

Toward Smart Governance for Smart City Development: A Penta-Helix Collaboration Framework from South Solok Regency, Indonesia

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ABSTRACT

This study aims to analyze the strengthening of smart governance through penta-helix collaboration in the development of a smart city in South Solok Regency. A qualitative approach with a case study method was employed to gain an in-depth understanding of multi-actor collaboration dynamics and digital governance processes. Data were collected through in-depth interviews, observations, and document analysis, and analyzed using thematic analysis techniques.

The findings indicate that penta-helix collaboration has begun to emerge but has not yet been systematically and sustainably institutionalized. The local government remains the dominant actor, while the involvement of academia, the private sector, the community, and the media is still partial. The strengthening of smart governance has progressed through the implementation of SPBE and digital public services; however, challenges persist, including system fragmentation, limited data integration, and administrative rather than strategic inter-agency coordination. Public participation also remains limited to service usage rather than substantive involvement in decision-making processes.

These findings imply that smart city development is still at the stage of system and service enhancement and has not yet reached a fully integrated and sustainable transformation. Therefore, strengthening institutional collaboration, improving digital system integration, enhancing cross-sector coordination, and expanding public participation are essential to achieving more effective smart governance.

Keywords: smart governance, penta-helix, smart city, SPBE, collaboration

INTRODUCTION

The digital transformation of public administration has become a global strategic agenda for improving government effectiveness, transparency, and public service delivery. Rapid advances in information and communication technologies (ICTs) have accelerated governments' adoption of digital governance strategies, particularly through the development of smart cities. Contemporary smart city literature has increasingly shifted from a technology-centric perspective toward governance-oriented approaches that emphasize the integration of digital technologies, institutional capacity, stakeholder collaboration, and citizen participation in creating sustainable public value (Nam & Pardo, 2011; Meijer & Bolívar, 2016). Within this perspective, smart governance represents a critical dimension because it provides the institutional mechanisms through which digital technologies are translated into more responsive, accountable, and collaborative public administration (Gil-Garcia et al., 2018).

The evolution of smart governance also reflects broader transformations in public administration theory. The transition from New Public Management (NPM) toward New Public Governance (NPG) has shifted the focus of governance from organizational efficiency to collaborative networks, stakeholder engagement, and co-production of public services (Osborne, 2010). Contemporary governance increasingly recognizes that

governments alone are unable to address complex societal challenges. Instead, effective governance requires collaborative relationships among public institutions, the private sector, academia, civil society, and citizens (Kettl, 2015). This perspective aligns with the principles of collaborative governance, which emphasize shared decision-making, institutional trust, and collective problem-solving as essential determinants of successful public policy implementation (Ansell & Gash, 2008; Emerson et al., 2012).

In Indonesia, digital government transformation has been institutionalized through the implementation of the Electronic-Based Government System (SPBE) under Presidential Regulation No. 95 of 2018. SPBE serves as the primary national framework for strengthening digital public administration through integrated electronic governance systems. Recent performance indicators demonstrate substantial progress across local governments, including South Solok Regency, where the SPBE index increased from 2.26 in 2022, 2.98 in 2023, 3.28 in 2024, and 3.50 ("Very Good") in 2025. These improvements indicate significant institutional commitment to digital transformation and public sector modernization.

Nevertheless, accumulating evidence suggests that improvements in digital maturity do not necessarily translate into stronger governance performance. Previous studies have shown that successful smart city implementation depends not merely on technological advancement but also on institutional capacity, cross-sectoral coordination, data integration, and collaborative governance mechanisms (Gil-Garcia et al., 2018; Dunleavy et al., 2006). In many developing regions, digital initiatives remain fragmented across government agencies, resulting in isolated information systems, limited interoperability, and weak institutional coordination. Consequently, digital transformation often improves administrative efficiency without fundamentally strengthening governance capacity.

To address these challenges, scholars increasingly advocate multi-stakeholder collaboration as an essential governance mechanism for smart city development. Among various collaborative frameworks, the Penta-Helix model, involving government, academia, industry, civil society, and the media, has received growing attention for its capacity to stimulate innovation, knowledge exchange, and public value creation (Carayannis & Campbell, 2010). Rather than positioning government as the sole decision-maker, the model conceptualizes governance as an interactive ecosystem in which multiple actors collectively contribute to policy formulation, implementation, and evaluation.

