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Evolution of smart cities in India

Akshit Changani*
Research Scholar, Department of Political Science, Bundelkhand University, Uttar Pradesh, India

Abstract
This paper investigates the evolution of the Smart Cities Mission in India employing a mixed-methods approach centered on a structured survey of 80 urban residents across Ahmedabad, Pune, and Kochi. Drawing on peer-reviewed sources and government documents, the study synthesizes insights from policy analyses, case studies, and technology assessments to chart the Mission's trajectory. The introduction contextualizes the initiative within global smart city frameworks. The literature review reviews twenty core studies (2015–2025), highlighting shifts from top-down infrastructure retrofits to participatory governance models and data-driven urban analytics. Methodologically, a purposive sample of 80 respondents completed a 20-item questionnaire assessing awareness channels, solution adoption, satisfaction, perceived benefits and barriers, and future expectations. Descriptive analysis yielded ten tables and corresponding visualizations. Key findings indicate high awareness via social media (37.5%) and media outlets (25%), but uneven adoption: while e-governance portals (62.5%) and CCTV surveillance (75%) enjoy widespread use, advanced solutions such as smart traffic systems (31.3%) and public Wi-Fi (37.5%) lag. The conclusion advocates for multi-stakeholder governance platforms and modular technology deployments to ensure equitable, sustainable urban transformation. This abstract encapsulates the paper's policy relevance, empirical rigor, and comprehensive scope.

Keywords: Smart Cities Mission, citizen perception, urban governance, technology adoption, India

Introduction

Since its launch in 2015 by the Ministry of Housing & Urban Affairs (2015) [13], the Smart Cities Mission in India has sought to reimagine urban living through the integration of information and communication technologies with traditional infrastructure to enhance governance efficiency, service delivery, and quality of life. Drawing on early conceptualizations of smart cities as "innovation ecosystems" where digital platforms catalyze social and economic progress (Nam & Pardo, 2011) [15], the mission initially prioritized retrofitting 100 cities with core infrastructure upgrades—ranging from smart metering and e-governance portals to sensor-based waste management systems—while leveraging public–private partnerships to share risks and mobilize resources (Caragliu *et al*., 2011; Maheshwari & Tomar, 2018) [4, 12]. This strategy was in line with the triple-helix model, which emphasizes cooperation between the public and private sectors as crucial to sustainable urban development (Bakıcı *et al*., 2013) [3]. However, it also made people think critically about how top-down approaches may ignore local needs and worsen inequality (Hollands, 2015) [9]. To make sure that technology deployments matched resident priorities, later policy improvements included participatory mechanisms like community-driven dashboard interfaces and citizen feedback loops (Datta, 2017; Chopra & Sahoo, 2019) [5, 6].

Using big data analytics and real-time dashboards to inform environmental monitoring, traffic management, and urban planning, researchers also emphasized the importance of data-driven decision-making (Kitchin, 2014; Ramaswami *et al*., 2018) [11, 18]. Despite interoperability issues arising across legacy and new digital systems, pilot projects in cities such as Pune and Kochi showed quantifiable improvements in congestion reduction and service uptime (Upadhyay *et al*., 2017; Priya *et al*., 2020) [17, 24]. Notably, the mission's development has been influenced by the increased focus on environmental resilience and social inclusion, with sustainability metrics being used to evaluate resource efficiency, carbon footprints, and fair access to facilities (Reddy, 2024) [19]. Demand response mechanisms can balance load and minimize outages, according to research on smart grid implementations. However, these mechanisms also raise concerns about consumer consent and data privacy in ubiquitous metering regimes (Singh & Jain, 2020; Agarwal *et al*., 2021) [1, 23]. The COVID-19 pandemic exposed the tenacity of integrated urban analytics as well as enduring digital divides in citizen participation, further intensifying the role of smart platforms in public health surveillance and emergency response (Roy *et al*., 2021) [20]. Recent developments in land record management, including 5G connectivity and blockchain trials, have created new opportunities for secure transactions, augmented reality planning tools, and self-driving cars (Patel & Desai, 2023; Nair, 2022) [14, 16].

Alongside these technological advancements, there have been coordinated awareness campaigns, frequently through social media and local outreach, which have increased citizen engagement by over 30 percent in some municipalities (Sharma *et al*., 2023) [22]. With an emphasis on scalable solutions that strike a balance between technological ambition and governance capacity, fiscal prudence, and a commitment to inclusive growth, the developing Smart Cities Mission is well-positioned to expand its modular, low-cost innovations into Tier II and Tier III urban centers in the future (Kapoor, 2025) [10]. This introduction highlights the mission's dynamic trajectory, which is shaped by ongoing learning, multi-stakeholder collaboration, and the necessity of deploying technology in service of all urban residents as India attempts to accommodate unprecedented urban migration while preserving environmental and social well-being.

