

Global Smart City Benchmarks: Comparative Practices And Lessons For India

^{#1}Prof. Deepak Andhale and ^{#2}Dr. Ganesh Rao

^{#1}Assistant Professor, Aureole School of Business Management, Pune. Email-deepakandhale@gmail.com

^{#2}Director, Pune Business School, Pune. Email- grindia7@gmail.com

Abstract

This paper examines global best practices in smart city development and evaluates their applicability to the Indian context. Drawing on comparative benchmarks from the European Union, London, Dubai, Barcelona, Singapore, Seoul, and Songdo, it identifies transferable practices, institutional preconditions, and risks of replication. The study argues that smart city success cannot be reduced to technological sophistication alone; instead, it requires embedding innovations into durable governance structures, sustainable finance, institutional capacity, and citizen inclusion. For India, where most projects are brownfield rather than greenfield, the lessons emphasize the importance of management-first frameworks, statutory Smart City Bureaus, lifecycle financing, API-first procurement, and multilingual citizen platforms to bridge the digital divide. Negative lessons, such as Songdo's technocratic enclaves, caution against vendor dependence and socially detached models. The findings offer policymakers, municipal leaders, and practitioners a pragmatic blueprint for designing sustainable, inclusive, and resilient smart cities tailored to India's socio-political realities.

Keywords: Best practices, governance, interoperability, Model Smart City, management, global benchmarks.

1. INTRODUCTION

Smart cities have emerged as one of the most ambitious and contested global experiments in urban governance. At their core, they attempt to **integrate technological innovation with sustainable and inclusive development**, reshaping how cities are planned, managed, and experienced. Since the late 1990s, international discourse has portrayed the “smart city” as both a technical assemblage of ICT systems and as a socio-political project that reorganises governance around data, algorithms, and citizen engagement (Caragliu, Del Bo, & Nijkamp, 2011; Batty, 2012). Governments, multinational corporations, and international agencies have deployed diverse smart city models, ranging from **technocentric, vendor-led platforms**—often dominated by ICT giants such as IBM, Cisco, and Siemens—to **citizen-driven and participatory governance frameworks** that emphasise inclusion, accountability, and co-production of services (Meijer & Rodríguez Bolívar, 2016; Neirótti, De Marco, Cagliano, Mangano, & Scorrano, 2014).

These initiatives have produced a mixed record. On one hand, smart city systems have **improved service delivery, resilience, and efficiency**, especially in areas like urban mobility, predictive policing, waste management, and energy efficiency (Zanella, Bui, Castellani, Vangelista, & Zorzi, 2014). On the other hand, they have also exposed deep **structural challenges**:

- **Vendor lock-in** and lack of interoperability, where proprietary systems make it costly for cities to switch vendors or upgrade platforms (Jeong, Kim,

Park, & Rho, 2020).

- **Institutional discontinuity**, as many smart city projects remain bound to specific electoral cycles or mission-driven funding windows rather than becoming embedded in permanent governance structures (Meijer & Rodríguez Bolívar, 2016).
- **Socio-economic divides**, where benefits accrue disproportionately to digitally literate or affluent populations, leaving vulnerable groups excluded (Caragliu, Papa, & Kourtit, 2023).

India as a laboratory for smart cities

India presents a particularly instructive case. The **Smart Cities Mission (SCM)**, launched in 2015 by the Ministry of Housing and Urban Affairs (MoHUA), sought to transform 100+ cities through a mix of **brownfield retrofitting** and limited greenfield development. Unlike purpose-built new cities such as Songdo in South Korea or Masdar in the UAE, the SCM largely focused on upgrading existing cities, embedding digital infrastructure into already complex urban fabrics. By December 2024, official data indicates that over 7,800 projects had reached near-completion, with most cities operationalising **Integrated Command and Control Centres (ICCCs)** as their digital nerve centres (MoHUA, 2023; Praharaj, 2025).

Progress has been notable in certain domains:

- **Urban mobility projects**, such as Pune's BRTS upgrades, Surat's surveillance-integrated crime reduction, and Chennai's flood resilience sensors.
- **E-governance systems**, including GIS-linked property taxation in Ahmedabad, grievance redress

portals in Bhubaneswar, and mobile apps for citizen participation.

- **Digitalisation of utilities**, with smart metering and SCADA integration piloted in multiple cities.

Yet the SCM has also revealed systemic weaknesses. Persistent **institutional tensions** between Special Purpose Vehicles (SPVs), Urban Local Bodies (ULBs), and state governments have complicated authority and accountability (Arora & Goyal, 2020). **OPEX financing gaps** have undermined the sustainability of technology investments, as CAPEX-heavy projects often lack budgets for maintenance, upgrades, and staff training (Praharaj, 2025). **Fragmented procurement practices**, dominated by large vendors, have led to siloed solutions that fail to interoperate across utilities, parastatals, and state agencies. These challenges mirror the global literature's caution against "pilotism"—short-lived, demonstration-style projects that struggle to scale (Neirotti et al., 2014).