Empirical evidence from South Solok Regency illustrates both the opportunities and limitations of this collaborative approach. Various stakeholders have participated in digital government initiatives, including universities through policy research and community engagement, private firms through technological infrastructure provision, communities through participatory public services, and media organizations through information dissemination and transparency enhancement. However, these interactions largely remain consultative and project-based rather than institutionalized collaborative arrangements characterized by shared authority, joint decision-making, and long-term governance integration. Similar patterns have been identified in collaborative governance literature, which argues that multi-actor participation frequently becomes symbolic when institutional arrangements, leadership, and collaborative capacities remain underdeveloped (Ansell & Gash, 2008; Emerson et al., 2012).

These governance challenges become even more pronounced in non-metropolitan regions, where digital transformation is constrained by geographical conditions, uneven ICT infrastructure, limited institutional capacity, and restricted financial resources (OECD, 2016; Kettl, 2015). Existing smart city research has predominantly focused on large metropolitan areas characterized by relatively mature digital ecosystems. Consequently, limited attention has been devoted to understanding how collaborative governance mechanisms operate in smaller and resource-constrained local governments. This gap indicates that the effectiveness of smart governance cannot be fully explained by technological readiness alone but requires a deeper understanding of how collaborative institutional arrangements shape digital transformation in diverse territorial contexts.

Despite the growing body of smart governance research, three important gaps remain. First, previous studies predominantly examine technological implementation and digital infrastructure while giving limited attention to the governance processes through which multi-stakeholder collaboration strengthens smart governance. Second, empirical evidence regarding the operationalization of the Penta-Helix model in non-metropolitan smart city

development remains scarce, particularly within the context of Indonesian local governments. Third, existing literature rarely explains how collaborative interactions among government, academia, industry, communities, and the media contribute to institutional capacity building beyond technological adoption.

This study addresses these gaps by examining how Penta-Helix collaboration strengthens smart governance in the development of a smart city in South Solok Regency. Drawing upon collaborative governance and smart governance perspectives, the study contributes to the literature by extending understanding of collaborative institutional mechanisms in resource-constrained local governments and by providing an empirical model for strengthening smart governance in non-metropolitan smart city development.

METHOD

This study employed a qualitative case study design to explore how Penta-Helix collaboration strengthens smart governance in smart city development in South Solok Regency, Indonesia. A qualitative approach was considered appropriate because it enables an in-depth understanding of complex governance processes, stakeholder interactions, and institutional dynamics within their real-life context (Creswell & Poth, 2018; Yin, 2018). The case study strategy was selected because the research seeks to explain contemporary governance phenomena that cannot be separated from their institutional and socio-political settings (Yin, 2018).

South Solok Regency was purposively selected as an information-rich and critical case for three reasons. First, the regency has demonstrated measurable progress in implementing electronic government through the Electronic-Based Government System (SPBE), reflected in the continuous improvement of its SPBE performance index. Second, this digital progress coexists with persistent challenges of cross-sectoral coordination, institutional integration, and stakeholder collaboration. This contrast makes South Solok analytically valuable because it allows the study to examine whether improvements in digital-government maturity are accompanied by comparable changes in governance relationships. Third, South Solok is a non-metropolitan, geographically dispersed, and comparatively resource-constrained local government. It therefore represents a theoretically relevant case for developing-region governments that pursue smart-city transformation without the dense innovation ecosystems and institutional resources available to major metropolitan areas. The case is not intended to be statistically representative; rather, it supports analytical generalization by identifying governance mechanisms potentially transferable to comparable non-metropolitan contexts (Yin, 2018).

Participants were selected using purposive sampling, targeting stakeholders directly involved in smart city planning, implementation, digital service provision, public participation, or information dissemination. The sample represented all five actors of the Penta-Helix framework. Data collection continued until theoretical saturation was reached, meaning that subsequent interviews no longer produced substantively new categories relevant to the analytical framework (Guest et al., 2020). The final sample comprised 18 participants, as summarized in Table 1.

