

A Multi-City Study of Congruency between Smart City and Transportation Reforms and Their Effects

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Abstract

Introduction: Rapid urbanization is posing complicated problems in the areas of governance of urban reforms. Extant research signifies the role of immense interplay between such urban reforms in influencing sectoral functions of urban local bodies and in turn the public benefits. It is however less understood how broader urban reforms need to be shaped in consideration with their embedded reforms that target specific sectoral reforms to enhance urban quality of life. In particular, there have been growing calls for alignment between major sectoral reforms like that of mobility and the broader ones like that of smart city within which the former tends to be embedded.

Objectives: To this end, this article examines the dynamics of alignment between smart city reforms and multi-modal transportation reforms and their effect on the urban quality of life.

Methods: Through a grounded, inductive, qualitative, case-based approach, the article attempts to contribute to theory by comparatively studying the congruency in the governance of smart city and transportation reforms amongst four Indian cities.

Results: The findings indicate that a greater level of congruence between these broader and sectoral reforms stems from shared artefacts of reference, nested structures of steering entities and presence of institutional intermediaries. The article further validates the findings by correlating the levels of congruence between reforms in each of these cities with the quality of life indices.

Conclusions: The findings call for functional integration across three layers – policy, organizations and actors. The article thereby adds to the conversation about urban development and opens the door to inclusive, resilient, and genuinely smart cities by combining mobility with smart city governance.

Keywords: Smart city, urban mobility, governance, integration, policy coherence.

1. Introduction

Rapid urbanization and rising population in cities have posed challenges to governments and urban local bodies in bringing forth a multitude of reforms under a broad umbrella (Raven et al., 2019). For instance, as cities around the world continue to grow, new mobility reforms for optimizing travel routes, improved logistical process optimization, and traffic management have become essential (Canitez, 2020). These mobility reforms have been contingent upon higher order policies that promote crucial coordination, integration, and cooperation between agencies and

the urban stakeholders under the ambit of smart city governance (Fu & Zhang, 2017). Concerns have been prevalently noted regarding the role of governments in not only planning urban reforms but carrying out them out by cooperating with multiple agencies and forming alliances. Criticisms on urban policies have been evocative of a shift from a purely technical focus on digital technology- driven models and marketing strategies to a socio- technical focus on equity and functionality in urban governance (Graaf et al., 2021).

Amongst the various urban reforms, smart cities and multi-modal transport integration have drawn

a lot of attention in recent times as cities look for sustainable and effective solutions to their infrastructure, and major transport problems. With the 17 Sustainable Development Goals that the United Nations has set for 2030, smart cities and urban mobility – coherently known as ‘smart mobility’ – have become the primary agenda for most of the cities (Stepniak et al., 2021). By virtue of the influence of smart mobility reforms on the basic need of the citizens, i.e. transportation, the measurable dimensions of public benefits will thus be diverse and include living, sustainability, and the economy. While technical challenges in smart mobility incorporate solutions involving environmentally friendly fuels and digital advanced transportation solutions, social challenges in the same necessitate citizen engagement and a focus on the sustainability of the developed solutions with good governance reforms as strong support (Munhoz et al., 2020). Thereby, smart mobility is deemed as a techno-social reform rather than a technical reform and the governance of the same is inherently challenging owing to the interplay of institutions, plural stakeholders, and the built environment (Ahmad & de Oliveira, 2016). In this context, Reardon et al. (2022) downplay the role of ‘urban experimentation’ (Soe & Drechsler 2018), and call for ‘institutional design’ which takes into consideration the multilevel governance alignment of broader reforms and their constituent sectoral reforms into account and how it may affect the public benefits. This article consequently attempts to investigate the dynamics of alignment between smart city reforms and multi-modal transportation reforms and their effect on the urban quality of life. The article attempts to contribute to theory by answering the following research question: How can smart city reforms be better aligned with mobility reforms to coherently improve public benefits? This article attempts to answer this question by comparatively studying the congruency in the governance of smart city and transportation reforms amongst four Indian cities. The article first presents the theoretical background on the challenges in the governance of smart cities, followed by challenges in the governance of mobility reforms, then followed by the challenges in the milieu of smart mobility.

Subsequently, the article describes the research methods that were adopted. The empirical observations and discussions follow next. The article concludes by summarizing the key findings from the research.

