AI: The Brain-Powering Smart Cities

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Abstract

Artificial Intelligence (AI) describes systems that can replicate human thought processes, including learning, reasoning, and making decisions. These abilities are driven by sophisticated algorithms, data analysis, and the recognition of patterns. The development of AI has been sometimes compared to the invention of electricity since it has as diverse applications as the usage of electricity. It can be used across multiple sectors of the economy including agriculture, healthcare, manufacturing, urban transport, disaster management, education, policy making, cyber-security, governance, energy solutions, and supply chain management. Artificial intelligence enhances predictive analytics, enabling improved planning and immediate interaction with citizens, contributing to more inclusive governance. It can also boost the operational efficiency of managing large systems. In India, the AI-enabled digital public-infrastructure platforms like Aadhaar, Digiyatra, UPI, and DigiLocker have revolutionised governance. This paper explores the various initiatives adopted by the state governments in India to use AI technology to develop and transform Indian cities into smart cities. The paper also seeks to examine the opportunities that AI offers as well as the challenges that the governments must address for successful integration of AI into the designing of these cities. The government needs to play the balancing act between innovation and ethical concerns.

Keywords: *Artificial intelligence, Smart cities index, Smart cities mission, Technology, Data security, Ethics*

Introduction

Artificial Intelligence (AI) describes systems that can replicate human thought processes, including learning, reasoning, and making decisions. These abilities are driven by sophisticated algorithms, data analysis, and the recognition of patterns. The development of AI has been sometimes compared to the invention of electricity since it has as diverse applications as the usage of electricity. It can be used across multiple sectors of the economy including agriculture, healthcare, manufacturing, urban transport, disaster management, education, policy making, cyber-security, governance, energy solutions, and supply chain management (Karger et al., 2025, Gracias et al., 2023). Artificial intelligence enhances predictive analytics, enabling improved planning and immediate interaction with citizens, contributing to more inclusive governance. It can also boost the operational efficiency of managing large systems. One of the biggest impacts of AI has been on the very cities we live in, transforming them into Smart Cities as well (Ahad et al., 2020). India has become the most populous country in the world with a population of 1.46 billion people. As per the 2011 Census, only 31.16% of the total population resides in urban areas but in absolute terms, it is 377 million urban dwellers. This means that there is going to be tremendous pressure on limited resources in the cities. This will further exacerbate problems like pollution, traffic congestion, and parking spaces. With the increasing population in urban areas, it is essential for cities to adapt to this growth by utilising their infrastructure and resources more effectively. Converting a city to a smart city can address this need by enabling cities to extract additional benefits from their current infrastructure (Wolniak & Stecuła, 2024, Kaur et al., 2023). Investing in Smart City upgrades will not only bring in fresh sources of income but also enhance operational effectiveness thereby leading to cost-savings.

At present there is a lack of comprehensive documentation on how AI is being used currently in India's smart cities. Sufficient analysis of success stories in various Indian cities is also not available. There is no framework yet to assess the readiness of Tier-II and Tier-III cities for compliance with AI-models. This paper attempts to analyse the interconnections between AI and Smart Cities and how AI can be applied to improve everyday life in cities. The paper also deals with the role of AI in shaping the core components of Smart City. It discusses

the Smart Cities Index 2025 and the adoption of AI in Smart Cities across the world. It further explores India's Smart City Mission and the various initiatives adopted by the state governments in India to integrate AI technology to develop and transform Indian cities into Smart Cities. The paper also identifies the challenges that governments need to address for successful integration of AI into the designing of these cities.

