of slums with limited infrastructure such as clean water, sanitation, and electricity, exacerbating social and economic inequalities (Bagheri, 2013). Yet, these communities exhibit a notable capacity for self-organiation, adapting to socio-economic pressures through dynamic, bottom-up processes. As Zappulla et al. (2014) note, slums are "unstable systems in continuous transformation," forming complex spatial arrangements that reflect adaptive survival strategies. In Belawan Bahari, dense housing and resourceful adaptations reveal the community's resilience, underscoring the need for inclusive strategies that both address residents' needs and leverage their inherent adaptability.

This study is grounded in agile urban development principles that stress flexibility, adaptability, and responsiveness to urban challenges, especially within slum settlements (World Economic Forum, 2016). Inspired by agile project management, these principles encourage stakeholder collaboration and continuous feedback to tackle complex urban issues (Daraojimba et al., 2024). As Russell (2011) highlights in The Agile City, agility in urban planning enables cities to swiftly modify infrastructure, buildings, and community layouts to reduce carbon emissions and boost resilience. Such an approach is particularly relevant in slum contexts, where residents face diverse and evolving challenges that demand responsive, co-created solutions (World Bank, 2021). Resilience has become increasingly integral to urban planning. A bibliometric analysis by Zuraidi et al. (2021, 2022) reveals that themes such as climate change, sustainability, and spatial planning are central to resilience research and critical in addressing vulnerabilities. By integrating agile and resilience-focused

strategies, urban planners can revitalise outdated housing, transport, and resource management systems through participatory approaches, fostering sustainable growth, socio-economic opportunities, and enhanced adaptability for vulnerable communities.

Building on this foundation, this study examines housing characteristics in Belawan Bahari's slum residences, focusing on structural, infrastructural, and social dynamics. Through observations, interviews, and community engagement, it investigates construction techniques, material quality, structural integrity, and access to essential amenities such as water, sanitation, and electricity. The study also explores community structures and shared spaces to understand the local social fabric. By applying agile principles, it aims to inform targeted interventions and policies that improve living conditions, enhance resilience, and guide future urban development efforts.

RESEARCH METHODOLOGY

This study focuses on Belawan Bahari Village in Medan Belawan District, Indonesia, a rapidly urbanising area of 230 hectares where slum settlements are emerging (Figure 1).

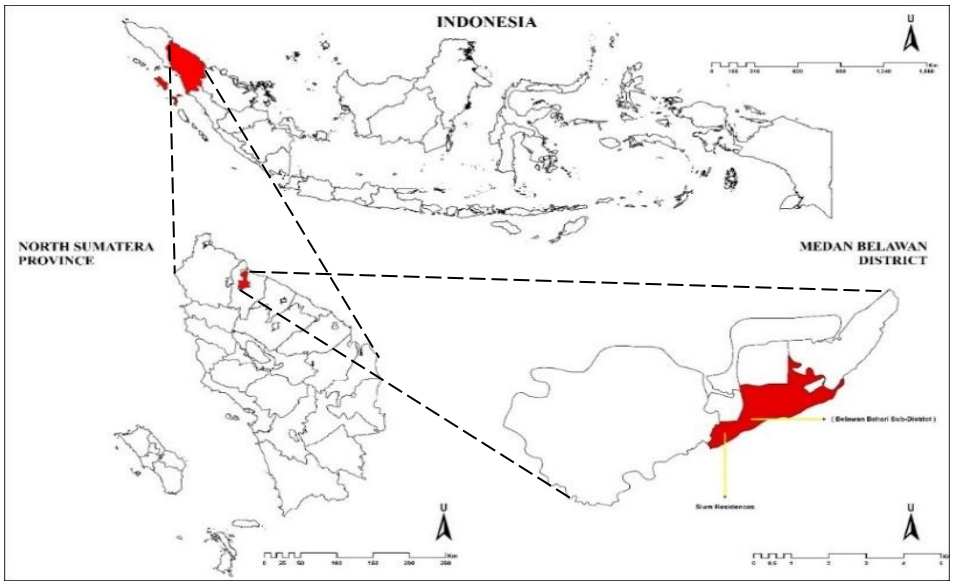

Figure 1: Study Location: Belawan Bahari Sub-district, Medan, Indonesia

Selected for its representative urban growth and informal settlement patterns, the village, home to 13,373 people across 3,069 families in 13 neighbourhoods ("Lingkungan") (Bureau of Statistic of Medan City, 2024),

