

SMART CITY INITIATIVES IN INDIA: LESSONS LEARNED AND PATHWAYS TO SUSTAINABLE DEVELOPMENT GOALS

Dr. S. SaiGanesh, Professor, Dayananda Sagar University, email: dr.saiganesh@dsu.edu.in;

Ms. Mousime Xalxo, Dayananda Sagar University, email: mousime.xalxo-rs-scms@dsu.edu.in

Ms. Nagarathna M, Dayananda Sagar University, email: nagarathna.m-rs-mgt@dsu.edu.in

ABSTRACT

India has witnessed rapid urbanization, its cities becoming hotbeds of cultural interaction, technology and economic development over the decades. As a result, this has led to some major national problems such as lack of access to key services, environmental pollution, and deficient infrastructure. In order to combat these issues, the government of India initiated the Smart Cities Mission on 25th June 2015. This mission aims to enhance urban areas by introducing a mix of green and technological solutions in favor of the well being of its residents. Institutional framework, particularly focusing on the vehicle partnerships and beneficiary programs like community-based development and pan city projects pertaining to building urban resilience and inclusion.

This chapter evaluates the impacts of India's smart cities mission on urban development through an examination of governance and technical frameworks. By analyzing the competencies of digital governance, intelligent transport systems and resource management based critical so into measures a city success in innovation for the 23rd century along with achieving resilience. The analysis in this article of the target relationship with the 11th SDG sustainable cities and communities. Make cities and human settlements inclusive, safe, resilient and sustainable AIISDG 11's targets smart cities mission has made significant advancement but there are still multiple challenges. These range from cybersecurity issues, data privacy and use of legacy infrastructure. With the help of global case studies such as Singapore and Barcelona, the research draws lessons to develop smart city initiatives. To realize this goal, we must promote broader accessibility and fairness through equal distribution of resources to all potential customers of the improved policy structures. The smart cities mission is an Indian urban development initiative to promote sustainable urbanization in country as a part of the national urban transport policy and contributes towards both national and international sustainable development agendas.

Keywords: SDG-11, smart cities, sustainable development, area-based development and governance.

1. INTRODUCTION

Indian cities continue to grow at an unprecedented rate, in a way that is making them hubs of economic growth, innovation and cultural exchange. The increasing urbanization has brought to light a number of concerns, including infrastructure deficiencies, environmental degradation and access inequities to basic services. To address these issues, the Indian government introduced the smart cities mission on June 25, 2015, which aims to revolutionize urban living and enhance the lives of its residents. It aims to meet the needs of different urban residents through the adoption of technology, the use of sustainable methods and approaches, and providing a sense of community and social inclusion in the design. The smart cities mission has evolved over the years to create special inclusion in the design. The Smart Cities Mission has evolved over the years to create special initiative like area-based development and pan city projects with institutional framework like special purpose corporation and competitive federalism. Such endeavors have led to a better understanding of the complexities of urban development and lessons for future projects. The smart cities mission is creating the ground work for replicating and scaling the best practices, and resolving some of the ongoing challenges in urbanization.

This paper aims to draw out lessons learnt and opportunities for replication from the mission to join the larger discourse of how to make cities resilient, inclusive and future proof in India. The chapter will discuss the important lessons learned from the execution of the mission and discuss future strategies for the effective growth of smart cities initiatives. The aim of the project is to evaluate the impact of the project activities with a focus on the practical results of digital governance systems, intelligent transport networks and optimization of resources, on the urban development. This evaluation is applicable especially in the context of India, where sustainable and scalable solutions are needed to address urbanization's challenges and meet SDG11 goals. Making cities equitable, safe, resilient and sustainable is a priority and there is a need to comprehensively evaluate the effectiveness of technical solutions to address all the challenges that cities are facing in India.

1.2. Literature Review

In India, urbanization is gaining momentum, which is catalyzing economic growth and cultural interactions, and also presents many challenges to the country's infrastructure and environment (Bansal and Jain, 20200. The Indian government's smart cities mission (2015) strives to overcome these challenges with technology as a means of sustainable urban development

(MoHUA,2019). The mission adopts the approaches like local area development (LAD) and pan city approaches and utilizes institutional structures like special purpose vehicles (SPVs) (Kundu, 2018). Many studies have shown how digital governance has the transformative power in smart cities in India. Smart transport networks and digital governance systems can enhance the mobility and administration in cities as suggested by Sharma and Raj (2021).