The concept of Smart Cities has undergone a significant transformation, over the years, evolving from rudimentary applications of technology to complex, integrated systems that aim to address a wide array of urban challenges (Faliagka et al., 2024). Initially referred to as "digital cities," these urban centers have progressively embraced information and communication technology to enhance various aspects of city life. There have been three waves of Smart Cities so far. In Smart City 1.0, the technology-providers implemented new technology in cities, even though the local government did not fully grasp the potential impacts of the technology or its influence on daily life (Tijjani et al., 2024). On the other hand, in Smart City 2.0, the cities themselves took the initiative with visionary leaders shaping the city's future and strategising the deployment of smart technologies and other advancements. In Smart City 3.0, the centre stage is held by a citizen-centric model. Vienna has adopted this innovative, third-phase approach. In Vienna, a collaboration has been established between the citizens and an energy firm. With this partnership, residents have been involved as investors in the local solar facilities (Skelton, 2024). The citizens have also been involved in addressing concerns like gender-equality and accessible housing. This phase is focused on infrastructure and efficiency, with projects centered on intelligent transportation systems, smart grids, and connected public services, demonstrating a commitment to digitalisation by fostering collaboration among stakeholders in both physical and digital realms (Tijjani et al., 2024). In our analysis of the literature, we found that no study has been done to look at the gains of India's Smart Cities' mission or where Indian cities stand in comparison to other smart cities across the world. Through this paper, there has been an attempt to address this research gap.

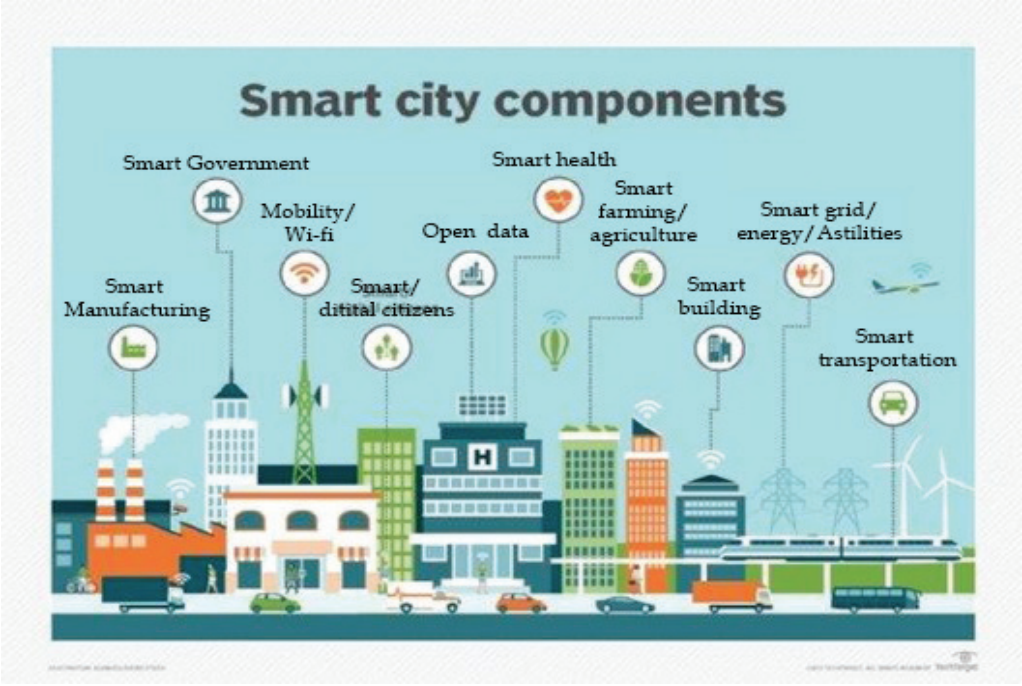
Smart Cities

A 'Smart City' is a community that employs information and communication technology to enhance its operational efficiency, disseminate information to the

public, and elevate the quality of government services and the well-being of its citizens. Figure 1 captures the various components of a Smart City, which includes Smart Manufacturing, Smart Health, Smart Grid or Utilities, Smart Transportation, Smart Government, Open Data, and Smart Citizens. (Peralta et al., 2022). AI plays a crucial role in converting a regular city into a Smart City.