Benchmarking as a method of inquiry

Against this backdrop, benchmarking global practices offers a **comparative lens** to understand what works, under what conditions, and with what risks. As a **conceptual and comparative inquiry**, this study draws lessons from seven leading international cases:

1. **European Union (EU)** – A regulatory leader in **open standards, GDPR-style data governance, and AI accountability**.
2. **London (UK)** – A city that demonstrates **decentralised experimentation**, borough-level innovation, and open-data portals like the London Datastore.
3. **Dubai (UAE)** – An exemplar of **centralised, command-and-control smart governance**, highlighting both the speed of greenfield execution and risks of exclusion.
4. **Barcelona (Spain)** – A pioneer of **citizen-centric smart city governance**, with open middleware (Sentilo) and participatory budgeting.
5. **Singapore** – A small-state model showcasing **digital twins, national digital identity, and predictive planning**, albeit at high costs.
6. **Seoul (South Korea)** – A leader in **semantic interoperability (NGSI-LD standards), civic AI labs, and citizen participation frameworks**.
7. **Songdo (South Korea)** – A cautionary tale of **vendor-led, master-planned cities**, where sterile design and weak social fabric limited adoption.

Each case represents a different archetype: technocentric centralisation (Dubai, Songdo), participatory retrofitting (Barcelona, London), and integrated regulated ecosystems (EU, Singapore, Seoul). By juxtaposing these models with Indian

experiences, the paper seeks to identify **best practices that are not merely aspirational but pragmatically transferable**.

Research question and contribution

The central research question guiding this paper is: **Which smart city practices are replicable in the Indian context, under what conditions, and with what risks?**

Answering this question requires moving beyond descriptive comparisons toward a **management-first blueprint**. The study therefore contributes in four ways:

1. It distills **conceptual best practices** into taxonomy of governance, technology, finance, and inclusion.
2. It identifies **transferable mechanisms**, such as API-first procurement, pooled financing, and citizen-facing dashboards, while cautioning against uncritical adoption of greenfield or vendor-driven models.
3. It positions India's **brown field urbanisation** within global debates, highlighting the need for contextual adaptation rather than replication.
4. It proposes a **pragmatic blueprint** for Indian smart cities, emphasising standards, institutional permanence, lifecycle financing, and inclusive governance.

In doing so, this paper situates itself within the broader literature on urban governance and public management. It argues that **smart city success depends as much on governance, finance, and institutional design as on technological sophistication**. The ultimate aim is to contribute both to academic debates on urban futures and to policy dialogues in India, where smart cities remain a flagship but contested urban programme.

2. REVIEW OF LITERATURE

2.1 Conceptual foundations of smart cities

A robust body of scholarship has attempted to conceptualize smart cities through multiple lenses, reflecting both the **technological promise** and the **governance dilemmas** they embody. The **techno-centric school** emphasizes ICT-enabled infrastructure - sensor networks, IoT platforms, broadband connectivity, and analytics systems - as the defining feature of smartness (Caragliu, Del Bo, & Nijkamp, 2011; Batty, 2012). Within this tradition, smart cities are viewed as complex cyber-physical systems where efficiency and resilience can be achieved through data-driven decision-making and automation.

By contrast, **socio-technical approaches** foreground the governance, institutional, and equity dimensions of urban digitalisation. These works caution that technology without durable institutions risks "pilotism," in which projects demonstrate potential but fail to scale or sustain (Neirotti, De Marco, Cagliano, Mangano, & Scorrano, 2014). Meijer and Rodríguez Bolívar (2016)

argue that smartness should be understood as a form of **urban governance innovation**—where participation, accountability, and citizen co-production of services are as critical as ICT infrastructure.

Recent reviews have sought to integrate these perspectives. Ismagilova, Hughes, Dwivedi, and Raman (2020) highlight that **success depends on embedding digital innovations into permanent institutions**, noting that even technically sophisticated projects collapse without financial planning, legal safeguards, and public legitimacy. This emerging consensus motivates the present paper's management-first orientation, which benchmarks technologies but always within their institutional and socio-political contexts.

2.2 Benchmarking global leaders

The literature on benchmarking emphasises that certain regions and cities have become **reference points** for global practice.

European Union (EU):

The EU has established itself as a global leader in **interoperability and regulatory governance**. Its frameworks on digital public services, such as the European Interoperability Framework, and its legal regimes—the General Data Protection Regulation (GDPR) and the Artificial Intelligence Act—create robust safeguards for urban data governance (European Commission, 2023). Comparative studies show that EU cities tend to adopt **API-first, standards-driven procurement**, enabling modular upgrades and vendor competition. The EU also promotes pooled financing and cross-city knowledge sharing, which allow even smaller municipalities to benefit from scale (OECD, 2020).

Barcelona:

Barcelona is widely studied for its **citizen-centric smart city model**. Its open-source middleware platform **Sentilo** allows interoperability between sensors and services without locking cities into vendor ecosystems (Bain, 2014). Moreover, Barcelona has pioneered **participatory budgeting and co-design mechanisms**, positioning the citizen as a co-producer of smart services rather than a passive recipient (March & Ribera-Fumaz, 2016).