Traditional works on smart cities has prescribed the integration of information technology into decision-making procedures, stakeholder relations, and government operations of urban affairs. This notion consists of ICT-driven internal transformation, data-driven evidence, social media development, and participatory decision-making in urban local bodies (Yin et al., 2015; Sanchez-Corcuera et al., 2019). Concurrent literature has begun to depart from the traditional perspectives on the framework of smart cities to an idea of smart urban governance - an essential component for resolving urban problems and encouraging cooperation amongst urban actors in the 4.0 era (Toan & Nhu, 2020). In order to address urban development issues and accomplish sustainable urban development goals, coordination and collaboration among stakeholders including government agencies, the public, and the private sector are essential. The multifaceted and intricate nature of urban issues is perceived to have a potential remedy in smart governance, which leverages digital data, information, and creative applications to foster productive stakeholder collaboration (Angelidou, 2015). In addition to discussing the significance of information-ism in forging a social compact and giving priority to establishments and enterprises based in cities, Kummitha & Crutzen (2017) argue that urban governance establishes connections with global city networks to facilitate the collaborative exchange and education of experiments and experiences. In order to create sustainable, resource-efficient cities, Swilling & Maarten (2017) addressed the necessity of new governance structures emerging from experimentation and systemic learning across cities -nicknamed as "entrepreneurial urban governance."

However, extant literature draws attention to the difficulties that rapidly urbanizing nations face in establishing smart city governance as well as the absence of context sensitivity when importing governance models from developed cities. Praharaj et al. (2018) examined about how, instead of

implementing band-aid fixes, aspirational smart cities in developing nations like India must confront ingrained structural problems with their local governments and begin the process of transforming their governance. Similarly, studies have been critical of a false caricature that delivery models such as the Special Purpose Vehicle (SPV) model in smart city reforms resolve governance-related issues in the related reforms. Reardon, et al. (2022) drew attention to the paucity of research on the influence of institutional design on the dynamics of multilevel governance in India in the body of current literature. The authors made the case that most of the smart city initiatives in the world which use special purpose vehicles (SPVs) to circumvent local-level institutions and to centralize power, depart from the cooperative and decentralized forms of governance that are emphasized in the discourse of countries' ruling class and smart city movements. Similar works have recommended the cities to give the democratic aspirations of their people top priority, and create tailored smart city governance frameworks that take lessons from the past. Idiculla (2015) noted the helplessness of local governments in developing contexts and postulated the role of intermediary groups and parastatal agencies in carrying out municipal functions, providing necessary background for comprehending the power dynamics at play. Rao & Kumar (2022) highlight the need to integrate information, planning, and policies across all government agencies and the services that the city and its stakeholders offer. Hartley (2023) emphasized the need to gauge the public perceptions in measuring the effects of policy congruence. The relationship between smart cities and quality-of-life factors have been much explored, with quality-of-life being considered one of the core values of smart cities.

Transport governance has led numerous advances in the urban context through the forms of shared mobility, electrification, time series analysis of traffic accidents, geographic information systems, new vehicle technologies, and analytical hierarchy process methods (Goncalves & Ribeiro, 2020). The extant narrative on urban transportation governance however reflects a lack of policy-integration in urban transportation reforms.

Kawathekar & Bakde (2021) emphasize the necessity of taking the application of policy scope matrices and interface matrices into consideration for physical, financial, functional and informational integration. Physical integration is one avenue that scholars have noted with considerable percolation in global cities. Unified metropolitan transportation authorities have been observed as the bridging organization to bring about physical integration across transport modalities. However, Dorina & Stead (2015) recorded physical integration to be challenging in view of frequent disputes of unilateral investments on connecting infrastructure between multiple transport modalities. Financial integration has been deemed essential in urban transport often to boost the financial viability of transportation systems through mechanisms such as value capture, cross-subsidization and fare aggregation. Roukouni et al. (2018) expressed that such financial integration mechanisms are successful in theory than practice as these mechanisms span beyond the commercial boundaries of the transportation systems.

Reyes-Rubiano et al. (2021) made the case for cutting-edge functional integration techniques in creating sustainable routes with low logistic costs while discussing the detrimental effects of the transportation industry on the environment and social welfare. The authors noted that competing modes of transport, uneven traffic loading and hopping bottlenecks are visible ill-effects of poor functional integration. Informational integration has been underlined as an output of transportation governance that uses technology to improve the efficiency and safety of transportation networks, including traffic management systems, real-time passenger information, and intelligent traffic signals (Mavlutova & Atstaja, 2023). Advancement of information and communication technology within cities determine the degree of information integration and models from Artificial Intelligence-driven operations research are employed to raise the bar for sustainable transportation.