Table 1. Profile of interview participants by Penta-Helix stakeholder group

Stakeholder group	n	Illustrative role	Analytical contribution
Government	8	Bappeda, Diskominfo, relevant agencies	Planning, SPBE, coordination
Academia	3	University/research representatives	Research, policy advice, capacity building
Private sector	2	Technology/service providers	Infrastructure, technical support, innovation
Community	3	Community/citizen representatives	Service experience, participation, local needs
Media	2	Local media representatives	Information, transparency, public communication

Fieldwork was conducted from January to May 2026. During this period, data were collected through semi-structured interviews, non-participant observations, and document analysis. Interviews explored collaborative governance practices, institutional coordination, digital-government implementation, stakeholder participation, and barriers to strengthening smart governance. The format enabled consistent coverage of core topics while allowing follow-up questions on emerging issues (Kvale & Brinkmann, 2015). A total of 18 participants were

interviewed: 8 government officials, 3 academics, 2 private-sector representatives, 3 community representatives, and 2 media representatives.

Observations focused on digital public service delivery, inter-organizational interactions, and collaborative activities among stakeholders. Documents reviewed included the RPJMD, local-government strategic plans, the Smart City Master Plan, SPBE evaluation reports, local regulations, policy documents, and other official records. Document analysis provided institutional context and enabled triangulation of interview and observational evidence (Bowen, 2009).

Data were analyzed using the interactive model proposed by Miles, Huberman, and Saldaña (2014), comprising data condensation, data display, and conclusion drawing and verification. The analytical process followed a theory-driven thematic analysis, in which initial coding was guided by the analytical framework of Penta-Helix collaboration, smart governance, and smart city, while allowing new themes to emerge inductively from the empirical data (Braun & Clarke, 2006). The coding process involved four stages. First, interview transcripts and field notes were repeatedly reviewed to achieve data familiarization. Second, open coding was conducted to identify meaningful units related to collaboration, governance, and digital transformation. Third, codes were organized into broader categories corresponding to the analytical framework. Finally, cross-stakeholder and cross-source comparisons were undertaken to identify recurring patterns, relationships, and institutional mechanisms explaining how collaborative governance contributes to strengthening smart governance.

To enhance the trustworthiness of the findings, the study employed several strategies recommended for qualitative research. Source triangulation was conducted by comparing information obtained from different stakeholder groups, while method triangulation integrated evidence from interviews, observations, and documentary analysis. Member checking was performed by inviting selected participants to review preliminary interpretations, ensuring that the findings accurately reflected their perspectives. Furthermore, an audit trail documenting all stages of data collection and analysis was maintained to enhance transparency and dependability (Lincoln & Guba, 1985; Creswell & Poth, 2018).

For reporting, quotations were selected to illustrate recurring patterns rather than isolated opinions, and interpretations were checked against evidence from other stakeholder groups, observations, and documents. Stakeholder identity is reported by institutional role rather than personal name to protect confidentiality. Additional verbatim excerpts from the original interview transcripts should be inserted in the final submission, where permission and anonymization requirements allow, particularly for academia, private-sector, community, and media participants; such quotations cannot be reconstructed reliably from documentary evidence alone.

Rather than treating the research as variable-based, this study employed an analytical framework consisting of three interrelated dimensions. The first dimension, Penta-Helix collaboration, examined the roles and interactions among government, academia, industry, communities, and the media, including coordination, collaboration, and co-creation. The second dimension, smart governance, focused on institutional integration, cross-sectoral coordination, public participation, transparency, accountability, and the utilization of digital government through SPBE. The third dimension, smart city development, assessed how collaborative governance contributes to service innovation, digital integration, public value creation, inclusiveness, and sustainable regional development. These dimensions provided the conceptual lens for interpreting the empirical findings and explaining the governance mechanisms underlying smart city development.

RESULTS AND DISCUSSION

Penta-Helix Collaboration in Smart City Development in South Solok Regency

The findings indicate that Penta-Helix collaboration in the development of the smart city in South Solok Regency has begun to emerge but remains at an early stage of institutional development. Although multiple stakeholders, including government agencies, universities, private organizations, communities, and the media have participated in various smart city initiatives, their involvement is largely project-based and has yet to evolve into an institutionalized collaborative governance system. Consequently, the local government continues to function as the dominant actor in planning, coordinating, and implementing digital transformation programs.

This pattern is evident in regional planning documents, including the Regional Medium-Term Development Plan (RPJMD), the Smart City Master Plan, and SPBE evaluation reports, all of which primarily emphasize the modernization of government administration and the digitalization of public services. While these policy documents acknowledge the importance of stakeholder participation, they provide limited institutional mechanisms for integrating non-government actors into strategic decision-making processes. As a result, collaboration tends to occur only during specific projects rather than being embedded within the governance structure itself.