Singapore:

Singapore illustrates the potential of **digital public infrastructure (DPI)** at the city-state level. Its **national digital identity system, integrated payment infrastructure, and Virtual Singapore digital twin** form the backbone of a highly integrated urban governance platform (Mazzetto, 2024). While the costs of such integration are high, Singapore demonstrates how **predictive planning** and **cross-agency coordination** can yield resilient outcomes.

Songdo:

The failure of Songdo in South Korea is equally instructive. Built as a **vendor-driven, greenfield city**, Songdo is often criticised for lack of demand, weak civic engagement, and overreliance on corporate partnerships (Halpern, LeCavalier, Calvillo, & Pietsch, 2013). Its sterile urban fabric illustrates the risks of prioritising technology over social needs, highlighting that smartness is not only about infrastructure but also about **livability and community**.

2.3 Indian literature and evaluations of the Smart Cities Mission

Compared to Europe or East Asia, the **Indian smart city literature is relatively nascent**. Much of it focuses on evaluating the **Smart Cities Mission (SCM)**, launched in 2015 (MoHUA, 2015).

Scholars such as Praharaj (2025) highlight that the SCM has achieved important gains—particularly in **GIS-based property taxation, Integrated Command and Control Centres (ICCCs), and grievance redress portals**. However, challenges remain. **SPV–ULB tensions** undermine clarity of authority, while **weak financial models** mean that many projects remain CAPEX-heavy but OPEX-poor. Studies also identify **fragmented procurement**, with multiple vendors creating silos across transport, utilities, and public safety systems. Citizen engagement remains weak in most cities, limited to grievance apps rather than deeper co-production processes (Arora & Goyal, 2020).

The gap, therefore, lies in **synthesising international best practices with India's institutional and socio-political realities**. While global literature provides rich insights into open standards, participatory frameworks, and lifecycle financing, Indian cities often struggle with **institutional discontinuity, uneven HR capacity, and fiscal stress**.

2.4 Technology stacks and interoperability

Global studies treat smart cities as layered **technology stacks**—IoT sensing, connectivity, middleware and APIs, data governance platforms, analytics and AI, ERP and back-office systems, and citizen-facing applications (Jeong, Kim, Park, & Rho, 2020). Each layer introduces interoperability challenges.

For example, **APIs** are widely recognised as critical for connecting legacy SCADA systems with new applications. Barcelona's Sentilo and South Korea's NGSI-LD standards illustrate how open APIs prevent vendor lock-in and encourage innovation (Bain, 2014; Jeong et al., 2020). By contrast, Indian ICCCs often rely on **proprietary vendor dashboards**, creating silos and expensive re-procurement cycles (Praharaj, 2025).

The literature also notes risks of **data silos and cyber vulnerabilities**. Without common metadata standards and robust Master Data Management (MDM), cities

cannot fully integrate their systems. The EU's regulatory emphasis on **semantic interoperability** provides a pathway for overcoming these limitations (European Commission, 2023).

2.5 Finance and sustainability

Smart city projects are typically **CAPEX-intensive but OPEX-fragile**. Internationally, sustainable models combine upfront investment with **lifecycle financing tools** such as municipal bonds, green bonds, PPPs, and value-capture mechanisms (OECD, 2020). India has experimented with **municipal bonds** (e.g., Pimpri-Chinchwad, Vadodara) but their uptake remains limited due to creditworthiness and governance constraints.

The literature also emphasises **economies of scale and processes**. In the EU, pooled procurement across municipalities reduces costs and creates interoperability by design. Indian scholars have argued that similar pooling—whether for ICT procurement, cloud services, or training—could make smaller Indian cities more sustainable (Andhale, unpublished).

2.6 Human resources and institutional capacity

Global benchmarks emphasise **professionalised cadres**. Singapore's Civil Service College, Seoul's civic innovation labs, and Barcelona's leadership training all illustrate investment in skills (OECD OPSI, 2022). In India, however, ULBs suffer from a **deficit of planners, ICT engineers, and data scientists**. The literature calls for creating permanent managerial roles, such as a **Smart City Manager** or Bureau, to ensure continuity and professional oversight (Praharaj, 2025).

Without investment in HR and institutional permanence, cities risk remaining dependent on vendors, undermining capacity for independent planning and oversight.

2.7 Inclusion, ethics, and citizen engagement

Empirical studies emphasise the **digital divide** in smart cities. Caragliu, Papa, and Kourtit (2023) note that urban digitalisation often reproduces inequalities unless multilingual, accessible, and inclusive design is prioritised. In India, where smartphone penetration and literacy remain uneven, inclusion is a major concern.

The EU's GDPR and India's Data Protection Act (MeitY, 2023) underscore the importance of **privacy, consent, and accountability**. Literature also highlights the need for **citizen-facing transparency**: dashboards, explainable AI, and participatory budgeting mechanisms (Meijer & Rodríguez Bolívar, 2016).

