JURNAL TEKNIK LINGKUNGAN
E-ISSN: 27146715
Journal homepage: www.envengjournal.com

Research Article

Bridging the Social-Institutional Gap in Sanitation Technology Implementation: A Case Study of Pontianak's Riverbank Slums

Adillah Nur Azmina Rahmah[1*], Amy Angelia[1], Ahmad Soleh Setiyawan[1], Nico Halomoan[1], Prayatni Soewondo[1], Prasanti Widyasih Sarli[1], Wita Lara Cahyani[1]

[1]Faculty of Civil and Environmental Engineering, Bandung Institute of Technology, Bandung, Indonesia
*correspondence e-mail: adillahami@gmail.com

Abstract

Slum settlements along riverbanks face complex challenges in accessing adequate sanitation due to limited space, flooding risks, and institutional fragmentation. This study examines the implementation of Tripikon, a decentralized wastewater treatment system, in Pontianak City's riverbank slums. Using a convergent parallel mixed methods approach, data were collected from 70 households via census sampling, complemented by in-depth interviews with six institutional stakeholders. Community participation was analyzed through a structural empowerment model using SmartPLS. Results show that opportunity structure, comprising regulatory support and institutional capacity, has a significant effect on participation ($\beta = 0.462$, $p < 0.001$), while community agency alone is insufficient. Field observations reveal that only 3 of 8 Tripikon units remain functional due to gaps in community involvement, monitoring, and technical support. Institutional interviews further highlight unclear operational mandates, fragmented responsibilities, and heavy reliance on national funding. The study concludes that bridging the social-institutional gap requires clearer role delineation, diversified financing, and stronger coordination mechanisms. This case study offers insights for sustainable sanitation interventions in informal urban settings, particularly those facing jurisdictional and infrastructural constraints.

Keywords: *community participation, institutional capacity, opportunity structure, slum settlements*

ARTICLE INFO

Citation: *Rahmah, A. N. A., Angelia, A., Setiyawan, A. S., Halomoan, N., Soewondo, P., Sarli, P. W., & Cahyani, W. L. (2026). Bridging the Social-Institutional Gap in Sanitation Technology Implementation: A Case Study of Pontianak's Riverbank Slums. Jurnal Teknik Lingkungan, 32(1), 11-20. https://doi.org/10.5614/j.tl.2026.32.1.2*

Article History:
Received 11 Jan 2026
Revised 06 Apr 2026
Accepted 12 Apr 2026
Available online 30 Apr 2026

1. Introduction

The provision of basic public facilities in slum settlements poses a significant challenge, particularly in the context of sanitation. The growing inequality in access to sanitation has become one of the most pressing issues in sustainable development, with many people unable to access such facilities simply because of where they live (Dickin & Gabrielsson, 2023). Slum settlements are characterized by one or more forms of deprivation, including inadequate access to improved water sources, insufficient sanitation facilities, overcrowded living conditions, poor structural quality of housing, and uncertainty of land ownership (UN-Habitat, 2016). Poor sanitation conditions can significantly exacerbate public health risks, particularly in slum settlements where communities face persistent challenges in meeting the minimum standards. Factors contributing to this include low priority among key stakeholders, limited funding, inappropriate technology implementation, and complex responsibilities among various parties (Isunju et al., 2011).

Riverbank slums represent a particularly vulnerable subset of informal settlements, as they are often exposed to flooding, tidal variations, and spatial constraints. These areas are typically inhabited by low- to middle-income communities, making conventional centralized sanitation systems impractical. Consequently, technologies that are low-cost, easy to install, and simple to maintain are preferred. Among various decentralized wastewater treatment options, the Tripikon technology has been identified as one of the most

suitable alternatives for such conditions (Angelia et al., 2024; Djonoputro, 2013). Previous studies have demonstrated its capacity to reduce water pollution by lowering BOD levels by 16–57%, COD by up to 67.39%, and *E. coli* concentrations by 70–90% (Angelia et al., 2024; Dikman Maheng et al., 2016; Marlisa et al., 2015; Normasari et al., 2017).

Despite its technical effectiveness, the implementation of Tripikon and similar decentralized sanitation technologies in slum settlements often faces systemic barriers that are not only technical but also institutional and social. Although public acceptance is already present and implementation is contextually appropriate (Angelia et al., 2024), implementation is often hindered by fragmented institutional mandates, unclear financing mechanisms, and the absence of coordinated governance structures. However, few studies have systematically analyzed how these social and institutional factors interact to influence the success or failure of sanitation technologies in informal urban settings.

