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Waste Management and Digital Citizen Participation in WPF3R Services using the Rais-MR3 Framework in Indonesian Local Government

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Abstract: Digital transformation has become a critical enabler for improving governance capacity and policy effectiveness in community-based waste management systems. This study examines governance challenges in waste collection and processing services and formulates the development direction of the Waste Collection *(Pappulung Aroppoe)* application within an e-governance and public policy framework. The analysis is guided by the Rais-MR3 framework to align institutional readiness, operational needs, and digital innovation. A qualitative approach was employed through semi-structured interviews with 16 residents aged 20–40 years across eight service-user and non-user locations in Panca Rijang District, complemented by a review of industrial innovation needs documents. The findings identify four key constraints affecting policy implementation and service delivery: limited waste collection fleets, the absence of an integrated and independent digital platform, fragmented daily operational data flows covering waste inputs and outputs, and insufficient trained human resources. Public literacy and engagement with the waste management program remain uneven, particularly in non-service areas, reflecting gaps in policy communication and digital outreach. The study concludes that effective e-governance in waste collection requires the integration of digital tools with local governance structures. It recommends developing the *Pappulung Aroppoe* application as a unified platform incorporating GIS-based collection scheduling, daily performance recording, incentive-based eco-points, and analytical dashboards to strengthen transparency, accountability, and citizen participation in local waste management policy.

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INTRODUCTION

Community-based waste management has emerged as a strategic public service response to increasing urbanization, environmental pressures, and service inequality in developing regions. Waste Processing Facilities applying the Reduce, Reuse, and Recycle

principle (WPF3R) represent a decentralized governance model that integrates waste collection, sorting, processing, and downstream product utilization such as compost, maggots, and recyclable materials. As a local public service, WPF3R requires coordination among multiple actors, operational reliability, and sustained citizen participation. Recent governance and sustainability studies emphasize that the performance of such systems is shaped not only by technical capacity but also by institutional arrangements, data governance, and service legitimacy (Jia et al., 2024; Rabetino et al., 2023).

Findings from the Industrial Call partner innovation requirements document indicate that WPF3R implementation faces persistent structural constraints. These include limited waste collection fleets that restrict service coverage, weak human resource capacity, and fragmented operational processes. Beyond these technical issues, governance-related challenges remain prominent, particularly the absence of an independently managed digital platform and the lack of continuous daily operational data flows connecting waste input, processing activities, and sales transactions. Such fragmentation limits monitoring, accountability, and policy learning, thereby constraining the effectiveness of local waste management governance (Abdurrahman et al., 2024; Nur et al., 2025; Jia et al., 2024).

To address these gaps, the innovation requirements document proposes the development of the *"Pappulung Aroppoe"* digital platform as a unified waste collection and management system. The proposed platform integrates spatial mapping of waste sources, GIS-based pickup scheduling, daily tonnage recording, incentive mechanisms through eco-points, and analytical dashboards for operators and policymakers. Previous studies suggest that digitally integrated platforms can enhance coordination, transparency, and service efficiency when they are embedded within supportive governance structures (Nesmachnow et al., 2025; Atofarati et al., 2025). In waste management contexts, such platforms also facilitate evidence-based decision-making and adaptive service planning (Okonta & Vukovic, 2024; Xu, 2025).

Nevertheless, digital innovation in public services does not automatically generate governance improvements. E-governance literature consistently shows that technological systems depend on legitimacy, institutional alignment, and citizen acceptance to function effectively. Actors' interpretive frameworks influence how technologies are understood, trusted, and used, shaping patterns of support, resistance, and institutionalization (Guenduez et al., 2020; Criado & O. de Zarate-Alcarazo, 2022).

Differences in digital literacy, prior service experience, and perceptions of fairness can hinder adoption, particularly in communities that are not yet integrated into formal service networks (Detthamrong et al., 2025).

From a public policy perspective, the uneven adoption of digital platforms reflects broader governance challenges. Dashboards and performance-monitoring tools are often promoted as instruments for transparency and accountability, yet their impact depends on indicator design, clarity of user roles, and data governance arrangements (Banerjee et al., 2025). Similarly, smart waste management initiatives employing AI or IoT technologies require institutional readiness and implementable governance frameworks to ensure that data-driven systems can be sustained in practice (Kannan et al., 2024). Without these conditions, digital platforms risk functioning as symbolic reforms rather than operational governance tools.