serves as a case study of housing dynamics. The research concentrates on Lingkungan VIII to examine structural, infrastructural, and social dimensions of slum housing. Structural aspects, such as construction methods and materials, affect safety and resilience yet remain constrained by limited resources (Killemsetty, 2021). Infrastructural issues, including inconsistent access to water, sanitation, and electricity, further intensify socio-economic inequalities (Oskam et al., 2021). Social dynamics, including neighbourhood ties and collective action, enhance resilience through resource-sharing networks (Aldrich & Meyer, 2015). Data collection involved site visits, interviews with residents and leaders, and participatory mapping to document local knowledge and priorities (Table 1). Employing purposive sampling and thematic analysis, the study identified recurring patterns that provide a strong foundation for agile, targeted interventions (Nowell et al., 2017). Agile principles underpin this process, allowing iterative data collection, real-time adjustments to research priorities, and adaptability to evolving insights (Andriyani et al., 2024).

Table 1 presents a sample of 45 individuals, predominantly male (67%) with females comprising 33%. The average age is 47.3 years, ranging from 23 to 74, indicating a predominantly mature demographic. Educational attainment is modest: 56% have completed middle school, 42% primary school, and only 2% have a high school education. Fishing is the primary occupation, involving 67% of individuals and underscoring its economic significance within the community. Additionally, 13% work in dried fish processing, while 9% are housewives. A smaller segment is economically dependent on family support, with 7% relying on children, 2% on parents, and 2% employed in sales. This profile reflects a community with limited educational advancement, a strong reliance on fishing, and a socio-economic structure sustained by artisanal work and family-based economic support.

Table 1: Respondent Profile

No.	Gender	Age	Education	Occupation
Respondent 1	M	69	Primary School	Fisherman
Respondent 2	M	46	Middle School	Fisherman
Respondent 3	M	60	Primary School	Fisherman
Respondent 4	M	57	Middle School	Fisherman
Respondent 5	M	37	Middle School	Fisherman
Respondent 6	M	45	Primary School	Fisherman
Respondent 7	M	53	Middle School	Fisherman
Respondent 8	F	40	Middle School	Housewife
Respondent 9	F	32	Middle School	Housewife
Respondent 10	F	49	Middle School	Dried Fish Artisan
Respondent 11	M	50	Primary School	Fisherman
Respondent 12	M	47	Middle School	Fisherman
Respondent 13	M	32	High School	Fisherman
Respondent 14	F	68	Primary School	Dependent on child

No.	Gender	Age	Education	Occupation
Respondent 15	F	46	Middle School	Dried Fish Artisan
Respondent 16	M	57	Middle School	Fisherman
Respondent 17	M	66	Primary School	Fisherman
Respondent 18	F	70	Primary School	Dependent on child
Respondent 19	F	74	Primary School	Dependent on child
Respondent 20	M	49	Middle School	Fisherman
Respondent 21	F	48	Middle School	Housewife
Respondent 22	F	37	Middle School	Housewife
Respondent 23	F	50	Primary School	Dried Fish Artisan
Respondent 24	M	52	Middle School	Fisherman
Respondent 25	M	48	Middle School	Fisherman
Respondent 26	M	53	Primary School	Fisherman
Respondent 27	F	23	Middle School	Dependent on parents
Respondent 28	F	54	Primary School	Dried Fish Artisan
Respondent 29	M	66	Primary School	Fisherman
Respondent 30	M	44	Middle School	Fisherman
Respondent 31	M	66	Primary School	Fisherman
Respondent 32	F	45	Primary School	Sales
Respondent 33	M	30	Middle School	Fisherman
Respondent 34	F	43	Middle School	Dried Fish Artisan
Respondent 35	M	57	Primary School	Fisherman
Respondent 36	M	28	Middle School	Fisherman
Respondent 37	M	34	Middle School	Fisherman
Respondent 38	M	45	Middle School	Fisherman
Respondent 39	M	34	Middle School	Fisherman
Respondent 40	M	43	Middle School	Fisherman
Respondent 41	M	59	Primary School	Fisherman
Respondent 42	M	24	Middle School	Fisherman
Respondent 43	F	26	Primary School	Dried Fish Artisan
Respondent 44	M	44	Primary School	Fisherman
Respondent 45	M	27	Primary School	Fisherman

