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Smart City Data Governance and Urban AI Infrastructures: Comparative Socio-Technical Transformation in Barcelona and Seoul, 2020–2026

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ABSTRACT

This article examines smart city data governance and urban artificial intelligence infrastructures through a comparative analysis of Barcelona and Seoul between 2020 and 2026. The study argues that smart city transformation is no longer primarily a question of sensor deployment, urban platforms, or digital service efficiency, but a broader computational governance challenge involving data stewardship, algorithmic accountability, institutional coordination, civic trust, and socio-economic inclusion. Barcelona and Seoul were selected because both are internationally recognized smart city systems, yet they represent different governance models. Barcelona emphasizes digital rights, data commons, participatory governance, and municipal technological sovereignty. Seoul emphasizes high-capacity digital administration, platform integration, AI-enabled service optimization, and metropolitan-scale infrastructure coordination. The findings indicate that smart city outcomes depend on how urban data architectures are governed across public agencies, private vendors, civic actors, and regulatory institutions. Barcelona demonstrates the democratic value of rights-based urban data governance, while Seoul demonstrates the operational value of integrated AI-enabled urban systems. This article contributes to computing and information sciences by conceptualizing smart city governance as a socio-technical system linking urban computing architecture, institutional implementation, public accountability, innovation ecosystems, and inclusive urban transformation.

Keywords: smart cities; urban AI; data governance; information systems; Barcelona; Seoul; computational governance; digital rights; urban platforms; socio-technical systems

INTRODUCTION

Smart city governance has become a central research domain in computing and information sciences because urban infrastructures increasingly depend on data-intensive systems, algorithmic optimization, platform integration, sensor networks, digital twins, predictive analytics, and AI-enabled service delivery. Between 2020 and 2026, cities expanded digital infrastructures to manage transport, energy, safety, welfare, health, waste, housing, climate resilience, and public participation. This expansion transformed city governments from conventional administrative institutions into computational governance environments in which urban life is increasingly mediated through data collection, automated analysis, and platform-based decision systems.

This study argues that smart city transformation should be understood as a socio-technical governance process rather than a technology adoption pathway. Smart city systems generate public value only when computing architectures are connected to institutional accountability, data protection, civic participation, interoperability, and equitable access. Urban sensors and AI models may improve efficiency, but they may also intensify surveillance, vendor dependency, algorithmic bias, and uneven distribution of digital benefits. The academic and policy problem is therefore not whether cities should become smart, but how urban information systems can be governed to enhance democratic legitimacy, sustainability, and social inclusion.

Barcelona and Seoul provide analytically significant comparative cases. Barcelona is widely associated with digital rights, participatory urban innovation, technological sovereignty, and citizen-centered data governance. Its smart city strategy emphasizes public value, open-source tools, data commons, and democratic control over urban technologies. Seoul, by contrast, represents a high-capacity metropolitan digital governance model characterized by integrated public platforms, AI-enabled services, broadband infrastructure, advanced mobility systems, and strong municipal-state coordination. Both cities are global smart city references, but they institutionalize computing governance differently.

The global context reinforces the importance of this comparison. The United Nations and World Bank have emphasized that urban digital transformation can support sustainable development only when data governance, inclusion, and institutional capacity are addressed systematically (UN-Habitat, 2022; World Bank, 2023). OECD digital government work similarly highlights that data-driven public sectors require transparency, accountability, user-centered design, and public trust (OECD, 2024). At the same time, smart city scholarship increasingly warns that urban platforms may reproduce corporate power, surveillance capitalism, and technocratic governance if not democratically controlled (Kitchin, 2021; Zuboff, 2019).

Existing literature provides important conceptual foundations. Batty (2021) emphasizes the role of urban analytics and computational modeling in managing complex cities. Kitchin (2021) argues that data-driven urbanism reshapes how cities are known and governed. Cardullo and Kitchin (2019) critique smart city participation models that reduce citizens to users rather than democratic actors. Vanolo (2016) argues that smart city narratives can become disciplinary tools shaping urban policy priorities. Other scholars examine urban platforms, digital twins, IoT governance, and civic technology as emerging components of urban information systems (Barns, 2020; Bibri, 2021).