Mobility governance is an important area within the urban governance concepts that allows transportation systems to be organized in a collaborative and efficient way (Wolniak, 2023). The idea behind urban transport governance is to use modern technologies and innovative solutions

to improve the quality of life in cities and increase their efficiency and sustainability. Okraszewska et al. (2023) emphasizes the role of urban mobility in improving air quality, residents' health, and traffic safety through smart traffic monitoring systems and quick response to dangerous situations. The analysis goes on to show how smart mobility in a smart city improves traffic safety, lowers air pollution, increases mobility, and introduces creative transportation options all of which improve the quality of life for city dwellers.

2. Objectives

Our article is driven by the necessity to build a bridge between smart city reforms and mobility reforms through appropriate governance structures. Citing this necessity, Prasad & Alizadeh (2020) review smart mobility missions to enhance urban development efforts by offering smart solutions, a high quality of life, and essential infrastructure. Even though there are various methods of developing smart mobility, such as greenfield development, redevelopment, and retrofitting, the necessity for coherent and sensible policies are highlighted to enhance city planning, lower the demand for transportation, increase mobility, and lessen congestion in smart cities, Prakash (2019) emphasizes the significance of creative solutions to problems pertaining to a better synchronization between smart city reforms and transportation reforms. To expedite the implementation of smart mobility, the author highlights the necessity for reforms at various levels of government and recommends giving priority to reforms to send messages to the sector, highlight immediate successes, and guarantee advancement on the long-term reform agenda. To encourage private sector involvement in smart mobility projects, cross-sector institutional reforms are advised (Smith et al., 2019). These reforms include building the capacity of urban local bodies (ULBs), devolution of authority to determine and collect local taxes and user fees, and strong leadership at the city level. Thereby, there is a need for focus on closing gaps in service delivery and improving the quality of life by and large. Creative methods are at the centre for managing and funding Transit Oriented Development strategies wherein it is important to

have a strong municipal revenue base and effective urban governance to implement these innovations (Waddell, 2016). Wei & Mogharabi (2013) highlight how crucial it is to build effective public-private partnerships, improve systemic capacity, and increase operational efficiency to implement sustainable and replicable urban reforms that bridge transportation and urban planning. Smart economy, smart people, smart governance, smart mobility, smart environment, and smart living are among the dimensions and subdimensions that are used to assess the performance of smart cities and further research is necessary to document the innovation journey of these cities (Penazzi et al., 2019).

We find gaps in governance frameworks that prevent efficient policy implementation. However, there are a number of obstacles to mobility reforms, including a lack of infrastructure, financial limitations, and public support. Very few studies examine how smart city governance and mobility governance interact, even though many focus on either one or the other. The absence of integrated approaches that balance mobility reforms with smart city reforms is a critical gap in the literature that our research has identified. Our objective is to close this gap by putting forward a comprehensive framework that considers both factors at once.

3. Methods

The authors conduct a qualitative and comparative analysis of smart cities and multi-mode transportation integration. The approach consists of comparing the chosen smart cities to derive the answers to our research questions and achieve the research objectives. This study analyzes not only the components of current smart cities but also those that are being developed soon and are developing creative solutions to enhance their infrastructure. The social, economic, environmental, political, and financial effects of integrating innovations in the smart city infrastructure, particularly in the transportation sectors, will be examined in more detail as needed through the qualitative study. This research methodology makes sense because our study examines the difficulties legislators encounter when putting smart city governance and smart mobility reforms into practice. Figure 1 briefs the

research methodology.