ANALYSIS AND DISCUSSION

This section discusses the general profile of slum residences in the study area, followed by a detailed examination of the structural, infrastructural, and social dynamics that shape housing conditions in these settlements. It also explores the implications of these findings for urban development and policymaking (Table 2).

Housing Profile of Slum Residences

The housing profile in Belawan Bahari's slum residences highlights critical aspects of the built environment, spatial organisation, and socio-economic dynamics (Table 2).

Table 2: Housing Profile of Slum Residences in Belawan Bahari, Medan

Items	Descriptions
House Type	Stilt houses with plank floors are designed to prevent waterlogging from frequent tidal flooding.
House layout	Consists of one bedroom, a multipurpose common room, and a small bathroom.
House Size	60% of respondents reside in houses measuring between 60 m² - 100 m², while the remaining 30% occupy homes ranging from 10 m² - 50 m².
Residents in 1 house	4 to 6 people
Land Ownership	property rights and use rights.
Spatial structure of neighbourhood	The lack of institutionalised spatial planning has led to unregulated housing construction, resulting in densely packed homes that heighten the risk of fire hazards.
Buildings Distance	The building density and designation are very high (0.5m – 2 m) apart.
Settlement pattern	The settlement follows a linear pattern, with dense housing flanking both sides of the road.
Shared space	Residents utilise the available space to dry sea products, such as salted fish, with limited land preventing the creation of green open spaces.

Most homes are stilt houses with plank floors, designed to mitigate flooding during high tides. These structures range from 10 m² to 100 m² and typically house 4 to 6 residents (Figure 2a). The homes are compact, typically consisting of a single bedroom, a multipurpose common room, and a small bathroom. The absence of formal spatial planning has resulted in densely packed housing, with gaps as narrow as 0.5m to 2m, increasing fire risks and limiting emergency access. A resident recounted, *"When a fire broke out, it spread so quickly that no one could help. The spaces are just too tight."* Land ownership is diverse, with some residents holding formal property rights, providing a degree of stability, while others rely on informal use rights, facing ongoing uncertainty and vulnerability. One resident shared, *"We live here because my grandfather used this land for years, but without papers, there's always fear."* Informal land transactions are based largely on trust and personal relationships, as a community leader remarked, *"Without documents, it's all about knowing who to talk to and building trust."* These dynamics underscore the significant challenges of ensuring tenure security and promoting long-term settlement stability.

Figure 2: Housing Environment (a. Stilts house with plank floor; b. House Structure; c. Road Condition; d. Shared space)

Structural Dynamics of Slum Residences

Through site observations, interviews, and community engagement, a nuanced understanding of the structural dynamics within the slum settlements of Belawan Bahari emerged. These dynamics of slum residences encompass several key aspects vital to understanding the built environment of these informal settlements. This section explores three critical components: construction methods and techniques, materials used in slum housing, and an assessment of structural integrity (Figure 2a dan 2b).

