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Transforming Public Services through Smart Cities: Systematic Review of Civic Engagement Models

[1]Ahmad Royyan Aulia*, [2]Muhayat, [3]Nailah Nurul Ramadhani
[1,2]Program Studi Teknologi Informasi, Universitas Islam Negeri Antasari Banjarmasin
[3]Program Studi Psikologi Islam, Universitas Islam Negeri Antasari Banjarmasin
[1,2,3]Jl. A. Yani Km. 4,5 Banjarmasin, Kalimantan Selatan
*e-mail: royyanaulia0808@gmail.com

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Abstract

The transformation of public services through smart city development increasingly relies on digital technologies and data-driven approaches. Yet this transformation does not automatically produce meaningful citizen engagement or inclusive governance. Prior studies have examined digital transformation, citizen participation, data governance, stakeholder collaboration, and inclusion largely as separate strands, leaving the connections among them insufficiently synthesized. This study aims to identify the patterns, enabling factors, and barriers that shape the relationship between data-driven approaches, civic engagement, and public service delivery in smart cities. A Systematic Literature Review was conducted following the PRISMA 2020 guidelines. The Scopus search yielded 293 records, of which 50 studies published between 2020 and 2026 were included in the thematic synthesis. The findings show that digital transformation expands public service delivery, but its benefits depend on institutional capacity and local governance conditions; that citizen engagement is shaped by trust, perceived benefit, and institutional design rather than by platform availability alone; that data governance supports transparency and accountability but can reinforce bias when data are not representative; and that multi-stakeholder collaboration and inclusion determine whether benefits are distributed equitably. The main contribution is an integrative conceptual framework that positions institutional capacity and collaboration as enabling conditions, links civic engagement and data governance as interdependent components, and treats inclusion as a cross-cutting condition. The novelty of this study lies in synthesizing five previously separate dimensions into a single framework that guides policymakers and provides a basis for future empirical testing.

Keywords: *data-driven civic engagement, digital governance, inclusion, public service delivery, smart city.*

1 Introduction

Cities across the globe increasingly rely on digital technologies and data-driven infrastructures to manage urbanization, resource constraints, and rising demand for responsive public services. Quantitative evidence supports this trend: in 160 Chinese prefecture-level cities, participation in national smart city pilot programs is associated with measurable gains in the level, breadth, and diversity of public services, although the effect is significant mainly in higher-income regions [1]. Case-based evidence from Taiwan adds that a municipal digital-payment platform can strengthen service delivery, stimulate collaboration among government, businesses, and citizens, and create public value beyond transactional convenience [2].

This promise does not automatically translate into citizen-centered outcomes. A comparison of India, Singapore, and Indonesia shows that the effectiveness of smart city governance depends less on the sophistication of technology than on coordination, engagement mechanisms, institutional capacity, and adaptation to local conditions [3]. The wider literature likewise documents a shift from technology-led to citizen-centered governance, while identifying persistent technological, informational, bureaucratic, and access-related barriers to citizen involvement [4].

Governance challenges also extend to urban data itself. Benchmarking of data governance models across European cities shows wide variation in how well they meet basic requirements such as standardized formats, clear access protocols, and cross-departmental collaboration [5]. Equity is equally at stake: in South African metropolitan municipalities, centralized and technocratic

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governance combined with uneven infrastructure has concentrated smart technologies in already advantaged areas and left historically marginalized communities with limited access to connectivity and services [6].

Taken together, these studies reveal three limitations in the existing literature. First, each addresses a single dimension: public service outcomes [1], [2], institutional capacity and citizen-centered governance [3], [4], data governance [5], or inclusion [6]. Second, the evidence is context-bound, resting on one national pilot program [1], one city platform [2], one regional benchmark [5], or one national setting [6], which limits comparison across settings. Third, because the dimensions are studied in isolation, it remains unclear how they interact to determine whether data-driven initiatives support civic engagement and equitable service delivery or merely modernize urban administration. This fragmentation across disciplines, methods, and regions calls for a systematic synthesis.

Accordingly, this study conducts a systematic literature review of data-driven approaches to civic engagement and public service delivery in smart cities, guided by three questions: (RQ1) what patterns characterize the relationship between data-driven approaches, civic engagement, and public service delivery? (RQ2) which factors enable or hinder this relationship? (RQ3) how do the technological, participatory, data governance, collaborative, and inclusion dimensions interact? Compared with earlier work, this study makes three contributions: it synthesizes five dimensions that have been examined separately, it quantifies the evidence base of 50 included studies by publication year and analytical dimension, and it proposes an integrative conceptual framework that links civic engagement to data governance and treats inclusion as a cross-cutting condition.

2 Literature Review

This review organizes prior research into five strands that correspond to the analytical dimensions of the study. Each strand is introduced through its guiding concept, followed by the evidence that qualifies it and the gap it leaves open (Table 1).