This paper addresses this gap by examining the socio-institutional dynamics influencing the implementation of the Tripikon technology in Pontianak City's riverbank slums. Specifically, it analyzes the governance arrangements and institutional capacities that affect community participation and technology sustainability. By identifying key barriers at policy and operational levels, this study proposes actionable strategies to bridge the mismatch between institutional frameworks and community realities in the pursuit of sustainable sanitation for informal urban settlements.

2. Methodology

This study employed a mixed method approach using a convergent parallel design. Both quantitative and qualitative data were collected simultaneously and later merged to strengthen the interpretation of findings. The methodological framework was organized into three main components: identifying factors that influence community participation, evaluating existing conditions of Tripikon implementation, and analyzing institutional perspectives and readiness.

Each component addresses a different level of the social–institutional system, yet all are interconnected in examining the implementation of sanitation technology in riverbank slums.

2.1 Factors influencing community participation

This component investigates how community empowerment shapes participation in domestic wastewater management. The study employed an empowerment framework, which is primarily influenced by agency and opportunity structure (Alsop et al., 2006) as shown by Figure 1. Community empowerment is both a process and an outcome that involves shifts in power relations among individuals and groups (Laverack, 2006), either through redistributing authority (power-over) or enhancing self-determination (power-from-within) (Laverack, 2004). In practice, it reflects how communities build collective capacity to address structural barriers affecting their well-being (Jones & Sidell, 1997), supported by practitioners who facilitate opportunities for capacity building (Laverack, 2006).

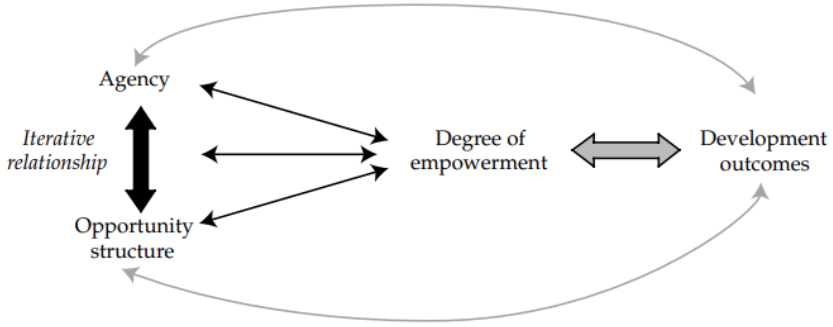

Figure 1. Empowerment framework

Source: (Alsop et al., 2006)

Agency refers to individuals' ability to act in pursuit of their interests, depending on both personal resources and surrounding societal structures (Petesch & Narayan, 2010). However, agency alone is insufficient for empowerment when institutional constraints limit the exercise of choice (Alsop et al., 2006). Opportunity structure encompasses the regulatory and structural conditions established by institutions that enable or

restrict agency (Ekren, 2021). Both dimensions work synergistically to shape empowerment outcomes and, consequently, community participation.

This study adapts the empowerment framework developed by the World Bank (Petesch & Narayan, 2010), with the variable model illustrated in Figure 2, which conceptualizes empowerment as a function of agency and opportunity structure. Dimensions of agency include financial capacity, knowledge, motivation, aspirations, and local organizational strength, while opportunity structure reflects institutional openness and government implementation capacity. This model guided the identification and statistical testing of factors influencing participation.