Construction Methods and Techniques

In Belawan Bahari, construction methods reflect the informal nature of the settlements, with most homes built using salvaged materials, wood, and corrugated metal sheets. These ad-hoc techniques, including bricklaying, timber framing, and metal sheet roofing, result in semi-permanent structures that often lack durability (Table 2). Observations of brittle, poorly maintained walls and makeshift roof reinforcements highlight significant structural vulnerabilities, particularly in high-risk environments such as flood-prone areas (Killemsetty, 2021). These findings align with studies from Kibera, Nairobi, and Dharavi, Mumbai, where informal construction relies heavily on locally available materials and labour (UN HABITAT, 2017). However, unlike Kibera, where mud-based walls and tin roofing dominate, Belawan Bahari's reliance on timber framing and metal sheets reflects adaptation to coastal conditions and the need for mobility in case of relocation. This underscores the site-specific responses to environmental constraints, illustrating the diverse construction strategies employed in slums worldwide.

Materials Used in Slum Housing

The materials used in Belawan Bahari reflect a trade-off between affordability and structural resilience (Table 2). Common materials, such as corrugated metal

sheets, salvaged wood, boards, plywood, and plaster, offer cost-effectiveness but raise concerns about long-term durability. For example, wooden frames with zinc sheet roofing provide basic shelter but lack robustness against natural disasters like high tides or strong winds. Similar trends are observed in informal settlements in Phnom Penh, Cambodia, where cost-effective materials dominate due to financial constraints (Alshubiri & Al Ani, 2024).

Table 3: Observation Checklist for Housing Dynamics in Slum Residences

Observation Aspects	Field Notes
Structural Dynamics	
Construction methods and techniques of housing	Semi-permanent buildings with walls that have become brittle due to age and lack of maintenance.
Materials used in slum housing	The roof structure consists of a simple wooden frame with a zinc sheet covering, while the walls are constructed using boards, plywood, and plaster
The structural integrity of the housing	Many buildings in the settlement show signs of structural instability, including corroded foundations, porous roofs, water leaks, wall cracks, and sagging roofs, indicating widespread structural weaknesses.
Infrastructural Dynamics	
Water supply	Clean water networks are not yet available to all homes.
Sanitation facilities	Available for every home
Electricity	The electrical network is available but suffers from an unreliable supply, high costs, and safety risks due to makeshift wiring.
Waste management system	There are no trash facilities available, leading to indiscriminate disposal of waste.
Road network	The road network is accessible but is partially damaged due to frequent tidal flooding.
Social Dynamics	
Community structure and organisation	Neighbourhood committees
Interpersonal relationships and social networks	In these communities, social ties often extend beyond immediate family members to include neighbours, friends, and acquaintances.

Structural Integrity

The examination of structural integrity in Belawan Bahari's slum settlements revealed a range of housing conditions, from well-maintained buildings with reinforced foundations to deteriorating structures showing signs of instability (Figure 2b). While some homes were built with solid roofing and reinforced foundations to reduce disaster risks, many exhibited signs of decay, including rusted materials, water leaks, wall cracks, and sagging roofs, highlighting significant structural weaknesses. Additionally, residents expressed concerns about the safety of their homes, particularly during natural disasters when

structural damage heightens their vulnerability. Community engagement activities, such as participatory mapping, facilitated discussions on potential solutions to address these vulnerabilities, emphasising the importance of community-led initiatives and stakeholder collaboration to reinforce housing structures and enhance disaster resilience (Zuraidi et al., 2023).

Infrastructural Dynamics

The quality of housing in slum settlements is profoundly impacted by the availability and accessibility of essential amenities. This section examines how infrastructure, particularly water supply, sanitation facilities, electricity, waste management, and the road network, affects housing conditions within the context of Belawan Bahari's informal settlements (Figure 3).

Water Supply

In Belawan Bahari, residents face disparities in water access, characterised by irregular supply, poor water quality, and the financial burden of purchasing water. These challenges mirror findings in Lagos, Nigeria, where slum residents rely on vendors due to the inadequacy of public water systems (Oskam et al., 2021). A unique feature of Belawan Bahari is the use of participatory mapping exercises, which revealed collective concerns and calls for action. This highlights an emerging trend in community-driven approaches to addressing water scarcity, aligning with the objectives of Sustainable Development Goal 6.