2.1 Digital Transformation and Public Service Delivery

Digital transformation is increasingly understood as a governance-dependent process rather than a technical upgrade: service outcomes depend on institutional readiness, regulation, and administrative capacity as much as on technology. In Dubai's multimodal transport system, service performance depends jointly on connectivity, accessibility, and sustainability orientation, with data-driven decision-making as one determinant among several [7]. In Nigeria, the adoption of artificial intelligence, digitalization, and renewable energy technologies is constrained by bureaucratic inefficiency, weak digital literacy, and inconsistent regulatory support rather than by the availability of technology [8]. In Indonesia, the digitalization of population administration, licensing, and health services differs by city size: metropolitan and large cities reach near-complete digitalization, while medium and small cities lag substantially [9]. Service benefits are therefore uneven across administrative settings, which raises the question of how citizens engage with the services made available to them.

2.2 Citizen Participation and Co-Creation

The participation literature repositions citizens from passive recipients to active participants and potential co-creators of public value. A survey of five Indonesian smart cities shows that co-creation behavior in online public services is driven less by platform availability than by perceived benefit, particularly benefit mediated through online social networks [10]. In Jakarta's rapid response services, accessibility, trust, and awareness determine whether citizens engage actively, and active participants report greater service benefit than disengaged users [11]. In India's Smart Cities Mission, a substantial proportion of technologically equipped citizens in Bhubaneswar and Bhopal remain structurally passive despite formal participatory spaces [12]. Participation is therefore contingent on trust, social embeddedness, and perceived value, which are largely external to platform design.

2.3 Data-Driven Governance

Data-driven governance rests on the premise that data support better decisions, yet data are neither neutral nor purely technical. Design-oriented work proposes architectures for structuring multi-source urban data, while acknowledging that few studies examine the governance challenges of operationalizing such strategies [13]. Analysis of resident-reported 311 complaints shows that reporting behavior varies systematically across neighborhoods along socio-spatial lines, so data that appear to reflect citizen needs can embed and amplify existing disparities [14]. Transparency

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dashboards can strengthen accountability, but poor data quality, limited interpretive capacity, and a single predefined view of urban reality often undermine this potential [15]. Uneven participation thus shapes the data available to decision-makers, which links this strand to the previous one.

2.4 Governance, Collaboration, and Stakeholder Involvement

Collaborative governance is commonly framed through the Quadruple Helix of government, academia, industry, and civil society, and through urban living labs. Applying the Quadruple Helix to Italian cities, internal and external open innovation significantly shapes how responsively cities implement digital public services [16]. Research on urban living labs shows that collaboration exists along a spectrum of formalization shaped by financial, legal, and organizational conditions, and that the municipality's dual role as public authority and partner creates friction even where shared decision-making is intended [17].

2.5 Inclusion and Accessibility

Inclusion operates as a cross-cutting condition. Conceptual work on digital helpers, the informal intermediaries who assist others in navigating digital systems, argues that these actors remain under-theorized despite mediating access for populations facing compounded barriers [18]. Research across four European cities finds that digital devices used to inform governance privilege some forms of knowledge while eclipsing the non-digital forms that remain essential for inclusive governance [19]. In South African metropolitan municipalities, investment in digital and physical infrastructure has concentrated in already advantaged areas, reinforced by centralized and technocratic governance, although collaborative and co-designed initiatives in some areas show that alternatives are achievable [6].

Table 1 summarizes the five strands, their guiding concepts, and the gaps they leave open. Taken together, they suggest plausible interactions: digital transformation conditions participation, participation shapes the composition and fairness of governance data, data governance depends on stakeholder arrangements, and all of these determine who is included in the resulting public value. Yet these relationships have been studied largely in isolation, within single contexts or single dimensions, and have not been synthesized systematically. This gap motivates the present review.

Table 1 Summary of the five strands of prior research

Dimension	Guiding concept	Representative evidence	Remaining gap
Digital transformation and public service delivery	Governance-dependent digital transformation	Outcomes depend on connectivity and sustainability orientation [7], institutional readiness [8], and city size [9]	Little attention to how citizens engage with unevenly available services
Citizen participation and co-creation	Citizens as co-creators of public value	Co-creation driven by perceived benefit [10]; engagement driven by trust, accessibility, and awareness [11]; structural passivity among equipped citizens [12]	Participation rarely linked to the data it generates
Data-driven governance	Data as a non-neutral resource	Architectures with limited governance analysis [13]; socio-spatial bias in complaint data [14]; limits of dashboards [15]	Bias and representativeness rarely tied to stakeholder arrangements
Collaboration and stakeholder involvement	Quadruple Helix and urban living labs	Open innovation and responsiveness [16]; spectrum of formalization [17]; technology-led, planning-led, and community-oriented involvement in three Chinese cities [20]	Collaboration seldom connected to participation and data outcomes
Inclusion and accessibility	Digital helpers and unequal infrastructure	Under-theorized digital helpers [18]; privileging of digital knowledge [19]; investment concentrated in advantaged areas [6]	Inclusion treated as a separate concern, not as a condition of the other dimensions

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3 Research Method

3.1 Research Design

This study adopts a Systematic Literature Review (SLR) design to examine existing scholarly evidence on data-driven approaches to civic engagement and public service delivery in smart cities. An SLR was chosen for three reasons. First, the objective established in the Introduction is to consolidate evidence that is currently dispersed across separate thematic streams, disciplines, and geographical contexts, rather than to generate new primary data through surveys, interviews, or experiments. Second, an SLR applies explicit and replicable procedures for identifying, screening, and selecting studies, which reduces the selectivity of a conventional narrative review. Third, the included studies are methodologically heterogeneous, ranging from quantitative panel analyses and surveys to qualitative case studies and conceptual or design-oriented contributions, which makes statistical meta-analysis inappropriate and calls for a qualitative synthesis. The study-selection process follows the PRISMA 2020 guidelines, which provide a transparent and widely recognized framework for reporting how records move from identification to final inclusion.

