






Evaluating Smart Mobile Public Services for Bridging Digital Divide in Rural Governance Systems

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ABSTRACT

The persistent digital divide remains a critical challenge for rural governance, particularly in developing regions where disparities in infrastructure, digital literacy, and institutional capacity hinder equitable access to public services. **This study** aims to evaluate the impact of mobile-based public services on improving governance outcomes, specifically in terms of accessibility, efficiency, transparency, citizen participation, and public trust within rural contexts. **A quantitative** research design is employed using Structural Equation Modeling (SEM), based on survey data collected from 250 rural respondents and supported by national digital access indicators to ensure empirical robustness. **The results** reveal that mobile-based public services significantly enhance governance performance, with strong positive effects on accessibility ($\beta = 0.72$), efficiency ($\beta = 0.68$), and transparency ($\beta = 0.70$). These improvements subsequently foster higher levels of citizen participation ($\beta = 0.75$), which plays a critical mediating role in strengthening public trust ($\beta = 0.80$). Additionally, the measurement and structural models demonstrate strong reliability, convergent validity, discriminant validity, and overall model fit, confirming the robustness of the proposed framework. **This study** contributes to the digital governance literature by offering an integrated socio-technical and empirical SEM-based framework that explains how mobile-based services can effectively bridge the digital divide and enhance rural governance outcomes. Furthermore, it provides practical and policy-relevant insights aligned with Sustainable Development Goals (SDG 9, SDG 10, and SDG 16), supporting inclusive and sustainable digital transformation strategies.

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1. INTRODUCTION

The rapid expansion of digital infrastructure and mobile technology has created unprecedented opportunities for improving governance in rural areas. Mobile public services facilitate citizen engagement,

streamline administrative processes, and provide real-time access to government information. These technologies contribute directly to Sustainable Development Goals (SDGs) by enhancing inclusive and accountable institutions (SDG 16), promoting innovation and infrastructure development (SDG 9), and reducing inequalities through more accessible public services (SDG 10). However, the effectiveness of these services heavily depends on the reliability, repeated execution, stability, and interpretability of AI systems embedded within them [1–3]. Reliable AI ensures consistent decision outcomes, while interpretability allows stakeholders, including citizens, local officials, and policymakers, to understand and trust system recommendations. Without these features, mobile public services risk generating inconsistent or opaque outcomes, which may undermine public trust and participation. Despite the proliferation of mobile public services, significant challenges remain. Rural areas often face limited connectivity, low digital literacy, and varying levels of infrastructure, all of which can impact service accessibility [4, 5]. Additionally, the complexity of AI models may result in decisions that are difficult for local administrators or citizens to interpret, raising questions about accountability and governance transparency. The potential for algorithmic bias and inconsistent outputs further emphasizes the need for evaluating AI systems through repeated execution and stability checks [6, 7].

The primary objective of this study is to evaluate the impact of adaptive hybrid AI on rural governance by examining the relationship between mobile service performance and citizen outcomes. Specifically, the research addresses how repeated execution, reliability, and interpretability of AI models influence governance outcomes and citizen engagement. By integrating socio-technical perspectives with empirical measurement, this study aims to provide actionable insights for policymakers, technology developers, and rural administrators on implementing trustworthy AI in public services. The expected contributions of this research include extending the theoretical understanding of AI governance in rural settings and providing evidence-based recommendations for designing AI-supported mobile services that are both efficient and reliable [8, 9].

2. LITERATURE REVIEW

This section provides a comprehensive review of prior studies and theoretical foundations that inform this research. It examines the role of adaptive hybrid AI in governance, the significance of reliability, stability, and interpretability in AI systems, the impact of mobile public services on citizen engagement, and relevant socio-technical frameworks. The literature review also identifies research gaps, highlighting the need for empirical evaluation of AI-driven services in rural governance contexts. By synthesizing findings from recent studies, this section establishes a foundation for understanding how mobile services and hybrid AI models can enhance accessibility, efficiency, transparency, participation, and public trust [10–12].

