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Research Article

PHYSICAL TRANSFORMATION OF FLOATING HOUSES AND AHP-BASED POLICY PRIORITIES FOR WATER SETTLEMENT MANAGEMENT IN KAMPUNG AWANG LANDAS

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Abstract

Floating-house settlements (rumah lanting) in Kampung Awang Landas remain an adaptive form of water-based housing but face physical deterioration, limited basic services, and weak policy recognition. This study examined the physical transformation of rumah lanting and identified management priorities using a sequential exploratory mixed-methods design. Qualitative exploration involved 15 informants, comprising 12 floating-house residents, two government officials, and one community elder. The subsequent assessment covered all 18 floating-house units and used Analytic Hierarchy Process (AHP) judgments from three purposively selected experts. Qualitative and observational findings were used to formulate four AHP criteria and 16 subcriteria. The results showed that 50.0% of units were in moderate condition and 27.8% were in poor condition, with the most extensive material transformation occurring in roofs and walls. AHP synthesis ranked Institutional and Government Policy as the highest-priority criterion (0.378), followed by Technical-Infrastructure (0.293), Economic-Livelihood (0.206), and Socio-Cultural and Local Wisdom (0.123). The highest-ranked subcriteria were Policy Direction (0.146), Floating-House Legality and Land Tenure Status (0.112), and Basic Utilities (0.098). The study proposes the PPAI framework, comprising Policy, Physical, Access, and Institutional dimensions, as an evidence-informed planning framework for context-sensitive floating-house settlement management in Kampung Awang Landas.

Keywords: Floating-House Settlement, Local Wisdom, Physical Transformation, Water-Based Housing

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INTRODUCTION

Water-based settlements are an important form of socio-ecological adaptation in riverine and wetland environments. Rapoport (1969) explains that dwelling forms are shaped by the interaction between environmental conditions, cultural values, and everyday practices. In central South Kalimantan, floating houses locally known as rumah lanting enable households to remain close to fishing grounds, water-based transport routes, and wetland-dependent livelihoods. Kampung Awang Landas in Sungai Buluh Village, Labuan Amas Utara District, Hulu Sungai Tengah Regency, is one of the remaining actively inhabited floating-house settlements in the region. However, the number of floating houses has declined as land-based infrastructure has expanded and residents increasingly shift toward terrestrial housing.

Floating houses rely on buoyant foundations, floor structures, walls, roofs, and mooring systems that allow dwellings to respond to water-level fluctuations. Prihatmaji and Nugraha (2019) examined the potential application of expanded polystyrene (EPS) floating technology for foundation engineering in Banjarmasin and highlighted the importance of buoyancy and structural stability in water-based housing. In a different setting, Sandhika and Maghzaya (2024) assessed bamboo lanting houses, plastic-drum floating houses, and EPS-based floating houses as flood-mitigation alternatives in Bulungan Regency. Their study shows that the applicability of floating-house technology depends on local housing typologies, material availability, utility integration, safety, maintenance requirements, and local flood conditions.

In Kampung Awang Landas, the sustainability of floating houses is challenged by interconnected physical, service, and institutional problems. Field observations indicate deterioration in buoyant foundations, floors, roofs, and mooring systems, while households have limited financial capacity to undertake major repairs. These physical constraints are compounded by limited access to basic services and by the lack of a housing-policy framework designed specifically for water-based settlements. Existing housing-assistance programmes generally rely on conventional land-based ownership requirements, which may exclude floating-house residents from formal support mechanisms (Kementerian Sosial Republik Indonesia, 2021). This situation creates a policy gap in which socially and culturally legitimate residents remain administratively marginal (Satterthwaite, 2020).

Previous studies have addressed particular aspects of floating-house settlements. Rahman (2014) identified structural deterioration and the need for preservation measures, while Febriyani (2025) showed that the persistence of floating-house communities is influenced by social, economic, and infrastructure conditions. Nurmaningtyas et al. (2026) further demonstrated the value of community-based approaches and local knowledge for managing water settlements. Nevertheless, previous studies have not sufficiently integrated four interconnected dimensions within a single policy analysis: physical building conditions, geospatial settlement configuration, local wisdom and community perspectives, and expert-based policy prioritisation.

This study addresses that gap through a sequential exploratory mixed-methods design. Qualitative interviews, field observation, and document analysis were first used to identify the physical vulnerabilities, livelihood dependence, local knowledge, service needs, and institutional constraints experienced by the floating-house community. These findings informed geospatial mapping of the settlement and the development of an Analytic Hierarchy Process (AHP) hierarchy for expert prioritisation of policy issues. The primary conceptual novelty of this study lies in the integration of physical-condition assessment, geospatial evidence, local wisdom, and AHP-based priorities within one evidence-linked analytical framework. The PPAI Model, defined as Policy, Physical, Access, and Institutional, is the operational output of that integrated framework rather than a separate or unsupported policy claim.

Accordingly, this study aims to: (1) analyse the physical characteristics and material transformation of floating-house building components in Kampung Awang Landas; (2) identify physical, service, access, socio-cultural, and institutional issues based on field and interview evidence; and (3) determine policy priorities for floating-house settlement management using AHP. The study is expected to contribute an evidence-linked framework for inclusive water-settlement management and to provide context-sensitive policy options for Hulu Sungai Tengah Regency.

RESEARCH METHOD

Research Design

This study employed a sequential exploratory mixed-methods design, in which qualitative exploration was conducted first and was followed by quantitative-spatial and decision-analysis phases (Creswell & Clark, 2010). This design was selected because the study required an in-depth understanding of physical transformation, water-based livelihoods, local wisdom, basic-service constraints, and institutional issues affecting floating-house settlements, followed by structured measurement and prioritisation of the identified policy issues (Mertens, 2024).The qualitative phase involved in-depth interviews, participant and non-participant observation, and document analysis. A total of 15 qualitative informants participated in the study, comprising two government officials (OPD01 and OPD02), one local community elder (T01), and 12 active floating-house residents (W01–W12). Interviews explored settlement history, building conditions, material transformation, livelihood dependence, access to basic services, local ecological knowledge, community participation, legality, and policy expectations. All interviews were audio-recorded with participant consent, transcribed verbatim, and analysed using inductive thematic analysis. Informant identities were anonymised to protect privacy and encourage candid responses.

The qualitative findings directly informed the development of the subsequent AHP instrument. First, recurrent themes from interviews, field observations, and document analysis were compiled into an initial issue inventory. Second, the identified issues were reviewed against the physical-condition survey and field observations to retain only issues that were repeatedly reported and empirically observable. Third, the retained issues were organised into four main AHP criteria: Technical-Infrastructure, Economic-Livelihood, Socio-Cultural and Local Wisdom, and Institutional and Government Policy. These criteria were subsequently operationalised into 16 subcriteria, including construction and buoyancy, mooring stability, basic utilities, sanitation, access walkways, livelihood dependence, maintenance costs, social cohesion, river-based local wisdom, legality, community participation, assistance programmes, and policy direction. Accordingly, the AHP hierarchy was derived from qualitative and observational evidence rather than independently imposed before fieldwork.

The quantitative-spatial phase used high-resolution drone imagery, ground GPS surveys, and ArcGIS Pro to map all 18 identified floating-house units, surrounding river space, access walkways, and adjacent settlement conditions. Spatial findings were compared with qualitative accounts to examine the relationship between settlement configuration, physical vulnerability, access conditions, and residents' experiences. The spatial analysis was used primarily to document the current configuration and physical context of the settlement. The AHP assessment was conducted using Expert Choice with three purposively selected experts, coded P01–P03. The expert panel consisted of the Regional Secretary of Hulu Sungai Tengah Regency, a member of the Hulu Sungai Tengah Regency Parliament, and the Head of the Housing, Settlement Areas, and Land Affairs Office of Hulu Sungai Tengah Regency. The inclusion criteria required each expert to hold a formal institutional position or have demonstrated professional experience relevant to regional governance, settlement policy, housing, infrastructure, spatial planning, or land affairs, as well as familiarity with the Hulu Sungai Tengah context.

