Drivers Making Smart Cities More Sustainable: Comparative Analysis of Smart Cities of Uttar Pradesh

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Abstract

This comparative analysis explores the drivers that are making smart cities in Uttar Pradesh, India, more sustainable. The concept of smart cities aims to leverage technology and innovative approaches to create sustainable and inclusive urban environments. Uttar Pradesh, one of the largest states in India, has been actively pursuing the development of smart cities to address the challenges of rapid urbanization. This study examines the key drivers that contribute to the sustainability of smart cities in Uttar Pradesh and compares their approaches to urban development. By analyzing the strategies, policies, and initiatives implemented in these cities, valuable insights can be gained to enhance their sustainability and guide future smart city projects in the region. The findings of this study will provide a comprehensive understanding of the factors influencing the sustainability of smart cities in Uttar Pradesh and contribute to the ongoing efforts to create more environmentally friendly and resilient urban areas.

Keywords: Smart cities, Sustainability, Urban development, Uttar Pradesh, Comparative analysis.

Introduction

With the rapid pace of urbanization and the increasing challenges faced by cities, the concept of smart cities has gained significant prominence worldwide. Smart cities aim to harness technology, data, and innovation to create sustainable and inclusive urban environments that improve the quality of life for their residents. In India, the government's Smart Cities Mission has propelled the development of smart cities across the country, including the state of Uttar Pradesh.

Uttar Pradesh, located in northern India, is one of the largest states in terms of population and land area. With its bustling cities and growing urbanization, the state faces numerous challenges related to infrastructure, transportation, energy, and waste management. In response to these challenges, several cities in Uttar Pradesh have embarked on the journey to transform themselves into smart cities, incorporating digital technologies and innovative solutions to improve urban services and sustainability.

In the age of automation, cities are undergoing significant transformations, evident in the multitude of projects implemented by countries in recent years, leading to the integration of technologies within urban environments. The implementation of smart city initiatives holds immense potential for enhancing government efficiency and enhancing the overall quality of life. By leveraging appropriate infrastructure and analytical solutions, smart city technologies have the capacity to create safer, more equitable, and highly livable communities. However, the progress of smart cities extends beyond mere efficiency improvements. They also serve as invaluable tools for economic development, attracting businesses and residents seeking flexible work opportunities. The concept of smart cities is garnering significant attention as a means to enhance urban performance and elevate the overall quality of life.

Nevertheless, despite its popularity, the concept of smart cities lacks a definitive definition and framework for determining its specific application areas. This ambiguity has led to extensive debates within the theoretical discourse of urban planning and social sciences, given the significant financial investments already allocated to smart city initiatives (Vanolo, 2016). The promise of smart cities lies in their potential to tackle the intricate complexities and challenges of urban environments, ultimately enhancing the quality of life and fostering the development of sustainable cities (Monfaredzadeh & Berardi, 2015).

This comparative analysis focuses on exploring the drivers that are making smart cities in Uttar Pradesh more sustainable. By examining the strategies, policies, and initiatives implemented in these cities, valuable insights can be gained to enhance their sustainability and guide future smart city projects in the region. Understanding the factors influencing the sustainability of smart cities in Uttar Pradesh is crucial for addressing the pressing environmental and socio-economic concerns and fostering a more livable and resilient urban environment.

The primary objective of this study is to provide a comprehensive analysis of the smart cities in Uttar Pradesh, with a particular emphasis on their sustainability aspects. By conducting a comparative analysis, we can identify common patterns, success factors, and potential areas for improvement. This research will contribute to the ongoing discourse on smart cities and sustainability, providing valuable insights into the strategies and approaches that can drive positive change in urban development.

Sustainable Cities

With over half of the global population residing in urban areas since 2007, cities have emerged as the primary living spaces for people. This trend is expected to continue, with estimates projecting that 70% of the world's population will be living in cities by 2050 (World Bank, 2018). The influential Brundtland report ignited a discourse surrounding critical themes of environment, development, and governance. Published in 1987, the report has since prompted extensive investigations within the academic community, exploring the concept of sustainability, economic and equity issues, as well as institutional, environmental, and urban concerns. The call for sustainable development represents a practical response to the challenges of our time, and the objectives outlined in the report enjoy widespread acceptance (Sneddon et al., 2002).

A precise definition has been formulated for sustainable cities, which should serve as the fundamental principle for all urban areas. According to this definition, sustainable cities are those that fulfill the developmental requirements of their inhabitants without placing unsustainable burdens on local or global natural resources and systems (UN, 2013 cited in Satterthwaite, 1992, p. 3). The UN report (2013, p. 54) further asserts that achieving these goals necessitates effective city governance capable of both realizing these benefits and adopting a sustainable framework that facilitates urban growth within ecological boundaries.

Since 2015, the United Nations has identified 17 interconnected Sustainable Development Goals (SDGs) that encompass a wide range of objectives. One of these goals, Sustainable Cities and Communities, sets specific targets to be achieved by 2030. These targets include ensuring access to affordable housing, developing sustainable transportation systems, and promoting resident participation and inclusion in the planning of sustainable cities.

Establishing a policy framework to foster the sustainable development of urban areas is essential for ensuring legitimacy and democratic governance. Crucially, engaging stakeholders and facilitating consultations is imperative because policies serve as the foundation for decision-making processes in various domains such as policy formulation, planning, and business. In an administrative system, politics plays a vital role in overseeing change and offering guidance or approaches to decision-makers (Solesbury, 2013).

In accordance with Dhingra and Chattopadhyay (2016), a smart and sustainable city aims to achieve its objectives in a flexible, reliable, scalable, accessible, and resilient manner. These objectives include: 1. Enhancing the quality of life for its residents. 2. Promoting economic growth and generating better employment opportunities. 3. Improving the well-being of citizens by ensuring access to social and community services. 4. Adopting an environmentally responsible and sustainable approach to urban development. 5. Ensuring efficient delivery of basic services and infrastructure, such as public transportation, water supply, drainage, telecommunication, and other utilities. 6. Addressing climate change and environmental challenges effectively. 7. Establishing an effective regulatory framework and local governance mechanism that promotes equitable policies.

Smart City Concept

The concept of smart cities has gained significant attention in recent years as urban areas seek innovative solutions to tackle the challenges of urbanization, resource scarcity, and environmental degradation. Sustainability has become a crucial aspect of smart city development, emphasizing the need for cities to adopt environmentally friendly practices, efficient resource management, and a high quality of life for their residents.

The emergence of terms like "smart city," "digital city," "information city," and "knowledge city" has become prominent in the realm of urban development and strategy. The concept of a smart city was first introduced as early as 1994, and with the support of smart city projects backed by the European Union, there has been a significant increase in publications on this topic since 2010 (Dameri & Cocchia, 2013). Presently, the term "smart city" has become a popular buzzword and a key component of the growing trend towards sustainable urban development. However, despite its widespread use, there remains a lack of clear and consistent understanding regarding its precise definition (Caragliu et al., 2011).

Smart city initiatives are being implemented with varying functions across different cities and countries. In many cases, these initiatives are targeted at specific districts within a city, aiming to enhance various aspects of urban life through the adoption of smart city solutions. These solutions may include the development of high-quality housing, the improvement of safety and security measures, the promotion of economic growth, and the provision of reliable water supply, among other areas of focus. Each city's smart city projects are tailored to address specific needs and challenges in their local context.