3.2 Search Strategy and Study Identification

The literature search was conducted in the Scopus database, selected for its broad coverage of peer-reviewed journal literature on smart cities, urban governance, and public service delivery, and for its consistent indexing, which supports a transparent and reproducible search. The search was structured around three keyword groups reflecting the core focus of the review: smart city urban governance, smart city public service, and smart city data-driven. These groups were designed to capture literature at the intersection of smart city development, digital and data-driven transformation, public service delivery, citizen or civic engagement, and governance, in line with the research problem stated in the Introduction. The search covered publications from 2016 to 2026 and initially identified 293 records.

3.3 Screening and Study Selection

The flow of record identification, screening, eligibility assessment, and inclusion is presented in Figure 1.

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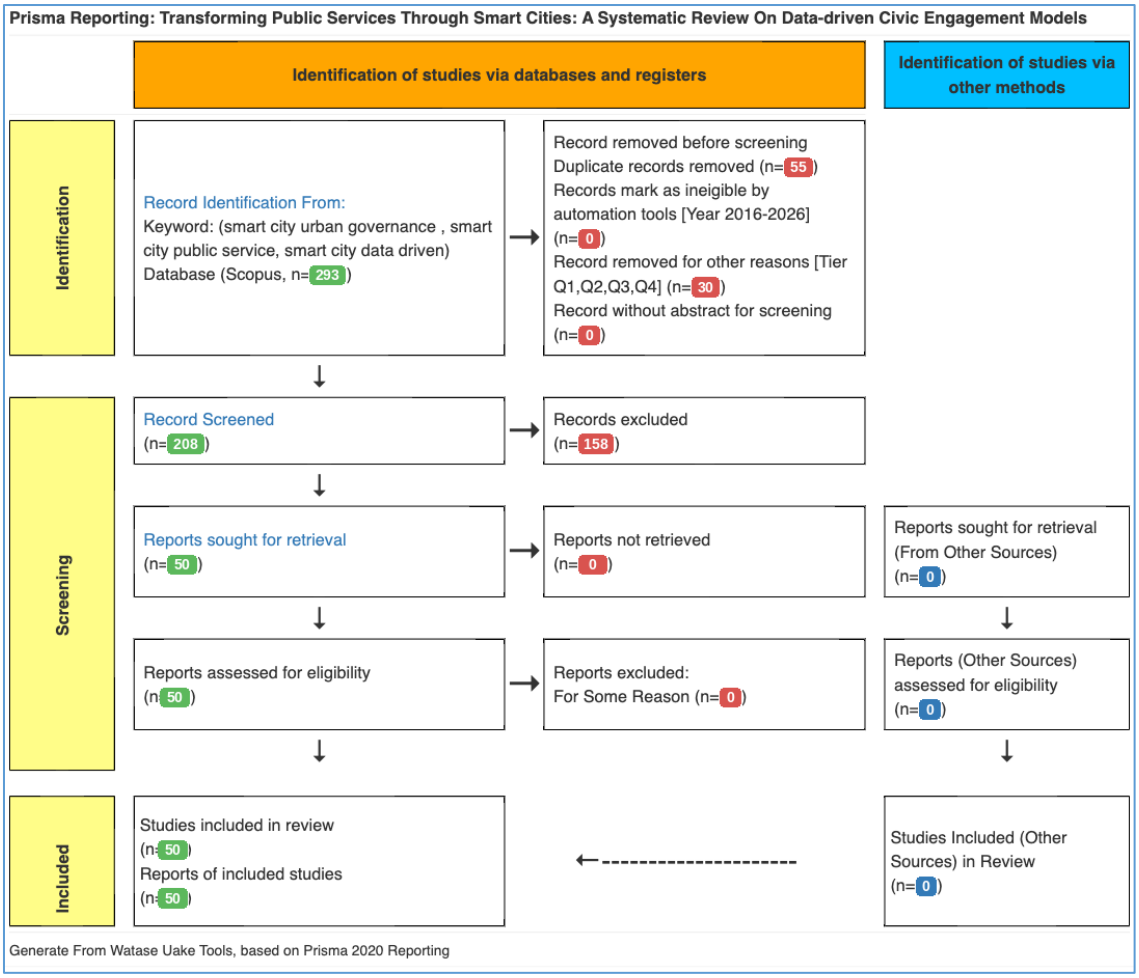


Figure 1 PRISMA flow diagram

Of the 293 records identified, 55 duplicates were removed, leaving 238 records. A further 30 records were removed because their sources did not hold a Scopus quartile ranking (Q1 to Q4), leaving 208 records. These were screened by title and abstract for relevance to the scope of the review, and 158 were excluded because they did not sufficiently address smart cities in relation to public service delivery, digital or data-driven transformation, citizen or civic engagement, governance, stakeholder collaboration, or inclusion and accessibility. The remaining 50 reports were retrieved and included in the final corpus, which forms the evidence base analyzed in the Results and Discussion. Table 2 summarizes the corpus by publication year and by primary analytical dimension.