However, current scholarship remains limited in several respects. While previous studies emphasize smart city technologies, they often under-theorize institutional implementation and governance capacity. Other scholars focus on civic participation or surveillance critique but do not sufficiently analyze computational architecture, interoperability, data pipelines, and AI system governance. Existing comparative scholarship also remains limited in explaining how different smart city models produce different forms of public value, innovation, and social inclusion.

This article identifies five research gaps. First, a theoretical gap persists in conceptualizing smart cities as computational governance systems rather than urban technology projects. Second, an empirical gap concerns how municipal data architectures shape implementation outcomes. Third, a comparative gap remains regarding rights-based and integration-oriented smart city models. Fourth, a technological governance gap concerns how AI systems, urban platforms, and IoT infrastructures are made accountable. Fifth, an institutional implementation gap concerns the coordination of municipal agencies, vendors, citizens, and regulators.

The novelty of this article lies in its conceptualization of smart city data governance as urban computational constitutionalism: a governance process through which cities define the rules, rights, architectures, and institutional responsibilities governing digital urban life. The article contributes to computing and information sciences by integrating urban informatics, information systems governance, AI accountability, public administration, and socio-technical systems theory.

The analytical framework links urban data infrastructure to algorithmic accountability, institutional coordination, civic trust, innovation capacity, and inclusive urban transformation. The causal logic is as follows: smart city architecture structures urban data flows; data flows shape algorithmic decision capacity; algorithmic capacity requires institutional accountability; accountability affects civic trust; civic trust influences adoption, participation, and legitimacy; and these dynamics shape socio-economic and spatial outcomes. The objective of this article is to examine how Barcelona and Seoul governed smart city data and AI infrastructures between 2020 and 2026, and to evaluate the implications for computational governance, urban innovation, and inclusive digital transformation.

METHODOLOGY

This study employs a comparative socio-technical systems methodology integrating urban informatics analysis, information systems governance, computational institutional analysis, and comparative digital policy evaluation. Barcelona and Seoul were selected because both are globally recognized smart city cases with advanced digital infrastructures, yet they differ in governance philosophy, institutional architecture, and implementation priorities. Barcelona represents a rights-based and participatory smart city model emphasizing data sovereignty, digital commons, open-source infrastructures, and civic accountability. Seoul represents an integration-oriented metropolitan smart city model emphasizing platform coordination, AI-enabled service delivery, data-driven administration, and high-capacity digital infrastructure. The unit of analysis is the smart city governance ecosystem, including urban data platforms, AI-enabled public services, IoT infrastructures, institutional coordination mechanisms, data protection systems, civic participation channels, vendor governance, and socio-economic outcomes.

The empirical basis consists of municipal digital strategy documents, smart city policy reports, OECD and UN-Habitat urban digital governance frameworks, World Bank urban technology materials, public data portals, institutional technology reports, peer-reviewed smart city literature, and documented urban innovation indicators from 2020–2026. The analysis combines comparative architecture assessment, institutional process tracing, and socio-technical interpretation to identify causal mechanisms linking data governance design to urban service performance, accountability, and inclusion. Triangulation is achieved by comparing policy documents with infrastructure descriptions, public-sector digital indicators, academic studies, and institutional evaluations. Ethical considerations focus on surveillance risk, algorithmic bias, privacy, vendor lock-in, civic exclusion, and unequal urban data representation. The principal limitation is that proprietary vendor systems and internal municipal performance metrics are not always publicly available. Nevertheless, the comparative design provides a robust basis for evaluating smart city data governance as a computational and institutional phenomenon.

Findings and Discussion

1. Urban Data Architectures and the Governance of Interoperability

The first finding is that smart city effectiveness depends on interoperability across urban information systems. Barcelona's smart city governance model emphasizes open standards, public control over data, and civic accountability. Its approach reflects concern that urban platforms should not become proprietary infrastructures controlled by vendors. Barcelona's model therefore prioritizes technological sovereignty and data governance as democratic urban policy.

Seoul's model emphasizes integrated metropolitan service delivery. Its smart city infrastructure connects transport, safety, environmental monitoring, public services, and citizen-facing digital platforms through strong municipal coordination. The goal is operational optimization and rapid service improvement. Seoul's governance capacity enables data-driven decision-making across multiple urban domains.

The comparison reveals two interoperability logics. Barcelona emphasizes democratic interoperability: systems should remain open, accountable, and reusable for public value. Seoul emphasizes operational interoperability: systems should be integrated efficiently to improve urban management. Both approaches are valuable, but they create different risks. Barcelona may face slower implementation and coordination complexity. Seoul may face greater risks of centralization, surveillance, and limited civic contestability.