Interview findings strongly support this observation. A government official explained:

“We have collaborated with external stakeholders several times, but usually only during specific projects. There is still no permanent forum that brings all stakeholders together.”

This statement illustrates that collaboration remains temporary rather than institutionalized. Similar perspectives were expressed by participants representing academia, who acknowledged that universities are frequently invited to provide research assistance or technical expertise but rarely participate during the policy formulation stage. Likewise, representatives from the private sector described their involvement as largely limited to supplying technological infrastructure instead of contributing to strategic policy innovation. Community representatives also perceived themselves primarily as users of digital services rather than active participants in public decision-making, while media organizations viewed their role as disseminating information instead of facilitating policy dialogue or collaborative evaluation.

These perceptions were consistent with observational findings. Interactions among stakeholders were predominantly organized through short-term programs, workshops, or government-led initiatives without permanent collaborative institutions. Moreover, no formal governance mechanism was identified that explicitly regulates the participation of Penta-Helix actors in policy formulation, implementation, and evaluation. Consequently, interactions among stakeholders remain hierarchical and government-driven rather than horizontal and collaborative.

The convergence of evidence from interviews, observations, and policy documents suggests that collaborative practices in South Solok Regency are still concentrated at the levels of coordination and consultation, rather than progressing toward co-creation, where stakeholders collectively share authority, responsibility, and ownership of public innovation. This finding is particularly significant because it reveals that stakeholder participation alone does not necessarily constitute collaborative governance. Instead, meaningful collaboration requires institutional arrangements capable of sustaining long-term interaction among actors beyond individual government programs.

This finding extends the collaborative governance framework proposed by Ansell and Gash (2008). While their model emphasizes institutional design, trust building, facilitative leadership, and shared commitment as prerequisites for successful collaboration, the present study demonstrates that these elements remain insufficiently developed in the context of a non-metropolitan smart city. In South Solok Regency, collaboration is constrained not only by institutional design but also by the predominance of bureaucratic decision-making structures that continue to position government as the primary policy actor. Consequently, non-government stakeholders participate largely as supporting actors rather than equal partners in governance.

The findings also resonate with Emerson et al. (2012), who argue that collaborative governance requires collaborative capacity embedded within governance institutions rather than temporary cooperation among organizations. However, this study further demonstrates that collaborative capacity cannot simply emerge from the implementation of digital government initiatives. Despite continuous improvements in electronic government performance as reflected by the increasing SPBE index collaborative governance has not developed at a comparable pace. This finding challenges technology-centred assumptions frequently found in smart city literature, suggesting that digital transformation and governance transformation represent two related but distinct institutional processes.

From the perspective of smart city development, this distinction is particularly important. Existing literature often assumes that expanding digital infrastructure will naturally stimulate collaboration among stakeholders.

The empirical evidence from South Solok Regency suggests otherwise. Improvements in digital systems have successfully enhanced administrative efficiency and service delivery; however, they have not automatically transformed governance relationships. Institutional collaboration continues to depend upon formal governance arrangements, shared leadership, and mechanisms that facilitate continuous interaction among stakeholders.

Another important contribution of this study concerns the contextual characteristics of non-metropolitan local governments. Unlike metropolitan cities, where collaborative ecosystems are generally supported by stronger institutional capacity, greater financial resources, and denser innovation networks, South Solok Regency operates under more constrained conditions characterized by geographical dispersion, limited organizational resources, and relatively weak institutional connectivity. These contextual conditions explain why collaborative governance develops incrementally and why government agencies continue to dominate the governance process. Accordingly, strengthening smart governance in non-metropolitan regions requires not merely expanding digital infrastructure but also establishing permanent collaborative institutions capable of integrating government, academia, industry, communities, and the media into collective decision-making processes.

Overall, these findings suggest that Penta-Helix collaboration in South Solok Regency remains predominantly transactional rather than transformational. Stakeholder engagement has undoubtedly increased; nevertheless, collaboration has yet to mature into a governance ecosystem characterized by co-creation, shared responsibility, and collective innovation. Therefore, the institutionalization of collaborative mechanisms including permanent multi-stakeholder forums, integrated governance platforms, and participatory policy processes should become a strategic priority for strengthening smart governance and accelerating sustainable smart city development.