These strategies concentrate on revitalizing urban development policies within the current urban landscape. They encompass a range of policies aimed at compacting urban areas and intensifying land use, including initiatives such as the redevelopment of brownfields and the utilization of underutilized land (Van der Waals, 2000; Nefs, 2006).

Urban centers worldwide are increasingly seeking solutions to enhance transportation connectivity, foster mixed land use, and provide high-quality urban services that can yield long-term economic benefits. One crucial aspect of this endeavor is the establishment of efficient and superior public transportation systems that address economic demands and facilitate workforce mobility, thus playing a pivotal role in driving urban development.

The ASCIMER, 2017 report positions itself as a versatile tool that can be applied to projects in any city. Its primary objective is to evaluate and prioritize projects by considering the specific challenges faced by urban areas. However, the report emphasizes that the selection of the appropriate project alone is insufficient for achieving success in smart city initiatives. It acknowledges that the development of a smart city project is a complex and extended process in which effective management plays a crucial role. Understanding the involvement and influence of stakeholders at each stage of the project becomes paramount for accomplishing the desired goals.

Sustainability is a core principle guiding smart city development. It encompasses environmental, economic, and social dimensions, aiming to create cities that are resource-efficient, resilient, and socially inclusive. Sustainable smart cities focus on reducing carbon emissions, promoting renewable energy, efficient waste management, green infrastructure, and enhancing the quality of life for residents. The Triple Bottom Line (TBL) approach, which emphasizes the economic, environmental, and social aspects of sustainability, provides a theoretical framework for analyzing the sustainability of smart cities.

Smart City Concept in India

The Ministry of Urban Development (MoUD) released the "City Mission Statement and Mission Guidelines" on June 25, 2015, outlining the vision for Smart Cities and the strategic components of the mission. The primary objective of the smart city mission is to integrate economic growth with enhancing people's quality of life by fostering local development and leveraging technology to achieve tangible outcomes. The mission's strategic components include:

(a) Retrofitting: This involves upgrading and revitalizing existing areas to make them smarter and more efficient.

(b) Redevelopment: The focus is on transforming existing areas, including comprehensive slum development, to improve living conditions and the overall quality of life in cities.

(c) Green Field development: New areas are planned and developed around cities to accommodate the increasing urban population. These areas will serve as hubs for technology innovation, information highways, and the creation of data, enabling the application of smart solutions for residents and communities.

(d) Pan-city development: The mission emphasizes the need to expand the implementation of smart infrastructure and services across the entire city, ensuring that smart solutions benefit all residents and promote inclusive growth. This includes creating employment opportunities and improving income distribution, particularly for the underprivileged.

The primary objective of the smart city mission is to harmonize economic growth with enhancing the well-being of individuals by bolstering local development and leveraging technology, with a particular focus on achieving tangible outcomes. The mission aims to achieve this by implementing area-based development strategies that will revitalize existing areas through retrofitting and redevelopment initiatives. This includes comprehensive planning for slum development to uplift the quality of life and overall conditions throughout the city. Furthermore, the mission emphasizes the crucial role of connecting technology to concrete results, thereby ensuring that smart solutions effectively contribute to the city's progress.

To address the increasing urban population, it is essential to develop new areas (referred to as greenfield areas) surrounding cities. This development serves multiple purposes, including accommodating population growth, fostering technological innovation and convergence, establishing information highways, generating valuable data, and expanding infrastructure and services to facilitate the implementation of smart solutions for residents and communities in smart cities. Consequently, these endeavors will lead to an

improved quality of life for all citizens, create employment prospects, enhance income structures, particularly for marginalized and disadvantaged individuals, and ultimately foster inclusive cities that cater to the present and future needs of their inhabitants.

Objective of the study

The objective of this study is to explore and analyze the key drivers that are making smart cities in Uttar Pradesh, India, more sustainable. The study aims to examine the approaches to urban development implemented in these smart cities and identify the initiatives that contribute to their sustainability. By conducting this comparative analysis, the study seeks to provide valuable insights into the factors influencing the sustainability of smart cities in Uttar Pradesh. The objectives of the study include:

1. Investigating the key drivers and factors that contribute to the sustainability of smart cities in Uttar Pradesh.
2. Analyzing the strategies and initiatives related to area development, solid waste management, water supply, transportation, health and education, energy, and other relevant aspects of smart city development.
3. Identifying the impact and effectiveness of these sustainability measures in enhancing the overall quality of life, economic development, and environmental sustainability in smart cities.

Research Methodology

The comparative analysis of smart cities in Uttar Pradesh and their drivers for sustainability involve a systematic approach. First, to identify the smart cities in Uttar Pradesh that would be included in the analysis. These criteria may have considered factors such as the level of technological integration, urban development initiatives, sustainability goals, and availability of relevant data. The selection aimed to ensure a diverse representation of smart cities in terms of size, location, and development stage. Once the smart cities were identified, a comprehensive data collection process undertaken. This process has involved gathering both qualitative and quantitative data from secondary sources, such as government reports, academic literature, and publicly available data, have been utilized to collect information on the implementation of smart city initiatives, sustainability measures, and their impact on urban development.

The collected data have been analyzed using qualitative and quantitative techniques. Qualitative analysis has involved content analysis, and identification of key drivers and challenges in the sustainable development of smart cities. Quantitative analysis has included statistical analysis, comparative studies, and visualization of data to identify patterns and trends across the selected smart cities.

Instrumentation

This study is based on a comparative analysis of 5 smart cities of Uttar Pradesh: Lucknow, Kanpur Nagar, Prayagraj, Agra and Varanasi. Table 2 illustrates the 5 cities reflecting the population and phase wise selection of the city.

Table 1 Comparing 10 smart cities.

City	Population	Selection Round
Agra	1,585,704	Third
Aligarh	874,408	Fourth
Bareilly	903,668	Fifth
Jhansi	505693	Fourth
Kanpur	2,765,348	Third
Lucknow	2,817,105	Second
Moradabad	887,871	Fifth
Prayagraj	1,112,544	Fourth
Saharanpur	705478	Fifth
Varanasi	1,198,491	Third

Lucknow City

Lucknow has been chosen as one of the Smart Cities as part of the Ministry of Urban Development's 100 Smart City Mission. The Smart City initiatives in Lucknow primarily revolve around Area Development, which includes the establishment of Wi-Fi hotspots in parks, restoration of monuments, development of the Gomti riverfront, and the creation of open spaces. The city's strategic focus is centered around four key aspects: "Jeevant Lucknow" (livable), "Sugam Lucknow" (mobility), "Swachh Lucknow" (cleanliness), and "Samruddh Lucknow" (prosperity). These four dimensions are further divided into eight focal areas: economic development, healthcare and education, public safety and security, energy management, area development, IT connectivity and digitalization, water supply, solid waste management, and transportation.

Table 2 Lucknow City focus areas and smart initiatives.