Figure 1

Components of a Smart City



Source: Techtarget

Functioning of a Smart City Using AI Technology

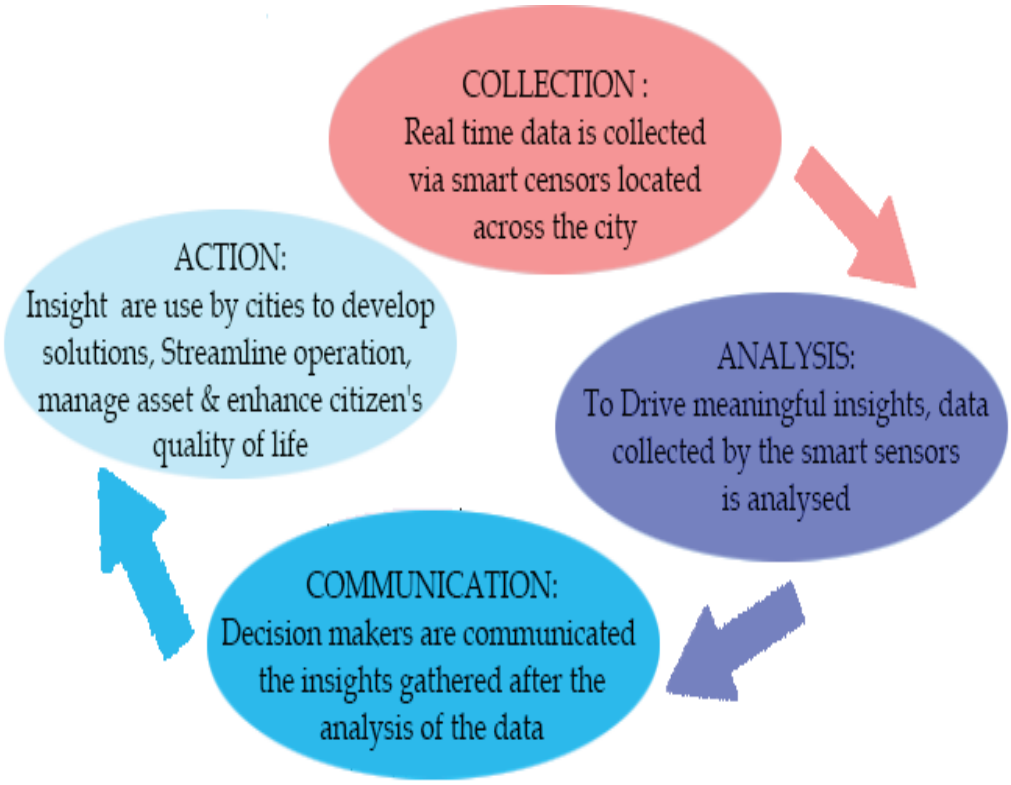
Any aspect of urban management can be included in a Smart City project. The common ones are:

Traffic Management: All urban areas struggle with increasing traffic, congestion, and carbon emissions. AI enables real-time traffic analysis to anticipate traffic patterns through the Intelligent Traffic Management Systems

(ITMS) leading to improved traffic flows, reduced bottlenecks, more efficient public transport systems and better safety (Tahmasseby, 2022). For instance, the 'Waymo' autonomous (driverless/ self-driving) taxis in the US cities of San Francisco, Los Angeles, and Austin. These smart cabs are expected to reduce demand for owned vehicles, congestion on the road as well as vehicular emissions.

Figure 2

How a Smart City Works Using AI Technology



Maintaining Public Infrastructure: AI can be used for detecting the deteriorating public infrastructure and alert authorities when repairs are required. Smart citizens can assist by alerting authorities via a Smart City app

when buildings, roads, and clogged drains leading to water logging or leaking water pipes need repair and maintenance. Thus, the AI can play a huge role in assisting in cost-effective and timely repairs.

Efficient Resource Use: Buses in cities can be fitted with sensors, which will provide data helpful in route-planning. This data can then be used to reduce underused routes and ease the overloaded ones. The same may also assist drivers in locating vacant parking spots using smart parking metres. Smart metres also facilitate digital-payment options. Another area where AI can be extremely helpful is to prevent wastage of precious water resources. Many cities across the world have hit 'Day Zero' due to indiscriminate exploitation of the groundwater. By identifying leakages in the water system, AI can prove to be a boon in ensuring conservation and effective use of water resources. Similarly, AI can be used to detect theft of electricity or leakages in the grid and help conserve electricity by preventing misuse.