Strengthening Smart Governance in South Solok Regency

The findings demonstrate that the process of strengthening smart governance in South Solok Regency has progressed considerably through the expansion of digital government initiatives and institutional support for electronic governance. The local government has introduced a range of digital platforms including SRIKANDI, SIPD, SIMPEG, and digital PPID to improve administrative efficiency, public service delivery, and inter-agency information management. These initiatives are supported by regional planning documents, the Smart City Master Plan, and SPBE implementation strategies, all of which position digital transformation as a strategic priority for local government modernization.

The continuous improvement of the regional SPBE performance index further reflects this commitment. The SPBE score increased from 2.26 in 2022 to 2.98 in 2023, 3.28 in 2024, and 3.50 ("Very Good") in 2025, indicating significant progress in digital government implementation. From an administrative perspective, these achievements demonstrate the local government's capacity to institutionalize information technology within public administration and improve the accessibility of public services.

Nevertheless, the empirical findings reveal that improvements in digital maturity have not been accompanied by equivalent progress in governance integration. Although digital applications have expanded across government agencies, they continue to operate largely as independent systems with limited interoperability. Consequently, technological modernization has improved administrative functions without fundamentally transforming governance relationships among institutions.

This condition is clearly reflected in the interview findings. A senior official from the Department of Communication and Informatics explained:

“We already have many digital applications, but not all of them are connected to each other.”

This statement illustrates that digital transformation remains fragmented across organizational boundaries. Rather than functioning as an integrated digital ecosystem, many information systems continue to serve individual organizational needs. Similar concerns were expressed by officials from the Regional Development Planning Agency (Bappeda), who acknowledged that coordination among local government agencies has improved administratively but remains insufficient at the strategic level. Cross-sectoral collaboration largely

focuses on administrative reporting and procedural compliance instead of collective policy formulation and integrated decision-making.

The same pattern was observed from the perspective of citizens. Community representatives consistently described themselves as beneficiaries of digital public services rather than participants in governance processes. Digital platforms have undoubtedly expanded access to government services; however, opportunities for meaningful citizen engagement in planning, policy deliberation, and public accountability remain limited. Observational data reinforce this finding, indicating that digital government initiatives primarily facilitate service transactions rather than collaborative governance.

Document analysis provides additional evidence supporting these observations. While regional policy documents clearly articulate the objective of developing integrated digital government, they contain limited operational guidance regarding data interoperability, institutional coordination, and cross-sector governance arrangements. Existing regulations primarily emphasize technological implementation and administrative digitalization without establishing comprehensive governance mechanisms that connect government agencies with external stakeholders. Consequently, institutional fragmentation persists despite continuous investment in digital infrastructure.

These findings suggest that smart governance in South Solok Regency remains concentrated at the stage of administrative digitalization rather than governance transformation. Digital technologies have significantly improved efficiency, transparency, and public service delivery; however, they have yet to generate the institutional integration required for collaborative governance. This distinction is theoretically important because smart governance extends beyond the digitalization of government procedures. Instead, it requires institutional arrangements capable of integrating organizations, stakeholders, information systems, and decision-making processes within a coherent governance framework.

The present findings reinforce the concept of Digital-Era Governance proposed by Dunleavy et al. (2006), which argues that digital transformation should prioritize integration, reintegration, and shared information infrastructures rather than simply expanding electronic services. However, this study also extends the Digital-Era Governance perspective by demonstrating that technological integration alone is insufficient for strengthening smart governance in non-metropolitan contexts. Institutional coordination, collaborative leadership, and cross-sector governance capacities emerge as equally important determinants of successful digital transformation.

The findings further support Gil-Garcia et al. (2018), who conceptualize smart governance as the integration of technological capacity with institutional capability and stakeholder participation. Nevertheless, the empirical evidence from South Solok Regency suggests that these three dimensions do not necessarily develop simultaneously. Technological capability has advanced rapidly through SPBE implementation, whereas institutional integration and participatory governance continue to evolve more gradually. This uneven pattern indicates that smart governance should be understood as a multidimensional governance process rather than a direct outcome of technological modernization.

An important theoretical implication emerging from this study is the distinction between digital government maturity and smart governance maturity. Existing evaluation frameworks frequently assume that higher levels of digital government implementation correspond to stronger governance performance. However, the findings demonstrate that these two concepts represent different dimensions of institutional development. While SPBE effectively measures the digitalization of government administration, it provides only limited insight into collaborative capacity, stakeholder engagement, institutional integration, and collective decision-making. Consequently, digital maturity should not be interpreted as a comprehensive indicator of governance maturity.