This study adopts the Rais-MR3 framework as an integrative governance perspective for analyzing WPF3R services and guiding the development of the *Pappulung Aroppoe* application. Rais-MR3 conceptualizes public service systems as configurations of legitimacy and process integrity, service management, data-based monitoring, accountability and transparency, resource orchestration, and operational resilience. By linking these dimensions, the framework enables an assessment of how digital platforms can strengthen governance capacity rather than merely digitize existing routines. This approach is consistent with design science principles that emphasize grounding artifact development in real-world problems and iterative evaluation (Hevner et al., 2004; Peffers et al., 2007).

Empirically, this article presents a preliminary qualitative investigation of residents' perceptions of WPF3R services across service-user and non-user areas. The analysis focuses on residents' knowledge, experiences, and perceived barriers to service adoption, and systematically synthesizes these findings with the innovation needs articulated in the Industrial Call document. This approach recognizes citizen experience as a critical input for public service design and governance reform, particularly in decentralized and community-based service systems (Guenduez et al., 2025).

Based on this context, the study is guided by the following research questions: (1) How do differences in program literacy, service awareness, and service experience between WPF3R users and non-users shape perceptions of waste management governance and service legitimacy at the local level? (2) What governance-related

barriers, particularly in service communication, data transparency, and the provision of service evidence, contribute to the low adoption of WPF3R services and the limited use of the *Pappulung Roppoe* application? (3) How do residents' perceptions and experiences correspond with the operational and data governance gaps identified in the industry innovation requirements document? (4) How can the Rais-MR3 framework be operationalized to translate identified adoption and governance gaps into governance-oriented design recommendations for the *Pappulung Roppoe* digital platform.

RESEARCH METHOD

This study adopts a descriptive qualitative research design to explore governance challenges and adoption dynamics in community-based waste management services. A qualitative approach is appropriate for capturing residents' perceptions, experiences, and interpretations of public service delivery, particularly in contexts where digital platforms and governance mechanisms are still evolving. Semi-structured interviews were employed to allow flexibility in probing respondents' knowledge, attitudes, and expectations while maintaining comparability across cases (Yang et al., 2024; Scott et al., 2025). In addition to primary data, this study utilizes industrial innovation requirement documents as contextual data to identify operational constraints and technological needs shaping WPF3R governance, including limitations in fleet availability, the absence of an independently managed digital platform, and fragmented daily operational data flows (Helo & Thai, 2024; Zrelli & Rejeb, 2024; Moyano-Londoño et al., 2025).

Fieldwork was conducted in Panca Rijang District through interviews with residents aged 20–40 years (n = 16), selected to reflect the most active and digitally exposed segment of the population. Informants were distributed across eight locations, with two respondents per location, comprising both WPF3R service users and non-users. Service-user areas included Macorawalie, Rappang, and Lalebata Villages (six informants), while non-user areas included Kadidi, Timoreng Panua, Bulo Wattang, Bulo Timoreng, and Cipotakari Villages (ten informants). This distribution enabled a comparative assessment of perceptions between areas with different levels of service exposure and adoption.

Informants were selected using a convenience random approach, whereby residents encountered in public spaces or their immediate living environments were invited to participate after confirming their status as WPF3R users or non-users. This

approach was chosen to capture spontaneous and experience-based perceptions while ensuring representation from both adoption categories. Ethical considerations were observed by informing participants about the purpose of the study and ensuring voluntary participation. The sample size was considered sufficient for a preliminary qualitative investigation aimed at identifying dominant themes rather than producing statistical generalizations.

The semi-structured interview guide covered five core themes: (1) knowledge and understanding of the WPF3R program, (2) service experience among users, (3) perceived problems and expectations related to waste management services, (4) awareness and exposure to the *Pappulung Roppoe* application, and (5) preferences regarding application features and socialization channels (Roy et al., 2025). Interview data were analyzed using thematic analysis, involving open coding, theme development, and comparison between user and non-user groups (Ahmed et al., 2025). The resulting themes were subsequently mapped onto the Rais-MR3 governance dimensions to translate empirical findings into governance-oriented recommendations for strengthening WPF3R services and guiding the development of the *Pappulung Roppoe* digital platform.