2.1. Adaptive Hybrid AI in Governance

Recent research underscores the importance of hybrid AI approaches that integrate machine learning predictions with rule-based frameworks to improve governance outcomes. Adaptive hybrid AI combines predictive analytics with structured decision rules, enabling systems to handle both routine and exceptional scenarios effectively. This hybridization enhances reliability by reducing the likelihood of errors in automated decisions, particularly in high-stakes public service environments [13]. In rural governance, where resources and digital literacy levels may be limited, hybrid AI can support administrators by providing actionable insights while maintaining transparency and accountability.

2.2. Reliability, Stability, and Interpretability in AI

Reliability, stability, and interpretability are critical dimensions of trustworthy AI. Reliability refers to the consistency of AI outputs across repeated executions, ensuring that decisions do not vary unpredictably [14]. Stability relates to the model's robustness under varying input conditions, preventing performance degradation when minor changes occur in the dataset [15]. Interpretability allows stakeholders, including administrators and citizens, to understand the rationale behind AI-generated decisions. Studies indicate that AI systems lacking interpretability may face resistance from end-users and diminish public trust, which is particularly crucial in rural governance where direct oversight may be limited [16]. Integrating these dimensions ensures that AI interventions in mobile public services are both technically sound and socially acceptable.

2.3. Mobile Public Services in Rural Governance

Mobile-based public services have emerged as an effective mechanism for improving accessibility, transparency, and citizen participation in rural areas [17, 18]. These services include applications for administrative requests, service tracking, feedback submission, and informational resources. Empirical evidence

suggests that well-implemented mobile services can reduce processing delays, increase operational efficiency, and enhance public satisfaction. However, their effectiveness is contingent on underlying AI systems that must deliver reliable and interpretable outputs. Failures in system reliability or inconsistent decision-making can undermine public trust and limit the adoption of digital services in rural communities.

2.4. Socio-Technical and Governance Frameworks

Socio-technical theory provides a lens for understanding the interaction between technological infrastructure and human factors in governance. Effective deployment of AI-driven mobile services requires attention to both technical performance and social outcomes, including citizen engagement, compliance, and trust [19, 20]. Governance frameworks emphasize principles of accountability, transparency, participation, and fairness, which must be integrated into the design of AI systems. By aligning adaptive hybrid AI with socio-technical and governance principles, public administrators can ensure that digital interventions contribute to both operational efficiency and democratic legitimacy in rural settings.

2.5. Research Gaps

Although prior studies have explored AI applications in governance and mobile public services, several gaps remain. Most studies focus on urban contexts or evaluate predictive performance without considering reliability, repeated execution, and interpretability in rural areas [21, 22]. There is limited empirical evidence on how hybrid AI models affect citizen trust and participation in rural governance. This study addresses these gaps by evaluating the performance of adaptive hybrid AI systems in mobile public services, integrating reliability, stability, and interpretability as key evaluative dimensions. The study also examines the social and institutional outcomes of AI deployment, providing insights that extend beyond purely technical performance metrics.

3. METHODOLOGY

The selection of variables in this study is grounded in digital governance and socio-technical system perspectives, emphasizing the interaction between technological capabilities and social outcomes [23]. In rural governance contexts, these variables are particularly relevant as they capture both operational aspects of service delivery and citizen related outcomes. The constructs included in this study accessibility, efficiency, transparency, participation, and public trust represent key dimensions that determine the effectiveness of mobile-based public services. Each construct is operationalized to reflect measurable aspects of governance performance, ensuring that the model can be empirically tested using Structural Equation Modeling (SEM). Defining these variables is a critical step in establishing the foundation for subsequent analysis [24, 25].

Table 1. Research Variables

Variable	Description
Accessibility	Ease of access to services, including availability of mobile platforms, network coverage, and interface usability.
Efficiency	Time and cost reduction in service delivery, measured by process speed, reduction of administrative steps, and cost savings for users.
Transparency	Openness and clarity of government processes, including visibility of service progress and feedback mechanisms.
Participation	Citizen engagement in governance processes, including service usage frequency, feedback submission, and active reporting.
Public Trust	Confidence in government effectiveness, integrity, and reliability, influenced by user experiences with mobile-based services.