Focus Area	Smart City Initiative	Impact
Energy	Electricity - Smart Metering	Reliability of power supply
	Solar Roof Top PV	Reduced dependence on and conservation of energy from conventional sources
	PNG network	Reduced dependence on and conservation of energy from conventional sources
	Electricity - Underground distribution cabling and relocation of transformers	Reliability of power supply
	Energy Efficient Street lighting	Improved living conditions for the urban poor
Area Development	Establishing of Wi-Fi Hotpots in Park	Preservation of ecosystems and open spaces
	Restoration of Lal Baradari	Boost to local identity and economy
	Establishing of Open Gym	Preservation of ecosystems and open spaces
	International Culture Heritage Centre Chattar Manzil	Boost to local identity and economy
	Conservation of Darshan Vilas Kothi	Boost to local identity and economy
	Conservation of Archeological Research Heritage Centre - Roshan Ud Dolah Kothi	Boost to local identity and economy
	Heritage Conversation Institute at Kothi Gulestaan e eram	Boost to local identity and economy
	Gomti River Front Development	Preservation of ecosystems and open spaces
	Office Building of Lucknow Municipal Corporation	Citizen friendly and cost-effective governance and public services
	Awadh Point Central recreational space - Begum Hajarat Mahal Park	Boost to local identity and economy
	Beautifications of parks Greens and Establishing of Open Gyms and Wifi hotspots	Preservation of ecosystems and open spaces

	Improvement, strengthening and repair work of internal roads of ABD area	Improved walkability
Economic Development	Value Capture Financing Tools for Smart City Development	Boost to local identity and economy
	City Branding	Boost to local identity and economy
IT Connectivity and Digitalization	Consulting Services for Municipal Tax and Fee Improvement	Citizen friendly and cost-effective governance and public services
	Consulting Services for Improvement in Advertisement Tax	Citizen friendly and cost-effective governance and public services
	Smart City Knowledge Management Centre	Improved safety and security of citizens, particularly vulnerable groups (women, children, and elders)
	Lucknow Smart City Management Sytem Portal	Citizen friendly and cost-effective governance and public services
	Construction of Lucknow Smart city Office and Central - Commandandcontrol Centre	Improved safety and security of citizens, particularly vulnerable groups (women, children, and elders)
Urban Transport/ Non-Motorised Transport and Walkability	public bike sharing	Reduced dependence on and conservation of energy from conventional sources
	One Lucknow unified smart mobility card	Transportation and mobility
	Variable message signs	Transportation and mobility
	Transformation of Kaiserbagh Bus Stand to Model Bud Stand	Transportation and mobility
	Integrated Traffic Management System	Transportation and mobility
Safety and Security	Smart City Surveillance System	Improved safety and security of citizens, particularly vulnerable groups (women, children, and elders)
Solid Waste Management/Water Supply/Sewerage and Septage	Refuse Compactor	Citizen friendly and cost-effective governance and public services
	Smart Grid - Waste Water treatment and reuse	Conservation and reuse of critical resources
	Solid Waste management - GPA and ICT for user charge collection, Smart Community bins, road cleaning equipments	Improved sanitation condition
	Road cleaning equipmentandPCTS Machine	Improved sanitation condition
	Assessment of Non-Revenue Water and Developing Strategy and Implementation Action Plan for Reduction	Assured water supply
	Improvement, strengthening and repair work of drains of internal roads of ABD area	Improved sanitation condition

	Procurement 100 no Dust Bins of 1100 Ltrs and 500 no. 100 ltrs	Citizen friendly and cost-effective governance and public services
	Setting up of STP 1.5 MLD at Hathi Park	Conservation and reuse of critical resources
	Dust Bin Procurement 1100Ltrs 100 nos. in ABD area	Improved sanitation condition
	Smart Grid - Waste Water treatment and reuse Phase 2	Assured water supply
Social Sectors Health and Education	Sanitation- Public community Toilets	Improved sanitation condition

Source: https://smartcities.gov.in

Kanpur City

Kanpur, the 11th most populous urban city in India and the largest urban agglomeration in Uttar Pradesh, has set a goal for its Smart City initiative. The aim is to transform Kanpur into an inclusive and thriving city that offers ample opportunities, efficient urban services, sustainable growth, and a healthy living environment, with a specific focus on the Ganga river, industries, and commerce. The strategic focus of the city revolves around five key points: "Sampann" for regional growth, "Sachal" for smart mobility, "Sakriya" for citizen services, "Satat" for sustainability, and "Swasth" for a clean environment. These five key points are further translated into seven focus areas: economic development, healthcare and education, energy management, area development, IT connectivity and digitalization, water supply, solid waste management, and transportation. Table 3 provides an overview of these seven focus areas and the impact of the smart city initiatives in Kanpur.

Table 3 Kanpur City focus areas and smart initiatives.

Focus Area	Smart City Initiative	Impact
Energy	Intelligent LED streetlights	Reduced dependence on and conservation of energy from conventional sources
	Underground wiring and strengthening of transformer	Reliability of power supply
	Intelligent Solar LED streetlights	Reduced dependence on and conservation of energy from conventional sources
Area Development	Ganga Riverfront Development	Boost to local identity and economy
	Develop Open Gym	Improved health and education services
	Beautification and Automation of Ghantaghar in front of Railway Station	Boost to local identity and economy
	Tree Plantation Tree Guard_Impact Project	Preservation of ecosystems and open spaces
Economic Development	Develop Naveen Market as non-vehicle streets	Improved walkability
IT Connectivity and Digitalization	Smart City Operation Centre	Citizen friendly and cost-effective governance and public services

	Smart Travel Card	Citizen friendly and cost-effective governance and public services
Urban Transport	Multi-level Car Parking	Transportation and mobility
	Integrated Traffic Management System	Transportation and mobility
Solid Waste Management/Storm Water Drainage	Community Toilets	Improved sanitation condition
	Waste processing and disposal	Conservation and reuse of critical resources
	Strengthening and augmentation of Drainage network	Improved sanitation condition
Social Sectors Health and Education	Construction of Hockey Astroturf in Green Park Stadium, Kanpur	Boost to local identity and economy
	Public Toilets and Bins	Improved sanitation condition

Source: https://smartcities.gov.in

Prayagraj City

The Smart City initiative in Prayagraj revolves around five major focus areas: Safety and Security, Area Development, IT Connectivity and Digitalization, water supply, solid waste management, and Transportation. These focus areas are instrumental in driving the development and impact of smart city initiatives. Table 4 provides a comprehensive overview of these five focus areas and the specific impact of the smart city initiatives implemented in Prayagraj.

Table 4 Prayagraj City focus areas and smart initiatives.

Focus Area	Smart City Initiative	Impact
Area Development	Development of Night Market, Kamla Nehru Road	Boost to local identity and economy
	Place Beautification of Selfie Point	Citizen friendly and cost-effective governance and public services
	CONSTRUCTION OF RAILWAY UNDERPASS AT SHIVKUTI	Transportation and mobility
	Open Air Gym	Improved living conditions for the urban poor
	3-D Painting Work	Improved living conditions for the urban poor
	Underground cabling for electricity work (Katra area)	Reliability of power supply
	Open Air Gym Phase -II	Improved living conditions for the urban poor
	Green Space Development in ABD Area	Preservation of ecosystems and open spaces