RESULTS AND DISCUSSION

Program Literacy, Service Experience, and Perceived Legitimacy of WPF3R Governance

A pronounced divergence in program literacy between WPF3R users and non-users, shaping how waste management governance is perceived at the local level. Among non-users, NVivo coding is dominated by categories indicating minimal or absent awareness of the WPF3R program. Informants in this group frequently lack knowledge of service types, collection schedules, and the environmental or economic rationale underpinning the program. This limited awareness restricts their ability to recognize WPF3R as a legitimate public service, as governance processes remain largely invisible. In contrast, users display higher levels of awareness derived from direct service interaction, suggesting that experiential exposure plays a critical role in shaping perceptions of governance legitimacy.

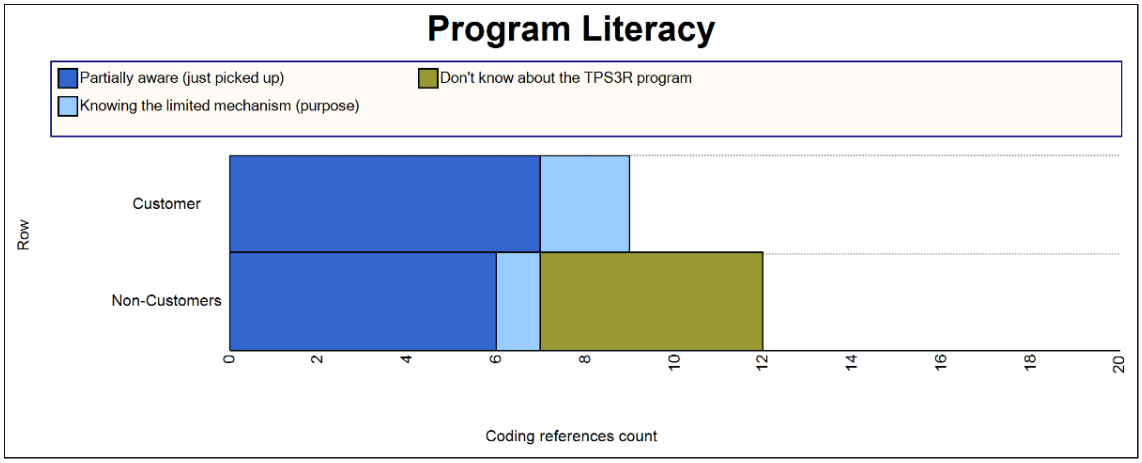

Figure 1. Program Literacy
Source: Processed by the author based on the results of Nvivo 12

Figure 1 shows that the relatively higher literacy observed among users remains partial and operationally narrow. User knowledge is largely confined to waste collection activities, with limited understanding of processing mechanisms, downstream products, data management, or incentive schemes. This partial literacy indicates that routine service contact does not necessarily translate into comprehensive governance awareness. Consequently, users' perceptions of legitimacy are grounded in service functionality rather than an understanding of institutional processes, limiting their capacity to evaluate accountability, transparency, or performance beyond immediate service outcomes.

Differences in service experience further reinforce these perceptual divides. Users emphasize the importance of schedule certainty and service consistency as baseline indicators of governance quality. Reliable service delivery reinforces trust and sustains participation, even when broader governance processes remain opaque. Non-users, however, often interpret the absence of clear information and perceived uneven service coverage as indicators of weak governance. For this group, uncertainty regarding service availability and reliability undermines confidence in the system and reinforces disengagement, illustrating how service experience mediates perceptions of legitimacy.

The contrast between awareness and experience also shapes how governance authority is interpreted. Users tend to associate legitimacy with the tangible presence of services, while non-users evaluate governance based on the clarity and accessibility of information. This divergence suggests that governance legitimacy is constructed through different evaluative lenses: operational performance for users and informational transparency for non-users. Without mechanisms to bridge these perspectives,

governance remains fragmented, privileging those already integrated into the service system.

The findings indicate that differences in program literacy, service awareness, and service experience produce uneven perceptions of waste management governance and legitimacy. Low literacy among non-users constrains recognition of WPF3R as a credible public service, while partial literacy among users limits deeper engagement with governance processes. Addressing these gaps requires governance strategies that combine reliable service delivery with systematic communication and transparency efforts, ensuring that legitimacy is built not only through operational performance but also through shared understanding of service objectives and processes.