Figure 3: The infrastructure dynamics (water supply, sanitation facilities, electricity, waste management system, road network)

Sanitation Facilities

Sanitation in Belawan Bahari shows a positive aspect in the availability of toilet, a notable improvement compared to settlements in Sub-Saharan Africa, where open defecation remains common due to a lack of facilities (Aladelokun & Ayiti,

2023). However, challenges related to functionality, maintenance, and hygiene persist, reflecting issues reported in settlements in Jakarta, Indonesia, where poorly maintained toilets pose significant public health risks (Ferianto & Widodo, 2024). A distinguishing feature in Belawan Bahari is the presence of basic sanitation infrastructure, though it lacks effective community-led management systems. This highlights the potential for targeted investment and community-driven maintenance programs to improve hygiene standards.

Electricity

While Belawan Bahari benefits from a functioning electricity network, challenges such as unreliable supply, high costs, and safety hazards from makeshift wiring are prevalent in informal settlements globally (Table 2). Similar issues are reported in Cape Town, South Africa, where illegal connections result in frequent outages and safety risks (Jefferson, 2015). Unlike settlements like Kibera, Nairobi, where access to electricity remains a significant barrier, Belawan Bahari has better electricity infrastructure but still suffers from inefficiencies. A unique opportunity exists in fostering community-led sustainable energy initiatives, which could help address concerns related to affordability and reliability.

Waste Management System

The absence of waste management infrastructure in Belawan Bahari results in indiscriminate disposal, posing significant environmental and health risks (Figure 2c). This mirrors findings from Addis Ababa, Ethiopia, where inadequate waste management in slums exacerbates pollution and disease outbreaks (Eshete et al., 2024). However, Belawan Bahari's reliance on ad-hoc disposal methods is less structured compared to waste-picking systems in settlements like Rocinha, Brazil, where informal recycling networks help reduce waste (Arcidiacono et al., 2017). The findings emphasise the urgency for designated waste disposal systems and awareness campaigns, in line with best practices from other settlements that integrate informal waste collectors into formal systems.

Road network

The road network in Belawan Bahari, while present, is vulnerable to frequent tidal floods, which compromise mobility and access (Figure 4). This issue is consistent with studies in Jakarta, where slum roads are regularly affected by flooding, hindering transportation and economic activity (Gomez-Cunya et al., 2020). However, unlike settlements in Dhaka, Bangladesh, where road quality varies based on proximity to formal neighbourhoods, the road conditions in Belawan Bahari are uniformly poor, with tidal floods being the primary environmental stressor (Martín et al., 2021). Investment in flood-resilient road

infrastructure, such as raised and reinforced pathways, would improve mobility and reduce the environmental impacts.

Social Dynamics

Understanding the social dynamics within slum residences is essential for gaining insight into the community fabric and interpersonal relationships that shape daily life in informal settlements. This section explores three key aspects: community structures and organiations, interpersonal relationships and social networks, and the analysis of shared spaces.

Community Structures and Organizations

Site visits revealed the presence of various community structures and organisations in Belawan Bahari, including informal leadership and neighbourhood committees, which play crucial roles in fostering social cohesion and collective action. Informal leaders, often referred to as *"tokoh masyarakat"* (community figures), are influential in coordinating initiatives and advocating for better living conditions. One resident stated, *"Pak Ali always organises us when there's a need—whether for cleaning the drains or addressing our concerns to the local government."* This mirrors findings from studies in Kibera, Nairobi, where informal leaders and grassroots organisations play a significant role in community development and conflict resolution (UN HABITAT, 2020).