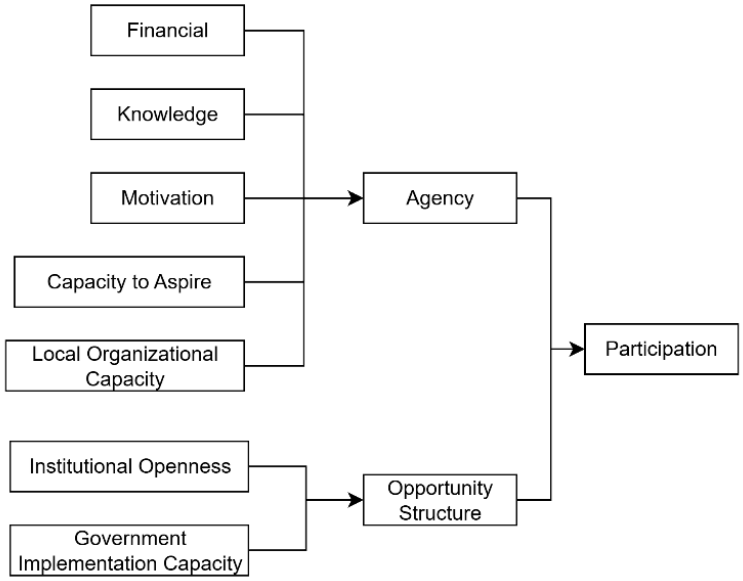

Figure 2. Community empowerment variable model

Data were collected through a structured household questionnaire using a census sampling approach, since each location had fewer than 100 households. Census sampling ensures comprehensive inclusion of all eligible units within the study area (Australian Bureau of Statistics, 2025). The study areas were selected based on the Mayor's Decree of Pontianak City No. 394/D-CKTRP/2024, which designates official slum settlements across the city. Two locations were chosen as the research sites: Tambelan Sampit Subdistrict and Sungai Sawi Luar Subdistrict, both prioritized due to their status as riverbank communities with elevated flood risks and informal housing conditions over water. The final sample consisted of 70 households (30 in Panglima A. Rani and 40 in Kayu Manis). Eligible respondents were household heads aged 17 years and above or married, ensuring awareness of environmental and sanitation issues.

Data were analyzed using Structural Equation Modeling (SEM) with SmartPLS, enabling simultaneous estimation of relationships among latent variables. Both measurement and structural models were tested to assess reliability, validity, and causal relationships between agency, opportunity structure, and participation.

2.2 Evaluation of existing conditions for the implementation of Tripikon technology

To complement the quantitative analysis, the second component assessed the current condition and sustainability of Tripikon units installed in selected riverbank communities. This stage focused on identifying the technical and non-technical factors influencing the long-term use of the system.

The assessment involves both technical and non-technical aspects. Technical aspects include environmental compatibility, performance, durability, replicability, ease of operation and maintenance, as well as the availability of spare parts. Meanwhile, non-technical aspects encompass community acceptance, willingness to pay, self-management systems, operation and maintenance costs, and the role of local stakeholders in monitoring (Djonoputro et al., 2010).

Primary data were collected through direct observations and household questionnaires targeting residents who currently use or previously used Tripikon. The evaluation sample included two households in Tambelan Sampit Subdistrict, three in Banjar Serasan Subdistrict, and another three in Parit Mayor Subdistrict. This data was obtained from the Pontianak City Health Office and monitored directly by the local health centers (Puskesmas) (by its acronyms in Indonesian) in each respective subdistrict.

The analysis was categorized into four main aspects which is technical, operational, social, and institutional. These four aspects together provide a comprehensive overview of the factors influencing the sustainability of Tripikon usage from the user perspectives within the target communities. This stage supports the findings from the previous identification of factors influencing community participation and offers further understanding from the community level.

2.3 Institutional perspectives and readiness

The third component explored the institutional dimension of the social–institutional gap through semi-structured in-depth interviews with six key stakeholders involved in sanitation governance in Pontianak's slum settlements. Stakeholders were identified using a power–interest matrix, adapted from prior research (Siddik et al., 2024). Respondents included representatives from the Public Works and Spatial Planning Office (PUPR) (by its acronym in Indonesian) at both Pontianak City and West Kalimantan Province, the Regional Development Planning Agency (Bappeda) (by its acronym in Indonesian) of Pontianak City and West Kalimantan Province, the Provincial Housing and Settlement Office (Disperkim) (by its acronym in Indonesian) of Pontianak City, and the Regional Infrastructure Development Agency (BPPW) (by its acronym in Indonesian) for West Kalimantan Province.

Interviews explored institutional roles, coordination, and perceptions regarding sanitation management in riverbank slums. Key topics included governance challenges, sustainability of sanitation programs, institutional awareness and acceptance of Tripikon, and the feasibility of wider adoption. Respondents were also asked about willingness to support implementation through funding, technical training, or community mentoring, and about ongoing or planned wastewater management initiatives in riverbank areas.

This institutional inquiry complements the earlier analyses by revealing how policy-level readiness and coordination mechanisms affect community participation and technology sustainability. Together, the three methodological components provide an integrated understanding of the social and institutional factors shaping sanitation condition in Pontianak's riverbank slums.

3. Result

3.1 Structural factors affecting community participation

The analysis of community participation in domestic wastewater management was conducted using Structural Equation Modeling (SEM) with SmartPLS. First, all outer loading values exceeded the minimum threshold of 0.5, indicating sufficient convergent validity for each indicator. No indicators were eliminated during the measurement model evaluation. Internal consistency was confirmed through Composite Reliability and Cronbach's Alpha, with all constructs surpassing the required threshold of 0.7. Furthermore, convergent validity was supported by Average Variance Extracted (AVE) values above 0.5 for opportunity structure and participation. Although the AVE for Agency was slightly below the threshold, its high composite reliability justified its inclusion. These results indicate that the measurement model is reliable and valid.