Table 2 Characteristics of the 50 included studies

Category	Group	Studies (n)	Share (%)
Publication year	2020	8	16
Publication year	2021	8	16
Publication year	2022	7	14
Publication year	2023	4	8
Publication year	2024	5	10
Publication year	2025	10	20
Publication year	2026	8	16
Primary analytical dimension	Digital transformation and public service delivery	11	22
Primary analytical dimension	Civic engagement, participation, and co-creation	12	24

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Category	Group	Studies (n)	Share (%)
Primary analytical dimension	Data-driven governance and decision-making	11	22
Primary analytical dimension	Governance, collaboration, and stakeholder involvement	11	22
Primary analytical dimension	Inclusion, accessibility, and related challenges	5	10
Total	All included studies	50	100

3.4 Inclusion and Exclusion Criteria

Studies were eligible for inclusion when they addressed smart cities in relation to at least one of the following dimensions: public service delivery, digital transformation, data-driven governance or decision-making, citizen or civic engagement, governance, stakeholder collaboration, or inclusion and accessibility, and when they were published between 2016 and 2026 in sources holding a Scopus quartile ranking (Q1 to Q4). Although the search covered the ten-year period from 2016 to 2026, all 50 studies that met the inclusion criteria were published between 2020 and 2026. This distribution reflects the results of the screening and selection process rather than a restriction of the initial search period. Studies were excluded if they were duplicates, if their source did not hold such a ranking, or if their substantive focus, as determined during title and abstract screening, did not sufficiently align with the scope of the review. Not every included study addresses all of these dimensions. The criteria establish relevance to the broader scope of the review, while the thematic synthesis identifies how individual studies contribute to specific dimensions.

3.5 Data Extraction and Thematic Synthesis

The 50 included studies were analyzed comparatively rather than summarized individually. Information on each study's focus, context, methodological approach, and main findings was recorded and compared to identify recurring themes, relationships, differences, and contextual variations. Thematic synthesis was chosen because it allows evidence from different methodologies and geographical contexts to be brought together inductively, so that patterns emerge from the body of literature as a whole and points of convergence and divergence can be examined. The synthesis proceeded in three steps: findings were coded inductively, related codes were grouped into themes, and the themes were compared across studies to examine how they relate to one another.

The synthesis produced five analytical dimensions that structure the Results and Discussion: the transformation of digital public services and public service delivery; citizen participation, civic engagement, and co-creation; data-driven governance, analytics, and decision-making; governance, institutional transformation, and stakeholder collaboration; and inclusion, accessibility, inequality, and related challenges. These dimensions were developed inductively rather than imposed as a predetermined coding framework, and they allow the review to examine how the five dimensions relate to one another instead of treating each as a separate topic. Each study was assigned to the dimension in which it is primarily discussed (Table 2). No formal meta-analysis, statistical effect-size calculation, or software-assisted coding was applied. The synthesis instead relies on qualitative comparison and interpretation of the findings, arguments, and contextual evidence reported across the 50 studies.

4 Results and Discussion

Table 2 shows how the 50 studies are distributed across the five analytical dimensions, and Table 3, at the end of this section, collects the quantitative evidence they report. Each subsection presents the evidence for one dimension and interprets it against the theoretical lenses introduced in the Literature Review.

4.1 Digital Transformation and Public Service Delivery

Eleven of the 50 studies examine digital transformation and public service delivery (Table 2). Their quantitative evidence consistently shows measurable but conditional gains. In 160 Chinese prefecture-level cities, smart city pilot programs raise public service levels by first expanding the extensive and intensive margins of service provision, but the effect is significant only in high-income regions [1]. Across 212 prefecture-level cities, smart city construction improves the overall level of

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public services, with particularly pronounced gains in education, medical services, and social life security, although the size of the effect varies across cities [21]. In Indonesia, an analysis of 61 smart cities shows that metropolitan and large cities have achieved near-complete digitalization of population administration, licensing, and health services, whereas medium and small cities lag considerably, most notably in licensing and health [9]. Public library investment in India follows a similar logic of uneven allocation, favoring new facilities and IT integration over strengthening existing institutions across all participating cities [22].

Service-level outcomes depend on the institutional environment. In Indonesia, digitalization is associated with faster processing, reduced in-person interaction, and improved traceability, outcomes that are amplified where cities consolidate services into integrated platforms [9]. In Nigeria, adoption of artificial intelligence and renewable energy technologies is only moderate and adoption of blockchain is low, constrained by weak digital literacy, inadequate regulation, and inconsistent political commitment [8]. In Taiwan, a municipal payment and city-token platform generates public value because it enables coordinated action among government, businesses, and citizens, not because of the payment technology itself [2]. Conceptual work on smart city information argues that the sustained operation of data exchanges requires governance rules that support political, financial, and operational sustainability [23]. In Zabrze, near-universal household internet access created favorable conditions for remote services, and remotely handled cases rose during the COVID-19 pandemic, yet a majority of residents surveyed in 2021 still preferred in-person service, even while expressing dissatisfaction with aspects of it such as long queues [24].