The three experts were selected to provide complementary executive-administrative, legislative-representative, and technical-sectoral perspectives. The AHP exercise was intended as a purposive expert-elicitation process for establishing local policy priorities, rather than as a statistical survey of all stakeholders. Nevertheless, the limited number of experts is acknowledged as a study limitation; therefore, the results are interpreted as an expert-informed local priority structure and not as a general representation of all stakeholder preferences. Each expert independently completed pairwise comparisons using Saaty's 1–9 scale. Individual judgments were aggregated element by element using the geometric mean, and the aggregated matrices were synthesised in Expert Choice to obtain local and global priorities. Expert Choice reported an inconsistency value for each individual and combined matrix. A matrix was considered acceptable when the reported inconsistency value was below 0.10 (Saaty, 2008). The aggregated pairwise-comparison matrices, derived local priorities, global priorities, and matrix-specific inconsistency values are reported in Tables 6–11.

Data collection and analysis were conducted from September 2025 to May 2026. Initial site familiarisation, preliminary mapping, and qualitative exploration were conducted from September to October 2025. The main fieldwork, including interviews, observation, physical-condition assessment, drone mapping, GPS surveys, and document review, was undertaken from December 2025 to January 2026. Data transcription, thematic analysis, spatial processing, and formulation of the AHP hierarchy were conducted from February to April 2026. Verification and member checking were conducted in April 2026. The three AHP questionnaires were completed in May 2026, followed by integration of the qualitative, spatial, and AHP findings. Data credibility was strengthened through source triangulation across resident, local-community-leader, and government perspectives; method triangulation across interviews, observation, and documents; member checking; and an audit trail documenting the major analytical decisions. Oral and written informed consent were obtained from all qualitative informants before data collection commenced.

Time and Place of Research

The study was carried out in Kampung Awang Landas, Sungai Buluh Village, Labuan Amas Utara District, Hulu Sungai Tengah Regency, South Kalimantan Province. This village is located in a wetland area influenced by tidal fluctuations, with water-level differences of approximately 4-5 m between the rainy and dry seasons and water depths of around 5-6 m during the dry season (Safariansyah, 2012). Access to the area still depends partly on river transportation using jukung or wooden boats, although wooden walkways connecting housing clusters have been constructed. Kampung Awang Landas was selected because it is one of the remaining pockets of actively inhabited floating-house settlements in Hulu Sungai Tengah Regency with a documented number of units. The area represents a critical water-settlement condition that has come under pressure from bridge and road development over the last ten years. Preliminary observations indicated sufficient variation in building conditions to support a comprehensive analysis of material transformation.

The spatial scope of the study covered all 18 identified floating-house units and a 500-meter buffer zone including the network of walkways, small piers, river public spaces, and adjacent stilt houses. Fieldwork was conducted in three intensive visit cycles: September–October 2025 (initial exploration), December 2025–January 2026 (main data collection), and April 2026 (verification and member checking).

Research Target/Subject

The government-official group consisted of two informants coded OPD01 and OPD02. They were interviewed because of their positions and authority in settlement-related issues, but their personal identities are not disclosed in the article. Quotations from these informants are presented as institutional perspectives rather than as personal views. Both OPD informants agreed to be cited in terms of their official positions, as their statements represent the formal policy stance of their respective institutions. Each interview with these informants lasted approximately 75–90 minutes and followed an interview guide focusing on regulations, programs, constraints, and policy vision.

The local-community-leader group comprised one female informant (T01) who is recognized by residents as an elder of the community. T01 has lived in the floating-house area since childhood and holds rich historical knowledge regarding community development, memalas sungai rituals, and intergenerational social dynamics. Her identity is protected in accordance with the consent she provided, reflecting her status as a private individual who does not occupy a formal public office. The active-resident group consisted of 12 informants (W01–W12) selected according to two criteria: they resided permanently in floating-house units at the time of the study and were willing to participate in in-depth interviews. Their demographic characteristics varied in terms of length of residence (15–55 years), origin (native locals and in-migrants), household composition (1–5 members per unit), and livelihood (for example, fishing and small-scale grocery trading). No real names of resident informants are included in this article, in order to protect their privacy in line with social-research ethics principles and the ethical guidelines of Universitas Lambung Mangkurat.

All interviews were conducted face-to-face at the informants' floating houses, enabling the researchers to simultaneously observe the physical condition of the dwellings that formed the context of the interviews. The interviews were conducted in a mixture of Indonesian and Banjar, depending on informant comfort. Interview duration ranged from 45–75 minutes for resident informants and 75–90 minutes for government informants. Audio recordings were made with participants' consent and transcribed verbatim for subsequent analysis.

Research Procedure

The study began with a qualitative phase involving preliminary area mapping, identification of key informants, in-depth interviews, field observation, and document review. Findings from this phase were then used to develop survey indicators and spatial-analysis parameters. The subsequent quantitative phase involved data collection through structured questionnaires, aerial photography using drones, satellite-image interpretation, and GPS surveys to verify the location of floating-house units. All results were then integrated to formulate an evidence-based policy model for floating-house settlement management.

Instruments, and Data Collection Techniques

The qualitative instrument package comprised: (1) a semi-structured interview guide containing 28 open-ended questions covering housing history, physical building conditions, local wisdom, and policy perceptions; (2) an observation checklist with 65 physical and social indicators; and (3) documentation equipment (DSLR camera, audio recorder, and handheld GPS). Geospatial instruments included a DJI Phantom 4 Pro+ drone for aerial photography at a ground resolution of approximately 5 cm per pixel that produced orthophotos, as well as built-in satellite imagery in ArcGIS Pro to support area analysis. Qualitative data collection was conducted through face-to-face in-depth interviews lasting 45–90 minutes per session (Marshall et al., 2022), participant and non-participant observation over a cumulative total of 45 days, and document analysis of village records, RTLH (uninhabitable-house rehabilitation) data, disaster-management agency (BPBD) reports, and spatial-planning documents (RTRW). All interviews were audio-recorded with the informants' consent and transcribed verbatim for thematic analysis using qualitative data-analysis software.

The AHP instrument was structured as a three-level hierarchy comprising the overall goal, four main criteria, and sixteen subcriteria. The four main criteria were Technical–Infrastructure, Economic–Livelihood, Socio-Cultural and Local Wisdom, and Institutional and Government Policy. Each criterion was elaborated into subcriteria representing basic-service needs, structural stability, livelihood security, participation, legality, and policy direction.

Judgments were provided by three experts using Saaty's 1–9 pairwise-comparison scale and processed using specialized software. The AHP questionnaires were administered in focused sessions of 60–90 minutes per expert, guided by the researchers to ensure consistent understanding of the operational definitions of each criterion and alternative. Spatial data collection included drone surveys that generated orthomosaic imagery for an area of approximately 12 hectares, GPS field surveys to verify the coordinates of 18 units, physical-dimension measurements of buildings using a laser distance meter, and photographic documentation of structural components for each unit.

Data Analysis Technique

Qualitative analysis was conducted through transcription, coding, categorization, thematic analysis, and the development of interpretive narratives based on interview, observation, and document data. Quantitative analysis employed descriptive statistics to describe respondent characteristics, housing conditions, and basic services, while spatial analysis was performed through map overlays, digitalization, and the interpretation of multi-temporal imagery. Integration of the two approaches was carried out through triangulation, joint displays, and meta-inference to generate comprehensive conclusions serving as the basis for the floating-house settlement policy model. Qualitative data were analyzed using inductive thematic analysis following the six steps proposed by Braun & Clarke (2006), namely data familiarization, generation of initial codes, development of candidate themes, review and refinement of themes, naming of themes, and construction of an analytical narrative with the support of qualitative data-analysis software. Spatial data were processed in ArcGIS Pro 3.2 through orthorectification of drone imagery and digitization of floating-house units (Lillesand et al., 2015).

AHP analysis was conducted through hierarchy construction, independent completion of pairwise-comparison matrices by the three experts, geometric-mean aggregation of individual judgments, synthesis of local and global priorities in Expert Choice, and assessment of the matrix-specific inconsistency values reported by the software. All combined inconsistency values were below 0.10. Integration of findings was achieved through an integrated synthesis (joint display) that brought together the results of qualitative, spatial, and AHP analyses within a single policy-model framework. The synthesis process referred to Grindle (1980) framework on the content and context of policy implementation and considered Maslow's (1943) hierarchy of needs to assess the alignment of policy alternatives with the basic needs of river-based communities.

The study faced several limitations. The number of AHP experts was limited to three because of the small pool of officials with relevant regency-level competencies. Historical imagery was used only for contextual interpretation because a reproducible multi-temporal land-cover classification and accuracy assessment could not be established. In addition, variation in informants' understanding of policy concepts required further clarification during interviews. These limitations were addressed through source and method triangulation, member checking, and an audit trail of major analytical decisions..