The path coefficient analysis provides insights into the strength and direction of relationships among constructs. As shown in Table 1, agency has a weak and statistically insignificant relationship with participation ($\beta = 0.091$, $p = 0.521$), whereas opportunity structure demonstrates a strong and statistically significant effect on participation ($\beta = 0.462$, $p = 0.000$).

Table 1. Path coefficients and hypothesis testing results

Hypothesis	Path coefficient	T Statistics	P Values	Remark
Agency → Participation	0.091	0,642	0,521	Not Significant
Opportunity Structure → Participation	0.462	4,233	0,000	Significant

These findings are further reinforced by the hypothesis testing results, confirming that only the relationship between opportunity structure and participation is supported. Therefore, institutional support appears to be a more decisive factor than community agency in shaping participation outcomes.

3.2 Household level evaluation results

Tripikon technology was implemented in eight households along the Kapuas River, across three subdistricts. Observations and user surveys revealed that only three households continued using the system, while the rest had discontinued due to various technical and non-technical issues. Table 2 compares successful (active users) and unsuccessful (inactive users) cases to identify key factors influencing sustained use.

Table 2. Key differentiating factors between active and inactive Tripikon users

Key Factors	Active Users	Inactive Users
Early involvement (planning, construction, testing)	Involved from the beginning, resulting in a sense of ownership	Not involved from the beginning, only received the final product
Monitoring by local stakeholders (e.g., RW, subdistrict, etc.)	Present, such as RW leaders or academic facilitators	No regular external monitoring
Design compatibility with environmental conditions	Adjusted to local characteristics (vent, seat, capacity)	Not compatible; e.g., wave resistance, unsuitable installation
Availability of written/manual guide	Some lacked manuals but received verbal instructions	Unavailable, relied on prior knowledge or memory
Ability to resolve minor technical issues	Performed light maintenance (adding EM4, tightening joints)	Issues left unaddressed
Knowledge transfer during user change	No user change or informal transfer occurred	New users unaware of system origin and lacked explanation

3.3 Institutional acceptance and stakeholder involvement

Insititutional roles and responsibility

The interviews revealed distinct institutional roles in relation to sanitation in riverbank slum areas. PUPR of Pontianak City is responsible for initiating technological innovations aligned with the socio-economic and environmental characteristics of the area. This agency has implemented several domestic wastewater development activities, including communal wastewater treatment plant (WWTP) funded by special allocation fund (DAK) (by its acronyms in Indonesian), local government budget (APBD) (by its acronyms in Indonesian), national government budget (APBN) (by its acronyms in Indonesian), and foreign loans. Around 30 communal WWTPs have been built in Pontianak, but implementation highly depends on site characteristics and community readiness, which remains a challenge in riverbank areas.

Bappeda of Pontianak City focuses on planning and coordination across sectors. The agency emphasizes its role in planning, while execution and budgeting are handled by technical departments. For example, with WWTP projects, technical aspects like piping fall under the PUPR, while Bappeda ensures interdepartmental coordination. Disperkim acknowledged limited involvement in sanitation, attributing the responsibility primarily to the city's PUPR. Although the agency manages slum settlements, sanitation issues, even in slums are under the city's PUPR authority.

The Provincial PUPR has a regional mandate but has not conducted wastewater-related interventions in Pontianak since 2021. Its jurisdiction is broader, but certain location like the Kapuas River fall under Kalimantan River Center (BWSK) (by its acronyms in Indonesian). Currently, the agency focuses on drinking water provision and facilitating cooperation agreements (PKS) (by its acronyms in Indonesian) under the water supply system master plan (RISPAM) (by its acronyms in Indonesian) program. The Provincial Bappeda aligns with its city-level counterpart but operates at a regional scale. The agency facilitates cross-regional coordination and drafts a sanitation master plan.

BPPW of West Kalimantan is responsible for infrastructure planning, development, and coordination with local and national governments. It also emphasized the importance of optimizing the use of regional

autonomy laws and resources to support more detailed program planning and sustainable infrastructure outcomes.

Institutional coordination, perception, and readiness

Interviews with institutional stakeholders revealed recurring challenges in coordination, perception, and readiness related to the implementation of decentralized sanitation systems in riverbank slum settlements. Responsibilities remain fragmented across administrative levels, with city agencies holding primary authority for planning and execution, while provincial and national institutions cite jurisdictional constraints. Coordination between these entities is often weak, resulting in overlapping mandates and limited intervention capacity, particularly along areas such as the Kapuas River, which falls under national jurisdiction.