---Insert Figure 1 Research Process about here---

In the pursuit of our research project, which aims to conduct a comparative and qualitative analysis of smart city and multi-modal transportation integration systems across multiple cities, we rely on secondary data sources. These sources include a wide spectrum of academic and practicable knowledge learned from various channels. We scour reputable websites, databases, and digital repositories. These platforms host a variety of information, comprising research articles, reports, case studies, and policy documents relevant to smart cities, their transportation reforms and systems. The digital landscape provides real-time access to evolving trends, best practices, and innovative solutions integrated into cities worldwide. We delve into academic literature books, peer-reviewed journals, and conference proceedings. These texts provide in-depth analyses, theoretical frameworks, and empirical findings. Publications provide a solid foundation, permitting us to explore established theories, methodologies, and historical perspectives. We scrutinize articles from reputable news outlets, industry publications, and research organizations. These sources often present practical insights, case studies, and expert opinions. They bridge the gap between academic research and real-world applications, offering a pragmatic view of smart city initiatives. We engage with thought-provoking blogs, opinion pieces, and thought leader contributions. These informal yet valuable sources shed light on emerging trends, challenges, and innovative practices. Blogs provide a fresh perspective, capturing the dynamism of urban advancement and the voices of practitioners and enthusiasts. Our reliance on secondary data guarantees a comprehensive and holistic approach. By synthesizing information from diverse channels, we transcend individual city boundaries and gain insights into overarching patterns, success factors, and areas for improvement. As we embark on this comparative journey, our commitment to thorough analysis and evidence-based decision-making remains unwavering.

Grounded theory and qualitative research both depend on the open coding and axial coding principles, which we apply in our data processing

and analysis. Open coding is the methodical division of unprocessed data, such as documents, field notes, and interview transcripts, into discrete units pertaining to the cities like Hyderabad, Bengaluru, Pune and Kapur which were selected for the study. Throughout this procedure, we thoroughly examine the data to find concepts, patterns, and recurrent themes. A descriptive code is given to each segment. We can investigate various viewpoints, find surprising insights, and keep an open mind to new themes. Conversely, axial coding expands on open coding by creating links between codes to comprehend hierarchies, causal connections, and relationships. We categorize and subcategorize codes in this way. In order, to provide depth and coherence, axial coding entails asking questions such as: How do these concepts relate? What are the underlying structures? This process enables us to create a conceptual framework that encapsulates the essence of our research. We obtain our data from a variety of cities' journals, blogs, articles, and case studies. We analyze these documents using open coding, finding themes about technology adoption, governance, and integrated mobility solutions in each of the chosen cities separately. Furthermore, we investigate connections among these themes through axial coding. What impact do governance practices have on mobility policies? Through this iterative process, we uncover nuances specific to each city while discerning overarching patterns applicable across contexts. Our commitment to open and axial coding ensures a robust analysis— one that transcends the four selected cities and contributes to the broader discourse on smart urban development especially through smart mobility. Conclusively, this methodology offers us a path forward for the forthcoming months to investigate and identify any recommendations still lacking in developing smart cities and improving their transportation infrastructure.

4. Results

The idea of a “Smart City (SC)” has become popular in the last decade, with experts around the world highlighting that SCs offer promising solutions to existing urban problems caused by rapid urbanization. Both developed and developing

countries are embracing the concept by initiating and investing significant capital in SC programs. India is one of them. By 2030, India is expected to have the largest concentration of megacities. As part of such forecasts, the study of such booming cities was chosen, in which corresponding reforms that can have an impact on the respective goals have already been implemented. The cities studied for this research process are Hyderabad, Bengaluru, Pune, and Kanpur. The reason for this is that these are cities that show continuous growth in infrastructure and other areas. This research takes a holistic approach to understanding the direction of the reforms implemented. Through this iterative process, we uncover city-specific nuances while recognizing overarching patterns that are applicable across contexts. Analyzing existing documents such as books, newspapers, websites as well as legal records and case studies for an in-depth study that can provide detailed qualitative data of the four selected cities is done as part of data collection with better results.

Bengaluru

Bangalore, located in the South of India, has been selected as one study area. This is because the city is typical of a rapidly developing mega-city that has long been suffering from a shortage of urban services and urban management. In our judgment, therefore, Bangalore is one of the best and most timely case study candidates among the large Indian cities and allows a deep exploration of the issues of sustainable development and mobility. Bangalore has a leading place as the regional center of culture and information and is one of the most important agglomerations in terms of both urbanization and job opportunities in the southern part of India.

The Bangalore urban highway and public transport system is far behind what is needed to foster economic development. Traffic problems are acute, and the regional and local authorities are now developing many improvements plans and proposing heavy budget allocations for highway construction. The only means of motorized transport is road-based on an insufficient road network with low speeds and long travel times (the average speed in the city area is already as low as 10-13 km/hr, which is bad even compared to many other growing Asian cities). The only form of public

transport is by bus and only very recently have the first 40 air-conditioned buses been introduced. Intermediate forms of public transport are not managed or organized (the share of intermediate public transport is 12.6%).