Smart grids and resource optimization approaches increase the economic resilience and sustainability, as per Kumar et al., 2020. The projects are aligned with sustainable development goals (SDG)11 (United Nations 2021) which has the objective of inclusion, safe and sustainable cities. While this has improved, there are still some issues. Issues like data protection, cybersecurity threats, and integrating existing systems are still significant challenges for effective implementation (Gupta and Agarwal, 2022). In this regard, a comparative study of the smart city mission in India with that of the smart cities in countries like Barcelona and Singapore emphasizes the need for existing regulations and the collaboration among the stakeholders (Patel and Mehta, 2021). The finding from these cities demonstrates that to achieve the successful implementation of smart city projects, people's participation, transparency in governance and equitable resources distribution are crucial (Chakrabarti,2020)

Moreover, the importance of public-private partnership (PPP's) to make smart cities viable has been emphasized (Dasgupta and Roy, 2019). AI -powered analytics, the Internet of Things (IoT), and big data solution have been recognized as a major element to enhance urban planning and decision making (Singh et.al,2022). However, researcher warn that the same technology that could make a significant difference in increasing socioeconomic equity is not necessarily the answer. SDG 11 is geared to make cities and human settlements inclusive, safe, resilient and sustainable. The competitive landscape across sectors has significant implications for sustainable urban development, particularly in developing economies such as India, where rapid urbanization places increasing pressure on infrastructure, governance and resource management (Kookana et al.,2020). To build sustainable cities, it is important that they are economically stable, which can be measured by key business metrics, including customer acquisition cost and sales conversion rates. Innovation capabilities, organizational efficiency, and human capital are fundamental components of smart city development, as they enhance competitiveness, improve economic performance and support sustainable urban growth (Zhao et al., 2021).

Suppliers play a vital role in achieving sustainable urban development by providing high quality products, technologies, and services that strengthen urban infrastructure, improve resource efficiency and foster collaborative business ecosystem essential for smart city development (Bibri et al., 2017). To develop sustainable urban economies, there is a need for good supplier management and strong supply chains. Furthermore, interdepartmental collaboration, supported by data driven performance measurement and integrated digital governance, enhances organizational efficiency, reduce operational uncertainty, and contributes to the economic resilience and sustainable development of smart cities (Yigitcanlar et al., 2022). Sales process automation and digital transformation technologies minimize the need for traditional sales models, increase productivity and support the sustainable development of the sales role.

Rapid urbanization has intensified the need for sustainable urban development, particularly in developing economies such as India. The Smart Cities Mission has emerged as a strategic policy initiative that integrates digital technologies, institutional reforms, and citizen centric governance to improve urban infrastructure and quality of life. The smart city development extends beyond technological interventions by emphasizing governance structures, stakeholder participation, and sustainable resource management (Kesar & Ache, 2024).

Sustainable development goal 11 serves as the principal framework guiding India's smart cities mission by promoting inclusive, safe, resilient and sustainable communities. Smart city policies have increasingly focused on improving environmental quality while simultaneously enhancing economic competitiveness, public health and social inclusion. The localization of SDGs through smart governance mechanism has therefore become an important strategy for accelerating sustainable urban development in India (Smart Cities Mission, India: Localizing Sustainable Development Goals | UN-Habitat, n.d.)

Economic resilience has emerged as another important dimension of smart city development. Recent studies suggest that innovation ecosystems, digital entrepreneurship, public private partnerships, and technology enabled business environments strengthen urban competitiveness while generating employment opportunities and improving productivity (Kesar & Ache, 2024).

Citizen participation and collaborative governance have emerged as essential determinant of successful smart city implementation. Contemporary literature emphasize that smart cities should prioritize participatory planning, stakeholder engagement, transparency, and co creation rather than relying exclusively on technological infrastructure. Indian smart city projects

increasingly recognize the importance of involving local communities, private organizations throughout planning and implementations. Such collaborative governance models improve accountability, strengthen public trust, and ensure that smart city investments respond effectively to local socio-economic needs (Kesar & Ache, 2024).