Awareness of the Tripikon system varied across agencies. Several respondents were initially unfamiliar with the technology but acknowledged its contextual suitability after being briefed. Most institutions expressed conditional support for its adoption, emphasizing the need for sufficient technical justification, clear budgeting mechanisms, and community engagement.

Despite generally positive perceptions, several limitations persist. These include budgetary restrictions, unclear division of roles, and the absence of long-term operational frameworks. Stakeholders highlighted the importance of feasibility studies, sustainable funding models, and stronger application of decentralization principles to ensure alignment between technological innovation and institutional systems. Overall, the findings underscore a gap between rhetorical support and practical readiness, emphasizing the need for more coherent governance and stable financing structures to sustain sanitation initiatives in riverbank slum contexts.

4. Discussion

In decentralized sanitation systems, the success of technological adoption depends not merely on technical feasibility but on the alignment between community readiness and institutional support. These findings indicate that neither technology nor evidence operate independently in driving adoption. Instead, implementation is shaped primarily by organizational routines, contextual values, professional agendas, and resource constraints (Webster & Gardner, 2019).

Understanding this alignment provides the conceptual basis for examining how these two forces operate in practice. The following section explores how community willingness interacts with institutional capacity, highlighting why institutional factors ultimately play a more decisive role in shaping adoption outcomes.

4.1 Community readiness is present, but institutional support is more decisive

Quantitative analysis of community participation shows that, despite the existence of local agency and motivation, opportunity structure significantly determine whether this potential can be sustained or not ($\beta = 0.462$; $p < 0.001$). Although community members have expressed willingness to adopt sanitation innovations such as Tripikon (Angelia et al., 2024), this acceptance alone is insufficient to ensure sustainable implementation.

This finding resonates with broader policy implementation studies, particularly in the domain of spatial planning (Oliveira & Hersperger, 2018). Institutional support that is not fully implemented indicates problems in formal planning such as making it almost impossible to control urban development, causing haphazard growth and development, and resulting in a dysfunctional institutional framework (Wapwera et al., 2015). Therefore, institutional readiness must be more than just a promise. There needs to be real and inclusive governance practices so that collaboration in finding solutions can truly be realized.

These quantitative findings are further supported by household-level evaluations. Key factors influencing the sustainability of Tripikon use and active user participation fall under the realm of opportunity structure, including direct community involvement from the planning to operational stages, the presence of local stakeholders for monitoring and oversight, availability of written manuals for operation and maintenance, and effective knowledge transfer mechanisms.

Social readiness is an essential prerequisite, but it is not sufficient to guarantee the success of an intervention. Achieving the desired results requires simultaneous support from institutional readiness and economic readiness, both of which fall within the institutional domain (Sarkodie & Strezov, 2019). Therefore, the

implementation of technology, such as wastewater treatment in riverbank slum settlements, does not depend solely on technical specifications. Its success is fundamentally supported by a participatory approach and continuous institutional support throughout all stages of the process.

Although evidence suggests that institutional support plays a key role, the underlying factors behind these limitations require further analysis. The next section will outline specific institutional barriers that hinder the effective implementation of decentralized sanitation systems such as Tripikon.

4.2 *Institutional barriers to effective implementation*

Normative support without operational commitment

First, institutional support for Tripikon tends to be more normative than practical, reflecting the absence of established practices for the implementation of sanitation management in riverbank slum settlements. Although the relevance of Tripikon for riverbank slums is widely recognized and has received verbal support from most institutions, its practical implementation is hampered by jurisdictional constraints.

This phenomenon is very similar to what is described as "street-level bureaucracy", a condition in which actors support policy objectives in principle, but in practice avoid responsibility for implementation (Lipsky, 1980). This behavior is described as a *coping mechanism*, commonly observed among lower-level bureaucrats operating under constrained institutional environments. Faced with limited resources, ambiguous mandates, or misaligned authority structures, these bureaucrats often reduce service visibility, selectively prioritize actions, or shift accountability to other entities (Mochammad, 2023). The verbal support given to Tripikon was not matched by direct operational involvement. As a result, although it appeared to be a positive development, this gap directly exacerbated the implementation gap and hindered the adoption of this technology at the local level.

Fragmented coordination and overlapping mandates

Beyond rhetorical support, institutional fragmentation further hinders program continuity, as overlapping mandates create confusion over roles and accountability (Hendrarso et al., 2025; Mursyid et al., 2021). The absence of a lead coordinating entity remains a recurring issue, particularly in the provision of basic public services. Each institution operates within its own mandate, with limited inter-agency coordination. One agency focuses on planning, while another is responsible as executor. However, none explicitly claim to have a concrete strategy for adopting wastewater treatment technologies tailored for riverbank settlements.