Measurement and sectoral differences show that no single template exists. In Dubai, structural equation modeling of the perceptions of mobility professionals shows that transport success is a latent construct shaped jointly by integration and connectivity, accessibility, data-driven decision-making, sustainability orientation, and service coverage [7]. In the tourism sector, an integrated platform, a big-data system for analyzing tourist behavior, and an optimized transport network were reported to produce high visitor satisfaction in a follow-up survey [25]. Comparing Vienna, Singapore, and San Francisco, all three cities draw on data from sensors, citizens, and administrative archives, yet their smart service portfolios differ according to strategic priorities and service mix [26].

These results are consistent with the governance-dependent view of digital transformation set out in the Literature Review. Technology widens service coverage, but the size of the gain depends on regional income [1], city size and administrative capacity [9], and institutional readiness [8]. The Chinese panel evidence [1], [21] shows that this conditionality holds in samples of 160 and 212 cities, which strengthens the case-based findings from Taiwan and Nigeria [2], [8]. Two implications follow. First, aggregate indicators can mask differences in how citizens experience services, as the preference for in-person service in Zabrze shows [24], which leads to the question of civic engagement addressed in the next subsection. Second, evaluating whether a data-driven service succeeds requires multidimensional indicators rather than deployment alone [7].

4.2 Civic Engagement, Participation and Co-Creation

Twelve of the 50 studies address civic engagement, participation, and co-creation (Table 2). Evidence on whether digital infrastructure produces participation is mixed. In Indonesia, smart city initiatives and e-government both have a significant positive effect on community involvement, yet digital literacy has a negative direct effect while partially mediating these relationships [27]. Among technologically equipped citizens in India's Bhubaneswar and Bhopal, a substantial share remain structurally passive despite formal participatory spaces [12]. In Tehran, a horizontally structured municipal system and the politics of governing a capital city limit smart governance even though citizens express clear preferences for transparency, participation, efficiency, and accountability [28].

Participation is shaped by individual and social factors rather than by channel availability. Co-creation behavior in five Indonesian smart cities depends on perceived benefit, trust, and self-efficacy [10], and engagement in Jakarta's rapid response services depends on accessibility, trust, and awareness and varies considerably between citizens [11]. The move from technology-led to citizen-centered governance is better described as an uneven and ongoing process constrained by technological, informational, and bureaucratic barriers [4]. At the level of channels, an analysis of 333 official smart city apps and more than 15,000 user comments in China shows that the apps are widely used, but many suffer from overcomplicated interfaces, unclear functional hierarchies, and low user

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friendliness [29]. Among lead users, willingness to use a service and to share personal information depends largely on its perceived usefulness in daily life [30].

Feedback channels turn complaints into data. Beijing's 12345 hotline has a measurable dampening effect on the recurrence of illegal parking and unclean public spaces, but the effect is inconsistent for construction management and market regulation [31]. Analysis of negative comments on an online public comment board in a Chinese megacity shows that urban problems cluster around construction and housing issues, particularly in industry-oriented and newly developed fringe areas [32]. During a public health emergency, information quality, system reliability, and responsiveness significantly improved citizens' continuous experience of a smart city service, which in turn shaped overall engagement, whereas these qualities did not show the same effect on first-encounter experience [33]. E-participation platforms expand opportunities for interaction, but whether public input influences decisions often remains ambiguous [34].

These findings qualify the assumption that expanding digital access proportionately expands participation. They are consistent with the relational view of co-creation in the Literature Review, in which trust, perceived benefit, and social embeddedness matter more than platform availability [10], [11], [12], and the same pattern appears in contexts as different as Indonesia [27], India [12], Iran [28], and China [29]. Two mechanisms recur. Channel design and perceived usefulness determine whether a channel becomes a meaningful point of engagement [29], [30], and institutional responsiveness to citizen input varies across problem types [31], [32]. Because complaints and comments become data for municipal decision-making [31], [32], uneven participation also shapes the data examined in the next subsection, which links civic engagement to data governance.

4.3 Data-Driven Governance and Decision-Making

Eleven of the 50 studies address data-driven governance and decision-making (Table 2). Their central finding is that data become useful for decisions only when governance arrangements determine how they are standardized, shared, and managed. A systematic review of data-driven smart city applications notes that access to real-time data supports forecasting, service planning, and decision-making, but only where cities find genuine opportunities to use it innovatively rather than simply accumulating it [35]. Interviews with representatives of 27 European cities identify data silos, weak cross-departmental collaboration, and the absence of a shared data-driven culture, and translate them into requirements for standardized formats, clear access guidelines, and stronger collaboration; existing governance models vary considerably in how well they meet these requirements [5]. Design-oriented work on urban data management similarly argues that multi-source data need structured approaches, since few studies address the governance challenges of operationalizing such strategies [13].