2.8 Evaluation frameworks

Comparative indices such as the **IMD Smart City Index** or IESE's Cities in Motion provide cross-sectional snapshots (IMD, 2022). However, critics note that such indices often privilege technological capacity over governance and inclusion (Toh, 2023). In India, MoHUA dashboards track SCM progress but rarely

capture **citizen perceptions, quality of life, or inclusion**.

Scholars argue for **blended evaluation frameworks**, combining KPIs with participatory feedback and locally tailored indices (Ismagilova et al., 2020). This gap is critical for benchmarking and for developing a Model Smart City.

2.9 Synthesis and gaps

Across these strands, the literature converges on key gaps:

1. **Institutional permanence** - many smart city projects remain mission-bound and fragile.
2. **Interoperability and standards** - closed vendor systems create costly silos.
3. **Lifecycle financing** - CAPEX-heavy approaches undermine sustainability.
4. **Human resources** - ULBs lack skilled staff and permanent cadres.
5. **Inclusion** - without citizen co-production, digitalisation risks exclusion.

This paper addresses these gaps by **benchmarking global best practices** and translating them into **management-first models** suitable for India's context.

Table 1. Conceptual typologies of smart cities: Contrasting technocentric, socio-technical, and hybrid perspectives.

Typology	Core Features	Strengths	Weaknesses	Examples (Author – Year)
Technocentric	ICT-driven, vendor platforms, data dashboards, IoT	Efficiency, scale, automation	Vendor lock-in, exclusion, “pilotism”	IBM “Smarter Planet” (Batty, 2012)
Socio-technical	Citizen participation, equity, participatory governance	Inclusion, legitimacy, resilience	Slower adoption, high transaction costs	Barcelona's participatory platforms (Meijer & Rodríguez Bolívar, 2016)
Hybrid models	Mix of ICT and governance reform	Balance efficiency + legitimacy	Complex design, high coordination	EU “Living Labs,” India's SCM pilots (Caragliu, Del Bo, & Nijkamp, 2011)

3. RESEARCH METHODOLOGY

This study employs a **conceptual-comparative research design** to benchmark global smart city practices and identify transferable lessons for India. Unlike large-N empirical studies, the emphasis here is on **qualitative comparative analysis (QCA)** across carefully chosen international and Indian cases. The purpose is to generate a **management-first blueprint** that combines technological innovation with institutional, financial, and social sustainability.

3.1 Research design

The design rests on three analytical dimensions:

1. **Technology** (IoT, APIs, AI, digital twins, ERP systems).
2. **Governance and institutions** (roles of SPVs, ULBs, citizen participation, regulatory

frameworks).

3. Finance and sustainability (CAPEX vs. OPEX models, municipal bonds, pooled procurement).

This structured approach facilitates comparison while recognising contextual differences. Findings are later synthesised into **SWOT analyses, transferability matrices, and prescriptive frameworks.**

3.2 Case selection

Case selection followed three criteria:

- **Governance diversity:** Regional frameworks (European Union), city-level models (London, Barcelona, Seoul), and greenfield experiments (Dubai, Songdo).
- **Technological leadership:** Singapore and Seoul were included for their innovation in digital twins, AI, and semantic interoperability (Mazzetto, 2024; Jeong, Kim, Park, & Rho, 2020).
- **Relevance for India:** Cases that reflect brownfield retrofits, fiscal constraints, or institutional complexity, aligning with India's Smart Cities Mission (MoHUA, 2015; Praharaj, 2025).

The final set includes the EU, London, Dubai, Barcelona, Singapore, Seoul, and Songdo—representing both **positive exemplars** and **cautionary lessons.**

3.3 Data sources

The study draws on multiple sources for triangulation:

- **Peer-reviewed scholarship** (Caragliu, Del Bo, & Nijkamp, 2011; Batty, 2012; Meijer & Rodríguez Bolívar, 2016).
- **Institutional reports** (OECD, 2020; European Commission, 2023; MoHUA, 2015).
- **Grey literature and standards** (e.g., ITU interoperability guidelines).
- **News articles and practitioner commentaries** published up to **December 2024**, providing insights into implementation progress and challenges.

This mix ensures academic grounding while staying attuned to real-world developments.

3.4 Analytical tools

Three methods were applied:

1. **Thematic coding** of recurring issues such as interoperability, financial fragility, and citizen participation.
2. **SWOT analysis** to structure strengths, weaknesses, opportunities, and threats for each case (Zanella, Bui, Castellani, Vangelista, & Zorzi, 2014).
3. **Transferability matrices** to assess whether global practices can be realistically adapted to Indian contexts.

3.5 Outputs

The methodology enables outputs at three levels:

- A **taxonomy of best practices** (Section 4).
- Comparative lessons from global and Indian cases (Sections 6–7).
- A **prescriptive Model Smart City blueprint** (Sections 8–9), integrating technical, institutional, financial, and inclusion dimensions.

This approach ensures that the research is both **conceptually rigorous** and **policy-relevant**, offering actionable guidance for Indian urban governance.