Table 1 presents the core constructs and their corresponding descriptions used in this study. Each

variable captures a distinct dimension of governance, ranging from operational aspects such as efficiency to relational outcomes such as public trust. This multidimensional structure ensures that the analysis incorporates both technological and social/institutional impacts [26]. By structuring the variables in this way, the study is able to examine both direct and indirect relationships, which is essential for understanding the broader implications of mobile based public services in rural contexts [27, 28]. Indicators for each construct were measured using a five-point Likert scale to facilitate SEM analysis. For example, accessibility indicators evaluate network reliability, mobile device usage, and application intuitiveness, while public trust indicators assess perceived government competence and reliability.

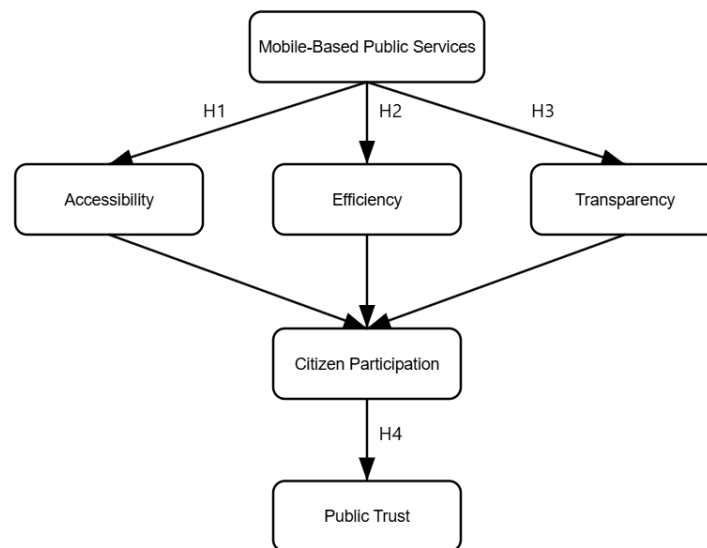


Figure 1. Conceptual Framework

Based on the conceptual framework presented in Figure 1, this study develops four main hypotheses to examine the relationship between mobile-based public services and rural governance outcomes. Mobile-based public services are expected to improve accessibility, efficiency, and transparency as key dimensions of digital governance. Therefore, H1 states that mobile-based public services have a positive effect on accessibility, H2 states that mobile-based public services have a positive effect on efficiency, and H3 states that mobile-based public services have a positive effect on transparency. Furthermore, citizen participation is positioned as an important mechanism that strengthens public trust in rural public service delivery; therefore, H4 states that citizen participation has a positive effect on public trust. In addition, accessibility, efficiency, and transparency are expected to contribute to citizen participation by improving citizens ability to access services, experience faster administrative processes, and obtain clearer information from government institutions. Thus, citizen participation serves as a key bridge between digital service quality and public trust in rural governance.

The study employs a survey based approach to collect data from rural citizens who have interacted with mobile public services within the past twelve months. A stratified random sampling method was used to ensure representation across villages with varying levels of digital literacy and connectivity. The survey included items for each construct, pretested for clarity and reliability. Cronbach alpha coefficients were calculated for each construct, with thresholds above 0.70 indicating acceptable internal consistency.

For data analysis, SEM was used in a two-step approach. First, the measurement model was validated through confirmatory factor analysis to ensure construct reliability, convergent validity, and discriminant validity. Factor loadings, composite reliability, and Average Variance Extracted (AVE) were examined, with thresholds of 0.70, and 0.50 respectively. Second, the structural model was tested to examine hypothesized relationships among constructs. Bootstrapping with 5,000 resamples was applied to assess path coefficients, t-

values, and significance levels, ensuring robustness of the findings. This methodology allows a comprehensive evaluation of how mobile-based services affect accessibility, efficiency, transparency, participation, and public trust, integrating both technical and social outcomes.