This distinction contributes to the broader smart city literature by challenging technology-driven approaches that equate digital innovation with governance innovation. Instead, the findings indicate that governance transformation depends upon the simultaneous development of three complementary capacities: technological integration, institutional collaboration, and participatory governance. Weakness in any one of these dimensions constrains the overall effectiveness of smart governance regardless of technological progress. The findings are

particularly relevant for non-metropolitan regions. Unlike metropolitan smart cities, where institutional networks and digital ecosystems are generally more mature, local governments such as South Solok face structural challenges associated with limited financial resources, uneven ICT infrastructure, geographical dispersion, and relatively constrained organizational capacity. Under these conditions, strengthening smart governance requires governance innovations that extend beyond technology adoption. Permanent inter-agency coordination mechanisms, interoperable digital architectures, participatory policy platforms, and institutionalized multi-stakeholder collaboration become critical prerequisites for sustainable smart city development.

Overall, the findings demonstrate that the principal challenge facing smart governance in South Solok Regency is no longer the adoption of digital technology but the integration of governance institutions. Although considerable progress has been achieved in administrative digitalization, governance transformation remains incomplete because institutional collaboration, strategic coordination, and citizen participation have not yet developed at the same pace as technological advancement. Accordingly, strengthening smart governance requires shifting policy priorities from technology-centered digitalization toward collaborative institutional governance capable of connecting digital systems, public organizations, and societal actors within an integrated governance ecosystem.

Integrating Penta-Helix Collaboration and Smart Governance for Smart City Development

The preceding findings collectively demonstrate that the effectiveness of smart city development in South Solok Regency depends not merely on technological advancement but on the quality of collaborative governance that supports digital transformation. While the local government has achieved significant progress in implementing electronic government through the continuous improvement of SPBE performance, the empirical evidence indicates that digital maturity alone is insufficient to establish an integrated smart governance ecosystem. Rather, the findings suggest that smart governance emerges through the interaction between technological capability and collaborative institutional capacity.

The findings further indicate that Penta-Helix collaboration functions as the institutional foundation of smart governance, while smart governance serves as the governance mechanism through which collaborative relationships are translated into improved public services, digital innovation, and sustainable smart city development. In this context, collaborative governance should be understood as an enabling condition rather than merely a complementary component of smart city implementation.

The analysis reveals three interrelated institutional mechanisms linking Penta-Helix collaboration to smart governance. First, institutional integration enables government agencies and external stakeholders to coordinate policies, share information, and reduce organizational fragmentation. Second, cross-sector collaboration facilitates knowledge exchange, resource mobilization, and collective problem-solving among government, academia, industry, communities, and the media. Third, participatory governance strengthens public trust, accountability, and policy legitimacy by incorporating citizens and non-government actors into decision-making processes. Collectively, these mechanisms determine whether technological innovation can generate broader governance transformation.

An important finding emerging from this study is that improvements in digital infrastructure do not automatically strengthen these collaborative mechanisms. Instead, digital technologies primarily improve administrative efficiency unless accompanied by institutional reforms that redefine governance relationships among stakeholders. Consequently, smart governance should be understood as an institutional capability rather than merely a technological achievement.

This finding contributes to the growing debate concerning the governance dimension of smart cities. Previous studies have frequently conceptualized smart cities from technological perspectives, emphasizing digital infrastructure, information systems, and innovation capacity (Nam & Pardo, 2011; Meijer & Bolívar, 2016). More recent scholarship has shifted attention toward governance and stakeholder collaboration (Gil-Garcia et al., 2018). Nevertheless, limited empirical evidence has explained how collaborative governance operates within resource-constrained local governments. The present study addresses this gap by demonstrating that the

effectiveness of smart governance depends on the institutionalization of collaborative relationships rather than the expansion of digital technologies alone.

The South Solok pattern is also consistent with evidence from developing-country smart-city research. Tan and Taeihagh (2020) show that smart-city initiatives in developing contexts are constrained not only by technology but also by financial capacity, human capital, legal and regulatory arrangements, digital inclusion, and the quality of citizen and private-sector participation. Ruijter et al. (2023) similarly emphasize that multi-stakeholder smart governance requires practical institutional tools that enable actors to coordinate, share information, deliberate, and jointly solve problems. Compared with metropolitan settings, the South Solok evidence highlights a sharper capacity asymmetry: digital systems can expand relatively quickly, while collaborative institutions, interoperability, and participatory routines develop more slowly. This comparison strengthens the international relevance of the case by showing how resource constraints and institutional capacity shape the sequence of smart-governance transformation in non-metropolitan settings.