	Drainage Works (Recasting and Sub-Surfacing) and Other Convergence Projects.	Improved walkability
	Prayagraj (Logo) Signage Board Near Kamdhenu at M.G. Road in Prayagraj	Improved living conditions for the urban poor
	Paint my city	Boost to local identity and economy
	Place Beautification - Cast Iron Tank - Heritage Restoration at Chandrashekhar Azad Park, Prayagraj	Preservation of ecosystems and open spaces
	Open Space & Park Level Improvement	Access to open spaces
	Development of Triveni Sangam Sthal	Access to open spaces
	Streetscape Improvement in Civil Lines + Others & alignment of Service	Access to open spaces
	BRAND ALLAHABAD "(ICT Platforms + Digital Marketing + Livelihoods	Access to open spaces
IT Connectivity and Digitalization	PMIS Project Management Information system for Kumbh Mela	Citizen friendly and cost-effective governance and public services
Safety and Security	Implementation of Integrated Command and Control Centre, ICCC	Improved safety and security of citizens, particularly vulnerable groups (women, children, and elders)
	Public Address System	Improved safety and security of citizens, particularly vulnerable groups (women, children, and elders)
	Surveillance Cameras for Police Prison Vehicles	Improved safety and security of citizens, particularly vulnerable groups (women, children, and elders)
	Bodyworn Camera	Improved safety and security of citizens, particularly vulnerable groups (women, children, and elders)
Sewerage and Septage	Wastewater Collection and Treatment for ABD	Improved sanitation condition
	Wastewater Treatment & Disposal for ABD area& Improvement in wastewater collection & treatment for rest of the town	Improved sanitation condition
Urban Transport	Smart Road No 1 Laxmi junction to Mazar T- junction	Transportation and mobility
	Smart Road No 8 - Development of Day Parking and Night Market Maharana Pratap Jn to Traffic Jn	Transportation and mobility
	Smart Road-4, Muir Road Part II, Anand Hospital Chauraha to Traffic Chauraha	Transportation and mobility

	Smart Road No 2, Shivramdas Gulati Marg _Maharana Pratap junction to Manmohan Park junction	Transportation and mobility
	Smart Road No 3, Muir Road part-1, Manmohan Park junction to Anand Hospital Junction	Transportation and mobility
	Smart Road No 6, Elgin Road	Transportation and mobility
	Smart Road-5, Kasturba Gandhi Marg, Maharana Pratap Junction to Anand Hospital Junction	Transportation and mobility
	Smart Road No 7, Sardar Patel Road	Transportation and mobility
	Work of Divider, Island, Stop Line in ABD Area	Improved living conditions for the urban poor
	Charging Station for Electric Buses	Transportation and mobility
	Redevelopment of Civil Lines bus station	Transportation and mobility
	Smart Road No.10 -Dr. Lohia Road Electrical Work	Reliability of power supply
	Smart Road No.16 - Tez Bahadur Sapru Road - Purshottam Das Tandon Road Crossing to Kasturba Gandhi Road Crossin. Electrical Work	Reliability of power supply
	Smart Road No.31 Mumfordganj Road Tripathi Chauraha to Kutchery Road - Electrical Work	Reliability of power supply
	Subhas Nagar Road Electrical Work	Reliability of power supply
	Improvement of Roads/flyover Bridge Under Other Departments (convergence Projects)	Transportation and mobility
	Bus Based Loop Transit System (33.3) + Resuscitation and Revamping of bus Service	Transportation and mobility

Source: https://smartcities.gov.in

Varanasi City

The Smart City approach in Varanasi aims to promote initiatives that prioritize core infrastructure development, ensuring a decent quality of life for its citizens, and creating a clean and sustainable environment through the application of "Smart" Solutions. The Varanasi Smart City initiative encompasses nine major focus areas: Economic Development, Safety and Security, Health and Education, Energy Management, Area Development, IT Connectivity and Digitalization, Water Supply and Solid Waste Management, Environmental Conservation including pollution control, and Transportation. Table 5 provides a comprehensive overview of these nine focus areas and highlights the impact of the smart city initiatives implemented in Varanasi.

Table 5 Varanasi City focus areas and smart initiatives.

Focus Area	Smart City Initiative	Impact
Energy	Installation of Heritage Street Light in ABD area by EESL - 8000 Nos.	Reduced dependence on and conservation of energy from conventional sources
	Improvement of Electrical Works in OLD KASHI AREA under Integrated Power Development Schemes (IPDS)	Reliability of power supply
	Retrofitting of streetlights (sodium light to LED light) at city level - 36000 Nos. by EESL.	Reduced dependence on and conservation of energy from conventional sources
Area Development	Repair and development of 24 roads with Heritage Development and Theme Enhancement in ABD area	Transportation and mobility
	BEAUTIFICATION OF RAJGHAT OVERHEAD WATER TANK, NEAR MALVIYA BRIDGE IN VARANASI	Boost to local identity and economy
	Redevelopment and Construction of Smart Placemaking under Pandeypur Flyover	Conservation and reuse of critical resources
	Beautification of Badshah Bagh Overhead Water Tank, Near Pisach Mochan kund in varanasi	Boost to local identity and economy
	BEAUTIFICATION OF NAGAR NIGAM OVERHEAD WATER TANK, NEAR SIGRA	Boost to local identity and economy
	Landscaping and Artwork under and on the Flyover from Chaukaghat to Andhrapul, Till Bus Stand	Conservation and reuse of critical resources
	BEAUTIFICATION OF PANNALAL PARK OVERHEAD WATER TANK, NEAR VDA OFFICE VARANASI	Boost to local identity and economy
	BEAUTIFICATION OF CHAUKA GHAT OVERHEAD WATER TANK, NEAR CHAUKA GHAT CROSSING IN VARANASI	Boost to local identity and economy
	Smart Place Making under Mahmoorganj Fly over	Boost to local identity and economy
	Beautification of Varanasi Smart City	Conservation and reuse of critical resources
	Development of Dashashwamedh-Godowlia cultural quaters, Facde improvement	Preservation of ecosystems and open spaces
	Redevlopment of Town hall as heritage centre.	Preservation of ecosystems and open spaces
	Construction of Dhobi Ghat, 5 New + 3 renovations	Reduced pollution

	Development of Street Vending Zone at Durga Kund and entrepreneur skill development for Street Vendors under Street Vendors Act 2014	Boost to local identity and economy
	Development of New Community Toilet Complex, CTC in Phase - 3 under JICA GAP - II	Improved sanitation condition
	Illumination or Façade lighting at Ghats	Boost to local identity and economy
	Ghats Revitalization and Facade Restoration Project	Boost to local identity and economy
	Construction of Multi-level Two-Wheeler Parking at Godowlia Chowk, In Varanasi	Transportation and mobility
	Improvement and Upgradation of 8 Road Intersectio in Varanasi	Transportation and mobility
	Development of 81 Heritage sites of Varanasi including four Kunds - Shankul Dhara, Iswargange, Pitrikund, Matrikund.	Conservation and reuse of critical resources
	Development of New Community Toilet Complex, CTC in Phase - 4 under JICA GAP - II	Improved sanitation condition
	Rejuvenation of Kunds under CSR by ONGC	Conservation and reuse of critical resources
	Redevelopment of Harishchadra Ghat-Electric crematorium	Reduced pollution
	Ghat Improvement under JICA including 27 Changing Rooms	Conservation and reuse of critical resources
	Development of New Community Toilet Complex (CTC) in Phase - 1 under JICA GAP-II	Improved sanitation condition
	Development of Manikarnika Ghat	Improved sanitation condition
	Development of New Community Toilet Complex, CTC in Phase -2 under JICA GAP - II	Improved sanitation condition
	Development of New Community Toilet Complex, CTC in Phase - 5 under JICA GAP - II	Improved sanitation condition
	Information signage on 84 Ghats in Varanasi	Boost to local identity and economy
	Other CSR initiatives, HPLC, AAI, BHEL, Reliance Jio, Scindhia Trust etc. in terms of Solid Waste Management, Construction of toilets, development of parks	Improved sanitation condition