Sector evidence shows that coordination across agencies matters as much as technology. A stakeholder analysis of air quality management in Indian smart cities finds that efforts are hampered by siloed agencies, inconsistent data calibration, weak alignment between smart city initiatives and air quality programs, and difficulty translating scientific data into action, and it argues for a shared, accessible governance ecosystem that enables cross-sector data exchange and builds trust among stakeholders [36]. In China, the National Big Data Comprehensive Pilot Zones strengthened the formal institutionalization of emergency collaboration across provinces through two pathways, technological innovation for risk monitoring and early warning, and digital government capacity for data sharing and standardized procedures, with the strongest effect where administrative capacity, absorptive capacity, and demand for coordinated services were already high [37]. A healthcare case study shows that a big data analytics framework can translate operational data into usable insight for city managers [38].

Data are not neutral, and the evidence shows several ways in which they can mislead. On representativeness, citizen-reported complaint data from a mid-sized American city show that reporting behavior varies systematically by neighborhood socio-spatial characteristics rather than by the actual distribution of problems, so prioritization based on such data can distort fairness [14]. On transparency, dashboards used by two smart city governments support accountability, but poor data quality, unclear interpretation, and user confusion about what metrics imply limit the benefit [15]. On stewardship, an analysis of the proposed Urban Data Trust in Sidewalk Toronto argues that its design treated personal data as a commodifiable asset and reinforced the economic interests of the managing company rather than empowering democratic public control [39]. In crisis conditions, spatiotemporal

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location big data are essential for epidemic response, yet existing data services could not meet the full demands of an epidemic, which points to the need for data-sharing mechanisms that link ordinary times and "wartime" conditions [40]. Adoption also matters: citizens' prior participatory experience and technological innovativeness, together with the range of tools municipalities offer, significantly influenced the uptake of e-participation [41].

These findings support the Literature Review's view that data are a non-neutral resource whose value depends on governance. Governance acts as the connective layer between technical infrastructure and decision-making: standardized formats, clear access rules, and cross-departmental and cross-sector collaboration allow data to move from fragmented pools toward data-driven services [5], [13], whereas weak arrangements leave sophisticated systems isolated within departments or sectors [35]. The Chinese pilot-zone evidence shows that the institutional payoff of data governance depends on conditions external to the data infrastructure, such as administrative capacity [37], which echoes the uneven performance of the European governance models [5]. Fairness is a second condition: because municipal systems use citizen-generated data to prioritize resources, unrepresentative data can encode existing inequalities [14], which links this dimension to the uneven participation discussed in the previous subsection. Transparency and trust mechanisms such as dashboards and data trusts must be judged by their governance substance rather than by their existence [15], [39], and the readiness of data services before an emergency [40] and citizens' willingness to adopt participation channels [41] shape whether data-driven governance earns public trust.

4.4 Governance, Collaboration, and Stakeholder Involvement

Eleven of the 50 studies examine governance, institutional transformation, and collaboration (Table 2). They converge on the view that implementation outcomes depend more on the institutional arrangements through which technology is deployed than on the technology itself. Fieldwork in Hanoi, Ho Chi Minh City, and Da Nang shows that smart city development in Vietnam's single-party context is shaped by hierarchical coordination, constrained stakeholder participation, and state-led collaboration, producing a hybrid model that foregrounds central leadership while permitting negotiated engagement [42]. A comparison of India, Singapore, and Indonesia reaches a similar conclusion: effective governance depends on institutional configurations that manage urban inclusion and adapt to local political and administrative conditions, rather than on technological sophistication [3]. In India, a quantitative policy analysis of Integrated City Command and Control Centers finds substantial variation in their architecture and use across cities, with adoption and execution shaped by city size; cities using them prioritize technology-driven mobility, surveillance, and utility functions over social and environmental concerns, and the model can extend greater control to corporate entities in public affairs [43].

Coordination approaches also vary within a single national context. Three Chinese cities show technology-led, planning-led, and community-oriented patterns of stakeholder involvement [20]. Research on digital platforms as coordination mechanisms in Chinese smart cities finds that scholarship has focused on technical capabilities while overlooking the role of platforms in shaping governance structures, data-sharing protocols, and user-centered design, which are preconditions for cross-sector collaboration [44]. Living labs are described as spaces of urban experimentation within a developmental governance approach, allowing government-led initiatives to test and refine interventions as a formal element of governance practice [45]. A conceptual framework for collaborative smart urban governance distinguishes arrangements in which stakeholders are merely consulted from those in which they participate as partners in shared decision-making [46].

Empirical evidence shows how collaboration translates into capacity and where it falters. A quadruple helix analysis of a longitudinal dataset of Italian cities finds that the combined integration of internal and external open innovation significantly shapes how responsively cities implement digital public services [16]. Research on urban living labs finds that they exist along a spectrum of formalization shaped by financial, legal, and organizational conditions, and that the municipality's dual role as public authority and partner creates tension and delay even where shared decision-making is intended [17]. A systematic review of platform urbanism concludes that City-as-a-Platform arrangements can support participatory governance based on collective knowledge and open data, but face constraints from governmental structures, uneven citizen engagement, and unequal technology access [47]. In Serbia, urban governance is a practical novelty, and Southeast European countries

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outside the European Union lag in applying governance instruments to smart city development; the reported insights emerged from collaboration within the cross-border INTERREG CLEVER project [48].