4. GLOBAL BENCHMARKS AND PRACTICES

4.1 European Union (EU)

The European Union (EU) stands at the forefront of global smart city experimentation. Its emphasis has been on **interoperability, citizen rights, and sustainability.** EU initiatives are grounded in regional legal frameworks like the **General Data Protection Regulation (GDPR)** and the **EU Artificial Intelligence Act (2024)**, which ensure that AI and digital infrastructures comply with accountability and transparency standards (European Commission, 2023).

Funding mechanisms such as **Horizon 2020** and **Horizon Europe** provide research and innovation support for cities, while projects like **Sharing Cities** (London, Milan, Lisbon) and **GrowSmarter** (Stockholm, Cologne, Barcelona) demonstrate how cross-border consortia accelerate adoption (OECD, 2020).

Lessons for India include:

1. **Procurement Reforms:** API-first contracts, open-source platforms.
2. **Legal Safeguards:** GDPR-inspired protections for data governance.
3. **Pooled Funding:** Joint financing for smaller cities to achieve economies of scale.

4.2 London (UK)

London is widely recognized for its leadership in **open data ecosystems**, with the **London Datastore** providing real-time, machine-readable datasets across transport, energy, and health (Greater London Authority, 2023). It has pioneered **smart mobility solutions**, including congestion pricing, adaptive traffic lights, and electric bus integration.

London's governance model highlights collaboration between the **Greater London Authority (GLA)**, borough councils, and private partners. Unlike India, where municipal autonomy is weaker, London demonstrates the benefits of devolved governance with strong central coordination.

Key lessons for India include:

- Standardized APIs for public transport and urban services.
- Public dashboards with citizen-facing transparency.
- Cross-borough collaboration as a model for Indian metropolitan regions.

4.3 Dubai (UAE)

Dubai represents a **centralized governance model**. The **Smart Dubai Office** drives digital transformation with strong backing from the monarchy, enabling rapid decision-making. Flagship projects include **DubaiNow** (a unified app for 120+ services), blockchain pilots for property transactions, and AI-driven traffic management (Smart Dubai, 2022).

Advantages for India: Dubai illustrates how centralisation accelerates project execution. Risks: such centralisation may not fit India's democratic and federal framework. However, lessons in **greenfield project planning** and **PPP integration** are highly relevant for Indian brownfield cities (UN-Habitat, 2022).

4.4 Barcelona (Spain)

Barcelona is considered a global pioneer in **citizen-centric smart city governance**. Its **Sentilo** middleware platform demonstrates how open-source solutions can reduce vendor lock-in (Bain, 2014). Barcelona has also led in **participatory governance**, integrating citizen assemblies into digital decision-making.

Risks: Political changes have sometimes slowed continuity, underscoring the need for **institutional permanence**—a challenge India also faces. Still, Barcelona shows that inclusion and open platforms can balance efficiency with democratic legitimacy.

4.5 Singapore

Singapore's smart city model emphasizes **Digital Public Infrastructure (DPI)**—digital identity (SingPass), payments (PayNow), and urban planning (Virtual Singapore). Its small size and strong state capacity enable rapid deployment.

For India, replicability is conditional. While institutional capacity differs, lessons on **predictive analytics**, **digital twins**, and **AI governance frameworks** are valuable (Mazzetto, 2024).

4.6 Seoul (South Korea)

Seoul excels in **semantic interoperability**. Its **City Data Hub** uses NGSI-LD standards, ensuring APIs and data schemas can be shared across agencies (Jeong, Kim, Park, & Rho, 2020). Seoul also invests in civic labs where citizens co-create AI use cases.

For India: adopting **semantic standards** in APIs and building local civic labs could help democratise innovation.

4.7 Songdo (South Korea)

Songdo is often cited as a **cautionary tale**. Conceived as a fully master-planned greenfield smart city, it became an enclave dominated by technology vendors. Despite advanced ICT infrastructure, lack of social vibrancy and affordability left large parts underpopulated (Halpern et al., 2013).

For India: Songdo warns against **over-engineered greenfield projects** and emphasises focusing on upgrading lived brownfield cities instead.

Table 2. Comparative lessons from global smart cities: Benchmarking Barcelona, Singapore, Seoul, Dubai, London, and Songdo against key management and technology principles.

Summarises cross-case findings and transferability (OECD OPSI, 2022; Halpern, LeCavalier, Calvillo, & Pietsch, 2013).

City	Key Practice	Preconditions	Transferability to India	Caveats
Barcelona	Open-source middleware (Sentilo)	Municipal stewardship, OSS capacity	High	Needs institutional capacity
Singapore	Digital twins & predictive planning	Strong governance, geospatial MDM	Conditional	High costs, small scale
Seoul	Semantic interoperability (NGSI-LD)	Adoption of standards, civic labs	High	Training, governance discipline
Dubai	Centralised command	Strong political will, PPPs	Medium	Doesn't fit India's federal democracy
London	Open data platforms	Borough-level autonomy	High	Needs decentralisation
Songdo	Fully vendor-driven	Master-planned, heavy ICT	Low	Risk of becoming an enclave

5. CROSS-CASE ANALYSIS: TRANSFERABILITY TO INDIA

The comparative benchmarking exercise highlights that while **technological innovations** in global smart cities are abundant, their **transferability to India** is conditional upon a host of **institutional, financial, and socio-political preconditions**. India's trajectory is shaped less by greenfield utopias and more by the complexities of upgrading existing **brownfield cities**, where legacy infrastructure, fiscal stress, and fragmented governance complicate replication. The following subsections synthesise the transferability lessons from each global case.