RESULTS AND DISCUSSION

General Physical Condition of Rumah Lanting Settlements

Floating houses in Kampung Awang Landas developed in response to the need of riverine communities to remain close to fishing grounds, water-based mobility, and livelihood activities. Initially, these dwellings served as temporary shelters for fishers; over time, they developed into more permanent residences and formed a distinct settlement community. This trajectory indicates that floating houses should be understood as a socio-ecological adaptation to inundated environments and river-based livelihoods rather than merely as a residual form of informal housing.

The expansion of land-based infrastructure has gradually shifted the spatial orientation of the community from the river towards terrestrial settlement areas. This change has affected perceptions of floating houses, which are increasingly regarded as less secure, less modern, and less compatible with dominant development patterns. Consequently, the symbolic and administrative position of floating-house settlements has weakened.

Field surveys of 18 floating-house units revealed substantial variation in physical conditions. Four units (22.2%) were classified as being in good condition, nine units (50.0%) were in moderate condition, and five units (27.8%) were in poor condition. This distribution indicates that most units require maintenance or rehabilitation. The observed deterioration is associated with limited access to durable local timber, rising material costs, and the constrained capacity of households to finance routine maintenance.

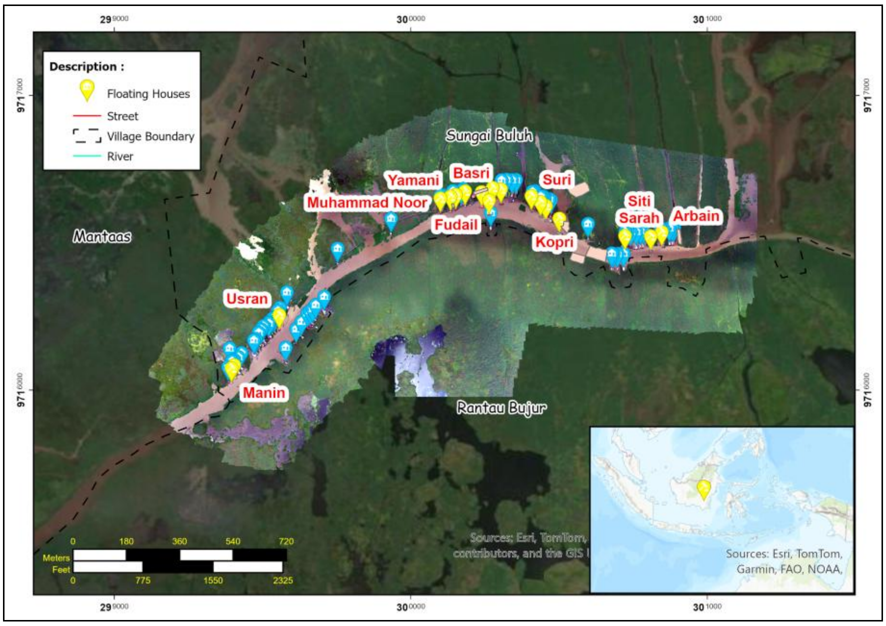

Figure 1. Spatial Distribution of Rumah Lanting in Kampung Awang Landas Based on Drone Imagery Analysis (2025–2026) (source: field survey and ArcGIS Pro)

Drone imagery and field GPS surveys documented the current spatial configuration of all 18 floating-house units. The settlement forms a linear pattern along the main river channel, with three clusters: a western cluster comprising seven units, a central cluster comprising six units, and an eastern cluster comprising five units. Units within each cluster are separated by approximately 2–8 m and are connected by wooden walkways, many of which required repair at the time of observation.

The spatial analysis in this study is limited to documenting the current location of floating-house units, access walkways, adjacent river space, and surrounding settlement conditions. Although historical imagery was reviewed to contextualise observed change, the available data do not provide a reproducible land-cover classification procedure, cloud-screening record, baseline and end-year settlement-area figures, or accuracy-assessment matrix. Therefore, this study does not report a quantified percentage reduction in water-based settlement area. Instead, the decline in the prominence of floating houses is interpreted through the convergence of current mapping, field observation, and interview accounts. Informants W01 and W07 reported that improved bridges and walkways encouraged some residents to construct land-based houses, indicating that infrastructure development has contributed to the gradual reorientation of settlement practices.

Table 1. Physical Condition Distribution of Rumah Lanting Units (n=18)

Physical Component	Good (%)	Moderate (%)	Poor (%)	Total (%)
Foundation (Float Base)	22.2	44.4	33.3	100
Frame Structure	27.8	55.6	16.7	100
Walls	22.2	50.0	27.8	100
Roof	33.3	44.4	22.2	100
Floor	27.8	50.0	22.2	100

Source: Field survey, 2025–2026

Table 1 shows that the foundation component (floating base) has the highest proportion of units in poor condition (33.3%), followed by walls and floors (27.8%). This is consistent with qualitative findings indicating that timber logs used as floating foundations are the most difficult components to replace because of current scarcity and high prices. The condition of the frame structure is relatively better due to the use of ulin wood, which has high durability in water, although several units still exhibit significant decay at the joints. Table 1 also highlights that the floating foundation is the most vulnerable component, given its highest share of poor-condition ratings (33.3%). This finding is important because, in floating houses, the foundation is not merely an ordinary structural element, but the core mechanism that enables the building to remain safely and stably afloat. When the foundation deteriorates, the risk of damage to other components such as floors, wall joints, and the mooring system increases in a cascading manner.

The wall and floor components also show relatively high levels of damage. This indicates that the problem of floating houses is not confined to the lower parts of the building that are in direct contact with water, but also affects the building envelope exposed to humidity, heat, and progressive material change over time. Therefore, rehabilitation of floating houses needs to be understood as an integrated intervention package rather than the isolated replacement of a single damaged component.

Material Transformation of Building Components

Material transformation is the most visible dimension of change in the floating houses of Kampung Awang Landas. This change has not occurred all at once, but has unfolded gradually through several stages: a fully traditional phase, an early hybrid phase, an advanced hybrid phase, and a semi-permanent phase. Each phase reflects an ongoing negotiation between local resource constraints, the need for building durability, and residents’ aspirations for housing that is perceived as more adequate and decent.

At the foundation level, the shift from timber logs to combinations of timber, drums, or other modern elements signals both material and cost pressures. Residents do not typically replace the entire buoyant system at once; instead, they tend to make partial adaptations according to household economic capacity. This pattern indicates that material transformation is incremental, highly pragmatic, and guided by considerations of maintaining the day-to-day functionality of the dwelling.

The most striking transformation has taken place in the roof component. Almost all units have replaced rumbia thatch with galvanized iron sheets or similar materials, primarily for reasons of durability, ease of maintenance, and market availability. However, this material “improvement” does not always translate into an overall enhancement of housing quality, as some modern materials introduce new problems such as increased indoor heat and reduced thermal comfort.

Transformations in walls, floors, and structural joints likewise show a mixture of traditional and contemporary elements. Floating houses can therefore no longer be understood as intact vernacular artefacts; they have become hybrid dwellings that retain the core logic of water-based adaptation while incorporating an increasingly diverse range of materials. This hybridity should be recognized as an empirical reality, not as a deviation from an idealized traditional form.

Table 2. Material Transformation of Rumah Lanting Building Components

Component	Traditional Material	Contemporary Material	Units Changed (%)
Foundation	Floating timber logs (ulin/galam)	Concrete slab + plastic drums	16.7
Frame Structure	Ulin wood joints	Ulin + iron bolts hybrid	38.9
Walls	Ulin/meranti planks	Plywood / GRC board / brick	44.4
Roof	Palm thatch (rumbia)	Galvanized iron sheet / clay tile	83.3
Floor	Wide ulin planks (gapped)	Bamboo mat / plywood / ceramic tile	33.3

Source: Field survey, 2025–2026

Table 2 shows that the roof component has undergone the most extensive transformation (83.3% of units), with almost all floating houses replacing rumbia thatch with galvanized iron sheets or tiles. This shift is driven mainly by ease of maintenance and material availability, although it has negative implications for indoor thermal comfort (Afdholy, 2017). Walls constitute the second most transformed component (44.4%), reflecting residents' efforts to improve durability and aesthetic appearance in line with modern housing aspirations. These data suggest that residents prioritize building parts that are most visible, most frequently damaged, or most directly affect everyday comfort. In other words, material-transformation decisions are shaped not only by technical considerations, but also by perceptions of modernity, status, and ease of maintenance.