Energy Efficiency: Smart cities require uninterrupted power supply for things to work smoothly and efficiently. Hence energy efficiency and conservation become crucial elements. How often have we seen streetlights on, during the day, while we struggle with power outages on the other? Smart sensors can detect when there are no vehicles or pedestrians on the road and use this data to turn the streetlights off (Farzaneh et al., 2021). With increasing availability of renewable energy, smart grid technology can incorporate it into the primary grid, supervise power failures, deliver electricity when needed, and improve planning, operations, and maintenance (Makumbe & Makusha, 2025).

Maintaining Law and Order: AI backed CCTVs can help in monitoring high-crime areas using face recognition technology (Al-Shaikh et al., 2024). This will contribute to increasing public safety (Hemalatha et al., 2025). Gunshot detection and location systems are in place in certain US cities, helping police apprehend criminals, in a short span of time.

Disaster Management: Smart sensors can be an essential part of a system that provides early warnings prior to cyclones, floods, landslides, or droughts.

Waste Management: According to the Ministry of Housing and Urban Affairs, India generates 62 million tons (MT) of municipal solid waste (MSW) every year, and by 2030, it is expected to reach 165 MT. Only 22% to 28% of this waste is treated. One of the biggest problems encountered in treating waste is the

segregation of mixed waste, also called Municipal Solid Waste. MSW comprises commercial and household waste and may contain paper, textiles, food scraps and plastics, which are difficult to segregate (earth5r.org). Therefore, the untreated waste ends up in either landfills or open dumps causing significant land, water, and air pollution. AI to the rescue! Robots can be used for waste segregation. This process will reduce landfills and make waste management much easier to monitor. Smart bins will indicate when bins need to be emptied and hence optimise waste collection routes.

Smart Buildings/Homes: Smart homes and smart buildings are a part of smart cities and comprise the use of many smart AI driven gadgets like robotic assistants, smart refrigerators, smart windows, smart TVs, smart lighting, smart security systems, smart heating/cooling, and smart air quality monitors.

Smart Manufacturing: The 4th Industrial Revolution is underway and is led by Smart Manufacturing. Innovative digital technologies are driving a fresh era of manufacturing advancement. "Smart factories" utilise industrial machinery that interacts with users, other devices, automated procedures, and systems to enable instant communication between the factory and the market for flexibility and enhanced productivity. These smart factories offer various advantages including enhanced operational efficiency, mass customisation, product excellence, sustainability, and safety, as well as reduced expenses (Ghahramani et al., 2020, Lila, 2021).

AI for Smart Health: AI can be used to monitor and analyse large volumes of data which can help in early detection of health issues and disease patterns (Antony, 2018, Xie et al., 2021). Smart wearable devices help in constant monitoring of the health of people and can provide useful insights for preventive measures. Robotic surgeries are already being carried out in hospitals across the globe.

Smart Cities Around the World : Based on IMD's Smart Cities Report 2025, published by the World Competitiveness Centre, Table 1 displays the top 10 smart cities across the globe out of a ranking of 146 countries. The criterion for the ranking is based on how infrastructure and urban technologies perform in the areas of governance, mobility, health and safety, opportunities, and activities.