Governance Barriers Shaping the Adoption of Digital Waste Management Services

The findings indicate that governance-related barriers—rather than technical accessibility—are central to explaining the low adoption of WPF3R services and the limited use of *Pappulung Roppoe*. NVivo visualization shows that both customers and non-customers are generally aware of the application, yet this awareness remains superficial. Informants frequently report uncertainty regarding the application's purpose, operational scope, and tangible benefits. Such ambiguity reflects weaknesses in service communication, where information dissemination does not translate into understanding or perceived relevance. As a result, the application is not recognized as an authoritative service channel capable of supporting governance functions such as accountability or citizen engagement, but rather as an incomplete initiative with unclear institutional status (Figure 2).

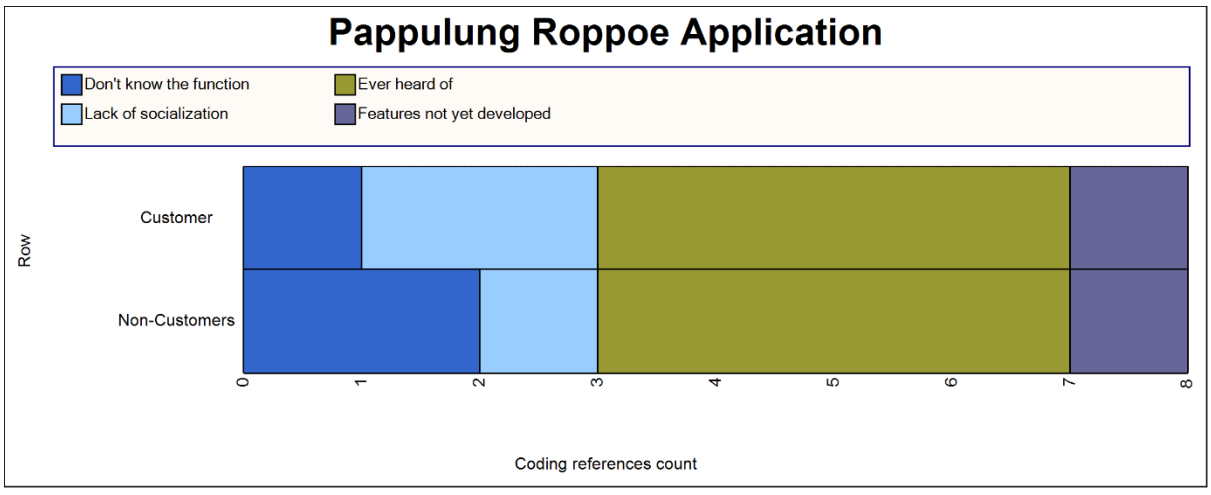

Figure 2. Pappulung Roppoe Application
Source: Processed by the author based on the results of Nvivo 12

Figure 2 shows that the category “ever heard of” dominates across both groups, while “do not know the function” and “lack of socialization” remain prominent at the early stages of engagement. This pattern suggests that communication efforts have emphasized exposure without ensuring comprehension. From a digital governance perspective, this indicates a failure to institutionalize *Pappulung Roppoe* within formal service routines and communication infrastructures. Without structured explanations of how the application supports service access, reporting, and participation, citizens lack the interpretive framework necessary to integrate the platform into their daily interactions with waste management services.

Beyond communication, deficiencies in data transparency further constrain adoption. Both user and non-user groups express the need for clearer information on service schedules, operational consistency, and waste management outcomes. The absence of an independent digital platform capable of consolidating and presenting such data reinforces perceptions of opacity and weak oversight. In governance terms, transparency is not merely a technical attribute but a relational condition that enables citizens to observe, assess, and trust public service performance. Where data remain fragmented or inaccessible, digital platforms struggle to generate legitimacy and sustained participation.

The lack of service evidence compounds these transparency challenges. Customers emphasize the importance of concrete indicators such as pickup confirmations, real-time status updates, and accessible complaint channels as signals of institutional reliability. Non-customers similarly identify visible proof of service performance as a prerequisite for considering participation. The innovation requirements document reinforces these perceptions by highlighting the absence of integrated daily operational data flows linking waste input, processing outputs, and sales transactions. Without such evidence, governance claims remain abstract, reinforcing skepticism and limiting the perceived value of digital engagement.

Overall, the findings suggest that low adoption of WPF3R services and the limited use of *Pappulung Roppoe* are driven by governance deficits in communication, transparency, and service evidence provision. These barriers inhibit the institutionalization of the application as an e-governance instrument and constrain its capacity to support accountability and participation. Addressing these challenges requires repositioning the application as a governance-oriented platform that

systematically communicates service rules, makes operational data visible, and provides verifiable service evidence. Such alignment is essential for strengthening trust and embedding digital tools within local waste management governance.