By contrast, the foundation shows the least change compared with other components. This low rate of transformation does not indicate that the foundation is unproblematic; rather, it highlights that the foundation is the most difficult part to replace because it is costly, technically complex, and requires higher levels of specialized knowledge. For this reason, government intervention should be directed primarily toward components whose replacement costs are beyond the capacity of households to bear independently.

Figure 2. Material Transformation of Rumah Lanting Building Components at Kampung Awang Landas

The main factors driving material transformation are: (1) the scarcity and high cost of local ulin and galam timber due to logging restrictions; (2) increased accessibility of modern materials via land-transport routes; (3) the influence of house-rehabilitation programs that use standardized modern materials; and (4) residents' aspirations to improve the appearance and comfort of their homes. The transformation pattern is not uniform, but is shaped by household economic capacity and by whether families are involved in government assistance programs. Figure 2 illustrates these material transformations in the floating houses of the Sungai Buluh area.

Local Wisdom in Water Settlement Management

Qualitative findings indicate that the sustainability of floating houses is determined not only by the quality of the built structures but also by the presence of local wisdom as a knowledge system governing how people live on water. This local wisdom encompasses ecological knowledge, mutual assistance, construction skills, and collective governance of river space. Together, these elements form an unwritten but effective mechanism of collective adaptation that has sustained the community over generations. Qualitative exploration identified four main domains of local wisdom in Kampung Awang Landas: (1) ecological knowledge of tides and wetland cycles; (2) social systems of mutual assistance in construction and maintenance; (3) technical knowledge of water-house construction; and (4) collective governance of river space. These domains are interrelated and combine to form a socio-ecological adaptation system that has proven effective over generations (Fahrianoor, 2025).

Ecological knowledge of tidal rhythms and water-level fluctuations provides the basis for technical decision-making. Senior residents know when water will reach certain peak levels, how to adjust mooring-line lengths, and where houses should be positioned to remain safe. This knowledge is crucial because many construction decisions for floating houses arise from cross-generational experience rather than formal engineering standards. One informant explained that experienced residents can predict seasonal maximum water levels based on natural signs such as the height of water-bird nests and the patterns of riparian vegetation. This knowledge determines the minimum height of the floating foundation, the appropriate length of mooring ropes, and the placement of entry stairs an informal ecological information system transmitted orally from generation to generation.

The mutual-assistance system (bahari in the Banjar language) in floating-house construction is a social mechanism that significantly reduces building costs and strengthens community solidarity. Another informant noted that in a single bahari session, 10–20 adults can complete the installation of a basic house frame in one day. The same system applies to the maintenance of shared wooden walkways and routine river-environment clean-ups, reflecting the collective values that Safariansyah (2012) identifies as characteristic of wetland-settlement communities. At the same time, local wisdom is under pressure. Modernization, shifting orientations among younger generations, and limited formal documentation are contributing to the gradual erosion of local knowledge. Consequently, water-settlement policies that focus solely on physical structures without strategies for preserving local knowledge risk undermining one of the core foundations of floating-house community sustainability.

Table 3. Dimensions of Local Wisdom in Rumah Lanting Settlement Management

Local Wisdom Dimension	Key Practices	Policy Relevance
Ecological Knowledge	Tidal prediction, water level reading, flood risk assessment	Basis for site-specific settlement design and disaster risk reduction
Gotong Royong System	Bahari (collective construction), titian maintenance, riverbank cleaning	Cost-effective community-based housing improvement mechanisms
Technical Construction	Floating log selection, ulin	Preservation of appropriate

Knowledge	wood joinery, ventilation gap flooring	building techniques for wetland environments
Collective Space Governance	Musyawarah for river access rules, shared mooring areas, waste management norms	Community-based participatory planning model for water settlement policy

Source: Qualitative Interviews and Participatory Observation, 2025–2026

Table 3 confirms that each dimension of local wisdom has concrete policy relevance. Ecological knowledge is essential for risk mitigation; mutual assistance is relevant for models of self-help housing improvement; construction knowledge is crucial for drafting technical rehabilitation guidelines; and collective governance is highly useful for strengthening community participation in planning. In other words, local wisdom is not merely a symbolic cultural element, but an implementable resource for water-settlement policy. The table shows that all four dimensions of local wisdom have direct policy implications, with the collective-governance dimension being particularly relevant as a participatory planning model that can be formalized in local regulations. Government informants emphasized that the regency government needs to integrate river-community musyawarah mechanisms into the settlement-planning process, rather than simply consulting communities after plans have already been prepared. This is consistent with Grindle's (1980) framework on the importance of inclusive policy design.

Threats to local wisdom come from three main directions: modernization that draws younger generations toward land-based lifestyles; declining frequency of mutual-assistance activities due to changes in the economic structure; and the absence of formal documentation, which makes local knowledge vulnerable to disappearing together with senior residents. One informant expressed concern that younger generations no longer understand how to read natural signs to predict tidal patterns. This situation underscores the urgency of documentation and revitalization programs for local wisdom as an integral component of settlement-management policy.

AHP Analysis: Criteria Weights and Policy Priorities

The AHP hierarchy comprised four main criteria: Technical-Infrastructure, Economic-Livelihood, Socio-Cultural and Local Wisdom, and Institutional and Government Policy. These criteria were derived from the qualitative and observational phases and were subsequently operationalised into 16 subcriteria. The AHP hierarchy was therefore developed from issues repeatedly identified through interviews, field observation, physical-condition assessment, and document analysis, rather than being imposed independently before data collection.

Each expert independently completed pairwise comparisons using Saaty's 1–9 scale. Individual judgments were aggregated element by element using the geometric mean, and the aggregated matrices were synthesised in Expert Choice to obtain local and global priorities. Expert Choice reported an inconsistency value for each individual and combined matrix. A matrix was considered acceptable when the reported inconsistency value was below 0.10. The aggregated pairwise-comparison matrices, derived local priorities, global priorities, and matrix-specific inconsistency values are reported in Tables 6–11.

The final synthesis shows that Institutional and Government Policy received the highest global weight (0.378), followed by Technical-Infrastructure (0.293), Economic-Livelihood (0.206), and Socio-Cultural and Local Wisdom (0.123). This result indicates that floating-house settlement issues cannot be addressed through technical rehabilitation alone. Rather, the effectiveness of physical improvement depends on policy direction, administrative recognition, programme accessibility, institutional capacity, and coordination among relevant agencies.

At the subcriterion level, Policy Direction, including preservation, restructuring, or relocation, ranked first (0.146). This was followed by Floating-House Legality and Land Tenure Status (0.112) and Basic Utilities, including electricity and clean water (0.098). These results indicate that the future of floating-house settlements depends not only on the physical condition of individual dwellings, but also on policy clarity, recognition, service provision, and participatory governance.

Table 4. Main Criteria and Global Weights from Expert Choice

Main Criteria	Global Weight
Institutional and Government Policy	0.378
Technical–Infrastructure	0.293
Ekonomi–Livelihood	0.206
Socio-Cultural and Local Wisdom	0.123

Source: AHP Synthesis Based on Three Expert Assessments.

Table 4 shows that the institutional and government-policy dimension received the highest priority. This finding does not reduce the importance of technical intervention. Instead, it demonstrates that physical rehabilitation, infrastructure improvement, and service provision are likely to be effective only when supported by an appropriate policy framework, feasible administrative recognition, adequate programme access, and cross-sector coordination.