Table 1

Smart City Ranking 2025 and comparison with 2024

City	Smart City Rank 2025	Smart City Rating 2025	Smart City Rank 2024	Change
Zurich	1	AAA	1	-
Oslo	2	AAA	2	-
Geneva	3	AAA	4	+1
Dubai	4	A	12	+8
Abu Dhabi	5	A	10	+5
London	6	AA	8	+2
Copenhagen	7	AAA	6	-1
Canberra	8	AAA	3	-5
Singapore	9	AAA	5	-4
Lausanne	10	AAA	7	-3

Source: IMD Smart City Index 2025

Zurich has put in place digital security, a smart building management system that links the city's heating, power and cooling systems, circular waste management, and energy efficiency. London is one of the smartest cities in the world. They have a 5G network which generates extensive real-time data crucial for traffic surveillance, law enforcement, and policing. A wide array of sensors, cameras, drones, and robots contribute to maintaining urban safety. A plan for repurposing excess heat from the Metro system to fulfill 38% of the city's heating requirements is a significant initiative. The city aims to reach net zero-emissions by 2030. Singapore has reduced waiting time for necessary public services. There is greater security in public areas. Nearly all administrative paperwork and procedures can be completed online, and citizens can access information from any location. Sensors and IoT-equipped cameras are employed to oversee the tidiness of public areas, crowd levels, and the traffic of registered cars. The city's advanced technologies aid citizens in tracking energy consumption, waste generation, and water usage in real-time. Singapore is also experimenting with self-driving vehicles, such as large robotic buses, and a health surveillance

system to ensure the welfare of its elderly population.

In Dubai, the Smart City technology plays a role in managing traffic flow, parking, urban development, and transportation. The city also implements intelligent solutions in healthcare, buildings, utilities, education, and tourism. In Oslo, Norway, effective waste management, energy conservation, traffic congestion alleviation, eco-design (circular economy: reuse, recycle, and reduce), and efficient architecture have all been applied. Whereas in Amsterdam more than 170 distinct operations, including solar-powered bus stops, billboards, lights, and smart metres, are part of the 2009-launched Amsterdam Smart City initiative. Dallas, Texas is a city in an arid region which receives little rainfall, making water a precious resource. Using smart devices to detect any leakages in the water supply system and fix them quickly helps Dallas prevent many gallons of water lost each year. A total of 1.7 trillion gallons of water were being lost each year in the U.S. due to water leaks. Seattle is a city flanked by water on one side and mountains on the other, having a space constraint. They have used smart monitoring for solving parking issues, homelessness data monitoring, early warning systems for earthquakes, assessing damages after an earthquake, and in New York City sensors have been installed to manage city services like waste management and public safety.

India's Smart Cities Mission

On June 25, 2015 the Honourable Prime Minister of India launched the Smart Cities Mission (SCM). By employing "smart solutions," the main aim of the mission is to assist communities in providing their inhabitants with a decent quality of life, environmentally friendly and enduring surroundings, and necessary infrastructure. By focusing on the physical, institutional, social, and economic aspects of the city, SCM aims to boost economic development and improve the standard of living of the people. In the first phase of the mission, one hundred cities were chosen to become Smart Cities. These Smart Cities can then become role models and help other cities by hand holding them and work towards equitable and sustainable development. Given below (Figure 3) are the six pillars of the mission. Figure 4 displays the progress of India's Smart Cities Mission, as on February, 2025.