	Cultural Upliftment through Audio-Visual IT Solution for Rituals at Shri Kashi Vishwanath Temple, Varanasi	Boost to local identity and economy
	Cultural Upliftment through Audio-Visual IT Solution for Rituals at Dashashwamedh Ghat, Varanasi	Boost to local identity and economy
IT Connectivity and Digitalization	Customized Solution for Government Project Management Solution GPMS and E-Governance Services	Citizen friendly and cost-effective governance and public services
	Varanasi Integrated Smart Solutions - Kashi Integrated Command and Control Centre (KICCC)	Citizen friendly and cost-effective governance and public services
	Implementation of Bio-metric Attendance System in Nagar Nigam	Citizen friendly and cost-effective governance and public services
Environment Including Pollution	Installation and Operation of Organic Waste Composter for Temple Waste (flower waste to compost) at Ram Ghat.	Improved sanitation condition
	Development and Construction of Kanha Ji Upvan, Gaushala for Stray cattle, Including Defect Liability Period for One Year at Chhitauni Village, Varanasi.	Reduced pollution
	Landscaping and development of 7 parks, Chandrika Nagar Park, Ratnakar park, Tilbhandeshwar park, Nati Imli Park, Sundarpur park, Sanjay Nagar park, and Ashok Vihar	Preservation of ecosystems and open spaces
	Redevelopment and Landscaping of four Smart Parks Including Operation and Maintenance for Five Years and Defect Liability Period for One Year, In Varanasi, Shastri Park, Ravinderpuri Park, Gulab Bagh Park, and Machhodari Park	Preservation of ecosystems and open spaces
	Landscape development of Beniabagh Garden	Preservation of ecosystems and open spaces
	Development and Beautification of Parks, Phase-II in Varanasi	Preservation of ecosystems and open spaces
	Rejuvenation of Mandakini kund	Preservation of ecosystems and open spaces
	Landscaping and development of 3 parks, Sahid Udyan, Park, Anand Park, Bhartendu Park	Reduced pollution
Urban Transport/Non-Motorised Transport and Walkability	Development of of 10 roads leading to heritage sites in Varanasi	Transportation and mobility
	Heritage Precinct of Road connecting Durgakund, Kurukshetra pokhara and Assi Ghat.	Improved walkability

	Repair of roads (80.26 KM) in Pan City by PWD	Transportation and mobility
	Development of Heritage walk at Piplani katra kabir chaura to Assi ghat	Transportation and mobility
	Development of Road Furnitures at 21 Junctions, in Varanasi	Improved walkability
Safety and Security	Procurement of firefighting bikes	Improved safety and security of citizens, particularly vulnerable groups (women, children, and elders)
	procurement of firefighting SUV	Improved safety and security of citizens, particularly vulnerable groups (women, children, and elders)
Water Supply	Installation of Water ATMs (5 nos.) under CSR by ONGC including O&M for 5 years.	Assured water supply
	Institutional Development Programme under JICA	Citizen friendly and cost-effective governance and public services
	Providing and installation of decentralized drinking water outlet system	Assured water supply
	Augmentation of existing Water Supply system including metering in Varanasi	Assured water supply
Solid Waste Management/Sewerage and Septage	Provision of dustbins for 10000 Street vendors	Reduced pollution
	Pilot Project for Sweeping, Collection and Transportation of MSW in 14 Wards under CSR activities.	Improved sanitation condition
	Construction of Interceptor Sewer and Pumping Main under JICA Assisted Ganga Action Plan-II Package - 1	Improved sanitation condition
	Design and Construction of 140 MLD STP at Dinapur under JICA Assisted Ganga Action Plan-II (Package - 3)	Improved sanitation condition
	Provision of dustbins at Ghats	Improved sanitation condition
	Renovation and rehabilitation of Kania MPS, Bhagwanpur, Dinapur STP and 5 Ghat Pumping stations Plant under JICA Assisted Ganga Action Plan-II (Package - 5)	Improved sanitation condition
	Procurement and Construction of Chaukaghat Phulwaria and Saraiya Pumping Stations under JICA Assisted Ganga Action Plan-II (Package - 2)	Improved sanitation condition

	Operation and Maintenance of Municipal Solid Waste Processing Plants in Varanasi	Reduced pollution
	Waste to energy decentralized plants 3TPD	Reduced pollution
	Bio Digestor Toilets D4	Improved sanitation condition
	Eco-restoration of Assi River by wastewater treatment	Reduced pollution
Social Sectors Health and Education	Development of Instrumentation Central Discovery Centre at Banaras Hindu University, BHU	Improved health and education services
	Chamatkari Chasma	Improved health and education services
	Renovation and Development of Homi Bhabha Cancer Hospital at Lahartara, Varanasi	Improved health and education services
	Upgradation, Operation and Maintenance of existing 12 Number Public Community Toilet in Varanasi	Improved living conditions for the urban poor
	Redevelopment & Construction of Macchodari Smart Senior Secondary School and Skill Development Centre	Improved health and education services
	Renovation and restoration of Man Singh Observatory (ASI) and Development of Virtual Experiential Museum titled - Ras-Ras Banaras at Manmandir (NCSM)	Boost to local identity and economy
Economic Development	Development of Trade Facilitation Centre and Crafts Museum at Bada Lalpur, Varanasi	Improved living conditions for the urban poor
	Development of Multi-Model Terminal - Inland Waterways Terminal	Boost to local identity and economy
	Culture cum Spritual Convention Centre	Boost to local identity and economy

Source: https://smartcities.gov.in

Agra City

The vision of Agra Smart City is to create a city that embodies the essence of the Taj Mahal, preserving its history, maintaining a pristine environment, offering world-class infrastructure, and abundant opportunities. It aims to be a safe place to live and a great tourist destination. Agra Smart City has undertaken several flagship projects, including the Integrated Command and Control Centre, Micro-skill Development Sector, Automated Self-cleaning Toilet, Smart Health Centre, and implementation of quality education through smart classes. The Agra Smart City initiative encompasses ten major focus areas: Economic Development, Safety and Security, Health and Education, Energy Management, Area Development, IT Connectivity and Digitalization, Water Supply and Solid Waste Management, Environmental Conservation

including pollution control, Housing, and Transportation. Table 6 provides a detailed overview of these ten focus areas and highlights the impact of the smart city initiatives implemented in Agra.

Table 6 Agra City focus areas and smart initiatives.