Governance Barriers to Digital Service Adoption in Local Waste Management

The findings indicate that governance-related barriers, rather than technological availability, are the primary factors constraining the adoption of WPF3R services and the use of *Pappulung Roppoe* as a digital service interface. Although both users and non-users demonstrate basic awareness of the application, this awareness does not translate into functional engagement. Informants commonly report uncertainty regarding the application's purpose, scope, and practical benefits, suggesting that service communication remains fragmented and insufficiently institutionalized. Consequently, the application is not perceived as an authoritative governance tool but as an incomplete or peripheral initiative, weakening its role in supporting service legitimacy and citizen engagement.

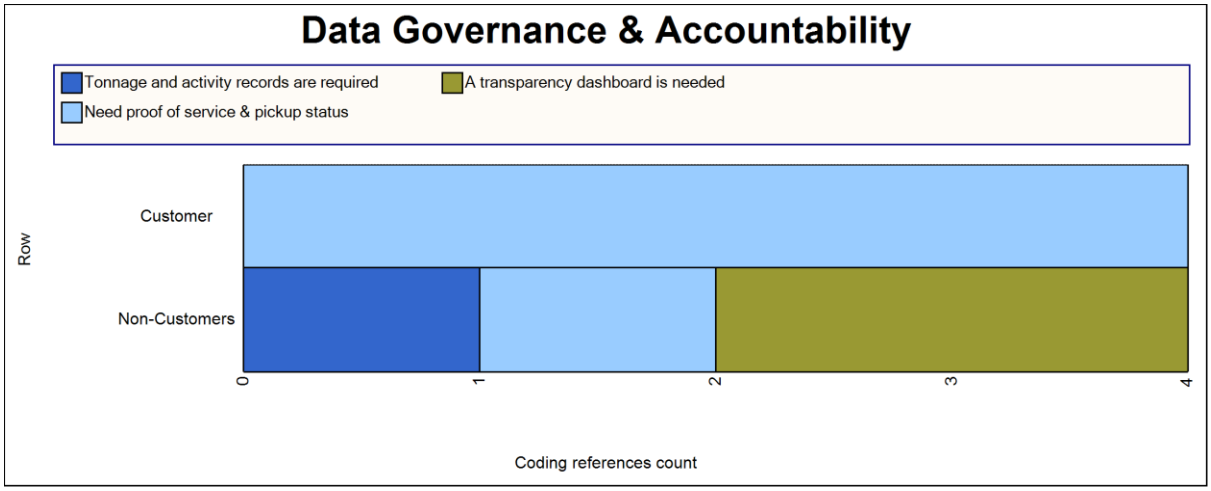

Figure 3. Data Governance & Accountability
Source: Processed by the author based on the results of Nvivo 12

Figure 3 shows that the category "ever heard of" dominates perceptions across both groups, while "do not know the function" and "lack of socialization" remain prevalent. This pattern reflects a communication strategy that prioritizes exposure over comprehension, resulting in shallow awareness without meaningful adoption. From an e-governance perspective, such outcomes indicate a failure to embed the digital platform within formal service routines and communication channels. Without structured narratives that link *Pappulung Roppoe* to service access, accountability, and participation,

citizens lack the interpretive framework necessary to integrate the application into their everyday interactions with public services.

In addition to communication gaps, deficiencies in data transparency significantly undermine adoption. Both users and non-users express the need for accessible information on service schedules, operational reliability, and waste management outcomes. The absence of an independent digital platform capable of consolidating and presenting operational data reinforces perceptions of opacity and weak oversight. In the context of digital government, transparency is not limited to data availability but also depends on citizens' ability to access, interpret, and trust information. Where such conditions are unmet, digital platforms fail to generate the credibility required for sustained engagement.

The lack of service evidence further constrains trust in the governance system. Users emphasize the importance of concrete indicators such as pickup confirmations, real-time service status, and responsive complaint mechanisms as signals of institutional reliability. Non-users similarly identify visible evidence of service performance as a prerequisite for considering participation. The absence of integrated daily data flows linking waste input, processing outputs, and sales transactions prevents the system from demonstrating performance and accountability, reinforcing skepticism and limiting the perceived value of digital participation.