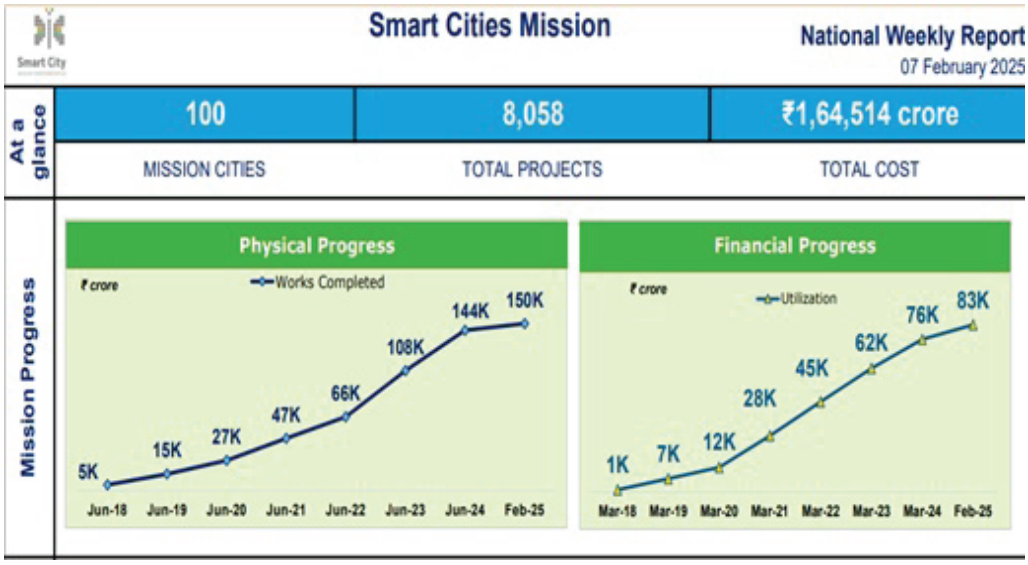
Figure 3

The Six Pillars of the Smart Cities Mission

Source: Smartcities.gov.in

Figure 4

Progress of India's Smart Cities Mission, 2018-25



Source: Smartcities.gov.in

In India, the AI-enabled digital public infrastructure platforms, like Aadhaar, UPI, Digiyatra, and DigiLocker have revolutionised governance. Those of us

who have used Digiyatra for domestic travel can vouch for the ease it brings to travel. Through face recognition, it enables visitors to move quickly through entry points without having to stand in multiple queues at multiple points, speeding up the entire process and minimizing the time required from entry at the airport to boarding the aircraft.

In 2023, the U.P government declared that it will develop Lucknow as the country's first AI city. The Karnataka government plans to use AI for identifying defaulters. AI-powered data analysis from Safe City cameras and BBMP *(Bruhat Bengaluru Mahanagara Palike)* vehicle surveillance will be used to detect illegal constructions, potholes, water stagnation points, garbage accumulation, unauthorised advertisements, and pedestrian encroachments.

Surat Smart City Development Limited caters to various departments which are involved in the management of the city traffic, fire and emergency services, incubation centres for innovation and trade facilitation, SUMAN eye (CCTV network) to cover bus stops, public parks, water works, water logging spots, and infrastructure construction sites.

The U.P. government, used AI based predictive-policing for crowd management during the Mahakumbh Mela in 2024. The Mahakumbh Mela, 2025, a major Hindu festival celebrated once every 12 years, signifying spiritual liberation was held this year from 13 January to 26 February in Prayagraj, Uttar Pradesh. It saw a footfall of 66 crore pilgrims in 45 days. These humungous crowds were managed with great dexterity by the government by using a digital command centre and drones, relying on the power of AI. More than 2750 CCTV cameras backed by AI tracked the crowd movements using facial recognition, traffic movement and vehicle number plate recognition. Under-water drones were deployed as well for aquatic surveillance.

Some of the shopping malls in Delhi, the capital city of India, have implemented 'Smart Parking Management Systems. These sensors detect whether a parking spot is free or taken and indicate at the entrance to the parking, how many slots are available or whether the parking is full. If mapped to an app, the car owners will be able to make the booking of the car parking on the app for the desired amount of time. If they are exceeding the time for which the slot is booked, the app will notify them (Asha et al., 2023; Sehar, 2023). Inside the parking area,

each parking slot is fitted with a light bulb and a sensor. Once the car occupies a parking space, the sensors send a signal to the light bulb to turn red. When the car leaves a parking slot, the light turns green. Thus, car owners need not waste time or fuel in locating a vacant parking slot or going in circles. They can simply locate a green light from far away and reach the vacant parking space. However, this system is not yet fully digitised as it has not been mapped to an app and the payment is also not online.

Challenges of Smart Cities

High Costs: The costs of moving to digitised networks may be significant in the initial stages though in the long term, the improved efficiency, reduced turnaround time, energy consumption and greater revenues will more than compensate for the higher initial costs. Figure 5 shows some of the global mega cities' population and the spending distribution of global Smart City initiatives in 2020. As we can see, Delhi tops the list of mega cities at number 3 in terms of the population but is not visible in the pie chart on the right signifying the low spending on smart city initiatives relative to the other countries.