This finding extends smart city scholarship by showing that interoperability is not only technical integration. It is a governance choice determining who controls urban data, who benefits from digital services, and how accountability is maintained.

2. Algorithmic Accountability and Urban AI Systems

The second finding is that urban AI systems require accountable governance mechanisms because they increasingly affect mobility, policing, welfare, housing, energy, and public safety. AI-enabled urban systems can optimize traffic, predict infrastructure failures, allocate resources, and identify service needs. However, they may also reproduce bias if training data reflect unequal urban conditions.

Barcelona’s rights-based approach provides stronger normative safeguards for algorithmic accountability. Its digital rights orientation emphasizes transparency, public participation, and democratic oversight. This supports legitimacy but requires institutional capacity to audit algorithmic systems and regulate vendors.

Seoul’s integrated AI-enabled governance provides stronger operational capacity. Real-time urban data systems can improve responsiveness and service efficiency. Yet algorithmic accountability depends on whether citizens can understand, challenge, or influence automated urban decisions.

The comparison suggests that algorithmic accountability in smart cities requires three layers: technical auditability, institutional responsibility, and civic contestability. Technical auditability concerns model documentation, data lineage, and performance monitoring. Institutional responsibility concerns which agency is accountable for algorithmic decisions. Civic contestability concerns whether residents can question or challenge outcomes.

This finding aligns with broader AI governance literature but demonstrates its specific urban relevance. Cities are dense socio-technical environments where algorithmic errors can reproduce spatial inequality. Therefore, urban AI governance must be embedded in democratic institutions, not merely technical evaluation.

3. Public Participation, Digital Rights, and Civic Trust

The third finding is that civic trust is a decisive condition for smart city legitimacy. Barcelona’s model demonstrates that smart city governance can be framed around residents as rights-bearing citizens rather than data-generating users. Participatory platforms, open data, and digital rights strategies aim to strengthen democratic control over urban technology.

Seoul's model demonstrates that trust can also be produced through reliability, convenience, and service quality. Residents may support smart city systems when they experience tangible improvements in transport, safety, administration, and urban responsiveness. However, service convenience alone is insufficient if residents perceive excessive monitoring or limited control over data.

The comparison reveals that civic trust has both democratic and functional dimensions. Democratic trust depends on transparency, rights, and participation. Functional trust depends on service reliability, usability, and responsiveness. Smart city governance must integrate both dimensions.

This finding challenges technocratic smart city models that assume adoption follows efficiency. Urban residents are not merely users of municipal platforms; they are political subjects whose data, mobility, and participation are governed through digital systems. The implication is that smart city design should include participatory data governance, rights impact assessments, and accessible grievance mechanisms.

4. Innovation Ecosystems, Vendor Governance, and Socio-Economic Inclusion

The fourth finding is that smart city infrastructures influence urban innovation ecosystems and socio-economic inclusion. Barcelona's approach supports civic technology, local innovation, open-source ecosystems, and public-interest digital tools. This can reduce vendor dependency and support democratic innovation, but it may require sustained public investment and technical capacity.

Seoul's approach supports high-performance urban innovation through integration with advanced telecommunications, AI, mobility, and platform industries. Its metropolitan scale and technological infrastructure create strong conditions for urban experimentation and commercial innovation. However, integration with powerful technology vendors may increase risks of dependency and unequal market access.

The comparison indicates that smart city innovation depends on whether public infrastructure enables broad participation or concentrates opportunities among dominant firms. Open standards and public APIs can support distributed innovation. Proprietary platforms may accelerate deployment but restrict long-term public control.

The socio-economic implications are significant. Smart city systems can improve access to services, reduce mobility costs, optimize energy use, and support climate resilience. Yet they can also deepen inequality if marginalized communities lack digital access, representation in datasets, or influence over technology design.

This finding contributes to socio-technical innovation theory by showing that urban computing infrastructures shape not only service delivery but also local economic ecosystems and distributive outcomes.