The Government of India (GoI) has released the Smart Cities Mission (SCM) Statement and Guidelines, which indicate that a Special Purpose Vehicle (SPV) named "Bengaluru Smart City Limited (BenSCL)" will be responsible for implementing the Mission at the city level.

Smart Bus Stop

Bangalore ELCITA Bus Stop aims to improve the convenience and sustainability of living and working in Electronics City. It introduces modern, environmentally friendly bus stops, bike rentals for shorter distances, and improved public transport. By integrating cutting-edge features into smart bus stops, ELCITA aims to improve overall local transportation. Strategies include implementing smart bus stops with features such as vertical gardens, vending machines, sanitary napkin dispensers, charging stations, smart trash cans, real-time bus status updates, and security measures. ELCITA aims to increase the use of public transport and reduce dependence on private vehicles. These futuristic bus stops use collected water for irrigation, and feature solar panels on the roof and automatic lighting. Plans include the integration of ATMs and e-toilets. The ELCITA bus stop project is self-funded through taxes and fees collected from industries in E-City Township. Commuters who use these efficient bus stops are satisfied with amenities such as vending machines, charging stations, and sanitary pads, leading to a shift towards public transport and contributing to less pollution and traffic congestion.

Bengaluru Bus Corporation

Bengaluru Bus Corporation has embarked on a transformative journey with the implementation of a comprehensive big data system that aims to revolutionize urban transport services in Bengaluru. The company operates an extensive fleet of over 6,000 buses and underlines its commitment to increasing efficiency and effectiveness with the strategic integration of automatic vehicle tracking, electronic ticket machines, and a linked passenger information system via a mobile app. Despite the challenges of

managing the massive volume of data and ensuring data protection and security, the company remains true to its purpose. The introduction of this advanced system not only optimizes routes, schedules, and resource allocation but also provides both passengers and management with accurate and timely information. Ultimately, these digitization efforts are expected to significantly reduce uncertainty and wait times for travellers, increase service efficiency, and reduce traffic congestion, thereby improving the overall urban transport experience for Bengaluru residents.

Footpath and Bicycle Track

The purpose of footpaths and cycle tracks in Bangalore is diverse and aims to improve urban mobility, promote healthy living, and create a sustainable environment. These paths provide safe and separated lanes for cyclists, encouraging more people to use bicycles for commuting. It is important to ensure that cycle paths are seamlessly connected to bus stops, subway stations, and other public transport hubs. This integration encourages people to cycle shorter distances while using public transport for longer distances. In addition, the creation of awareness campaigns promotes cycling as a healthy and environmentally friendly means of transport. For users, these routes provide fresh air, exercise, and quality time with friends and family while exploring the city. In addition, they contribute to improved traffic flow, reduced congestion, better cardiovascular health, increased fitness, and reduced stress. Encouraging walking and cycling also plays a crucial role in reducing greenhouse gas emissions, and the walking and cycling paths themselves become vibrant spaces of social interaction.

Waste management service

Bangalore Waste Management Services strives to achieve several important goals to address the city's waste problems. The aim of these plans is to efficiently manage waste from different sources such as households, companies, and institutions. Formal waste management services: The main source of revenue for these services is the service fees imposed on customers (residential complexes, companies, and institutions) for the collection, sorting, transportation, and processing of waste. Informal waste workers: These workers who care about the environment collect and sort recyclable

waste from streets and landfills. Their living and working conditions are often inadequate, resulting in an average daily income of between 150 and 200 Indian rupees. Seventy percent of informal waste workers surveyed earn an average of Rs. 100 to Rs. 200 per day or approximately Rs. 3,000-6,000 per month. Only 18% of officially registered workers earn between Rs. 200 and Rs. 300 per day or Rs. 6,000 and Rs. 9,000 per month. Only 1% of registered workers earn more than Rs. 3000 per month. This represents a tiny percentage. Benefits include reduced pollution through efficient waste management, which helps protect the environment. Air, water, and other pollution can be reduced by minimizing the amount of waste that ends up in landfills or incinerators using appropriate disposal techniques such as recycling and composting.