Focus Area	Smart City Initiative	Impact
Energy	LED Light Energy Saving Project	Reduced dependence on and conservation of energy from conventional sources
	Underground cabling duct	Citizen friendly and cost-effective governance and public services
	conversion of streetlights to LED	Reduced dependence on and conservation of energy from conventional sources
	SWH on Hotels	Reduced dependence on and conservation of energy from conventional sources
Area Development	Development of Mughal Museum including Auditorium and underground parking	Preservation of ecosystems and open spaces
	Development of Taj Orientation centre - Main Complex, Parking Complex, Horticulture, Open Air Theatre, Restaurant	Boost to local identity and economy
	Enhancing experience of accessing through improvement of west, east and south gate corridors, underground cabling, C.C. roads, footpaths, landscaping, CCTVs, Firefighting System,	Improved safety and security of citizens, particularly vulnerable groups (women, children, and elders)
	Development of corridor connecting Agra and Taj Mahal	Boost to local identity and economy
	Junction Improvement- Taj view crossing, bijli ghar and purani mandi junctions	Transportation and mobility
	Coversion of shanshanghat to eshamshanghat	Reduced pollution

	White scheme'-Painting buildings-white colour	Citizen friendly and cost-effective governance and public services
Economic Development	Micro Skill Development centre	Boost to local identity and economy
	Improvement of vicinity of lesser-known heritage monuments - Kali Masjid, Diwaniji Ka Maqbara, Dargah of Lala Bukhar, Teli pada mosque, Traditional Houses	Preservation of ecosystems and open spaces
	Bicycle sharing fort	Boost to local identity and economy
	Tourist Kiosks	Boost to local identity and economy
	Smart Signages advertisement screen mounted on street light poles	Boost to local identity and economy
Environment Including Pollution	Facade improvement in TajGanj along heriate walk, painting, area cleaning, landscaping, along 1 Shilpgram road, 2 Shilp gram road Diwanji ka Maqbura, and 3. 50 houses along Daresi Road, cleaning of Taj Corridor	Improved walkability
	Taj Park	Preservation of ecosystems and open spaces
Housing	rebuilding livelihoods and upgrading slums - redevelopment of slums	Improved living conditions for the urban poor
	in situ house upgradation	Improved living conditions for the urban poor
	Insitu house upgradation	Improved living conditions for the urban poor
IT Connectivity and Digitalization	Selection of Master system Integrator, MSI	Citizen friendly and cost-effective governance and public services
Urban Transport/Non-Motorised Transport and Walkability	Development of green walkway between AgraFort and Taj Mahal along Yamuna Kinara Road	Improved walkability
	Junction redesign	Transportation and mobility

	Smart Electric Buses for Agra City	Transportation and mobility
	provision of e-rickshaws	Transportation and mobility
	Agra Etawah Lion Safari Cycle Highway	Reduced pollution
	Roadside Plantation	Preservation of ecosystems and open spaces
Safety and Security	Women Distress centres- SHE centres	Improved safety and security of citizens, particularly vulnerable groups (women, children, and elders)
	Provision of Fire hydrants	Citizen friendly and cost-effective governance and public services
	Quick response centre for incident management	Improved safety and security of citizens, particularly vulnerable groups (women, children, and elders)
Solid Waste Management/Storm Water Drainage/Sewerage and Septage	Recycle or Bring Back centre	Improved sanitation condition
	Rainwater harvesting pits	Conservation and reuse of critical resources
	Taj East Drain Improvement plan	Improved sanitation condition
	Provision of household sewer connections	Improved sanitation condition
	Laying of sewer line	Improved sanitation condition
Social Sectors Health and Education	Upgradation of community toilets	Improved sanitation condition
	Public e- toilets	Improved sanitation condition
	Provision of Municipal Health centres kiosks	Improved health and education services
	Provision for Aanganwadi	Improved health and education services

Construction of individual toilets	Improved sanitation condition
Up gradation of Municipal Schools	Improved health and education services
Smart Classrooms	Improved health and education services