Interpersonal relationships and social networks

Semi-structured interviews with residents revealed the deep interpersonal relationships and social networks that underpin daily life in Belawan Bahari. Residents emphasised the importance of community support, which extends beyond family to include neighbours and friends. As one resident explained, *"When we face challenges, it's not just our family we turn to. Our neighbours are like family here."* These networks provide critical support in the absence of formal infrastructure, enabling residents to access resources and services while fostering resilience (Aldrich & Meyer, 2015). Belawan Bahari's reliance on extended social networks for support during crises mirrors a common trend in slum settlements worldwide. For example, in favelas in Rio de Janeiro, Brazil, Perlman (2010) found that residents depend heavily on informal social networks for access to resources and emotional support. What distinguishes Belawan Bahari, however, is that mutual assistance often extends to shared physical labour, such as collaborative roof-building or drainage cleaning, as well as the sharing of food or childcare responsibilities. This cooperation reinforces social bonds and helps residents cope with socio-economic constraints. As one respondent shared, *"When I needed help building a roof, my neighbours came without hesitation. We always help each other."*

Shared spaces

Participatory mapping activities highlighted the importance of shared spaces in Belawan Bahari (Table 2). Communal areas, such as courtyards, serve multiple functions - providing spaces for drying sea products like salted fish (Figure 2d) and hosting various community gatherings. This aligns with findings from studies on Kampung settlements in Yogyakarta, Indonesia, where community spaces play a central role in daily life (Ferianto & Widodo, 2024). However, the absence of green spaces limits recreational opportunities for residents. Residents expressed a deep connection to these communal spaces, seeing them as essential for fostering social cohesion and community interaction. As one participant shared, "*This courtyard is not just for work; it's where we meet, talk, and support each other."* The engagement process also revealed aspirations for improving shared spaces, fostering collaboration, and encouraging a sense of ownership over community initiatives (Zuraidi et al., 2023). By voicing their concerns and ideas, residents demonstrated a strong desire to enhance communal areas to better support their needs and interactions.

Integration of Agile Principles

Integrating agile principles provides a flexible and adaptive framework to address the complex challenges in slum settlements like Belawan Bahari. Agile methodologies, with their focus on collaboration, iterative problem-solving, and real-time responsiveness, align well with the shifting dynamics of informal settlements. Studies indicate that participatory approaches can build trust and ensure that solutions are tailored to local contexts. Practical strategies include upgrading essential infrastructure, such as improving drainage, waste management, and fire safety, with participatory planning to capture residents' priorities. Modular housing designs, inspired by Turner's (1972) incremental housing model, allow for phased construction, enabling families to expand and adapt their homes as needed. Social empowerment initiatives, such as skill centers and cooperatives, further reduce dependency and foster self-reliance (Malta, 2023). Formalising land tenure policies is also critical, as social tenure encourages residents to invest in home improvements without the risk of displacement, supporting sustainable urban development (Killemsetty, 2021). By integrating structural, infrastructural, and social interventions, these agile strategies support a responsive and resilient development pathway for Belawan Bahari.

CONCLUSION

Research conducted in Belawan Bahari's slum settlements offers critical insights into the complex interplay between housing characteristics, infrastructure, and social dynamics in informal urban environments. Key findings reveal how these

interconnected elements shape housing conditions and underscore the need for agile methodologies to address their inherent challenges. Through qualitative approaches such as site observations, interviews, and participatory community engagement, the study uncovers these interdependencies, establishing a foundation for informed, targeted interventions aimed at improving resilience and quality of life. The results highlight the limitations of traditional urban development approaches in addressing the distinct needs of slum communities, suggesting that more flexible, context-specific methods are essential. Agile strategies, particularly those that integrate community involvement, are well-suited to the dynamic nature of informal settlements, supporting efforts to enhance access to essential services, infrastructure, livelihood opportunities, and social inclusion. Moving forward, these findings advocate for collaborative partnerships between government bodies, civil society, and local communities, co-developing sustainable and resilient development strategies that can drive meaningful, long-term transformation.

ACKNOWLEDGMENT

The authors sincerely thank Universitas Negeri Medan and Universitas Syiah Kuala for their support. We also appreciate the cooperation of the Belawan Bahari community and local authorities, whose insights were invaluable to this study. Special thanks to all who contributed to this research.

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Received: 7th December 2024. Accepted: 5th March 2025