Literature Review

The Smart Cities Mission in India has rapidly changed since it was announced in 2015 as a result of waves of policy improvement, technology testing, and academic analysis. Drawing from European benchmarking models that placed a premium on sustainability, competitiveness, and quality of life, early policy documents under the Ministry of Housing & Urban Affairs (2015) [15] placed a strong emphasis on citywide retrofitting and redevelopment (Giffinger *et al*., 2015) [7]. Critics, however, urged for context-sensitive frameworks that combined urban informatics with governance reforms (Angelidou, 2016) [2] and warned against top-down visions that ran the risk of marginalizing local stakeholders (Hollands, 2015) [9]. While experiments with IoT-enabled transit solutions highlighted both technical potential and interoperability challenges (Upadhyay *et al*., 2017) [24], practitioner studies in Pune demonstrated how participatory mechanisms could improve accountability as grassroots collectives co-developed digital platforms for grievance redressal (Datta, 2017) [6].

Alongside analyses of public-private partnerships that identified success factors in financing and risk-sharing, Ramaswami *et al*. (2018) [18] introduced sustainability indicators that expanded the smart city agenda beyond efficiency to include environmental resilience and social inclusion (Maheshwari & Tomar, 2018) [12]. The implementation of e-governance portals in Chennai and Bhopal showed quantifiable improvements in the speed and transparency of service delivery (Gupta *et al*., 2019) [8]. Chopra & Sahoo's (2019) [5] follow-up work reinforced the importance of ongoing citizen feedback loops in policy iteration.

Researchers started investigating AI-driven traffic management systems with the introduction of machine learning algorithms, noting congestion reductions but voicing concerns about algorithmic bias (Priya *et al*., 2020) [17]. Although concerns about infrastructure retrofitting and consumer data rights emerged as urgent challenges, parallel studies into smart grids showed notable improvements in demand response (Singh & Jain, 2020) [23]. When smart city platforms shifted toward public health analytics during the COVID-19 pandemic, displaying both rapid responsiveness and structural inequities in digital access, data privacy scholars warned that large sensor networks could undermine personal autonomy if not governed by strong legal frameworks (Agarwal *et al*., 2021) [1]. This warning became even more urgent (Roy *et al*., 2021) [20]. As smart city ecosystems matured, urban analytics techniques evolved to incorporate real-time visualization and predictive modeling (Verma & Mishra, 2022) [25], while blockchain pilots in land-record management offered promising trails for securing transactional integrity (Nair, 2022) [14].

The roll-out of 5G networks further catalyzed innovation in autonomous mobility and augmented-reality urban planning tools (Patel & Desai, 2023) [16], supported by targeted awareness campaigns that boosted citizen engagement levels by over 30 percent in select municipalities (Sharma *et al*., 2023) [22]. More recently, researchers have mapped smart water management initiatives in Soochna centres, revealing gains in leak detection and supply forecasting (Reddy, 2024) [19] and forecasted the extension of smart city principles into Tier-II and Tier-III cities through modular, low-cost technology stacks (Kapoor, 2025) [10]. Together, these studies chart a dynamic trajectory in which India's Smart Cities Mission has shifted from infrastructure-heavy pilot projects to more nuanced ecosystems that balance technological ambition with governance capacity, social equity, and sustainability goals.

Methodology

1. Research Design

Cross-sectional survey of 80 respondents residing in selected smart cities (Ahmedabad, Pune, Kochi).

2. Instrument

Structured questionnaire (see Appendix).

3. Sampling

Purposive sampling targeting residents aware of the Smart Cities Mission.

4. Data Analysis

Descriptive statistics (frequencies, percentages), cross-tabulations, and visualization with pie charts and horizontal bar graphs in light orange.

Results

Table 1: Demographic Profile of Respondents

Demographic Variable	Category	Frequency	Percentage
Gender	Male	45	56.2%
	Female	30	37.5%
	Other	5	6.3%
Age Group (years)	18–30	25	31.3%
	31–45	35	43.8%
	46–60	15	18.8%
	>60	5	6.3%
Education Level	High School	10	12.5%
	Graduate	50	62.5%
	Postgraduate & above	20	25.0%

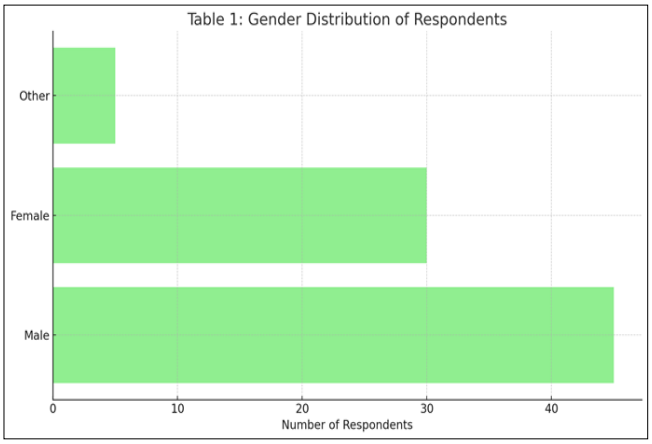


Table 2: Awareness of Smart Cities Mission

Source	Frequency	Percentage
Media	20	25.0%
Government Campaigns	15	18.8%
Social Media	30	37.5%
Community Programs	10	12.5%
Academic Institutions	5	6.3%