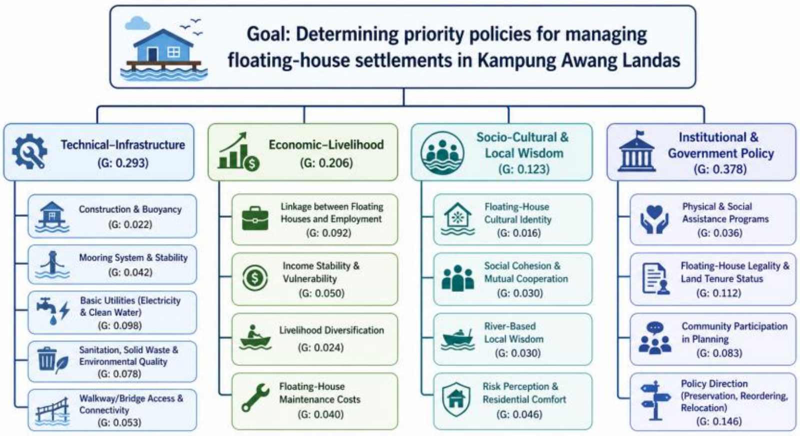

Figure 3. AHP Hierarchy of Policy Priorities for Floating-House Settlement Management in Kampung Awang Landas

Figure 3 presents the Analytic Hierarchy Process (AHP) hierarchy for determining policy priorities in managing floating-house settlements in Kampung Awang Landas, with a single overall goal at the top and four main criteria at the second level: Technical–Infrastructure, Economic–Livelihood, Socio-Cultural and Local Wisdom, and Institutional and Government Policy, each accompanied by its global weight. Beneath each main criterion are several subcriteria such as Construction and Buoyancy, Basic Utilities, Linkage between Floating Houses and Employment, Social Cohesion and Mutual Assistance, Floating-House Legality and Land Tenure Status, and Policy Direction, each with its own global weight, so that the figure as a whole illustrates how expert judgments are transformed into an ordered set of policy-intervention priorities considered most important for sustaining and improving the quality of floating-house settlements.

Table 5 provides a more detailed explanation of the priority arenas for intervention. The top three positions show that issues of policy direction, legal status, and basic utilities are far more urgent than the mere physical form of the house. This finding is important because it corrects approaches that too quickly reduce floating houses to a “slum” problem, whereas the core issues concern residential sustainability, service provision, and administrative recognition. Technical subcriteria such as mooring systems, sanitation, and walkway access still carry significant weight, but they are situated within a broader priority system. This indicates that journal readers should interpret the AHP results not as a list of discrete problems, but as a decision map that guides the sequencing of policy stages. Accordingly, the explanation of the table needs to link each weight to its practical policy implications for local government.

Table 5. Global Priority of AHP Subcriteria

Subcriteria	Global Weight
Policy Direction (Preservation, Reordering, Relocation)	0.146
Floating-House Legality & Land Tenure Status	0.112
Basic Utilities (Electricity & Clean Water)	0.098
Linkage between Floating Houses and Employment	0.092
Community Participation in Planning	0.083
Sanitation, Solid Waste & Environmental Quality	0.078
Access Walkways/Bridges & Connectivity	0.053
Income Stability & Vulnerability	0.050
Risk Perception & Residential Comfort	0.046
Mooring System & Stability	0.042
Floating-House Maintenance Costs	0.040
Physical & Social Assistance Programs	0.036
Social Cohesion & Mutual Cooperation	0.030
River-Based Local Wisdom	0.030
Livelihood Diversification	0.024
Construction & Buoyancy	0.022

Tables 6–11 provide the aggregated pairwise-comparison matrices, derived priority values, global priorities, and matrix-specific inconsistency values underlying the final AHP synthesis. Table 6 presents the matrix and priorities for the four main criteria, Table 7 reports the individual and combined inconsistency values for all five matrices, and Tables 8–11 present the matrices and derived priority values for the Technical-Infrastructure, Economic-Livelihood, Socio-Cultural and Local Wisdom, and Institutional and Government Policy subcriteria, respectively. Individual judgments from the three purposively selected experts were aggregated element by element using the geometric mean and synthesised in Expert Choice. The pairwise-comparison values reported in Tables 6 and 8–11 were reproduced from the Expert Choice combined comparison display. Because the available software output presented final global synthesis weights, the subcriterion priority values shown in Tables 8–11 were derived by

dividing each reported global subcriterion weight by the global weight of its respective parent criterion. For example, the derived priority of Basic Utilities was calculated as 0.098 divided by 0.293, resulting in 0.334, whereas the derived priority of Policy Direction was calculated as 0.146 divided by 0.378, resulting in 0.386. The combined inconsistency values were 0.0108 for the main-criteria matrix, 0.0084 for Technical-Infrastructure, 0.0104 for Economic-Livelihood, 0.0017 for Socio-Cultural and Local Wisdom, and 0.0141 for Institutional and Government Policy, all below the 0.10 acceptance threshold. Minor deviations in the summed derived priorities may occur because the reported global weights were rounded to three decimal places. These tables provide the comparison inputs, aggregation procedure, derived priority values, global priority outputs, and consistency evidence underlying the final policy-priority ranking.

Table 6. Aggregated Pairwise-Comparison Matrix and Reported Global Priorities for Main AHP Criteria

Main criterion	Technical-Infrastructure	Economic-Livelihood	Socio-Cultural and Local Wisdom	Institutional and Government Policy	Reported Global priority
Technical-Infrastructure	1.00000	0.60571	0.43089	0.69336	0.293
Economic-Livelihood	1.65096	1.00000	0.48075	0.51087	0.206
Socio-Cultural and Local Wisdom	2.32079	2.08008	1.00000	0.38517	0.123
Institutional and Government Policy	1.44225	1.95743	2.59625	1.00000	0.378

Note: The values in the matrix are reciprocal pairwise judgments from the Expert Choice combined comparison display. The priority values shown are global priorities because all four criteria were directly compared with respect to the overall goal.

Table 7. Consistency Assessment of Individual and Combined AHP Matrices

AHP matrix / parent node	Number of elements	Combined inconsistency	P01 inconsistency	P02 inconsistency	P03 inconsistency	Acceptance threshold	Decision
Main criteria	4	0.0108	0.0440	0.0228	0.0392	< 0.10	Accepted
Technical-Infrastructure subcriteria	5	0.0084	0.0288	0.0033	0.0264	< 0.10	Accepted
Economic-Livelihood subcriteria	4	0.0104	0.0392	0.0039	0.0539	< 0.10	Accepted
Socio-	4	0.0017	0.0039	0.0000	0.0039	< 0.10	Accept

AHP matrix / parent node	Number of elements	Combined inconsistency	P01 inconsistency	P02 inconsistency	P03 inconsistency	Acceptance threshold	Decision
Cultural and Local Wisdom subcriteria							ed
Institutional and Government Policy subcriteria	4	0.0141	0.0392	0.0444	0.0039	< 0.10	Accepted

Note: P01, P02, and P03 refer to the three individual expert accounts displayed in the Expert Choice inconsistency report. Combined refers to the aggregated group judgment used for the final AHP synthesis. The available Expert Choice output reported inconsistency values directly; CI and RI were not separately displayed.

Table 8. Aggregated Pairwise-Comparison Matrix and Derived Priority Values for Technical-Infrastructure Subcriteria

Subcriterion	Construction and Buoyancy	Mooring System Stability	Basic Utilities	Sanitation, Solid Waste, and Environmental Quality	Access, Walkways, Bridges, and Connectivity	Derived priority value	Global priority
Construction and Buoyancy	1.00000	0.43679	0.28114	0.28114	0.43679	0.075	0.022
Mooring System Stability	2.28943	1.00000	0.43679	0.43679	0.79370	0.143	0.042
Basic Utilities	3.55689	2.28943	1.00000	0.62996	0.55032	0.334	0.098
Sanitation, Solid Waste, and Environmental Quality	3.55689	2.28943	1.58740	1.00000	0.70711	0.266	0.078
Access, Walkways, Bridges, and Connectivity	2.28943	1.25992	1.81712	1.41421	1.00000	0.181	0.053

Note: Pairwise-comparison values are reproduced from the Expert Choice combined comparison display. Derived priority values were obtained by dividing each reported global subcriterion weight by the global weight of its parent criterion. These values are presented to show the relationship between the final global synthesis and each parent criterion. Minor deviations may occur because global weights were rounded to three decimal places.