Source: https://smartcities.gov.in

Comparative Analysis

1. Table 7: Area wise Smart City Initiatives

| Focus Area	District- Number of Projects of the city					
	Lucknow	Kanpur Nagar	Prayagraj	Varanasi	Agra	Total
Area Development	12	4	16	32	7	**71**
Solid Waste Management/Water Supply/Sewerage and Septage	10	3	2	15	5	**35**
Urban Transport/Non-Motorised Transport and Walkability	5	2	17	5	6	**35**
Energy	5	3	-	3	4	**15**
Social Sectors Health and Education	1	2	-	6	7	**16**
IT Connectivity and Digitalization	5	2	1	3	1	**12**
Economic Development	2	1	-	3	5	**11**
Safety and Security	1	-	4	2	3	**10**
Environment Including Pollution	-	-	-	8	2	**10**
Housing	-	-	-	-	3	**3**
Total	**41**	**17**	**40**	**77**	**43**	**218**
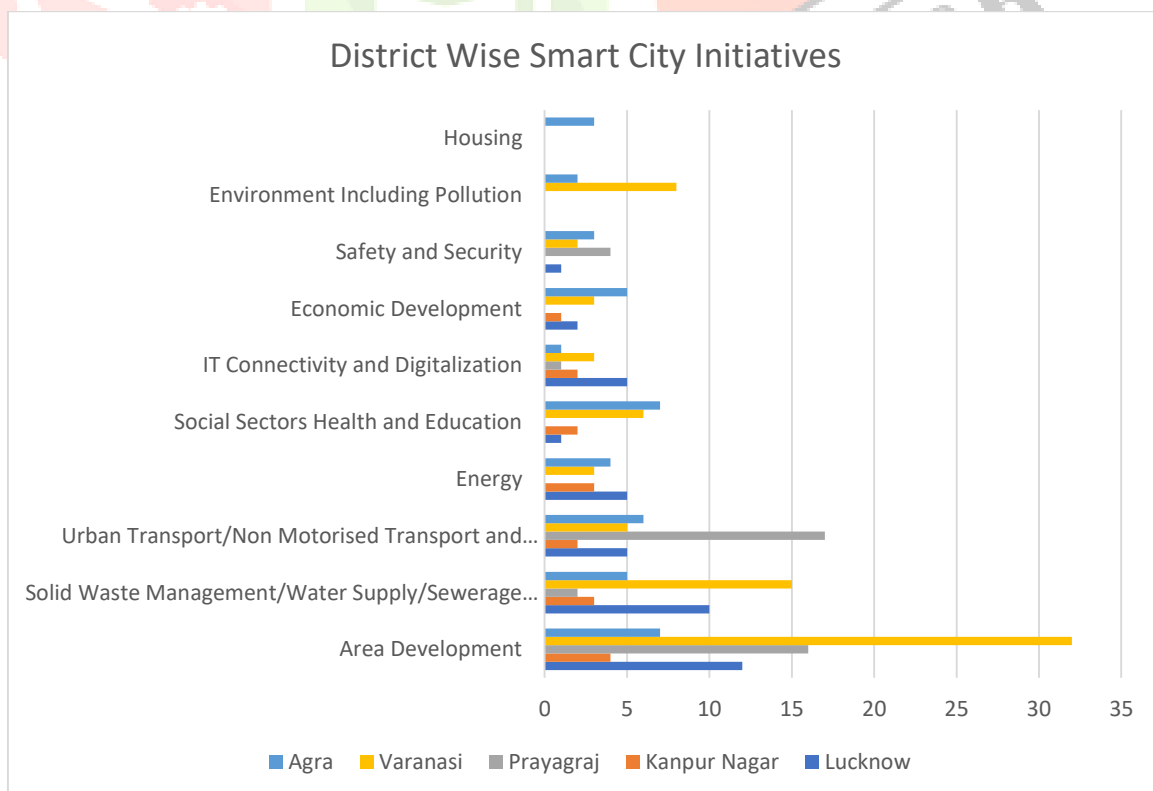
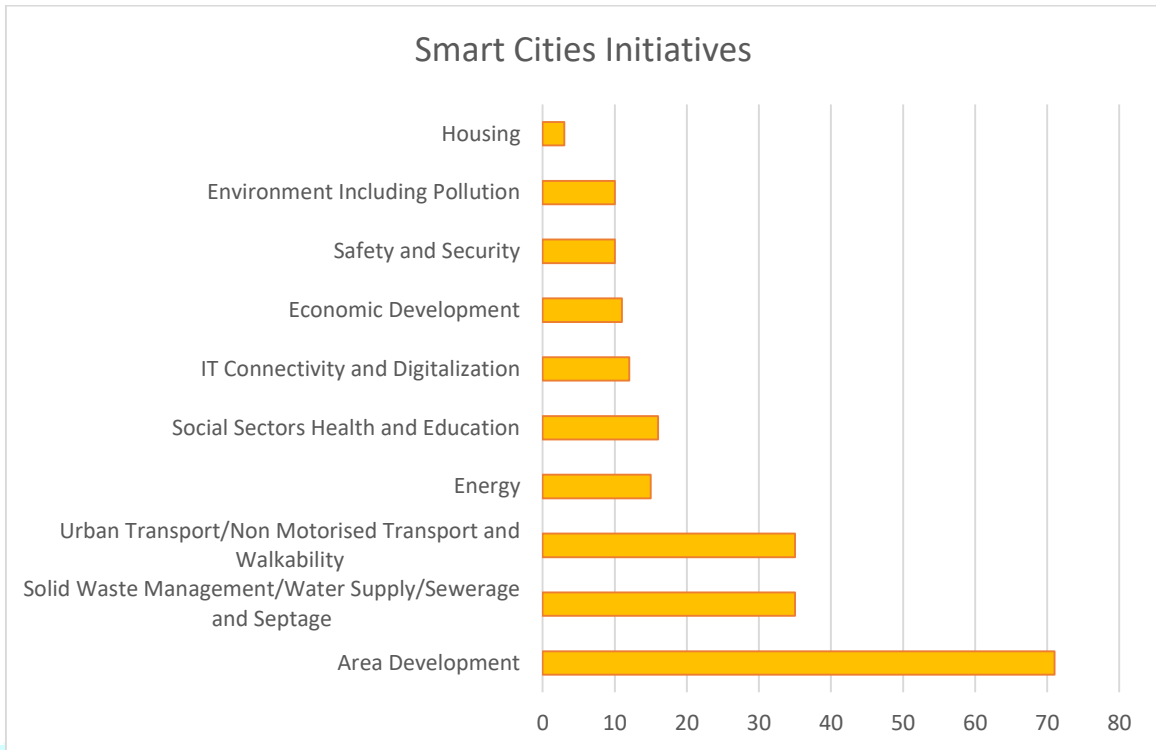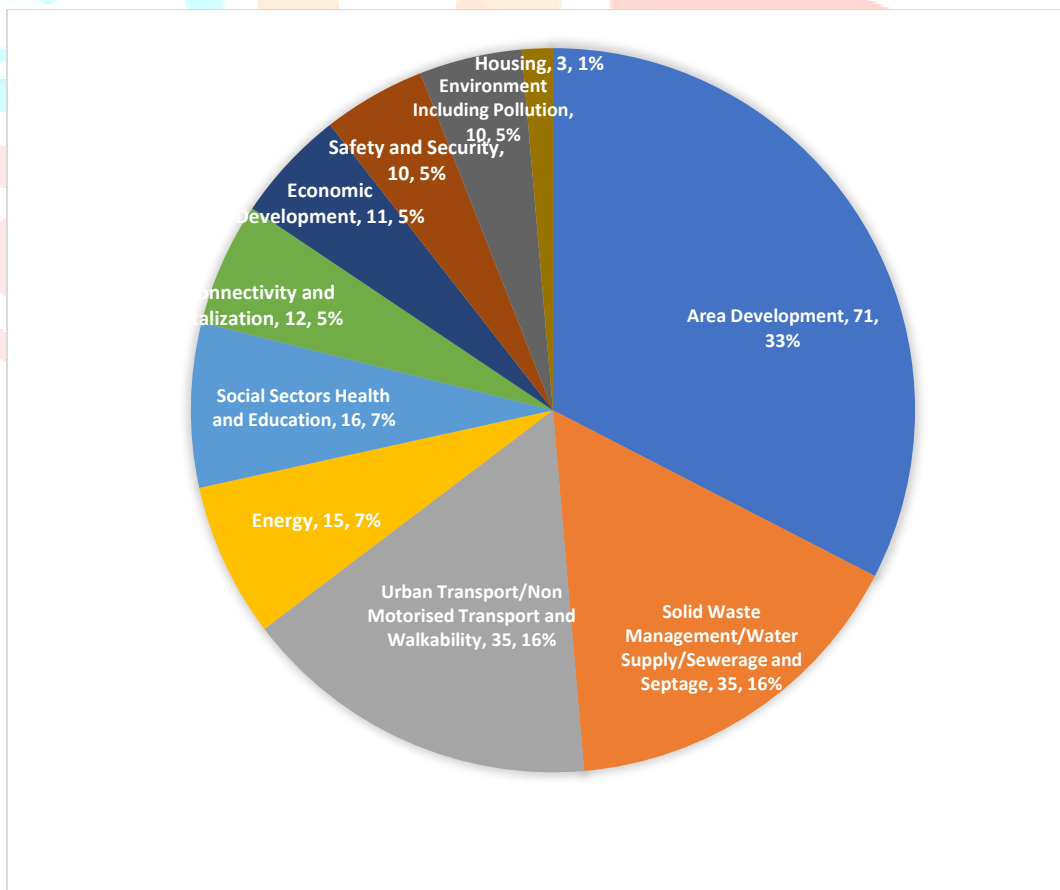Figure 1 District Wise Smart City Initiatives

Figure 2 Smart City Initiatives

According to Table 7, a total of 218 projects have been implemented, with 71 projects prioritizing Area Development, 35 projects focusing on Solid Waste Management, Water Supply, and Sewerage, 35 projects concentrating on Transportation, 16 projects emphasizing Health and Education, and 15 projects targeting the Energy sector. These statistics highlight the significance of Area Development in city planning, as it plays a crucial role in economic development. The data clearly indicates that cities recognize the importance of investing in Area Development initiatives to drive economic growth and enhance overall urban infrastructure.