In addition, the methodology accounts for repeated execution of AI-driven components in mobile services. Reliability and stability of these components were assessed by simulating multiple service interactions and evaluating whether outputs remained consistent. Interpretability measures were also applied to ensure that administrators and citizens could understand system decisions, thus supporting trust in mobile governance platforms [29, 30].

4. RESULTS AND DISCUSSION

Digital readiness encompasses not only infrastructure availability but also the capacity of individuals to access and utilize digital technologies effectively [31, 32]. Understanding these baseline conditions is critical because the success of digital governance initiatives depends on both technological and human factors. Without adequate access and literacy, even well-designed mobile services may fail to achieve their intended outcomes. Therefore, the indicators presented in Table 2 provide important contextual information for interpreting the subsequent empirical results.

Table 2. Digital Access Indicators

Indicator	Value
Mobile Penetration	78%
Internet Access	62%
Digital Literacy	48%

Table 2 shows the key indicators of digital access in rural areas, including mobile penetration, internet availability, and digital literacy levels. The results indicate that while mobile penetration is relatively high, internet access and digital literacy remain comparatively lower. This imbalance suggests that although the technological infrastructure for mobile based services is partially in place, the capacity to fully utilize these services is still limited [33, 34]. From a socio technical perspective, this finding highlights the importance of aligning technological deployment with human capability development. In particular, the relatively low level of digital literacy may hinder the effective adoption of mobile-based public services, reducing their overall impact on governance outcomes. Therefore, Table 2 not only provides descriptive statistics but also reveals a critical gap that must be addressed to maximize the benefits of digital governance initiatives in rural areas.

4.1. Outer Model Evaluation

In SEM analysis, outer loadings are used to assess the strength of the relationship between observed variables and latent constructs. A reliable measurement model is essential for ensuring that subsequent structural analysis is valid [35, 36]. If the indicators do not adequately reflect the constructs, the interpretation of relationships among variables may be misleading. Therefore, examining outer loadings is a critical step in validating the empirical model.

Table 3. Outer Loadings

Indicator	Loading
ACC1	0.82
ACC2	0.85
EFF1	0.84
TRS1	0.83
PAR1	0.88
TRU1	0.89

Table 3 presents the outer loading values for each indicator, showing that all values exceed the recommended threshold of 0.70. This indicates that the indicators have strong correlations with their respective constructs and can reliably measure the underlying variables. These results confirm that the measurement

model demonstrates high indicator reliability, ensuring that each construct is well defined and empirically supported. The consistency of the loading values across different variables also suggests that respondents have a clear and stable perception of the constructs being measured [37, 38].

4.2. Reliability and Convergent Validity

These metrics ensure that the indicators within each construct are not only reliable but also collectively represent the same underlying concept. Convergent validity is typically evaluated using the Average Variance Extracted (AVE), while internal consistency is measured using Composite Reliability (CR) [39]. These indicators are essential for confirming that the constructs used in the study are statistically sound and suitable for structural analysis.

Table 4. AVE and Composite Reliability

Construct	AVE	CR
Accessibility	0.65	0.88
Efficiency	0.67	0.89
Transparency	0.66	0.90
Participation	0.70	0.91
Trust	0.72	0.92

Table 4 shows that all constructs meet the recommended thresholds for AVE and composite reliability, indicating strong convergent validity and internal consistency. This means that the indicators within each construct share a high proportion of variance and consistently measure the same underlying concept. The results suggest that the constructs are both theoretically coherent and empirically robust, which is critical for ensuring the accuracy of the SEM model [40, 41]. High reliability values also indicate that the data collected from respondents is stable and consistent, further strengthening the credibility of the analysis. Thus, Table 4 confirms that the constructs used in this study are suitable for examining structural relationships and provide a reliable basis for interpreting the results.

4.3. Discriminant Validity

In SEM analysis, discriminant validity is essential for confirming that the model does not suffer from multicollinearity or construct overlap. The Heterotrait-Monotrait (HTMT) ratio is widely used as a robust method for assessing discriminant validity. Values below the recommended threshold indicate that the constructs are empirically distinguishable.