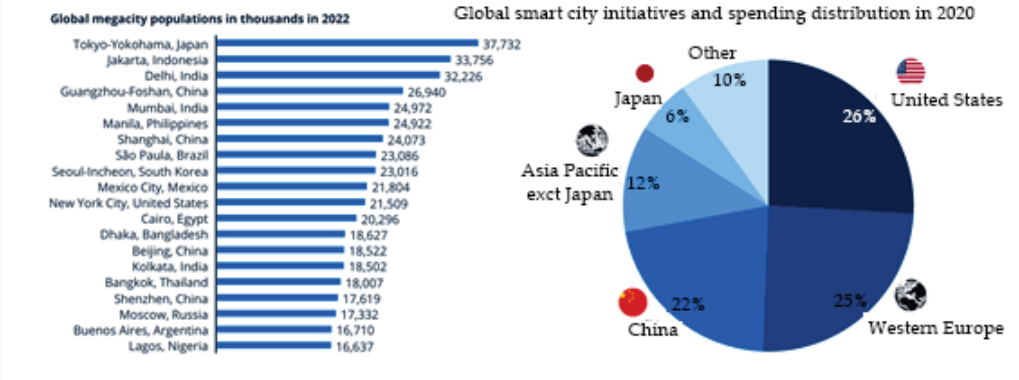
Data Security Issues: Security of data is of utmost importance in such a set up. Due to the fact that a significant portion of a city's essential infrastructure will be linked to the internet, it will be vulnerable to cyber-attacks (Szpilko et al., 2023). If not adequately protected, there is a risk that information may be stolen, operations halted by ransomware, machinery could be harmed, or individuals may be endangered, if crucial services are disrupted. The data gathered in Smart Cities must be made anonymous and should not include any personal details.

Accuracy of Data: Managing information is a vital component of any AI initiative. Data has to be cleaned and data accuracy is of utmost importance. There is a need to update statistics continuously due to changing regulations and the dynamic nature of information management in the public sector (Shoaib & Shamsi, 2019).

Connectivity Issues: The primary obstacle confronting smart cities is connectivity. The numerous IoT gadgets spread throughout the urban area would serve no purpose without a stable connection, leading to the demise of the Smart City itself (Haque et al., 2022).

Figure 5

Comparison of Global Megacities with respect to their populations and their spending on Smart City Initiatives in 2020



Source: Statista

Fostering Collaboration

Fostering a connection and partnership between the public and private sector and the citizens is key to the success of a Smart City. This bond is crucial as a significant portion of the efforts to establish and sustain a digital, data-focused setting take place, beyond government-involvement. For instance, the surveillance system for streets may incorporate sensors from one company, cameras from a different one, and a server from yet another, with the information being relayed to the government agency for further action. Therefore, establishing such platforms for such collaborations to thrive is crucial.

Conclusion

AI has the potential to improve productivity while rendering many jobs obsolete. India with its large workforce needs to skill and train the youth in emerging areas of AI. If we fail to prioritise this, we run the risk of not only suffering huge unemployment but also not reaping the 'once in a lifetime opportunity' of the demographic dividend.

If the gap between the haves' and the have-nots' is not bridged using health

and education, AI shall further exacerbate the inequalities plaguing the Indian economy. Those who have access to AI will be in a commanding position and can lead to further concentration of resources in a few hands, if not managed appropriately (Alseqyani, et al., 2025). Thus, the role of the state becomes paramount in balancing innovation and ethical issues, technological progress and unemployment, inequalities that AI may generate and the opportunities that it provides. The way forward, calls for a collaborative and strategic approach. The governments must prioritise the creation of reliable and strong data systems, invest in digital infrastructure, and promote AI literacy across all levels of governance. Policy frameworks must ensure that AI is used ethically, transparently, and inclusively. The government should also invest in private-sector innovation and academic research to build indigenous AI solutions, suiting the needs of that city, since, AI is not just building smart cities, rather it is shaping the future of our living.

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