These results confirm the Literature Review's argument that institutional design, rather than technological capacity, explains differences between smart city initiatives. National and state-level institutions set the coordination architecture, as in Vietnam [42] and across India, Singapore, and Indonesia [3], while localized arrangements, namely command-and-control centers [43], digital platforms [44], differentiated municipal patterns [20], and living labs [45], determine how these commitments are translated into practice. No single model is superior: centralized coordination can improve operational efficiency but narrows public priorities and concentrates influence among corporate and technical actors [43], whereas distributed or experimental arrangements accommodate local variation at the possible cost of coordination benefits [20], [45]. Collaboration produces institutional benefits only when it distributes genuine decision-making capacity [16], [17], [46], and platforms work as coordination infrastructure only when embedded in institutions that already support multi-actor participation [16], [47]. The Serbian case shows that this capacity depends on institutional maturity [48], which explains why collaboration is a governance resource in some contexts and a label in others.

4.5 Inclusion, Accessibility, and Related Challenges

Five of the 50 studies address inclusion, accessibility, and related challenges (Table 2), the smallest share of any dimension. Conceptual work on digital helpers argues that informal intermediaries who assist others in navigating digital systems mediate access for people facing compounded barriers, yet receive limited scholarly and policy attention [18]. Research across four European cities finds that digital devices used to inform governance privilege some forms of knowledge while eclipsing the non-digital forms that remain essential for inclusive governance [19]. In South African metropolitan municipalities, smart city investment in digital and physical infrastructure concentrated in already advantaged areas, leaving historically marginalized communities with constrained access to connectivity, data infrastructure, and public services, a pattern linked to centralized and technocratic resource allocation [6].

Inclusion also interacts with sustainability and service integration. Panel data on 26 smart cities between 2009 and 2019 show that smart city initiatives improved economic sustainability while compromising environmental and social sustainability [49]. A city cloud union framework identifies a technical barrier: service providers operate separately and struggle to communicate with the reliability and low latency needed for coordinated services, and the proposed architecture distinguishes individual from subscription-based services and introduces shared information and cooperative sharing to unify service provision [50].

These findings show that inclusion operates on interacting levels. Unequal access to digital tools and to the human support needed to use them [18] intersects with the unequal distribution of infrastructure and resources [6], and with the privileging of digital forms of knowledge [19]; at the systemic level, governance oriented toward measurable economic gains does not extend them to environmental or social sustainability [49], and fragmented service architecture can add its own barriers [50]. Because only 5 of the 50 studies treat inclusion as a primary focus, the evidence on this dimension is thinner than for the others, which is itself a gap for future research.

Read against the preceding dimensions, inclusion is a cross-cutting condition rather than a separate fifth theme. Digital transformation expands services unevenly, with benefits accruing to cities with greater administrative capacity [1], [9], [21]. Engagement depends on trust, perceived benefit, and social embeddedness rather than on access alone [10], [11], and because participation shapes the information that enters municipal systems, uneven engagement can produce unrepresentative data [14]. Data governance links infrastructure to decisions, but its fairness depends on the representativeness of the data it processes [5], [13]. Collaboration determines whether decision-making capacity is genuinely shared or remains symbolic while authority stays concentrated [17], [43], [46]. Inclusive and sustainable transformation therefore requires governance that treats equity, privacy, and service coherence as deliberate objectives across all five dimensions, rather than as outcomes assumed to follow from digital investment. The integrative conceptual framework in Figure 2 draws these relationships together.

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Table 3 Quantitative evidence reported in the reviewed studies

Source	Context and scale	Reported finding
[1]	160 prefecture-level cities, China	Pilot programs raise the level, breadth, and diversity of public services; significant only in high-income regions
[5]	Interviews with representatives of 27 European cities	Data governance models vary in how well they meet requirements for standardized formats, access guidelines, and cross-departmental collaboration
[9]	61 smart cities, Indonesia	Metropolitan and large cities reach near-complete digitalization of core services; medium and small cities lag, notably in licensing and health
[10]	Survey in five Indonesian smart cities	Co-creation is driven more by perceived benefit, especially through online social networks, than by platform availability
[21]	212 prefecture-level cities, China	Smart city construction raises the level of public services, with pronounced gains in education, medical services, and social life security
[24]	Resident survey, Zabrze, 2021	Remote handling of cases rose during COVID-19, yet a majority of residents still preferred in-person service
[29]	333 official smart city apps and more than 15,000 user comments, China	Apps are widely used, but many have overcomplicated interfaces and unclear functional hierarchies
[49]	Panel data on 26 smart cities, 2009 to 2019	Economic sustainability improved while environmental and social sustainability were compromised