Shakti Smart Card

The Shakti Smart Card offers the opportunity to include private and informal services within the scope of the program. Women can ride for free on all buses, public or private, and bus operators can receive a refund based on the number of cards used on their buses, Gadepalli said. The Shakti program is a good first step in improving access for women, particularly in middle- and low-income households. However, its benefits could be short-lived or limited, leaving several other important service elements unaddressed. These include improving service frequency to meet additional demand and expanding the public transport network to effectively cover all areas. Strategies include by eliminating travel costs, the program allows women and transgender people greater freedom of movement, thereby providing greater access to education, livelihoods, healthcare and recreation. The Shakti Smart Card also opens the possibility of including private and informal services in the program. To maximize impact, the bus fleet must be expanded, frequency increased, and crowds reduced. Challenges in coordinating with multiple stakeholders, including bus operators, subway operators and other transportation companies. This will benefit women and transgender people free on roads and buses across the state.

Bengaluru Smart City Portal

The Bengaluru Smart City portal is in line with the

Smart Cities Mission of the Government of India. Providing core infrastructure, ensuring a decent quality of life for citizens, creating a clean and sustainable environment, and implementing innovative “smart” solutions. Strategies include creating a Special Purpose Vehicle (SPV) for the Smart Cities Mission to ensure operational independence and autonomy in decision-making and mission implementation. By integrating services and data, the portal optimizes resource allocation. Efficient management of infrastructure such as surface drainage, sewage networks, water supply, electricity, and telecommunications leads to cost savings. The advantages of this portal are that it provides access to necessary services and information; the portal aims to improve people's quality of life. Access to vital resources such as the Air Quality Index (AQI), essential contacts, government offices, hospitals, pharmacies, ATMs, and dining options is made easier. Citizens can submit complaints on civic matters directly through the portal. The portal uses data for efficient city planning and administration. By integrating services, it contributes to better traffic management, waste management, and other essential aspects of city life.

Smart Streetlights

Bengaluru aims to improve energy efficiency, safety and overall city management using smart streetlights. Energy efficiency and waste reduction, improved security, cost optimization and consumption tracking, and phased implementation across all zones. Strategies The project supports the BBMP in accurately recording the amount of energy consumed. This data indicates the amount owed to the electricity provider. It also determines the causes of lights not working. The advantage is that CCTV cameras integrated into streetlights increase security and SOS systems enable immediate help in emergencies. The central control and monitoring system enables the central management of streetlights. Officials can adjust lighting levels remotely, eliminating unnecessary lighting during daylight hours.

Hyderabad

Hyderabad is a notable example of a smart city

among the many cities adopting this concept. Hyderabad, a thriving centre of economic activity and technological innovation, is in the centre of India and is not only a busy metropolis. The Hyderabad Smart City Mission was initiated by the Telangana government in recognition of the need to balance sustainability and inclusivity with the demands of urbanization. Hyderabad's goal to become a smart city includes making its transportation network a seamless, multimodal one as one of its main tenets. There was an urgent need to transform how people move through the urban landscape due to the city's rapid population growth and increasing traffic congestion. Hyderabad has set out to redefine urban mobility through a combination of policy changes, technology advancements, and well-timed investments. The purpose of this thesis is to examine the smart governance and transportation reforms that Hyderabad's smart city mission has put in place, with a particular emphasis on the creation of a multi-modal transportation system. Through an examination of the implemented programs, their effects on urban mobility, and the difficulties faced during the process, this research aims to provide light on the wider consequences of smart city programs for sustainable development and urban governance. This thesis attempts to contribute by means of an extensive analysis of Hyderabad's experiences.

Hyderabad Road Development Corporation Limited (HRDCL)