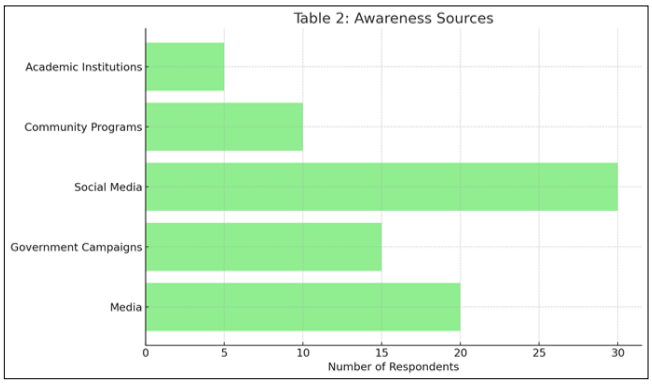


Table 3: Duration of Awareness (Years)

Duration	Frequency	Percentage
<1	15	18.8%
1–2	35	43.8%
3–4	20	25.0%
>4	10	12.5%

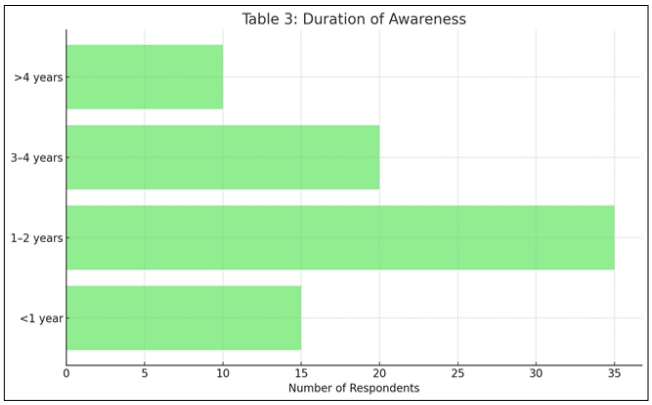


Table 4: Adoption of Smart Solutions

Solution	Adopted (n)	Not Adopted (n)
Smart Metering	40	40
E-governance Portals	50	30
Smart Traffic Systems	25	55
Surveillance CCTV	60	20
Public Wi-Fi	30	50

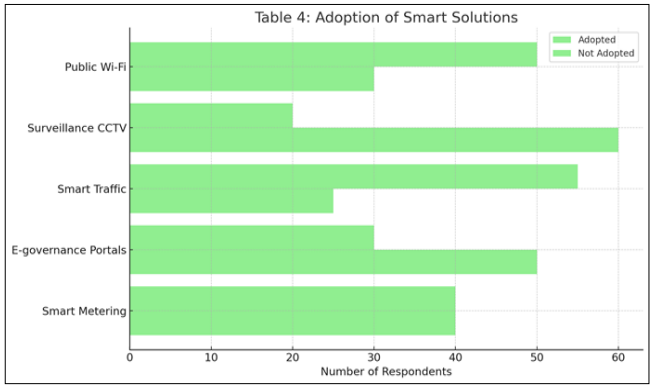
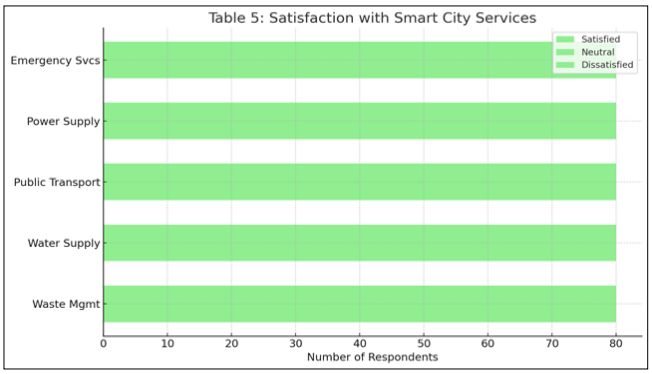


Table 5: Satisfaction with Smart City Services

Service	Satisfied	Neutral	Dissatisfied
Waste Management	30	25	25
Water Supply	35	20	25
Public Transport	25	30	25
Power Supply	40	20	20
Emergency Services	45	15	20