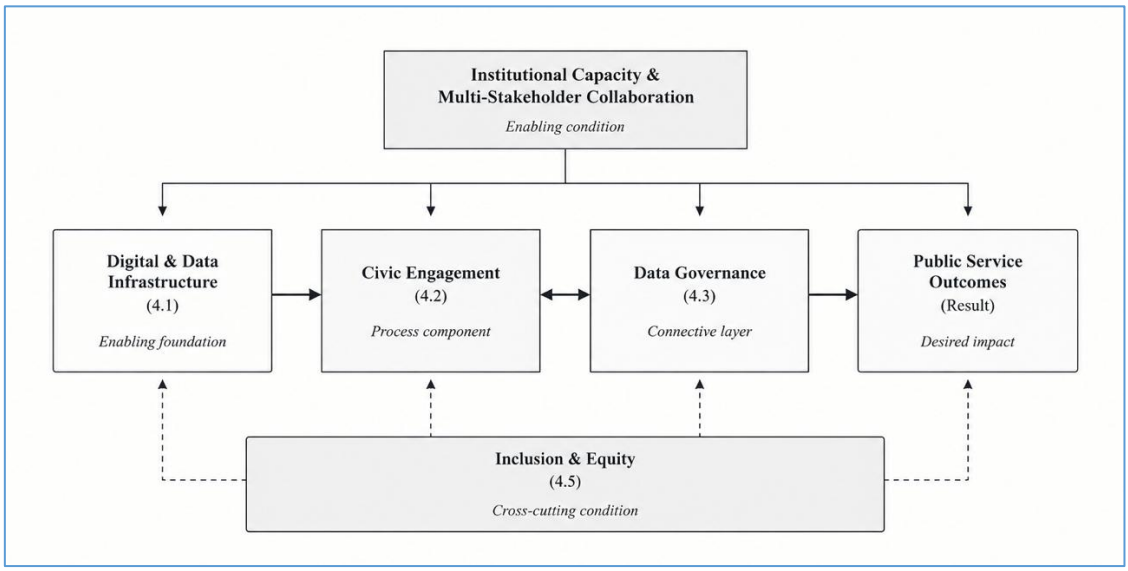


Figure 2 Integrative conceptual framework derived from the thematic synthesis of 50 included studies on data-driven civic engagement and public service transformation. Arrows represent conceptual relationships identified across the reviewed literature, not statistically tested or causal pathways.

Figure 2 presents the integrative conceptual framework derived from the five analytical dimensions. The framework depicts a core process running from digital and data infrastructure, through civic engagement and data governance, toward public service outcomes. Civic engagement and data governance are interconnected rather than sequential: citizen engagement generates the data on which governance systems depend, while uneven engagement can affect the representativeness of that data. This core process is supported by institutional capacity and multi-stakeholder collaboration,

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which the synthesis identifies as a recurring enabling condition across the digital transformation, civic engagement, data governance, and governance dimensions. Inclusion and equity are represented as a cross-cutting condition rather than a final-stage outcome, reflecting evidence that access to infrastructure and participation opportunities is itself unevenly distributed and shapes who can access the core process and who benefits from it. The framework is the theoretical contribution of this review: it reorganizes dimensions that earlier smart city research examined largely in isolation into a single integrative structure, and it is a conceptual synthesis that has not been empirically tested.

5 Conclusion

This systematic literature review examined how data-driven approaches in smart cities relate to civic engagement and public service delivery, and under what conditions these approaches produce meaningful and equitable outcomes. Drawing on 50 Scopus-indexed studies published between 2020 and 2026, covering cities in Asia, Europe, Africa, the Middle East, and North America (for example China, Indonesia, India, South Africa, and Serbia) and public services such as health, emergency response, transport, public libraries, and tourism, the review concludes that the transformation of public services through smart cities is primarily an institutional and relational achievement rather than a technological one. The studies were distributed across the five dimensions as 11 on digital transformation, 12 on civic engagement, 11 on data-driven governance, 11 on governance and collaboration, and only 5 on inclusion, which makes inclusion the least examined dimension. Digital transformation expands the reach and efficiency of public services, but unevenly, with gains closely tied to administrative capacity and institutional readiness. Citizen engagement does not follow automatically from the availability of digital platforms; it depends on trust, perceived benefit, and the design of communication channels. Data can strengthen transparency and accountability only when supported by clear governance arrangements, and data generated unevenly across a population can distort the fairness of the decisions built upon it. No single governance model proved universally effective; what matters is whether institutional arrangements distribute genuine decision-making capacity among stakeholders. Finally, smart city initiatives can concentrate benefits in already advantaged areas when inclusion is not deliberately built into governance, participation, and resource allocation.

The main contribution of this review is an integrative conceptual framework that brings together five dimensions previously examined largely in isolation. The framework positions institutional capacity and multi-stakeholder collaboration as enabling conditions for digital transformation, civic engagement, and data governance; represents civic engagement and data governance as interdependent components, in which citizen participation shapes, and is shaped by, the data available for decision-making; and treats inclusion as a cross-cutting condition that determines how benefits are distributed. In practical terms, policymakers and urban planners should treat governance design, participatory infrastructure, and inclusion safeguards as core components of digital transformation strategy rather than as secondary considerations.

This review has several limitations. As a qualitative synthesis, it provides no statistical testing of the relationships proposed in the framework, which are derived from patterns across the literature rather than from validated causal evidence. The included studies also vary in methodology, geographic scope, and analytical focus, so findings from one setting cannot be assumed to generalize to others, and some regions remain underrepresented. In addition, the search was limited to the Scopus database. Future research should therefore test the framework empirically using surveys, interviews, case studies, or comparative studies across different institutional and geographic settings, give particular attention to inclusion as the least represented dimension, and extend the search to additional databases.

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