Comparative analyses demonstrate that cities such as Singapore, Barcelona, Amsterdam, and Copenhagen have successfully combines digital innovation with participatory governance, environmental sustainability, and institutional collaboration. Researchers recommend that India strengthen data governance frameworks, encourage citizen centric innovation, expand public private partnerships, and improve interdepartmental coordination to enhance the long-term sustainability and resilience of smart city initiative. Such measures would accelerate India's progress toward achieving SDG11 while promoting inclusive and sustainable urban development (Kesar & Ache, 2024).

Thirdly the Smart Cities Mission is a step in the right direction towards sustainable urbanization through policies that are inclusive, technological innovation and strong governance systems. Adaptive policy frameworks and participatory governance models are areas of future research that help develop equitable urban expansion in India. The process of urbanization in India is picking up speed. Urbanization affects economic growth and cultural exchanges. It also creates challenges related to the environment and infrastructure (Bansal and Jain, 2020).

1.3 Advantages of Smart Cities: Perspectives on Urban Transformation in India

India's smart city initiatives have introduced noticeable improvements in the way many urban areas function, particularly in promoting sustainable and efficient living. One of the most visible changes is the stronger focus on public safety. Many cities have adopted advanced monitoring systems, improved emergency response services, and intelligent traffic management solutions that help reduce congestion and improve mobility.

Resource management has also become more efficient. Digital monitoring allows authorities to identify water leakage more quickly, reducing unnecessary wastage. Waste collection has become better organized through technology enabled scheduling, resulting in cleaner public spaces. In addition, several cities are increasing the use of renewable energy in public infrastructure, which supports environmental sustainability while helping lower operational costs.

Daily travel has also become more convenient for residents. Improved public transport systems, smarter traffic signals, and integrated mobility solutions have made commuting more predictable and less time consuming. Together, these developments demonstrate how smart city initiative are gradually improving urban services while supporting the broader goal of creating cleaner, safer, and more sustainable cities.

Table 1: Key Statistical Outcomes of India's Smart Cities Mission

Category	Metric	Value
Public Safety & Security	CCTV Surveillance Cameras Installed	83,000+
Public Safety & Security	Emergency Call Boxes Installed	1,884
Public Safety & Security	Public Address Systems Installed	3,000
Water Supply	Water Supply System Monitored via SCADA (km)	9,900+
Solid Waste Management	RFID-Enabled Vehicles for Waste Management	4,400
Streetlights	Solar/LED Streetlights Installed	52 Lakh+
Streetlights	Underground Electricity Cabling (km)	86,000+
Mobility	Smart Roads Constructed/Improved (km)	4,700+
Mobility	Cycle Tracks Developed (km)	580
Affordable Housing	Dwelling Units Constructed	49,300
Affordable Housing	Community Housing Rooms Constructed	1,562
Public Spaces	Parks/Green Spaces/Promenades Developed	1,300+
Education	Smart Classrooms Developed	7,654
Education	Digital Libraries Developed	40
Health	E-Health Centers/Clinics Developed	172
Health	Health ATMs Installed	155
Economic Hubs	Incubation/Skill Development Centers Developed	21
Economic Hubs	Market Redevelopment Projects Completed	56+
PPP Projects	PPP Projects Developed/Developing	199
PPP Projects	PPP Project Value (₹ Crore)	9,200
ICCC's	Smart Cities with Operational ICCC's	100

Table 1: The key findings of India's smart cities mission India's smart cities mission has truly moved the needle in a number of areas public safety, infrastructure, mobility, housing, education, health and economic growth. There are over 83,000 CTV cameras watching city streets and nearly 1,900 emergency call points so people can get help faster. Supervisory Control and Data Acquisition (SCADA) systems are being used to carefully monitor water networks that span close to 10,000km. Workers have laid down an astonishing 86,000km of

underground electricity cables. Sustainability is not getting left behind. Approximately 5.2 million solar and LED street lights that make the streets brighter and greener. Cities have 580 kilometers of new cycle lanes to tempt people out of their cars, 49,300 new housing units are up and running. Over 1,300 green spaces give people more breathing room. Smart classrooms and digital health centers are catching up with over 7,600 smart classrooms and 172 digital health centers.