The Telangana State Government has decided to identify and develop the Missing Link Corridors and Slip Roads which will continue to serve as the backbone for the future development areas and improve the existing transport network to alleviate the existing and increasing traffic congestion problems. These road connections will also serve as the shortest alternative routes. The Honorable Minister MA&UD and Principal Secretary to the Government. MA&UD has completed 133 links with a total length of 126.20 km after reviewing with GHMC and HRDCL officials. These road links are referred to as “Missing/Slip Roads” as they are intended to provide the missing links to distribute traffic more effectively across the road network in Hyderabad City. Strategies are the missingconnecting roads were developed

simultaneously with other strategic road projects. To meet schedules, coordination of construction activities and efficient management of resources were essential. Challenges faced are balancing the need for connectivity with practical technical considerations presented a challenge. Coordinating construction activities, managing resources and meeting schedules for both projects presented logistical challenges. Ensuring cooperation and compliance from property owners while simultaneously adhering to project timelines was a challenge. Enhance the mobility of Hyderabad residents by improving traffic operations on major corridors, shortening travel distances for commuters, and increasing road safety features. Economic growth will be promoted through the enhancement of commercial establishments and property values. Carbon emission levels will be reduced and journey times on main roads will be improved during peak hours. Dark areas will be opened to effectively control anti-social activities, and the risk of death for emergency patients will be reduced by facilitating the quick movement of ambulances, these are benefits of this reform.

HMDA (Hyderabad Metropolitan Development Authority)

HMDA was established to plan, coordinate, monitor, promote, and ensure the planned development of the Hyderabad Metropolitan Region. It coordinates the development activities of municipal corporations, municipalities, and other local authorities, Hyderabad Metropolitan Water Supply & Sewerage Board, Telangana Transmission Corporation, Telangana Industrial Infrastructure Corporation, Telangana State Road Transport Corporation, and other such entities. Apart from proposing a comprehensive land use plan for the Hyderabad Metropolitan Region as part of Master Plan 2031, HMDA is also working on a long-term mobility plan for the Hyderabad Metropolitan Region (HMA) and has submitted proposals for a vision statement. 2050 plan focused on HMA's future economy.

HEALTHWAY Hyderabad's New Cycling Destination

The concept of "HEALTHWAY" is to give people of all ages access to their own space and the opportunity to practice health-promoting activities at any time of the day. The 23 km long route is 4.5

m wide and accommodates three lanes, allowing cyclists to ride side by side. Additionally, the track is covered in solar panels that not only generate electricity but also protect riders from harsh weather conditions. Strategies include: 16,000 solar panels are installed on the roof of the route, generating 16 MW of electricity. The investment is expected to pay off within six years, meaning the project will be financially self-sufficient within 15 years. The route has five entry points including Narsingi, Kollur, TSPA, Vattinagulapalli, and Nanakramguda, and offers safety facilities such as first aid stations, bike docking stations, food stalls, CCTV and water dispensers. Hyderabad's solar-powered cycle path contributes to its efforts to reduce carbon emissions and cements its position as the most environmentally friendly cycle path in the world. HealthWay wants to expand beyond cycling as a recreational centre, offering amenities such as parking, security cameras, food courts, drinking water facilities, first aid stations and toilets. The challenge is that the HealthWay track requires seamless connectivity with existing infrastructure and requires collaboration with local authorities, care providers, and local communities for successful integration. The benefits are cycling is a beneficial activity that promotes physical activity, cardiovascular health, and overall well-being by providing a safe environment for outdoor exercise for all ages. The more people choose to cycle, the fewer traffic jams and air pollution will occur. The project also creates employment opportunities during the construction and maintenance phases.

Hyderabad Metro Rail Limited & Metro Smart Cards

The Hyderabad Metro aims to reduce traffic congestion, reduce pollution, improve quality of life and promote intermodal connectivity. It eases traffic flow by lowering the number of private vehicles on the road. The project also improves the quality of life by connecting different parts of Hyderabad, thereby increasing the quality of life. In addition, it stimulates economic growth by improving accessibility to commercial centers, educational institutions, and employment centers, attracting investment, and contributing to the city's prosperity. Strategies are L&T Metro Rail Advertising provides strategic advertising space in

Hyderabad Metro while Pay Tunes designs customized advertising adhering to legal and technical requirements. HMRL views subway stations as hubs of activity. These stations will house shopping malls, multiplex cinemas, offices, hotels, restaurants, clinics, and more, enhancing the overall city experience. Metro stations serve as a convenient and efficient solution to nearby neighborhoods, providing seamless travel and meeting daily needs. As retail options develop, they are becoming a key destination for commuters. Challenges at the Beginning of the Project Land acquisition in the Ameerpet section faced challenges due to opposition from local traders, leading to delays and negotiations. Benefits of the metro system include a significant decrease in the use of private vehicles, which lowers air pollution and traffic congestion. These strategically placed metro stations are simple for commuters to reach, and they easily connect to other forms of transportation.