The findings suggest that low adoption of WPF3R services and the limited use of *Pappulung Roppoe* stem from governance deficits in communication, transparency, and evidence provision. These barriers inhibit the institutionalization of digital tools and constrain their capacity to function as mechanisms of e-governance. Addressing these challenges requires repositioning the application as a governance instrument that systematically communicates service rules, provides verifiable operational data, and generates visible service evidence. Such alignment is essential for strengthening trust, enabling participation, and embedding digital platforms within local public service governance.

Operationalizing Rais-MR3 for Governance-Oriented Digital Platform Design

The empirical findings reveal that adoption barriers differ markedly between WPF3R users and non-users, underscoring the need for a governance-oriented translation of these gaps into digital platform design. NVivo analysis shows that among users, barriers are relatively limited and primarily relate to incomplete service

information. In contrast, non-users face more fundamental constraints, dominated by the failure of information to reach them and skepticism regarding unclear program benefits. These patterns indicate that adoption challenges are rooted less in usability or access and more in governance failures related to legitimacy, communication, and perceived value. Such disparities provide a concrete empirical basis for operationalizing the Rais-MR3 framework as a design logic rather than a purely diagnostic tool (Figure 4).

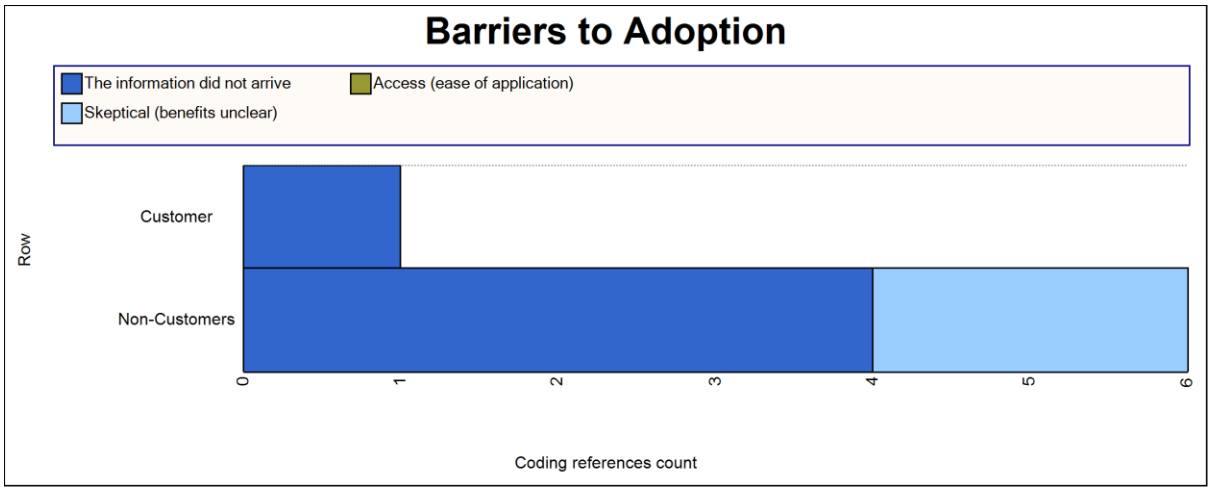

Figure 4. Barriers to Adoption
Source: Processed by the author based on the results of Nvivo 12

Figure 4 shows that non-adoption is driven by deficits in early-stage governance processes, particularly the communication of service rules, benefits, and participation pathways. The dominance of information-related barriers among non-users suggests that legitimacy has not been established prior to service engagement. From a Rais-MR3 perspective, this points to weaknesses in the integrity of processes and public-facing service rules, where citizens lack the minimum information required to recognize WPF3R as a credible and worthwhile public service.

Translating these findings into governance-oriented design recommendations requires aligning digital features with specific Rais-MR3 dimensions. First, addressing legitimacy and process integrity necessitates embedding clear service rules, schedules, and participation guidelines directly into the digital platform. Rather than functioning solely as a backend data tool, *Pappulung Roppoe* should serve as an authoritative reference point that clarifies what the service is, how it operates, and what citizens can expect. This aligns digital design with governance objectives of rule clarity and institutional trust.

Second, the prominence of skepticism among non-users indicates the need to operationalize accountability and transparency through visible service evidence. Features such as pickup confirmations, real-time service status, and publicly accessible performance summaries directly respond to citizens' demands for proof of service. By making operational data legible and accessible, the platform can transform abstract policy commitments into observable outcomes, reinforcing trust and reducing perceived risk associated with participation.