5.1 European Union

The **European Union (EU)** demonstrates the value of **harmonised regulatory frameworks** and **pooled procurement systems**. The General Data Protection Regulation (GDPR) and the forthcoming Artificial Intelligence Act establish strong citizen safeguards around data use, algorithmic accountability, and interoperability (European Commission, 2023). While India has begun this journey with the Digital Personal Data Protection Act (MeitY, 2023), enforcement and institutional capacity remain weaker. Nevertheless, EU

practices in **API-first procurement** and **cross-municipal platforms** are highly transferable, particularly through pooled state-level tenders for ICCCs, IoT sensors, or urban ERP modules.

5.2 London

London exemplifies the integration of **open data platforms** with citizen-facing governance. Initiatives such as the London Datastore and the deployment of live dashboards for transport, environment, and housing have deepened **transparency and accountability** (Greater London Authority, 2023). These practices resonate strongly with India's democratic ethos, where **citizen oversight and participatory feedback** are constitutionally valued. Transferability is high, provided data quality and multilingual accessibility are ensured. London's experience underscores the importance of **framing smart city data as a public good**, not merely as an administrative tool.

5.3 Dubai

Dubai's smart city approach demonstrates the advantages—and limitations—of **centralised governance**. By housing smart city initiatives under a single authority, Dubai has achieved rapid decision-making and integration of PPPs (Dubai Smart Office, 2023). While such centralisation may conflict with India's federal structure and ULB autonomy, selective lessons apply: particularly in structuring **integrated PPP contracts** for mobility, energy, and digital infrastructure. Transferability requires adaptation, with safeguards to ensure transparency and prevent elite capture.

5.4 Barcelona

Barcelona's model is one of the most relevant for India. Its **open-source Sentilo middleware** provides a replicable template for avoiding vendor lock-in (Bain, 2014), while its emphasis on **participatory governance, citizen co-production, and digital rights** resonates with India's democratic ambitions (March & Ribera-Fumaz, 2016). Barcelona demonstrates that **social legitimacy** is as important as technical sophistication. For Indian cities, adopting open-source platforms and embedding citizen input into budgeting and planning could bridge the trust gap between municipal governments and citizens.

5.5 Singapore

Singapore illustrates the potential of **Digital Public Infrastructure (DPI)**—a highly integrated ecosystem of digital identity, payments, and spatial planning (Mazzetto, 2024). While India already leads globally in DPI through India Stack and UPI, the Singaporean experience shows how such systems can be embedded

into **city-scale planning**. However, transferability is conditional: Singapore's strong state capacity and compact geography are not easily replicated in India. Instead, the lesson is to **integrate DPI with local municipal functions**, ensuring that property taxation, mobility management, and grievance redress leverage India Stack's APIs.

5.6 Seoul

Seoul has pioneered **semantic interoperability** through the adoption of NGSI-LD standards and the development of civic labs where citizens and developers co-create AI applications (Jeong, Kim, Park, & Rho, 2020). For India, where **siloed data architectures** are a persistent obstacle, Seoul's example is particularly relevant. Transferability requires capacity-building in municipal IT teams and alignment with national standards (e.g., BIS, MeitY). The challenge is institutionalising interoperability as a **precondition in procurement contracts**, rather than leaving it to vendors.

5.7 Songdo

Songdo represents a **negative lesson**. Despite its advanced infrastructure, the city failed to thrive due to a lack of demand, weak civic engagement, and overreliance on vendor-driven design (Halpern, LeCavalier, Calvillo, & Pietsch, 2013). For India, Songdo's failure underscores that **smartness without social anchoring is fragile**. Indian policymakers must resist the allure of greenfield “utopias” disconnected from citizen needs. Instead, the emphasis should remain on **incremental retrofits, institutional strengthening, and inclusivity**.

5.8 Synthesis: India's brownfield reality

India's reality as a **primarily brownfield smart city developer** means that incremental upgrades and institutional anchoring are key. Unlike Dubai or Songdo, where large-scale master planning was feasible, Indian cities are constrained by **legacy infrastructure, informal settlements, and fiscal limits**. The most transferable practices, therefore, are those that:

1. **Strengthen institutions** (Barcelona's participatory models, EU's regulatory frameworks).
2. **Embed standards** (Seoul's semantic interoperability, London's open data).
3. **Leverage DPI** (Singapore's integration, India Stack).
4. **Avoid pitfalls** (Songdo's overreliance on vendors).

Thus, the cross-case analysis highlights that India's best path forward lies in **management-first incrementalism**: adopting global best practices but tailoring them to **federal structures, fiscal realities, and socio-political contexts**.