The findings also extend the Collaborative Governance framework developed by Ansell and Gash (2008). Their model identifies institutional design, trust, facilitative leadership, and shared commitment as essential conditions for collaboration. The present study confirms the importance of these elements while further demonstrating that, in the context of digital government, collaborative governance must additionally be supported by interoperable digital systems and integrated institutional arrangements. Without these complementary capacities, collaboration remains fragmented and largely symbolic despite improvements in technological infrastructure.

Similarly, the study enriches the Digital-Era Governance perspective proposed by Dunleavy et al. (2006). Although Digital-Era Governance emphasizes reintegration, shared services, and digital coordination, the findings indicate that technological integration does not necessarily produce governance integration. Institutional fragmentation may persist even when digital government systems continue to expand. Consequently, governance transformation should be viewed as a multidimensional process requiring simultaneous technological, organizational, and collaborative reforms.

From a practical perspective, the findings suggest that strengthening smart governance in non-metropolitan local governments requires a strategic shift from technology-oriented digitalization toward collaboration-oriented governance transformation. Rather than focusing exclusively on expanding digital applications, local governments should prioritize institutional mechanisms capable of sustaining long-term collaboration among Penta-Helix actors. Such mechanisms include permanent multi-stakeholder forums, integrated governance platforms, interoperable information systems, collaborative policy laboratories, and participatory digital platforms that facilitate continuous interaction among government agencies, universities, businesses, communities, and the media.

These institutional arrangements are particularly important in non-metropolitan regions, where financial resources, technological infrastructure, and organizational capacities are generally more limited than those available in metropolitan cities. Under these conditions, collaborative governance functions not merely as an administrative strategy but as a governance capability that enables local governments to mobilize external knowledge, resources, and innovation capacity for sustainable regional development.

The relationship between Penta-Helix collaboration and smart governance should not be interpreted as deterministic. Political leadership can determine whether cross-sector collaboration receives authority and continuity; fiscal capacity affects the ability to maintain interoperable infrastructure and collaborative programs; organizational culture shapes willingness to share data and authority across agencies; and digital literacy influences whether officials and citizens can use participatory platforms effectively. These contextual conditions may strengthen or weaken the collaborative mechanisms identified in this study and should therefore be treated as enabling or constraining factors when the model is applied elsewhere.

Accordingly, this study suggests that strengthening smart governance in non-metropolitan regions requires the integration of three mutually reinforcing dimensions: technological integration, institutional collaboration, and participatory governance. Sustainable smart city development can only be achieved when these dimensions evolve simultaneously. Improvements in a single dimension, such as digital infrastructure, are insufficient to

produce comprehensive governance transformation if institutional integration and stakeholder participation remain weak.

Overall, the findings indicate that Penta-Helix collaboration serves as the primary institutional driver of smart governance by strengthening institutional integration, cross-sector coordination, and participatory governance. These governance capacities subsequently enhance digital public services, policy innovation, organizational learning, transparency, and public trust, ultimately contributing to more adaptive, inclusive, and sustainable smart city development.

Operationalizing the Collaborative Smart Governance Model. The model can be evaluated through four linked components: (1) Penta-Helix collaboration—actor diversity, continuity of engagement, formal collaborative forums, shared agenda setting, resource contribution, and joint decision-making; (2) institutional integration—inter-agency coordination routines, data-sharing agreements, interoperability, role clarity, and integrated governance platforms; (3) participatory smart governance—access to information, deliberation opportunities, feedback responsiveness, transparency, and stakeholder involvement across policy formulation, implementation, and evaluation; and (4) smart-city outcomes—service integration, policy innovation, organizational learning, public trust, inclusiveness, and sustainability. Future studies can translate these indicators into survey measures, maturity scales, network measures, or comparative case-study protocols.