Table 9. Aggregated Pairwise-Comparison Matrix and Derived Priority Values for Economic-Livelihood Subcriteria

Subcriterion	Linkage between Floating Houses and Employment	Income Stability and Vulnerability	Livelihood Diversification	Floating-House Maintenance Costs	Derived priority value	Global priority
Linkage between Floating Houses and Employment	1.00000	0.43679	0.28114	0.51087	0.447	0.092
Income Stability and Vulnerability	2.28943	1.00000	0.43679	0.69336	0.243	0.050
Livelihood Diversification	3.55689	2.28943	1.00000	0.62996	0.117	0.024
Floating-House Maintenance Costs	1.95743	1.44225	1.58740	1.00000	0.194	0.040

Note: Pairwise-comparison values are reproduced from the Expert Choice combined comparison display. Derived priority values were obtained by dividing each reported global subcriterion weight by the global weight of its parent criterion. These values are presented to show the relationship between the final global synthesis and each parent criterion. Minor deviations may occur because global weights were rounded to three decimal places

Table 10. Aggregated Pairwise-Comparison Matrix and Derived Priority Values for Socio-Cultural and Local Wisdom Subcriteria

Subcriterion	Cultural Identity of Floating Houses	Social Cohesion and Mutual Assistance	River-Based Local Wisdom	Risk Perception and Residential Comfort	Derived priority value	Global priority
Cultural Identity of Floating Houses	1.00000	0.50000	0.38157	0.38157	0.130	0.016
Social Cohesion and Mutual Assistance	2.00000	1.00000	1.00000	0.62996	0.244	0.030
River-Based Local Wisdom	2.62074	1.00000	1.00000	0.62996	0.244	0.030

Subcriterion	Cultural Identity of Floating Houses	Social Cohesion and Mutual Assistance	River-Based Local Wisdom	Risk Perception and Residential Comfort	Derived priority value	Global priority
Risk Perception and Residential Comfort	2.62074	1.58740	1.58740	1.00000	0.374	0.046

Note: Pairwise-comparison values are reproduced from the Expert Choice combined comparison display. Derived priority values were obtained by dividing each reported global subcriterion weight by the global weight of its parent criterion. These values are presented to show the relationship between the final global synthesis and each parent criterion. Minor deviations may occur because global weights were rounded to three decimal places.

Table 11. Aggregated Pairwise-Comparison Matrix and Derived Priority Values for Institutional and Government Policy Subcriteria

Subcriterion	Physical and Social Assistance Programmes	Floating-House Legality and Land Tenure Status	Community Participation in Planning	Policy Direction	Derived priority value	Global priority
Physical and Social Assistance Programmes	1.00000	0.28114	0.38157	0.32183	0.095	0.036
Floating-House Legality and Land Tenure Status	3.55689	1.00000	0.69336	0.62996	0.296	0.112
Community Participation in Planning	2.62074	1.44225	1.00000	0.55032	0.220	0.083
Policy Direction	3.10723	1.58740	1.81712	1.00000	0.386	0.146

Note: Pairwise-comparison values are reproduced from the Expert Choice combined comparison display. Derived priority values were obtained by dividing each reported global subcriterion weight by the global weight of its parent criterion. These values are presented to show the relationship between the final global synthesis and each parent criterion. Minor deviations may occur because global weights were rounded to three decimal places.

Figure 4 presents the dynamic sensitivity graph from the Analytic Hierarchy Process (AHP), displaying the weights of the four main criteria and sixteen subcriteria for floating-house settlement management as a series of colored horizontal bars. The left panel shows the relative contribution of each main criterion (Technical–Infrastructure, Economic–Livelihood, Socio-Cultural and Local Wisdom, and Institutional and Government Policy), while the right panel details the percentage priority of each subcriterion, such as basic utilities, legality and land tenure status, policy direction, and community participation. This visualization enables readers to quickly identify which criteria and subcriteria exert the greatest influence on the overall ranking of policy priorities.

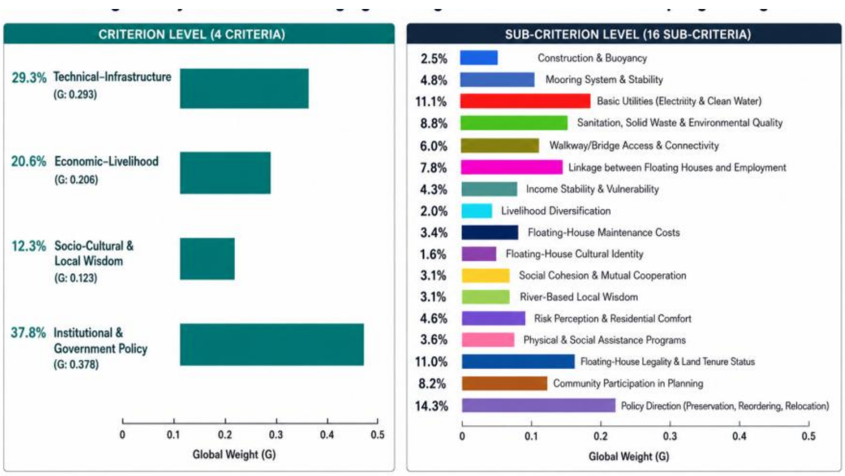

Figure 4. Combined: Dynamic Sensitivity Goal: Determining Priority Policies for Managing Floating-House Settlements in Kampung Awang Landas

Integrated PPAI Policy Model for Rumah Lanting Management

The synthesis of physical-condition assessment, spatial observations, resident and institutional interviews, and AHP prioritisation informed the development of the PPAI policy framework for floating-house settlement management in Kampung Awang Landas. PPAI refers to four interrelated dimensions: Policy, Physical, Access, and Institutional. The framework responds to the finding that the management challenges of rumah lanting cannot be addressed through building rehabilitation alone, because physical deterioration is interconnected with unclear housing recognition, limited access to basic services, livelihood dependence on the river, and fragmented institutional responsibility. Accordingly, PPAI should be interpreted as an evidence-informed framework for local policy deliberation and programme design, rather than as an adopted regulation or a completed implementation programme.

The Policy dimension addresses the need for a clear direction regarding preservation, settlement improvement, selective consolidation, or other context-sensitive interventions. This dimension is supported by the AHP finding that Policy Direction and Floating-House Legality and Land Tenure Status were the two highest-ranked subcriteria. The framework therefore recommends gradual administrative recognition, beginning with settlement and household registration, followed by the possible classification of floating houses as a specific form of water-based housing in local planning and regulatory instruments. Such recognition would not automatically establish land ownership rights; rather, it could provide an administrative basis for service delivery, programme targeting, and legal protection appropriate to the river-based settlement context.

The Physical dimension focuses on adaptive rehabilitation of floating houses assessed as being in moderate or poor condition. Field assessment identified 14 priority units requiring attention, particularly regarding buoyancy components, mooring stability, floors, walls, roofs, sanitation, and other safety-related elements. Rehabilitation should retain the adaptive logic of floating dwellings and should not simply apply technical standards designed for land-based housing. Existing housing-improvement programmes may be adapted for this purpose, provided that water-based technical guidance and site-specific safety criteria are developed.

The Access dimension concerns the provision and improvement of basic infrastructure and services, including walkway and bridge connectivity, clean water, electricity, sanitation, solid-waste management, and access to livelihood-related facilities. This component reflects the high AHP priority assigned to Basic Utilities and the observed relationship between housing conditions and accessibility within the settlement. Improvements should be planned as a settlement-level package rather than as isolated household interventions, because the safety and liveability of floating houses depend on shared infrastructure and environmental conditions. Access measures should also be coordinated with residents' livelihood patterns to avoid disrupting river-based economic activities.

The Institutional dimension focuses on cross-sector coordination, local-government capacity, community participation, and monitoring. The framework proposes that Disperkimtan coordinate housing-related programmes; PUPR support infrastructure and service improvements; BPN provide technical input on administrative and tenure-related issues; the culture-related agency document and integrate local knowledge; and BAPPERIDA align the framework with planning, budgeting, and monitoring processes. Residents should participate as substantive members of planning and monitoring processes, rather than only as programme beneficiaries. This institutional arrangement is proposed as a practical coordination option and would require further discussion, legal review, and commitment from the relevant agencies before implementation.