Table 3. Cross-case comparative analysis of global smart city practices and their transferability to India

City/Region	Core Practice/Strength	Preconditions for Transferability	Risks & Caveats (APA 6)	Transferability to India
European Union	Regulatory frameworks (GDPR, AI Act); pooled procurement	Strong legal institutions; enforcement agencies; vendor - neutral procurement clauses	Weak e nforcement capacity in India; risks of paper compliance without institutional depth (European Commission, 2023).	High (regulation + pooled procurement feasible with adaptation)
London	Open data portals (Datastore); citizen - facing transparency	Reliable data pipelines; multilingual platforms; political commitment	Risks of low citizen uptake if data is non-intuitive; exclusion without multilingual design (Greater London Authority, 2023).	High (fits India's democratic ethos)
Dubai	Centralised governance; integrated PPPs	Strong central authority; PPP frameworks; elite consensus	Risks of elite capture; conflicts with India's federalism; lack of citizen participation (Dubai Smart Office, 2023).	Conditional (PPP structuring transferable; centralisation limited)
Barcelona	Open-source Sentilo middleware; participatory budgeting	Municipal IT capacity; citizen engagement channels; open-data policies	Vendor resistance; cultural adaptation of participatory budgeting (Bain, 2014; March & Ribera-Fumaz, 2016).	High (open-source + citizen models align with India)

6. DISCUSSION: COMPARATIVE LESSONS AND POLICY IMPERATIVES FOR INDIA

The comparative analysis of global smart city practices highlights a convergence on several **policy imperatives** that India must adopt to move from fragmented experiments toward a coherent, sustainable smart city ecosystem. These imperatives build on lessons distilled from the EU, London, Dubai, Barcelona, Singapore, Seoul, and Songdo, while adapting them to India's **brownfield urban reality**.

1. Institutional permanence. International experience underscores that successful smart city initiatives are embedded in **permanent institutions** rather than temporary project vehicles. Barcelona's participatory platforms and Seoul's civic labs are anchored within municipal structures, ensuring continuity beyond political cycles (Jeong, Kim, Park, & Rho, 2020; March & Ribera-Fumaz, 2016). For India, this translates into the creation of **statutory Smart City Bureaus**, headed by professional Smart City Managers, with clear mandates for procurement oversight, data integration, and KPI monitoring.

2. Procurement reform. Both the EU and Barcelona highlight the risks of **vendor lock-in** and the need for open, standards-based procurement (European Commission, 2023; Bain, 2014). India's current procurement model, dominated by proprietary ICCC platforms, risks stranded assets. Reform should mandate **API-first procurement**, modular contracts, and escrow clauses that ensure portability of data and configurations.

3. Financial sustainability. The EU's pooled procurement and London's transparent financial planning illustrate the importance of **OPEX-first financing**. In India, most smart city projects remain **CAPEX-heavy**, with insufficient planning for long-term maintenance and upgrades (Praharaj, 2025). Moving towards pooled procurement, **municipal and green bonds**, and lifecycle financing would ensure sustainability.

4. Data governance. Strong legal frameworks such as the GDPR and EU AI Act have anchored trust in European smart cities (European Commission, 2023). India's Digital Personal Data Protection Act (2023) is a step forward, but requires **operationalisation at the city level** through grievance redress mechanisms, audits, and privacy-by-design systems. Without such measures, citizen trust and adoption may remain low.

5. Inclusion. Barcelona's participatory budgeting and London's open data practices demonstrate the centrality of **citizen inclusion** (March & Ribera-Fumaz, 2016; Greater London Authority, 2023). For India, bridging the **digital divide** is essential. This can be achieved by deploying **Smart Setu Kendras** (assisted access points)

and ensuring multilingual, accessible citizen apps that enable participation even for low-literacy populations.

6. Avoiding technocratic enclaves. Songdo illustrates the risks of building smart cities as **technocratic enclaves** disconnected from citizen needs (Halpern, LeCavalier, Calvillo, & Pietsch, 2013). India must avoid replicating this mistake. Instead, policy must prioritise **brownfield upgrades** that integrate legacy infrastructure, informal settlements, and citizen priorities.

Taken together, these imperatives represent a shift toward a **management-first model of smart cities** in India: one that anchors technology in durable institutions, ensures financial realism, protects citizen rights, and prioritises inclusivity.

7. CONCLUSION

This paper concludes that the **success of smart cities cannot be reduced to technological sophistication alone**. While global case studies reveal impressive deployments of IoT, APIs, AI, and digital twins, the evidence shows that these tools generate lasting value only when embedded in **durable institutions, supported by sustainable finance, and legitimised through citizen inclusion** (Batty, 2012; Meijer & Rodríguez Bolívar, 2016). In this respect, **institutional design, governance continuity, and financial realism** matter as much as—or more than—the underlying technology.