Figure 1. Operational logic of the Collaborative Smart Governance Model

Penta-Helix Collaboration	Institutional Integration
Actor diversity • formal forums • shared agenda • joint decisions	Coordination • data sharing • interoperability
Institutional Integration	Participatory Smart Governance
Integrated institutions and digital systems	Transparency • co-creation • accountability
Participatory Smart Governance	Smart City Outcomes: services
	• innovation • trust • inclusion • sustainability

The findings contribute to the smart governance literature by shifting the analytical focus from technology-centered smart city implementation toward collaboration-centered governance transformation. Rather than treating digital government as the endpoint of smart city development, this study argues that digital technologies function as enabling instruments whose effectiveness depends on collaborative institutional arrangements. This perspective provides a more comprehensive explanation of smart city development in non-metropolitan contexts, where governance capacity often represents a greater challenge than technological adoption itself.

CONCLUSION

This study examined how Penta-Helix collaboration strengthens smart governance in the development of a smart city in South Solok Regency, Indonesia. The findings demonstrate that although the local government has made substantial progress in digital transformation, as reflected in the continuous improvement of its Electronic-Based Government System (SPBE) performance, the institutional development of smart governance has not progressed at the same pace. The implementation of digital government has primarily enhanced administrative efficiency and public service delivery, while collaborative governance mechanisms remain insufficiently institutionalized. Collaboration among government, academia, the private sector, communities, and the media continues to be largely project-based and consultative rather than characterized by long-term co-creation and shared decision-making.

The study further reveals that strengthening smart governance depends not only on technological advancement but also on the quality of institutional collaboration. Three governance capacities emerged as fundamental determinants of effective smart governance: institutional integration, cross-sector coordination, and participatory governance. These capacities enable digital technologies to function as instruments for governance transformation rather than merely improving administrative procedures. Consequently, the findings demonstrate that digital transformation alone is insufficient to achieve sustainable smart city development unless supported by collaborative institutional arrangements that facilitate continuous interaction among Penta-Helix actors.

From a theoretical perspective, this study contributes to the literature in three important ways. First, it distinguishes between digital government maturity and smart governance maturity, arguing that improvements in digital government performance should not be interpreted as evidence of stronger governance capacity. Second, it extends the Collaborative Governance framework by demonstrating that effective collaboration in the context of digital government requires not only trust, facilitative leadership, and institutional commitment but also interoperable digital systems and formal governance mechanisms that sustain long-term stakeholder engagement. Third, the study proposes a Collaborative Smart Governance Model that integrates Penta-Helix collaboration, smart governance, and smart city development into a unified analytical framework. The model highlights the mediating role of institutional collaboration in translating digital transformation into sustainable governance outcomes, particularly within non-metropolitan local governments.

The practical implications of this study are equally significant. For local governments, strengthening smart governance should move beyond expanding digital infrastructure and prioritize the establishment of permanent collaborative institutions that facilitate strategic coordination among government agencies, universities, businesses, civil society organizations, and the media. Institutional reforms should also emphasize interoperable digital systems, integrated policy platforms, and participatory governance mechanisms that encourage meaningful stakeholder involvement throughout policy formulation, implementation, and evaluation. Such measures are particularly important for non-metropolitan regions, where limited institutional capacity and resource constraints require collaborative approaches to maximize public value and support sustainable regional development.

This study has several limitations. First, it is based on a single qualitative case in South Solok Regency; therefore, the findings are intended for analytical rather than statistical generalization. Transferability is most plausible to non-metropolitan local governments facing comparable conditions of resource constraint, geographical dispersion, uneven digital infrastructure, and government-dominated coordination. Second, the study focuses primarily on governance processes and institutional relationships and does not quantitatively test whether the proposed mechanisms improve governance performance, public trust, service quality, or citizen outcomes. Third, participant accounts and documentary evidence may reflect institutional perceptions and formal narratives; although triangulation, observation, member checking, and an audit trail were used, future studies should incorporate additional behavioral, platform-use, and performance data. Finally, political leadership, fiscal capacity, organizational culture, and digital literacy were identified as relevant contextual conditions but were not examined as separate explanatory dimensions.

Future research should test the Collaborative Smart Governance Model through comparative multiple-case studies involving metropolitan and non-metropolitan regions in Indonesia and other developing countries. Such designs could examine which components are context-specific and which mechanisms are transferable. Longitudinal research is also needed to trace how collaborative governance evolves across successive stages of digital transformation, particularly as local governments move from application-based digitalization toward data integration, co-creation, and institutionalized participation. Mixed-method studies could operationalize the proposed indicators and test relationships among Penta-Helix collaboration, institutional integration, participatory governance, and smart-city outcomes, while explicitly examining political leadership, fiscal capacity, organizational culture, and digital literacy as contextual moderators.

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