Table 12. Joint Display Linking Empirical Findings, AHP Priorities, and Proposed PPAI Responses

Empirical evidence	Related AHP priority	PPAI dimension	Proposed response	Interpretation
Fourteen of 18 floating-house units were classified as moderate or poor condition; float bases, walls, floors, sanitation, and mooring components required attention	Basic Utilities (0.098); Mooring System Stability (0.042); Construction and Buoyancy (0.022)	Physical and Access	Context-appropriate rehabilitation, buoyancy and mooring assessment, sanitation and basic-service improvement	Proposed response based on physical-condition findings and AHP priorities
Residents and government informants reported unclear administrative status and limited access to conventional housing programmes	Policy Direction (0.146); Floating-House Legality and Land Tenure Status (0.112)	Policy	Household and settlement registration; review of appropriate administrative recognition and planning integration	Administrative recognition is proposed, not equivalent to land ownership certification
Interviews documented *bahari/gotong royong*, river-based ecological knowledge, and community rules for shared river space	Community Participation in Planning (0.083); Social Cohesion and Mutual Assistance (0.030); River-Based Local Wisdom (0.030)	Institutional	Participatory planning, documentation of local knowledge, and integration of community practices into rehabilitation guidance	Proposed through co-design with residents and local institutions
Field observation documented walkway deterioration, sanitation needs, and shared-service constraints	Sanitation, Solid Waste and Environmental Quality (0.078); Access, Walkways, Bridges and Connectivity (0.053)	Access	Settlement-level improvements to walkways, clean water, sanitation, electricity, and waste management	Requires technical feasibility assessment and cross-sector coordination

Empirical evidence	Related AHP priority	PPAI dimension	Proposed response	Interpretation
Government interviews indicated fragmented institutional responsibility and the need for inter-agency coordination	Institutional and Government Policy criterion (0.378); Community Participation in Planning (0.083)	Institutional	Cross-sector coordination arrangement and participatory monitoring mechanism	Institutional option requiring formal agreement among relevant agencies

Note: This joint display shows how qualitative, physical-condition, spatial, and AHP findings informed the proposed PPAI responses. The responses are evidence-informed policy options and do not represent regulations, programmes, or institutional arrangements that have already been adopted.

Table 12 presents the joint display used to integrate empirical findings from physical-condition assessment, spatial observation, interviews, and AHP prioritisation into the proposed PPAI framework. The table shows that the proposed responses were not formulated independently of the evidence: physical deterioration in 14 moderate- and poor-condition units was linked to adaptive rehabilitation and service improvement; administrative uncertainty and limited programme access were linked to policy direction and administrative recognition; local knowledge and mutual-assistance practices were linked to participatory planning and institutional support; and shared access and sanitation constraints were linked to settlement-level infrastructure improvement. The highest AHP priorities, particularly Policy Direction, Floating-House Legality and Land Tenure Status, Basic Utilities, and Community Participation in Planning, provide an explicit prioritisation basis for these responses. Therefore, the PPAI framework should be interpreted as an evidence-informed set of policy options for Kampung Awang Landas, rather than as an adopted regulatory package, a confirmed institutional arrangement, or a model that can be directly transferred to all water-based settlements.

Table 13. Proposed Phased Action Plan for the PPAI Policy Framework

PPAI dimension and proposed programme	Key proposed activities	Indicative timeline	Potential lead agency	Indicative success indicator
Policy: Administrative recognition and policy direction	Settlement and household registration; review of appropriate legal and planning classification; preparation of occupancy-recognition mechanism	Year 1–5	Disperkimtan, BAPPERIDA, BPN	Floating-house units recorded; policy options and administrative mechanism prepared
Physical: Adaptive rehabilitation	Rehabilitation of moderate- and poor-condition units; preparation of water-based housing technical guidance	Year 1–3	Disperkimtan	Priority units receive context-appropriate structural and sanitation improvements
Access: Basic infrastructure and services	Repair of walkways and bridges; improvement of clean water, sanitation, waste	Year 1–4	PUPR, Disperkimtan	Improved connectivity and basic-service coverage in the

PPAI dimension and proposed programme	Key proposed activities	Indicative timeline	Potential lead agency	Indicative success indicator
	handling, and electricity access			settlement
Policy and Institutional: Regulatory integration	Integration of floating-house settlement considerations into local planning documents and relevant regulations	Year 2–4	BAPPERIDA, Disperkimtan, DPRD	Planning and regulatory instruments include water-based settlement considerations
Institutional: Capacity building and coordination	Formation of cross-sector coordination mechanism; training for officials and community planning facilitation	Year 1–3	BAPPERIDA, Disperkimtan, village government	Coordination mechanism established; relevant officials and community representatives involved
Institutional: Participatory monitoring and evaluation	Annual physical-condition review, participatory monitoring, and programme evaluation	Year 1–5	BAPPERIDA, Disperkimtan, village government	Annual monitoring report and community feedback mechanism available
Policy, Physical, and Access: Selective consolidation	Context-specific assessment and voluntary consolidation only for units with severe safety constraints	Year 3–5	Disperkimtan, village government	Safety risks reduced without unnecessarily disrupting social networks and livelihoods
Local-wisdom integration across PPAI	Documentation of local construction knowledge, river-based practices, and mutual-assistance mechanisms for use in programme design	Year 2–4	Culture-related agency, village government, community representatives	Local knowledge documented and considered in planning and technical guidance

Note: This action plan is a proposed implementation pathway derived from the study findings and AHP priorities. The proposed lead agencies, timelines, and indicators are indicative and require institutional agreement, technical assessment, legal review, and budget availability before implementation.

Table 13 translates the PPAI framework into a proposed phased action plan by linking each policy dimension with indicative activities, responsible institutions, timeframes, and monitoring indicators. The sequencing reflects the study’s priority structure: urgent actions, including registration, adaptive rehabilitation, basic-service improvement, institutional coordination, and monitoring, are proposed from the first year because they address immediate physical and administrative constraints. Regulatory integration and selective consolidation are positioned later because they require consultation, legal assessment, budget preparation, and stronger institutional readiness. Importantly, the table does not prescribe a fixed implementation sequence for all water-based settlements; it provides a context-specific planning option for Kampung Awang Landas that local government and residents may adapt through participatory deliberation. The inclusion of potential lead agencies and indicators is intended to make the framework operationally useful for programme planning and annual evaluation, while recognising that actual implementation depends on political commitment, inter-agency coordination, technical feasibility, and fiscal capacity.

The proposed PPAI framework is consistent with insights from previous studies of floating and water-based settlements, although its applicability beyond Kampung Awang Landas requires further cross-location validation. Naing and Halim's study of floating houses on Lake Tempe highlights the importance of structural adaptation to fluctuating water conditions, including floating and supporting components designed for changing water levels. Putro & Zain (2021) similarly documented active and passive adaptations of rumah lanting along the Melawi River, including changes in building position, orientation, access, function, and residents' daily practices in response to seasonal tides. In Agusan Marsh, Philippines, Sitcharon and Malaque (2024) found that floating-house typologies and settlement patterns were shaped by local environmental conditions, available materials, and household financial capacity, demonstrating the importance of community knowledge in water-based housing design. These studies support the relevance of combining adaptive physical measures, locally appropriate service improvements, and community-informed planning within the PPAI framework; however, they do not establish that the framework can be directly transferred to other water-based settlements without contextual adaptation and comparative testing.

Figure 6 presents the proposed evidence-informed PPAI framework for floating-house settlement management in Kampung Awang Landas. The framework integrates four interrelated dimensions: Policy, Physical, Access, and Institutional. The Policy dimension includes policy direction, administrative recognition, and planning integration; the Physical dimension addresses adaptive rehabilitation, buoyancy, mooring systems, and the safety of priority housing units; the Access dimension covers walkways, connectivity, clean water, electricity, sanitation, and waste management; and the Institutional dimension incorporates community participation, local wisdom, gotong royong, and cross-sector coordination. These proposed policy responses are informed by physical-condition assessment, spatial observation, resident and institutional interviews, and AHP priority synthesis, which are shown as empirical and decision inputs at the bottom of the figure. Institutional capacity, financing, and monitoring and evaluation are treated as enabling conditions for implementation. Therefore, the framework should be understood as a context-specific planning option that requires institutional agreement, feasibility assessment, and contextual adaptation before implementation or application in other water-based settlements.