Around 21 supporting jobs and startups have opened incubation centers and market improvement programs. With almost 200 projects, public private partnership projects worth 9.2 billion rupees are transforming the landscape with private companies also jumping in. And behind the scenes, all 100 smart cities currently have an integrated command and control center, helping city governments actually use data to run things better. It all helps bring technology into everyday life, make cities cleaner, more sustainable and better place to live in. Easier to get things done online and to resolve complaints with new digital services. The public is encouraged to participate so that they have more say in how their city grows. Waste is handled more smartly, energy is greener with renewables and LED lights, water and sewer systems are far more efficient. Smart parking, better transit, real time traffic management, less headache for traffic.

The economy is gaining momentum, and new trade hubs and skill development initiatives are helping people to get jobs and start businesses. Telemedicine is one of the examples of tools that enable people to access treatment in more ways without waiting in long lines in healthcare. The mission is responding to the needs of a fast-changing urban India, creating cities that are not just smarter but fairer and more livable.

States like Uttar Pradesh have the highest number of nominations, leading the way, an indicator of their focus on urban development, while less urbanized state like Chhattisgarh have fewer cities in the mix. The aim is to balance the progress so that all the urban areas, big or small, enjoy the advantages of better infrastructure and technology.

Table 2: Nominated Cities Under India's Smart Cities Mission

State/UT	Count	Cities
Uttar Pradesh	13	Agra, Aligarh, Bareilly, Gorakhpur, Jhansi, Kanpur, Lucknow, Meerut, Moradabad, Prayagraj, Rampur, Raebareli, Saharanpur, Varanasi

Tamil Nadu	12	Chennai, Coimbatore, Dindigul, Erode, Madurai, Salem, Thanjavur, Thoothukudi, Tiruchirappalli, Tirunelveli, Tiruppur, Vellore
Maharashtra	8	Amravati, Aurangabad, Kalyan-Dombivali, Nagpur, Nashik, Pune, Solapur, Thane
Karnataka	7	Belagavi, Bengaluru, Davanagere, Hubballi-Dharwad, Mangaluru, Shimoga, Tumakuru
Madhya Pradesh	7	Indore, Jabalpur, Bhopal, Gwalior, Sagar, Satna, Ujjain
Gujarat	6	Ahmedabad, Dahod, Gandhinagar, Rajkot, Surat, Vadodara
Andhra Pradesh	4	Amaravati, Kakinada, Tirupati, Visakhapatnam
Bihar	4	Bhagalpur, Biharsharif, Muzaffarpur, Patna
Rajasthan	4	Ajmer, Jaipur, Kota, Udaipur
Chhattisgarh	3	Bilaspur, Naya Raipur, Raipur

1.4 Overview of Smart City Mission and Key Technologies

The government launched the smart cities mission in 2015 to improve city life in India. The ambition is high to improve the live ability of cities through sustainable growth and better resources and equal chance for all. That means building new infrastructure creating new jobs. Protecting the environment and encouraging people to actually get involved in their communities. Today, cities have internet of things (IoT), digital dashboards and cloud systems that allow leaders to respond quickly and stay on top of what's happening on the ground. Services are moving online E- government portals and mobile apps. Getting a permit or paying bills, which is now much easier than it used to be. Transportation is also slowly getting better in the city. With real time tracking and data tools, cities can manage traffic lights, run buses and trains more smoothly and solve parking issues. More intelligent power grids, modern waste systems and new ways to deal with trash mean less waste and a lighter touch on the environment. Getting a leg up on safety too, city teams use high tech cameras and control centers to

1.5 Implementation Challenges and Best Practices

Building smart cities in India goes way beyond dropping in fancy gadgets and calling it progress. People have plenty of concerns data privacy, cybersecurity, and whether anyone's actually prepared to use all these new systems. Upgrading old infrastructure costs a fortune and

demands serious know-how. And, a lot of communities are always scrambling for funds, so the money just never stretches as far as everyone hopes.