The consequences of such fragmentation become even more pronounced under the socio-environmental pressures typical of urban slum settlements. High population density makes open defecation a serious threat to public health. The installation of new latrines and the desludging of existing ones face significant logistical and accessibility challenges. In addition, poor planning, labor shortages, and limited resources often lead to sanitation efforts being sidelined in these areas. The rapid pace of urbanization has not been matched by a corresponding expansion of sanitation service coverage, despite increased investments and policy commitments (Collender, 2011). In other words, the institutional weaknesses described above are compounded by the difficult operating environments of riverbank slums, where physical and socioeconomic constraints make coordinated service delivery even harder.

Similar patterns of institutional fragmentation and coordination failure have also been documented in other developing contexts. In the South African case, poor coordination between national and municipal levels has resulted in rising service backlogs, inefficient cost recovery, and widespread dissatisfaction in slum areas (Makaudze & Gelles, 2015). This reflects a deeper structural weakness, when roles and responsibilities are distributed without integration, implementation becomes severely impeded. Without a single accountable entity overseeing this process, these structural issues will persist and technological innovations will continue to struggle for institutional support.

Financial and resource allocation uncertainties

Finally, the lack of a stable and transparent financing structure prevents long-term planning and limits scalability, even when technical potential and community demand exist. Concerns about the sustainability persist due to unclear funding mechanisms and inadequate operational and maintenance (O&M) structures. Stakeholders emphasized a heavy dependence on central government funding and underscored the need for more adaptive resource rotation strategies. However, none of the respondents expressed certainty about

future budget allocations for implementing sanitation projects in riverbank slums along the Kapuas River, highlighting the uncertainty that undermines sustained service delivery.

These challenges are not unique to Pontianak but reflect a broader structural issue across developing urban contexts. For example, a case study in Kampala, Uganda, similarly found that unclear O&M responsibilities and limited budgets often led to sanitation systems being underutilized or failing to function optimally (Katukiza et al., 2010). Likewise, findings from Kotalama Urban Village in Malang indicated that sanitation infrastructure is frequently not used sustainably due to inadequate community-based maintenance and unclear financing mechanisms (Wijayanti et al., 2023).

Collectively, these findings highlight that funding and governance uncertainties are major barriers to decentralized sanitation systems. As a result, these systems become overly dependent on top-down funding, without any horizontal financial coordination mechanisms between local institutions. This situation ultimately limits the scalability and long-term sustainability of sanitation innovations such as Tripikon.

4.3 Manifestations of the Social–Institutional Gap

The relationship between social acceptance and institutional constraints results in multidimensional gaps that hinder the sustainability of sanitation innovations. These socio-institutional gaps are evident at the operational, organizational, and policy levels, as summarized in Table 3.

Table 3. Institutional and operational barriers to Tripikon implementation

No.	Gap type	Description
1	Social-Institutional Misalignment	The community showed high acceptance of Tripikon, but regulatory, technical, and financial support is still lacking.
2	Normative vs Operational Support	Agencies express verbal support, yet no implementation plans, budgets, or operational mandates follow.
3	Institutional Fragmentation	Responsibilities are spread across agencies, but no single actor coordinates efforts or leads implementation.
4	Passive Community Role in Lifecycle	Absence of engagement during design, implementation, and O&M phases leads to weak ownership and system neglect.
5	Absence of Monitoring	No mechanisms exist for training, user manuals, or continuity during resident turnover, undermining system sustainability.

4.4 Bridging the gap: implications for policy and practice

Bridging the social-institutional gap in sanitation requires moving from rhetoric to integrated policy. The first step is to clarify institutional responsibilities and mandates within the regulatory framework, especially for decentralized systems. This must be backed by dedicated funding and formal requirements for inter-agency coordination. Locally embedded bodies, including community groups, should be established to resolve ambiguity and maintain stakeholder engagement.

Financial strategies must also evolve, moving from a reliance on centralized budgets to diversified models that include municipal funds, community co-financing, and private sector engagement. Enhancing local capacity is essential, not just for technical O&M, but also for financial and administrative governance. To improve local ownership and long-term success, participatory planning must be embedded early in the project lifecycle.

An integrated O&M framework with monitoring tools, manuals, and targeted training for informal settlements is equally critical. Finally, policies must resolve jurisdictional overlaps by aligning institutional duties with the practical scope of the sanitation work, particularly near rivers. Without these structural reforms, institutions will not adopt new technologies, no matter how effective those technologies are.