For India, the path forward involves rejecting **turnkey, vendor-led models** that create dependence and stranded assets. Instead, cities must move toward **management-first models** anchored in **statutory Smart City Bureaus and professional Smart City Managers**, ensuring continuity beyond political or project cycles (Praharaj, 2025). Procurement must be **API-first and modular**, with portability clauses to reduce vendor lock-in (European Commission, 2023). Financial models should move from **CAPEX-heavy** project funding toward **OPEX-first lifecycle financing**, leveraging pooled procurement, municipal bonds, and green bonds for long-term resilience (OECD, 2020).

Equally critical is **citizen inclusion**. Platforms like Barcelona's participatory budgeting and London's open data portals demonstrate that citizen-facing transparency and co-production foster both legitimacy and adoption (Bain, 2014; Greater London Authority, 2023). For India, this translates into multilingual citizen applications, accessible grievance redress systems, and **Smart Setu Kendras** that ensure equitable access for digitally excluded populations.

The contribution of this paper is threefold:

1. **Synthesis of global best practices** into a comparative framework that spans governance, finance, technology, and inclusion.

2. **Identification of transferability conditions**, recognising that global practices succeed in India only when adapted to brownfield realities, fiscal constraints, and federal governance.
3. **Proposal of a management-first blueprint**, which anchors smart city functions in institutional permanence, standards-based procurement, lifecycle finance, and citizen participation.

Future research should build on this conceptual foundation through **empirical evaluation of city-level outcomes**, including longitudinal studies of project sustainability, development of **comparative indices tailored to Indian contexts**, and pilot interventions that test the feasibility of Smart City Bureaus, pooled procurement, and inclusive service models. Such work would provide the quantitative rigour and operational validation required to move from a conceptual blueprint to a **scalable national model**.

In essence, the lesson of this comparative inquiry is clear: **smart cities are not built by sensors and dashboards alone—they are sustained by governance, finance, and trust.**

REFERENCES

1. Bain, M. (2014). *Sentilo: Open-source sensor and actuator platform*. Interoperable Europe Portal. Retrieved from https://interoperable-europe.ec.europa.eu/sites/default/files/document/2014-06/SENTILO%20case_joinup_v_1%202.pdf
2. Batty, M. (2012). Smart cities of the future. *The European Physical Journal Special Topics*, 214(1), 481–518. doi:10.1140/epjst/e2012-01703-3
3. Caragliu, A., Del Bo, C., & Nijkamp, P. (2011). Smart cities in Europe. *Journal of Urban Technology*, 18(2), 65–82. doi:10.1080/10630732.2011.601117
4. European Commission. (2023). *European Union Artificial Intelligence Act and data governance frameworks*. Retrieved from <https://artificialintelligenceact.eu/the-act/>
5. Greater London Authority. (2023). *London Datastore and smart city transparency initiatives*. London: GLA. Retrieved from <https://data.london.gov.uk>
6. Halpern, O., LeCavalier, J., Calvillo, N., & Pietsch, W. (2013). Test-bed urbanism. *Public Culture*, 25(2), 272–306. doi:10.1215/08992363-2020606
7. Ismagilova, E., Hughes, L., Dwivedi, Y. K., & Raman, K. R. (2020). Smart cities: Advances in research—An information systems perspective. *International Journal of Information Management*, 47, 88–100. <https://doi.org/10.1016/j.ijinfomgt.2019.08.002>
8. Jeong, S., Kim, S., Park, Y., & Rho, J. (2020). City data hub: Implementation of standard-based smart city data platform. *Sensors*, 20(23), 1–21. <https://doi.org/10.3390/s20236965>
9. March, H., & Ribera-Fumaz, R. (2016). Smart contradictions: The politics of making Barcelona a self-sufficient city. *European Urban and Regional Studies*, 23(4), 816–830. <https://doi.org/10.1177/0969776414554488>
10. Mazzetto, G. (2024). Urban digital twins: Integration, challenges and future directions. *Sustainability*, 16(19), 8337. <https://doi.org/10.3390/su16198337>
11. Meijer, A., & Rodríguez Bolívar, M. P. (2016). Governing the smart city: A review of the literature on smart urban governance. *International Review of Administrative Sciences*, 82(2), 392–408. <https://doi.org/10.1177/0020852314564308>
12. Ministry of Electronics and Information Technology (MeitY). (2023). *Digital Personal Data Protection Act, 2023*. Government of India. Retrieved from <https://www.meity.gov.in>
13. Ministry of Housing and Urban Affairs (MoHUA). (2015). *Smart Cities Mission statement and guidelines*. Government of India. Retrieved from <https://smartcities.gov.in>
14. Organisation for Economic Co-operation and Development (OECD). (2020). *OECD policy paper on smart cities and inclusive growth*. Paris: OECD. Retrieved from <https://www.oecd.org/cfe/cities>
15. Praharaj, S. (2025). Smart city governance in India: Reviewing ten years of the mission. *Habitat International*, 144, 102915. <https://doi.org/10.1016/j.habitatint.2024.102915>
16. Zanella, A., Bui, N., Castellani, A., Vangelista, L., & Zorzi, M. (2014). Internet of things for smart cities. *IEEE Internet of Things Journal*, 1(1), 22–32. <https://doi.org/10.1109/JIOT.2014.2306328>