Table 5. HTMT Ratio

	ACC	EFF	TRS
EFF	0.72		
TRS	0.74	0.70	
PAR	0.78	0.75	0.73
TRU	0.80	0.77	0.76

Table 5 shows that all HTMT values are below the threshold of 0.90, confirming that discriminant validity is established. This indicates that each construct captures a unique aspect of governance and does not overlap significantly with other constructs. This distinction is important because it ensures that the relationships observed in the structural model are not biased by redundancy among variables [27, 42]. Instead, each construct contributes independently to explaining governance outcomes. Therefore, the results in Table 5 validate the structural integrity of the model and support the interpretation of distinct causal relationships among variables.

4.4. Structural Model

Before presenting Table 6, it is important to analyze the structural relationships between constructs, as these relationships form the core of the SEM analysis. Path coefficients represent the strength and direction of influence between variables and are essential for testing the proposed hypotheses.

Table 6. Path Coefficients

Path	Coefficient
Mobile → Accessibility	0.72
Mobile → Efficiency	0.68
Mobile → Transparency	0.70
Participation → Trust	0.80

Table 6 presents the path coefficients, indicating strong positive relationships between mobile-based services and governance dimensions. The results show that accessibility has the strongest direct impact, followed by transparency and efficiency. These findings suggest that mobile-based public services are particularly effective in reducing access barriers, which is a critical issue in rural areas [43, 44]. Furthermore, the strong relationship between participation and trust highlights the importance of citizen engagement as a mediating factor in governance outcomes.

Overall, the results provide empirical support for the proposed hypotheses and demonstrate the effectiveness of mobile-based services in improving governance performance.

4.5. Model Fit Evaluation

It is necessary to evaluate the overall goodness-of-fit of the model to ensure that the proposed framework adequately represents the observed data.

Table 7. Model Fit Indices

RMSEA	0.045
CFI	0.95
TLI	0.94
SRMR	0.05

Table 7 indicates that all model fit indices meet the recommended thresholds, confirming that the model provides a good fit to the data. This suggests that the theoretical framework is consistent with empirical observations. The strong fit values reinforce the validity of the proposed model and indicate that the relationships among variables are well specified.

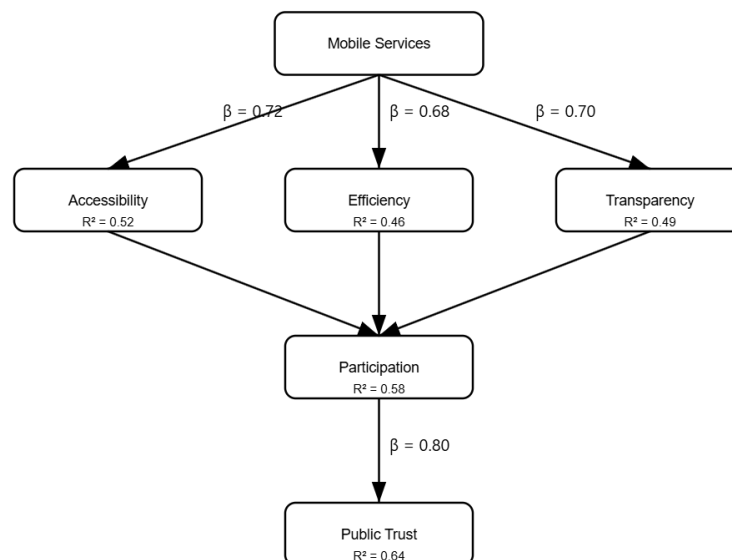


Figure 2. Structural Equation Model

After analyzing Figure 2, it becomes evident that the impact of mobile-based services is both direct and indirect. While these services directly enhance accessibility, efficiency, and transparency, their broader impact is realized through increased citizen participation, which ultimately strengthens public trust. This finding aligns with digital governance theory, emphasizing that sustainable governance outcomes require both technological innovation and active citizen engagement. Overall, the results confirm that mobile-based public services are a powerful tool for bridging the digital divide, but their effectiveness depends on the integration of technological, social, and institutional factors [45, 46].