Still, there's real hope. Cities like Surat and Pune did something different they pulled people in early, really listened, and made decisions that actually matched what locals needed. It wasn't just about flashy projects or ticking off checkboxes. Data plays a huge role, too. When cities actually use it right, they make smarter choices about budget, about where to fix things, about everyday stuff that really matters. Take a step outside India and you'll see cities like Singapore and Barcelona nailing it by teaming up with private companies, focusing on honest leadership, and choosing tech that can grow along with the city.

What's it going to take for Indian smart cities to really work. Real teamwork, building up skilled people, and keeping everything out in the open. It needs a plan that leans into technology but also makes sure no one falls by the wayside, no matter where they're starting. In the end, that's the only way to get genuine progress here or anywhere else.

1.5 Smart Cities and Sustainable Development Goals (SDGS): A Pathway to Inclusive and Sustainable Urbanization

The smart cities mission in India demonstrates strong alignment with the objectives of the United Nation Sustainable development goal (SDG) 11, which seeks to develop inclusive, safe, resilient and sustainable cities. Through the integration of strategic urban planning, data driven governance, digital technologies, and sustainable infrastructure. These initiatives contribute to improving the quality of urban life by enhancing accessibility, promoting efficient governance, strengthening environmental conservation and fostering socio-economic inclusion. Consequently, the smart cities mission serves as an important policy framework for advancing sustainable urban development and creating resilient cities that improve the well being of present and future generations.

1.5.1 Alignment with SDG 11 and Beyond

This paper opens by first grounding its analysis in the requirements for economically efficient urbanization set forth in United Nations Sustainable Development Goal 11, clarifies that this goal's core focus is to reduce environmental impact and ensure equitable access to basic services for all people, then introduces three categories of specific projects launched under the smart city mission to implement this goal, next supplements the carbon reduction requirements of Sustainable Development Goal 13 and two types of corresponding implementation

pathways, and proceeds to touch on relevant directions for improving resource efficiency. Wastewater management facilities and waste management technology can achieve two objectives of Goal 6 (clean water and sanitation); benefiting from the use of these facilities, we will have less pollution in the atmosphere. Sustainable Development Goal 16 (Peace, Justice, and Strong Institutions) aligns with the Mission's efforts to engage the public, improve accountability, and ensure that decision making is done collaboratively through the use of digital governance. Smart cities use technology to enhance public services, creating the foundation for future economic growth. This view applies to Goal 9 (Industry, Innovation, and Infrastructure).

1.5.2 Benefits to the Public

- Smart cities enhance quality of life for residents through the implementation of technologies such as public transportation, healthcare, and waste management.
- Through the deployment of Health ATMs and telemedicine services in cities like Bhopal and Surat, access to healthcare has improved for low-income communities.
- Additionally, smart cities facilitate the growth of entrepreneurs through the creation of talent development hubs, incubators, and facilitating business growth. For example, projects that focus on economic development have created great opportunities for entrepreneurship in cities like Pune and Bhubaneswar.
- Environmental Sustainability: Sustainable construction methods, collecting rainwater, and installing solar lights will help the cities minimize their environmental impact. all of these measures also directly improve public health because they help to improve water and air quality while using fewer resources.
- Increased safety & security: Using CCTV, ICCV, & other security devices and tools will allow greater security for the community by monitoring conditions live & allowing for a quicker emergency response.
- To promote inclusive urban development, smart cities prioritize the inclusion of underserved populations by making essential services and infrastructure available to them. To foster social equity, affordable housing programs and common areas must be in place.

1.5.3 Challenges and the Way Forward

While a number of issues inhibit the Smart Cities Mission from reaching its full potential, digital divide issues, cybersecurity threats, and concerns about data privacy are some of the most challenging. In order to overcome these barriers, establishing strong data privacy legislation as well as increasing digital literacy will be essential. In addition, both public-private partnerships and innovative finance models will be critical to developing the required solutions that successfully integrate existing infrastructure with new technologies through the use of technical resources in purchase decisions and implementation processes.