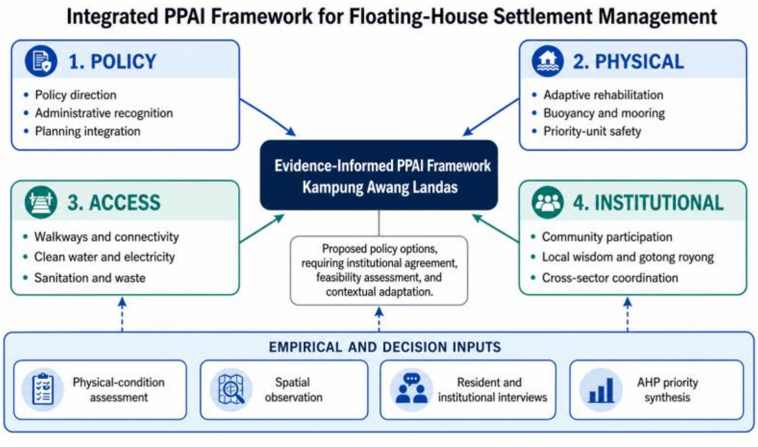

Figure 6. Evidence-Informed PPAI Framework for Floating-House Settlement Management in Kampung Awang Landas

CONCLUSION

This study shows that floating houses in Kampung Awang Landas are an adaptive river-based settlement form, but their sustainability is constrained by physical deterioration, limited service access, administrative uncertainty, and fragmented institutional support. The assessment of 18 units found that 50.0% were in moderate condition and 27.8% were in poor condition, with the floating foundation representing the most vulnerable component and roofs and walls showing the greatest material transformation. These findings indicate that rehabilitation needs should be addressed as an integrated package involving buoyancy, mooring, building components, sanitation, and settlement access rather than as isolated household repairs.

The AHP synthesis identified Institutional and Government Policy as the highest-priority criterion (0.378), followed by Technical-Infrastructure (0.293), Economic-Livelihood (0.206), and Socio-Cultural and Local Wisdom (0.123). At the subcriterion level, Policy Direction (0.146), Floating-House Legality and Land Tenure Status (0.112), and Basic Utilities (0.098) received the highest global priorities. The results suggest that physical upgrading alone is unlikely to sustain floating-house settlements without policy clarity, appropriate administrative recognition, basic-service provision, and meaningful community participation.

The study's principal contribution is the proposed PPAI framework, comprising Policy, Physical, Access, and Institutional dimensions. The framework links physical-condition evidence, spatial observations, local knowledge, qualitative accounts, and expert-based AHP priorities. It provides an evidence-informed planning option for Kampung Awang Landas, not an adopted regulation, fixed implementation programme, or universally applicable model. Its applicability is limited by the single-site design, 18 housing units, 15 qualitative informants, and three purposively selected experts; therefore, it should not be assumed to apply directly to other Indonesian water-based settlements without comparative validation. Future research should test the framework across riverine, lake, coastal, and wetland settings and examine how hydrological changes associated with climate variability may affect floating-house safety, services, livelihoods, and management priorities.

DECLARATION OF AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this manuscript, the authors used Perplexity (https://www.perplexity.ai/) to assist in improving grammar, language quality, and overall readability of the text. After using this tool, the authors carefully reviewed and edited the manuscript as needed and retain full responsibility for all of its contents.

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AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Data curation; Investigation; Formal analysis; Writing original draft..

Author 2: Supervision; Validation; Writing – review and editing; Methodology.

Author 3: Conceptualization; Resources; Investigation; Writing – review and editing.

Author 4: Supervision; Validation.

Author 5: Supervision; Validation.

REFERENCES

Afdholy, A. R. (2017). Tipomorfologi Permukiman Tepian Sungai Martapura Kota Banjarmasin. *Local Wisdom : Jurnal Ilmiah Kajian Kearifan Lokal*, *9*(1). https://doi.org/10.26905/lw.v9i1.1865

Braun, V., & Clarke, V. (2006). Qualitative Research in Psychology Using thematic analysis in psychology Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. http://www.tandfonline.com/action/journalInformation?journalCode=uqrp20%5Cnhttp://www.tandfonline.com/action/journalInformation?journalCode=uqrp20

Creswell, J. W., & Clark, V. L. P. (2010). Choosing a mixed methods design. In *Designing and Conducting Mixed Methods Research* (Second, pp. 53–106). Sage Publications, Inc.

Fahrianoor. (2025). *Komunikasi Lingkungan : Perspektif Budaya dan Media*. Simbioasa Rekatama Media.

Febriyani, E. (2025). Faktor kebertahanan rumah lanting di kelurahan kapuas kanan hilir. *Jurnal Ilmiah Membangun Desa Dan Pertanian (JIMDP)*, *10*(3), 323–332.

Grindle, M. S. (1980). *Politics and policy implementation in the Third World*. Princeton University Press.

Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2015). *Remote sensing and image interpretation* (Seventh ed). Wiley.

Marshall, C., Rossman, G., & Blanco, G. (2022). *Designing Qualitative Research* (Seventh). SAGE Publication, Inc.

Maslow, A. H. (1943). *A theory of human motivation. Psychological Review*. *50*(4), 370–396.

Mertens, D. M. (2024). *Research and Evaluation in Education and Psychology: Integrating Diversity With Quantitative, Qualitative, and Mixed Methods* (6th ed.). SAGE Publications, Inc.

Naing, N., & Halim, H. (2013). Sistem Struktur Rumah Mengapung di Danau Tempe Sulawesi Selatan. *Jurnal Permukiman*, *8*(3), 145. https://doi.org/10.31815/jp.2013.8.145-152

Nurmaningtyas, A. R., Hamzah, B., & Aprianti, E. (2026). Priority Strategy for Managing Water Settlement Using Eco-Settlement: SWOT-AHP Approach in Tobati Village, Jayapura, Indonesia. *SSRG International Journal of Civil Engineering*, *13*(6), 308–321. https://doi.org/10.14445/23488352/IJCE-V13I6P121

Peraturan Menteri Sosial Republik Indonesia Nomor 6 Tahun 2021 Tentang Perubahan Atas Peraturan Menteri Sosial Nomor 20 Tahun 2017 Tentang Rehabilitasi Sosial Rumah Tidak Layak Huni Dan Sarana Prasarana Lingkungan, Pub. L. No. 6 (2021). https://peraturan.bpk.go.id/Details/217209/permensos-no-6-tahun-2021

Prihatmaji, Y. P., & Nugraha, D. H. (2019). Keeping the Floating House Afloat in Banjarmasin: Implementation Potential of EPS Floating Technology for Foundation Engineering. *MATEC Web of Conferences*, *280*, 02001. https://doi.org/10.1051/matecconf/201928002001

Putro, J. D., & Zain, Z. (2021). Space Setting Process in Floating Houses (Rumah Lanting). *The 5th International Conference on Indonesian Architecture and Planning*, 1–15. https://doi.org/10.1088/1755-1315/764/1/012004

Rahman, M. A. U. R. (2014). Pelestarian Rumah Lanting Berlandaskan Budaya Sungai Masyarakat Kota Banjarmasin. *E-Journal Graduate Unpar Part*, *1*(2), 221–231.

Rapoport, A. (1969). *House Form and Culture*. Prentice-Hall, Inc.

Ruth, A., Wutich, A., & Bernard, H. R. (2024). The Handbook of Teaching Qualitative and Mixed Research Methods: A Step-by-Step Guide for Instructors. In *The Handbook of Teaching Qualitative and Mixed Research Methods: a Step-by-Step Guide for Instructors*. Routledge. https://doi.org/10.4324/9781003213277

Saaty, T. L. (2008). Decision making with the analytic hierarchy process. *Int. J. Services Sciences*, *1*(1), 83–98.

Saaty, T. L., & Vargas, L. G. (1962). Models, methods, concepts & applications of the analytic hierarchy process. In *Journal of the Operational Research Society* (Vol. 13, Issue 3). Springer Science+Business Media New York. https://doi.org/10.1057/jors.1962.41

Safariansyah, A. (2012). *Permukiman Rawa di Kalimantan Selatan*. Universitas Gadjah Mada.

Sandhika, R. R., & Maghzaya, A. R. (2024). Potential use of Floating Architecture for Flood Mitigation in Bulungan Regency. *Journal of Architectural Research and Design Studies*, *8*(1). https://doi.org/10.20885/jars.vol8.iss1.art2

Satterthwaite, D. (2020). Editorial: Getting housing back onto the development agenda: the many roles of housing and the many services it should provide its inhabitants. *Environment and Urbanization*, *32*(1), 3–18. https://doi.org/10.1177/0956247820905212

Sitcharon, R. M. P., & Malaque, I. R. (2024). Building with nature: The case of floating houses in Agusan Marsh, Philippines. In M. D. & D. Tanton (Ed.), *Sustainability and Health: the nexus of carbon-neutral architecture and well-being – 56th International Conference of the Architectural Science Association 2023 (ANZAScA)* (pp. 183–197). Architectural Science Association (ANZAScA).