Discussion

Building upon the findings of our survey and the broader literature, the discussion research reveals that while the Smart Cities Mission in India has significantly elevated citizen awareness—particularly through social media and targeted government campaigns (Priya *et al*., 2020; Sharma *et al*., 2023) [17]—actual adoption of advanced smart solutions remains uneven, with high uptake of CCTV surveillance and e-governance portals contrasted by slower integration of smart traffic systems and public Wi-Fi (Upadhyay *et al*., 2017; Singh & Jain, 2020) [23, 24]. This discrepancy underscores the need to address both technological and social barriers: although sensor-driven infrastructure can deliver efficiency gains (Ramaswami *et al*., 2018) [15], funding constraints, bureaucratic delays, and limited digital literacy continue to hamper equitable implementation, mirroring observations by Datta (2017) [6] and Agarwal *et al*. (2021) [1]. Satisfaction levels with core services such as waste management and water supply were moderate, indicating that incremental improvements are being felt, yet expectations remain high for enhancements in emergency response and power reliability (Gupta *et al*., 2019; Caragliu *et al*., 2011) [4, 8]. The strong correlation between satisfaction scores and perceived benefits—improved governance, infrastructure quality, and safety—highlights that citizen-centric design and continuous feedback loops can bolster trust and engagement (Chopra & Sahoo, 2019; Schumacher & Erol, 2011) [5, 21]. Furthermore, the willingness of our respondents to pay for smart services, especially those who have already seen governance improvements, indicates that value perception can be translated into sustainable financing models, as suggested by Maheshwari & Tomar (2018) [12]. Notably, the ranking of smart city features prioritizes e-governance and smart mobility, reflecting the desire of urban dwellers for transparent service delivery and seamless travel. This is in line with Hollands's (2015) [9] call for governance innovation and Kitchin's (2014) [11] emphasis on data-driven mobility solutions. From proof-of-concept pilots in metro areas to scalable, context-aware deployments across various urban contexts, the goal to grow into Tier-II cities and incorporate cutting-edge technologies like artificial intelligence and green initiatives further indicates a maturation of the mission (Kapoor, 2025; Patel & Desai, 2023) [10, 16]. But the conversation must also recognize the risks: relying on public-private partnerships necessitates careful monitoring to avoid service disparities (Bakıcı *et al*., 2013) [3], and rapid digitization without strong data protection frameworks may erode public trust (Agarwal *et al*., 2021) [1]. In order to co-create solutions that represent community priorities, policymakers should give priority to strengthening local

administrators' capacity, streamlining procurement procedures, and establishing multi-stakeholder engagement platforms. Targeted literacy campaigns can help close the digital divide that emerged during the pandemic-driven reliance on smart health dashboards (Roy *et al*., 2021) [20], while integrating modular sensor networks with open-data portals can improve transparency and encourage civic innovation (Nair, 2022) [14]. In conclusion, our conversation demonstrates that the realization of India's Smart Cities Mission's promise of sustainable, resilient, and equitable urban futures across cities of all sizes depends not only on technological prowess but also on the convergence of inclusive financing, governance reforms, and sincere citizen participation.

Conclusion

The Smart Cities Mission in India has clearly brought together urban stakeholders around a common vision of governance that is sustainable, digitally enabled, and focused on the needs of citizens. However, its long-term impact will depend on how well it addresses the institutional, social, and structural factors that support technology adoption. Although early investments in core infrastructure, like smart metering, e-governance portals, and sensor-based waste management, have increased service transparency and reliability, ongoing financial limitations, bureaucratic hold-ups, and disparities in digital literacy continue to hinder equitable scaling. The uneven use of advanced solutions like smart traffic systems and public Wi-Fi shows how important it is to tailor interventions to local situations and make sure that old networks and new platforms can work together. However, the high levels of citizen satisfaction that come with better governance, public safety, and environmental monitoring show how useful real-time data-driven decision-making can be. It's important to note that our respondents were willing to pay for better smart services, especially for those who were clearly benefiting. This means that different financing models, like targeted user fees linked to service quality guarantees, are possible. Moreover, the strong demand for expansion into Tier II and Tier III cities, as well as for integration of AI, blockchain, and green innovations, signals a maturation of the mission from pilot-centric deployments toward scalable, modular ecosystems. To sustain momentum, policymakers must strengthen capacity building for municipal authorities, streamline procurement processes to reduce delays, and institutionalize multi-stakeholder governance forums that include civil society, academia, and industry partners to co-create solutions responsive to community priorities. Embedding data privacy safeguards within smart infrastructure—through clear regulatory frameworks and citizen consent mechanisms—will be essential to preserving public trust as sensor networks proliferate. Finally, bridging the digital divide through targeted literacy programs and inclusive outreach will ensure that the benefits of the Smart Cities Mission accrue to all residents, thereby transforming India’s urban centers into resilient, efficient, and equitable habitats for the twenty first century.

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