2. **Impact on smart city initiatives**

Table 8

Impact on Smart City Initiatives	Lucknow	Kanpur Nagar	Prayagraj	Varanasi	Agra
Boost to local identity and economy	8	3	2	15	6
Citizen friendly and cost-effective governance and public services	6	2	2	4	4
Conservation and reuse of critical resources	2	1	-	6	1
Improved health and education services	-	1	-	4	4
Improved living conditions for the urban poor	1	-	5	2	3
Improved safety and security of citizens, particularly vulnerable groups (women, children, and elders)	3	-	4	2	3
Improved sanitation condition	5	3	2	15	7
Improved walkability	1	1	1	2	2
Preservation of ecosystems and open spaces	4	1	6	7	4
Reduced dependence on and conservation of energy from conventional sources	3	2	-	2	3
Reduced pollution	-	-	-	8	2
Transportation and mobility	4	2	13	6	4
Assured water supply	2	-	-	3	-
Reliability of power supply	2	1	5	1	-

3. **Projects to boost the local identity and economy.**

Table 9

Sr. No.		Area Development	Economic Development	Health and education	Total
1	Lucknow	6	2	-	8
	Total	8	8	-	8
	Percentage	**75**	**25**	**-**	**100**
2	Kanpur Nagar	2	-	1	3
	Total	3	-	3	3
	Percentage	**67**	**-**	**33**	**100**
3	Prayagraj	2	-	-	2
	Total	2	-	-	2
	Percentage	**100**	**-**	**-**	**100**
4	Varanasi	12	2	1	15
	Total	15	15	15	15
	Percentage	**80**	**13**	**7**	**100**
5	Agra	2	4	-	6
	Total	6	6	-	6
	Percentage	**33**	**67**	**-**	**100**

Table 9 provides insights into the number of projects aimed at enhancing the local identity and economy of each city. The data clearly indicates that Area Development projects play a significant role in creating economic opportunities, accounting for 71% of the total projects. Prayagraj City stands out with 100% of its projects dedicated to Area Development, followed by Varanasi with 80%, Lucknow with 75%, Kanpur Nagar with 67%, and Agra with 33%.

Additionally, the Economic sector accounts for 28% of the opportunities created for economic development, while the Health and Education sector contributes 2%. These findings highlight the substantial impact of Area Development initiatives in driving economic growth across the cities, emphasizing their role in fostering local identity and boosting the overall economy.

The significance of Area Development in creating economic opportunities, with Prayagraj City leading the way. The Economic sector also plays a notable role, while the Health and Education sector contributes to a smaller extent.

Findings

The findings from Table 7 reveal that a total of 218 projects have been successfully implemented across various cities. Among these projects, 71 have been dedicated to Area Development, underscoring its significance in urban planning. Additionally, 35 projects have focused on Solid Waste Management, Water Supply, and Sewerage, demonstrating the importance of efficient infrastructure in maintaining cleanliness and sanitation. Furthermore, 35 projects have concentrated on improving Transportation, enhancing connectivity and mobility within cities. Health and Education have also received attention, with 16 projects emphasizing

their development. Lastly, the Energy sector has been targeted by 15 projects, emphasizing the need for sustainable and efficient energy solutions.

These statistics indicate a clear understanding among cities about the pivotal role of Area Development in driving economic growth and improving overall urban infrastructure. It highlights the recognition of cities to invest in crucial areas such as infrastructure, waste management, transportation, healthcare, education, and energy to foster sustainable development and enhance the quality of life for their residents.

Table 9 underscores the significance of Area Development in creating economic opportunities, with Prayagraj City leading the way. The Economic sector also plays a notable role, while the Health and Education sector contributes to a smaller extent.

The key drivers that contribute to the sustainability of smart cities in Uttar Pradesh include Area Development, Solid Waste Management, Water Supply and Sewerage, Transportation, Health and Education, and Energy sector projects.

Area Development projects play a crucial role in city planning, accounting for a significant number of projects and creating economic opportunities.

Prayagraj City has shown the highest dedication to Area Development, followed by Varanasi, Lucknow, Kanpur Nagar, and Agra.

The Economic sector contributes significantly to economic development, while the Health and Education sector has a smaller impact.

The data highlights the recognition by cities of the importance of investing in Area Development initiatives to drive economic growth and improve urban infrastructure.

Results and conclusion

The results of this study demonstrate the strong focus on Area Development and its positive impact on economic growth in smart cities across Uttar Pradesh. The findings reveal that the cities prioritize sustainable strategies and initiatives to address the challenges of rapid urbanization and enhance the quality of life for residents.

In conclusion, the development of smart cities in Uttar Pradesh is driven by a commitment to sustainability and inclusivity. The focus on Area Development, along with initiatives in Solid Waste Management, Water Supply and Sewerage, Transportation, Health and Education, and Energy sectors, contributes to the overall sustainability and economic development of these cities. The findings highlight the importance of integrating technology and innovative approaches to create environmentally friendly and resilient urban areas.

Suggestions:

Continued emphasis on Area Development: Cities should prioritize and invest in Area Development projects to drive economic growth and improve overall urban infrastructure.

Strengthening Solid Waste Management and Water Supply: Efforts should be made to enhance solid waste management systems and ensure efficient and sustainable water supply and sewerage infrastructure.

Improving Transportation Systems: Cities should focus on developing smart transportation systems to enhance connectivity, reduce congestion, and promote sustainable mobility options.

Enhancing Health and Education Initiatives: Further investments should be made in health and education sectors to improve the quality of services and promote inclusive development.

Promoting Renewable Energy and Energy Efficiency: Increased emphasis should be placed on renewable energy sources and energy-efficient practices to reduce environmental impact and promote sustainability.

Overall, the findings suggest that a holistic and integrated approach to urban development, with a focus on sustainability and technology-driven solutions, can contribute to the creation of smart and sustainable cities in Uttar Pradesh.

References

Caragliu, A., Del Bo, C., & Nijkamp, P. (2011). Smart cities in Europe. *Journal of urban technology*, 18(2), 65-82.

Dameri, R. P., & Cocchia, A. (2013). Smart city and digital city: twenty years of terminology evolution. X Conference of the Italian Chapter of AIS, ITAIS, 1-8.

Dhingra, M., & Chattopadhyay, S. (2016). Advancing smartness of traditional settlements-case analysis of Indian and Arab old cities. International Journal of Sustainable Built Environment, 5(2), 549–563.

Ejigu, Alazar. & Haas, Tigran. (2011). Contextual Modernism and Sustainable Urbanism as New Housing Strategies - A way for better understanding the phenomena of concentrated poverty. Presented at the Enhr Conference 2011, Toulouse. Retrieved on 24t April, 2017 from http://www.enhr.net/documents/2011%20France/WS10/Haas%20and%20Ejigu-V3-WS10.pdf

Liu, Z. (2016). Remaking Economic Development. The Brookings Institution. Retrieved from https://www.brookings.edu/wpcontent/ uploads/2016/02/BMPP_RemakingEconomicDevelopment_Feb25LoRes- 1.pdf

Monfaredzadeh, T. & Berardi, U. (2015). Beneath the smart city: dichotomy between sustainability and competitiveness. International Journal of Sustainable Building Technology and Urban Development, 140-156

Nafziger, E. (2012). *Economic development*. Cambridge New York: Cambridge University Press.

Sneddon, C., Harris, L., Dimitrov, R., & Özesmi, U. (2002). Contested waters: Conflict, scale, and sustainability in aquatic socioecological systems. Society &Natural Resources, 15(8), 663-675.

T. Yigitcanlar, *Knowledge-based development processes of an emerging knowledge city: Brisbane*, Aust. AIZ J. 8 (2011), pp. 53–67.

United Nations. (2013) World Economic and Social Survey 2013, Sustainable Development Challenges. Department of Economic and Social Affairs. E/2013/50/Rev. 1. ST/ESA/344 Solesbury, W. (2013). Policy in urban planning: structure plans, programmes, and local plans. Elsevier.

Van Der Waals, J. (2000). The compact city and the environment: A review. Tijdschrift voor economische en sociale geografie, 91(2), 111-121.

Vanolo, A. (2016). Is there anybody out there? The place and role of citizens in tomorrow's smart cities Futures, 82, 29-36.

World Bank. (2018). [Online] Available at:
https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS

https://smartcities.gov.in