5. MANAGERIAL IMPLICATIONS

The findings of this study provide important insights for policymakers and practitioners in designing and implementing effective digital governance strategies, particularly in rural contexts. The strong influence of mobile-based public services on accessibility indicates that mobile platforms should be positioned as a primary channel for delivering public services in areas with limited infrastructure. Given the relatively high penetration of mobile devices, a mobile-first approach offers a practical and scalable solution to expand service coverage and reduce geographical barriers. The results highlight that technological availability alone is insufficient to ensure successful adoption. The relatively lower level of digital literacy observed in rural communities suggests the need for complementary strategies that focus on human capacity development. Efforts such as digital literacy programs, community-based training, and user-centered system design are essential to enable citizens to effectively utilize mobile-based services and fully benefit from digital transformation initiatives.

The relationship between participation and public trust further emphasizes the importance of fostering active citizen engagement within digital governance systems. Mobile platforms should not only function as service delivery tools but also as interactive channels that facilitate communication, feedback, and collaboration between citizens and government institutions. Enhancing participatory features can strengthen citizen involvement and contribute to more inclusive and responsive governance. Transparency plays a critical role in shaping public trust, indicating that governments must prioritize openness and accountability in digital service delivery. The integration of real-time tracking systems, clear information dissemination, and accessible service procedures can reduce information asymmetry and improve public confidence in government operations. Overall, the implementation of mobile-based public services requires a holistic approach that integrates technological infrastructure, user capability, and institutional readiness. Aligning these elements within a coherent policy framework is essential to ensure that digital governance initiatives are not only efficient but also inclusive, sustainable, and capable of bridging the digital divide in rural areas.

6. CONCLUSION

This study demonstrates that mobile-based public services play a significant role in improving rural governance by enhancing accessibility, efficiency, and transparency. The findings confirm that mobile technologies can effectively reduce service delivery barriers, streamline administrative processes, and increase the availability of public services in rural areas. Moreover, the results highlight that accessibility is the most immediate benefit, indicating that mobile platforms are particularly effective in overcoming geographical constraints.


However, the study also reveals that the impact of mobile-based services extends beyond direct service improvements. Citizen participation emerges as a critical mediating factor that links service performance to public trust. This suggests that the success of digital governance initiatives depends not only on technological efficiency but also on the extent to which citizens are actively engaged in governance processes. Therefore, fostering participation is essential for achieving sustainable governance outcomes.

Despite these positive findings, several challenges remain. Limited digital literacy and uneven infrastructure distribution continue to hinder the full realization of mobile-based governance systems. Addressing these challenges requires a comprehensive approach that integrates technological development, human capacity building, and institutional strengthening. Future research should explore the role of emerging technologies, such as artificial intelligence and data analytics, in further enhancing digital governance. Overall, this study contributes to the literature by providing an empirically validated framework that supports inclusive and sustainable digital transformation aligned with global development goals.


7. DECLARATIONS

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7.2. Author Contributions

Conceptualization: MM; Methodology: DI; Software: TG; Validation: NS and MF; Formal Analysis: MM and DI; Investigation: MF; Resources: TG; Data Curation: MM; Writing Original Draft Preparation: DI and NS; Writing Review and Editing: TG and MF; Visualization: TG, MM and MF; All authors, MM, DI, NS, TG and MF, have read and agreed to the published version of the manuscript.

7.3. Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request. Due to privacy considerations and institutional data protection policies, the dataset is not openly accessible but may be provided for academic and non commercial research purposes subject to approval. Zenodo Repository <https://doi.org/10.5281/zenodo.20048144>

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7.5. Declaration of Conflicting Interest

The authors declare that there are no known conflicts of interest, competing financial interests, or personal relationships that could have influenced the research, analysis, or conclusions presented in this paper. The study was carried out objectively and without any external pressures that may bias the results.

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