By linking community empowerment with institutional accountability, these recommendations advance a more integrated approach to sanitation governance. Such alignment not only enhances the sustainability of technologies like Tripikon but also contributes to broader efforts to reduce urban infrastructure inequality in rapidly urbanizing contexts

5. Conclusion

This study demonstrates that while community acceptance of technology in riverbank slum settlements is high, institutional support is the decisive factor for sustainable implementation. Institutional capacity is significantly constrained by fragmented responsibilities, ambiguous funding mechanisms, and the absence of clear operational frameworks, which inhibits the maintenance and scaling of innovations. The empirical analysis confirms that opportunity structures are stronger predictors of program outcomes than community agency alone.

These findings highlight a persistent social–institutional gap: community agency fails to translate into durable outcomes when institutional structures are weak or misaligned. Theoretically, this study posits that social readiness and institutional readiness must co-evolve for decentralized technologies to succeed in informal urban settings. This reframes sanitation innovation not merely as a technical challenge, but as a governance problem rooted in coordination, accountability, and empowerment.

Bridging the social-institutional gap requires a shift from formal support to concrete institutional reforms. Policies must clarify inter-agency mandates, strengthen coordination mechanisms, and design funding schemes toward more localized or community-based models. Integrating participatory planning and monitoring processes is essential for enhancing system ownership and operational sustainability. Further research should test the feasibility of this framework in other informal urban contexts and explore multi-level collaboration models that align community capacity with institutional capability.

Acknowledgement

The author gratefully acknowledges the financial support provided by the Community Service Program – Top-Down Scheme, Directorate of Community Service and Expertise Services (DPMK), Institut Teknologi Bandung (ITB), under the 2025 funding scheme.

Reference

Alsop, R., Bertelsen, M., & Holland, J. (2006). Empowerment in Practice : From Analysis to Implementation. *Empowerment in Practice*. https://doi.org/10.1596/978-0-8213-6450-5

Angelia, A., Soewondo, P., Halomoan, N., Sarli, P. W., & Setiyawan, A. S. (2024). Analisis Faktor Penerimaan Sistem Pengelolaan Air Limbah Domestik Setempat Pada Permukiman Kumuh Tipologi Tepian Sungai Kota Pontianak. *Jurnal Serambi Engineering*, *9*(4).

Australian Bureau of Statistics. (2025). *Census and sample | Australian Bureau of Statistics*. https://www.abs.gov.au/statistics/understanding-statistics/statistical-terms-and-concepts/census-and-sample

Collender, G. (2011). Urban sanitation: An unprecedented and growing challenge on JSTOR. *Waterlines*, *30*(4). https://www.jstor.org/stable/24686667

Dickin, S., & Gabrielsson, S. (2023). Inequalities in water, sanitation and hygiene: Challenges and opportunities for measurement and monitoring. *Water Security*, *20*, 100143. https://doi.org/10.1016/j.wasec.2023.100143

Dikman Maheng, M., Zevenbergen, C., Putra, A., & Ndibale, W. (2016). A Household Sanitation Technology for Amphibious Housing. *International Conference of Amphibious Architecture, Design and Engineering*. www.icaade2015.com

Djonoputro, E. R. (2013). *Opsi Sanitasi Yang Terjangkau Untuk Daerah Spesifik*. World Bank - Water and Sanitation Program.

Djonoputro, E. R., Blackett, I., Rosenboom, J.-W., & Weitz, A. (2010). Understanding sanitation options in challenging environments. *Waterlines*, *29*(3), 186–203. https://doi.org/10.3362/1756-3488.2010.020

Ekren, E. (2021). *Agency, opportunity structure and empowerment in everyday refugee life: Enduring and overcoming challenges of daily living in Cologne refugee shelters* [University of Bonn]. https://www.researchgate.net/publication/358129053_Agency_opportunity_structure_and_empowerment_in_everyday_refugee_life_Enduring_and_overcoming_challenges_of_daily_living_in_Cologne_refugee_shelters

Hendrarso, P., Kurnia, N., Subhan, A., Septiani, M. R., Gunawan, G., Nugroho, A., Tinggi, S., & Banten, I. A. (2025). Decentralization in a Unitary State: A Comparative Analysis and Adaptive Governance Design Based on Performance-Panji Hendrarso et.al Decentralization in a Unitary State: A Comparative Analysis and Adaptive Governance Design Based on Performance. *Jurnal Multidisiplin Sahombu*, *5*. https://doi.org/10.58471/jms.v5i05

Isunju, J. B., Schwartz, K., Schouten, M. A., Johnson, W. P., & van Dijk, M. P. (2011). Socio-economic aspects of improved sanitation in slums: A review. *Public Health*, *125*(6), 368–376. https://doi.org/10.1016/j.puhe.2011.03.008