1.5.4 Global Lessons and Best Practices

Smart urban developments have been an effective approach in the case of smart cities like Barcelona and Singapore, which have established themselves as global leaders in terms of smart urban innovation. The city of Barcelona demonstrates how active citizen participation, supported by a well-developed digital infrastructure and extensive internet of things applications, can improve urban governance and public service delivery. Its participatory approach illustrates the importance of involving residents in planning and decision making while using digital technologies to enhance the efficiency of city operations. Such practices highlight the role of inclusion governance in creating responsive and sustainable urban environments.

Similarly, Singapore offers a model of technology driven urban development through its integrated planning framework, effective governance, and efficient management of public infrastructure. The country's emphasis on data informed decision-making long term urban planning contributing to high standards of urban sustainability and service delivery. These experiences provide relevant lessons that can inform the implementation of smart city initiatives in India.

Adapting appropriate practices from Barcelona and Singapore, while considering India's diverse socio- economic and institutional context, can improve the scalability, inclusiveness and long-term sustainability of smart city project. In this regard, the smart cities mission serves as an important policy initiative for advancing the objectives of the sustainable development goals (SDGs), particularly SDG11, which focuses on developing inclusive, safe, resilient and sustainable cities. By promoting innovative technologies, integrated governance, and sustainable urban infrastructure, the mission seeks to address the complex challenges associated with rapid urbanization and improve the overall quality of urban life.

The provision of improved quality of life through enhanced public services, increased economic growth, and environmentally sustainable practices will help achieve the global Sustainable Development Goals through smart cities. For smart cities to achieve their full potential, they need to identify and address barriers to implementation, increase citizen participation, and learn from the experiences of other countries. The Smart Cities Mission is developing a strategy for creating resilient, inclusive, and sustainable urban ecosystems that will provide for all urban residents as India continues to rapidly urbanize.

1.5.5. Significant Points:

- Smart cities are linked to international goals such as SDG 11 to promote sustainable urbanization.
- The Sustainable Development Goals include minimizing waste, increasing the use of renewable energy, and improving water management.
- Improvements in public services, such as telemedicine and efficient transportation, enhance people's quality of life.
- The initiatives that promote skill development and entrepreneurship generate economic opportunities.
- Surveillance technology and integrated systems help improve public safety.
- Affordable housing and conveniently accessible infrastructure are fundamental to promoting diversity.
- The integration of legacy systems, data protection, and cybersecurity are areas that present challenges.
- India could learn a lot from global models like Singapore and Barcelona. To succeed, it is essential to involve citizens and base decisions on facts.
- Smart cities serve as a pathway to achieving inclusive, resilient, and sustainable urban development.

1.6 CONCLUSION

India's smart cities mission represents a transformative approach to urban development that aligns closely with the objectives of the sustainable development goals (SDGs), particularly those related to inclusive, resilient, and sustainable cities. By integrating digital technologies, data driven governance, and citizen centric planning into urban management. Initiative involving intelligent transportation systems, smart energy management, digital public services, and water conservation illustrate how technological innovation can improve urban efficiency while supporting economic development and environmental sustainability.

Despite these achievements, the long-term success of the mission depends on overcoming several structural and institutional challenges. Concerns related to data privacy, cybersecurity, and disparities in technological access continue to influence the effectiveness and scalability of smart city initiatives. Addressing these issues requires robust regulatory frameworks, integrated governance mechanisms and continuous investment in institutional and technological capacities. Furthermore, internationally recognized smart cities, including Barcelona and Singapore, demonstrated the importance of adaptive governance, integrated digital infrastructure, and active citizen participation in creating resilient and people centered urban ecosystems.

The smart cities mission has the potential to redefine India's urban development trajectory by fostering cities that are not only technologically advanced but also socially inclusive, environmental responsible and economically competitive. Achieving this vision will require stronger collaboration among government agencies, private sector stakeholders, and local communities to ensure that technological innovation is accompanied by equitable access and public accountability. By strengthening participatory governance, promoting sustainable resource management and prioritize inclusive urban planning, India can establish a scalable model of smart urbanization that contributes meaningfully to sustainable development while enhancing the quality of life for present and future generations.

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