Finally, Rais-MR3 emphasizes resource orchestration and operational resilience as critical dimensions for sustainable adoption. The integration of GIS-based scheduling, daily tonnage recording, eco-point incentives, and analytical dashboards should therefore be designed not as isolated technical modules, but as interconnected governance instruments. Such integration enables service providers to coordinate fleets, human resources, and data flows while allowing citizens to experience consistent, responsive, and adaptive services. In this way, *Pappulung Roppoe* becomes a mechanism for adoption governance—bridging communication gaps, strengthening legitimacy, and enabling data-driven decision-making—rather than merely a digital add-on to existing waste management practices.

Implications for Policy, Practice, and Research

The findings extend broader discussions on local digital governance by demonstrating that low adoption of public digital services is fundamentally an issue of *adoption governance*, rather than technological insufficiency. Limited program literacy, weak service communication, and minimal socialization indicate deficits in *process legitimacy* and *transparency*, which shape how citizens interpret the credibility and value of public services. For policymakers, this implies that digital initiatives such as WPF3R platforms must be embedded within governance arrangements that explicitly articulate service rules, participation pathways, and accountability mechanisms. Rather than treating digital platforms as project-based innovations, policy frameworks should position them as institutional instruments that construct legitimacy and enable citizen participation. This insight contributes to comparative debates on how local governments can strengthen digital governance capacity beyond the specific case of waste management.

From a service governance perspective, the study underscores the importance of reframing digital platforms as mechanisms for producing *service evidence* and reinforcing

accountability. While technical features such as GIS-based scheduling, tonnage recording, eco-point schemes, and dashboards are necessary, their governance value lies in how they make service performance visible and verifiable. Consistent with prior studies, dashboards strengthen accountability only when indicators are aligned with user needs and supported by sound data governance arrangements (Matheus et al., 2018). Accordingly, service practice should integrate *adoption-oriented indicators*—such as active user participation, complaint resolution rates, and engagement with incentive mechanisms—alongside technical performance metrics. This alignment operationalizes the Rais-MR3 dimensions of accountability, data-based monitoring, and service management, shifting the focus from system deployment to sustained institutionalization.

The study also contributes to theoretical discussions on technological frames by showing that citizen and service-actor interpretations of digital platforms critically shape adoption outcomes. The limited use of *Pappulung Roppoe* reflects not resistance to technology per se, but uncertainty regarding its governance role and practical relevance. Future research should therefore examine how technological frames evolve over time and how governance interventions—such as improved communication, service evidence, and feedback mechanisms—reshape these interpretations. In addition, the findings support a staged approach to digital transformation, where advanced technologies such as AI or IoT are introduced only after foundational data governance and public trust have been established. Prior research confirms that AI-based waste management systems are effective only when institutional readiness and data quality are in place (Olawade et al., 2024). By foregrounding adoption governance and legitimacy, this study opens pathways for comparative and longitudinal research on citizen participation and data-driven governance in decentralized public service systems.

CONCLUSION

This study demonstrates that uneven program literacy, limited service awareness, and fragmented service experience shape how WPF3R governance and legitimacy are perceived at the local level. Residents in non-user areas exhibit particularly low understanding of service scope and benefits, while users' knowledge remains largely operational and partial. Although awareness of Pappulung Roppoe exists, the application has not been institutionalized as a routine service channel due to weak communication,

insufficient service evidence, and limited data transparency. These findings show that adoption barriers are primarily governance-related rather than technical, confirming that effective digital public services depend on process legitimacy, transparent information flows, and visible accountability. By synthesizing citizen perceptions with documented operational constraints, the study addresses all research questions and identifies adoption governance as the central explanatory factor across literacy gaps, communication failures, and limited platform use.

The key implication is that local digital governance requires reframing digital platforms from project-based tools into governance instruments that enable legitimacy, participation, and data-driven accountability. The Rais-MR3 framework provides a coherent lens to translate identified gaps into governance-oriented design principles without reducing the analysis to an application blueprint. As an exploratory qualitative study, the evidence supports general claims about the primacy of adoption governance in decentralized public services while acknowledging limits to statistical generalization. Future work should advance from diagnosis to evaluation through staged implementation or piloting of Pappulung Roppoe, with systematic assessment of service-level achievement, participation dynamics, data quality, and citizen satisfaction. Longitudinal and comparative research across service domains will further clarify how legitimacy-building, transparency, and technological frames shape sustainable citizen participation in local digital governance.

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