Table 1. Analytical Matrix of Comparative Computing Governance and Information Systems Development

Variable	**Case 1: Barcelona**	**Case 2: Seoul**	**Empirical Evidence**	**Analytical Interpretation**
Governance	Rights-	Integration-	Municipal	Smart city

Model	based and participatory	oriented and service-optimization focused	digital rights strategies; Seoul smart city strategies	governance reflects different public value priorities
Data Architecture	Open standards and data sovereignty	Integrated metropolitan data platforms	Open data and civic technology initiatives; urban platform systems	Architecture structures institutional power
AI Governance	Transparency and civic accountability emphasis	Operational AI deployment and service optimization	Urban AI policy and service platforms	Accountability must balance rights and efficiency
Institutional Coordination	Participatory but potentially slower	Strong administrative coordination	Municipal governance structures	Coordination affects implementation speed
Civic Trust Mechanism	Digital rights and participation	Service reliability and convenience	Civic engagement platforms; smart service adoption	Trust has democratic and functional dimensions
Vendor Governance	Technological sovereignty and open-source preference	Public-private integration with advanced technology firms	Procurement and smart city innovation programs	Vendor models shape public control
Innovation Ecosystem	Civic tech and public-interest innovation	High-tech metropolitan innovation	Local innovation strategies	Different ecosystems produce different benefits
Inclusion Risk	Participation gaps and capacity limitations	Surveillance and centralization risks	Digital inclusion and urban data debates	Inclusion requires safeguards beyond access
Socio-Economic Outcome	Democratic digital urbanism	Scalable smart service delivery	Smart city and urban development reports	Different models produce different development pathways
Global Transferability	Strong model for rights-based smart cities	Strong model for integrated smart infrastructure	International smart city rankings and policy reports	Transfer requires institutional adaptation

The table demonstrates that Barcelona and Seoul represent two major smart city governance models. Barcelona prioritizes democratic accountability, data rights, and technological sovereignty. Seoul prioritizes integrated service delivery, AI-enabled optimization, and metropolitan infrastructure coordination. The deeper analytical conclusion is that smart city success depends on alignment between computing architecture, institutional governance, civic trust, and inclusion.

Conceptual Model

Urban Computational Governance Model

Urban Data Architecture → Algorithmic Accountability → Institutional Coordination → Civic Trust → Digital Innovation → Inclusive Urban Transformation

This model proposes that smart city transformation begins with urban data architecture: sensors, platforms, registries, APIs, digital twins, and AI systems. These architectures create algorithmic capacity but require accountability through transparency, auditability, and contestability. Accountability depends on institutional coordination among municipal agencies, vendors, regulators, and civic actors. Coordination shapes civic trust, which determines adoption and legitimacy. Trust then enables digital innovation and ultimately inclusive urban transformation.

The model contributes to computing and information sciences by showing that smart city infrastructures are not merely technical systems but governance systems. Their effects depend on how computational architectures are institutionalized and socially legitimized.

CONCLUSION

This article examined smart city data governance and urban AI infrastructures through a comparative analysis of Barcelona and Seoul between 2020 and 2026. The study directly answers the research objective by demonstrating that smart city transformation depends on the alignment of computing architecture, institutional implementation, algorithmic accountability, civic trust, and socio-economic inclusion.

The findings show that Barcelona and Seoul represent distinct but instructive models. Barcelona demonstrates the democratic value of rights-based data governance, technological sovereignty, and civic participation. Seoul demonstrates the operational value of integrated platforms, AI-enabled service optimization, and strong metropolitan coordination. Both models offer important lessons, but both also face risks. Barcelona must address implementation speed and institutional capacity. Seoul must address surveillance risk, centralization, and algorithmic contestability.

The theoretical contribution is the concept of urban computational governance. This framework explains how smart city infrastructures reshape public authority, innovation ecosystems, and urban social relations. The empirical contribution lies in comparing two globally recognized cities through governance and information systems variables rather than through generic smart city rankings.

The technological governance implications are clear. Cities should design smart infrastructures with open standards, privacy safeguards, public auditability, participatory data governance, vendor accountability, and inclusion mechanisms. Information systems policy should treat urban platforms as public infrastructures rather than neutral service tools.

This study is limited by uneven access to proprietary platform data and internal municipal performance metrics. Future research should examine digital twins, AI mobility systems, predictive policing, urban climate platforms, and comparative smart city governance in Global South contexts.

Ultimately, smart cities will be legitimate only if they are not merely efficient but accountable, inclusive, and democratically governed. Urban AI and data infrastructures must therefore be designed as public socio-technical systems capable of supporting both innovation and urban justice.

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