Jones, L., & Sidell, M. (Eds.). (1997). *The Challenge of Promoting Health*. Macmillan Education UK. https://doi.org/10.1007/978-1-349-25564-1

Katukiza, A. Y., Ronteltap, M., Oleja, A., Niwagaba, C. B., Kansiime, F., & Lens, P. N. L. (2010). Selection of sustainable sanitation technologies for urban slums — A case of Bwaise III in Kampala, Uganda. *Science of The Total Environment*, *409*(1), 52–62. https://doi.org/10.1016/j.scitotenv.2010.09.032

Laverack, G. (2004). Health Promotion Practice: Power and Empowerment. *Health Promotion Practice: Power and Empowerment*, 1–76. https://doi.org/10.4135/9781446215258

Laverack, G. (2006). Improving health outcomes through community empowerment: a review of the literature. *Journal of Health, Population, and Nutrition*, *24*(1), 113–120.

Lipsky, Michael. (1980). *Street-level bureaucracy : dilemmas of the individual in public services*. Russell Sage Foundation.

Makaudze, E. M., & Gelles, G. M. (2015). *The Challenges of Providing Water and Sanitation to Urban Slum Settlements in South Africa* (pp. 121–133). https://doi.org/10.1007/978-94-017-9801-3_5

Marlisa, D. F., Putri, D. W., & Soewondo, P. (2015, November). Modification Of Tripikon-S With Bioball Addition In Artificial Black Water Treatment For Swamp And Coastal Areas. *The Third Joint Seminar of Japan and Indonesia Environmental Sustainability and Disaster Prevention*.

Mochammad, S. (2023). Coping Mechanism for Street-Level Bureaucrats in the Implementation of Policies for Handling Coronavirus Disease 19 (Covid-19) in Gorontalo City. *International Journal of Social Science Research and Review*, *6*(6), 196–203. https://doi.org/10.47814/ijssrr.v6i6.1165

Mursyid, H., Daulay, M. H., Pratama, A. A., Laraswati, D., Novita, N., Malik, A., & Maryudi, A. (2021). Governance issues related to the management and conservation of mangrove ecosystems to support climate change mitigation actions in Indonesia. *Forest Policy and Economics*, *133*, 102622. https://doi.org/10.1016/j.forpol.2021.102622

Normasari, E. R., Setyono, P., & Probandari, A. N. (2017). Efisiensi Tripikon-S Sebagai Solusi Sanitasi Masyarakat Tepi Air Sungai Martapura Kota Banjarmasin. *Jurnal EKOSAINS*.

Oliveira, E., & Hersperger, A. M. (2018). Governance arrangements, funding mechanisms and power configurations in current practices of strategic spatial plan implementation. *Land Use Policy*, *76*, 623–633. https://doi.org/10.1016/j.landusepol.2018.02.042

Petesch, P., & Narayan, D. (2010). Moving Out of Poverty : Volume 4. Rising from the Ashes of Conflict. *Moving Out of Poverty, Volume 4*. https://doi.org/10.1596/978-0-8213-7631-7

Sarkodie, S. A., & Strezov, V. (2019). Economic, social and governance adaptation readiness for mitigation of climate change vulnerability: Evidence from 192 countries. *Science of The Total Environment*, *656*, 150–164. https://doi.org/10.1016/j.scitotenv.2018.11.349

Siddik, S. S., Setiyawan, A. S., Sarli, P. W., Soewondo, P., & Awfa, D. (2024). The stakeholder analysis of sanitation management in Pontianak City Slums. *E3S Web of Conferences*, *485*, 04003. https://doi.org/10.1051/e3sconf/202448504003

UN-Habitat. (2016). *Tackling Improvement in the Lives of Slum Dwellers*. UN-Habitat.

Wapwera, S. D., Mallo, D. M., & Jiriko, G. J. (2015). Institutional framework and constraints in the urban and regional planning system in Jos Metropolis, Nigeria. *Journal of Geography and Regional Planning*, *8*(10), 244–260. https://doi.org/10.5897/JGRP2015.0513

Webster, A., & Gardner, J. (2019). Aligning technology and institutional readiness: the adoption of innovation. *Technology Analysis & Strategic Management*, *31*(10), 1229–1241. https://doi.org/10.1080/09537325.2019.1601694

Wijayanti, D. P., Sutikno, F. R., & Surjono, S. (2023). Factors Influencing Sanitation Management in Slums on The Riverbank of Kotalama Urban Village. *International Journal Of Humanities Education and Social Sciences (IJHESS)*, *3*(2). https://doi.org/10.55227/ijhess.v3i2.702