Smart cards have been introduced by Hyderabad Metro Rail to increase efficiency and convenience for commuters. The Smart Card is a virtual wallet that enables easy travel; it costs Rs. 100 at metro stations and can be recharged online for an additional Rs. 100. Hyderabad Metro provides smart card applications. If the old card is lost or damaged, a new card is required, and the remaining balance is transferred to the new card. The project was implemented under a public-private partnership (PPP) model using the Design-Build-Finance-Operate-Transfer

(DBF OT) approach. Smart cards encourage frequent commuters to choose them because they offer cheaper fares than single tickets. The integration of smart card technology into the metro infrastructure presents certain challenges that must be carefully planned and implemented. This includes informing commuters about the benefits and efficient use of the technology, as well as simplifying the procedures for replacing damaged or lost cards and transferring funds to new cards. Benefits include that smart card users often receive cheaper fares than single-ride token users, making them an affordable choice for frequent commuters. To save time and eliminate the need for token

purchases, smart cards provide a convenient and effective way to enter and exit subway stations.

ACT Fiber Public Wi-fi

The aim of this ACT Fibernet has collaborated with the Government of Hyderabad to set up Wi-Fi hotspots across the city. This initiative is part of the Smart City project and is being implemented by the government. The strategies are ACT Fibernet increases brand visibility by providing free Wi-Fi hotspots, promoting positive user experiences, and improving its reputation through a stronger brand image. Free Wi-Fi in the ACT Fibernet network attracts more users and promotes customer loyalty and a positive perception of the company among residents and visitors. ACT Fibernet's free Wi-Fi service can collect valuable user data, enabling marketing strategies, service improvements, and targeted offers. Although ACT Fibernet offers free Wi-Fi, it has the potential to generate revenue through sponsored advertising, local business partnerships, or premium services. Installing fiber optic cables along pipelines and uneven terrain can prevent crews from drilling or excavating trenches for cable installation. Urban areas with overburdened infrastructure, mountainous regions, or underwater facilities present additional challenges. The advantage is that Wi-Fi hotspots are accessible to everyone, allowing users to save money on data plans and do Internet-related work on the go. Hotspot locations such as malls, airports and subway stations provide remote working opportunities and encourage people to return to work, thereby increasing productivity. Wi-Fi stations can help in emergencies by quickly connecting the population to emergency services and allowing them to regain control of the situation. The Internet is extremely useful for students, especially those who travel, as it allows them to access important information and resources.

Multi-Level Parking

The construction of a multi-storey parking facility in Nampally, Hyderabad aims to meet the growing demand for efficient and organized parking in the busy area close to tourist attractions like Hyderabad Railway Station and Exhibition Center, as part of smart city initiatives that integrate multiple parking options. Level parking with other means of transport. The strategies are similar. The

project will start near Charminar to ease parking problems. The complex is expected to provide paid parking for around 145 to 150 four-wheelers and an equivalent number of two-wheelers. The project aims to reduce traffic congestion by providing a designated parking space, thereby improving the smooth flow of traffic in the area. Nampally's multi-level parking system uses automated technology for efficient entry, exit, and vehicle movement, eliminating the need for human intervention. The parking fee is 100 rupees or more, depending on the length of time the car stays at the facility. Source: Hyderabad to get multi-level parking complex near Charminar to ease parking woes (siasat.com)

Smart Parking Under Flyover

The purpose was to help motorists avoid the hassle of finding parking when reaching the location. It would also help streamline traffic in the region and curb chaos. Challenges faced project have been scrapped due to maintenance issues, and commuters are not happy. GHMC official sources said that they are in the process of reviving the smart parking project and that they are exploring various models beforehand.

Kanpur

260 square kilometres make up the Kanpur metropolitan area. is Uttar Pradesh's largest city and the state's primary hub for business, industry, and education. With Kanpur's economy and population growing at a rapid pace and the resulting need for infrastructure, it was essential to use technology to manage every aspect of the smart city. A distinct Special Purpose Vehicle (SPV) called Kanpur Smart City Limited has been established by Kanpur Municipal Corporation.

SPV – Kanpur Smart City Limited

Kanpur Smart City Limited has managed to bring together all the industries, assets, and boundaries falling under the Kanpur Smart City jurisdiction under one GIS umbrella and leverage geospatial technology optimally for managing and continuously improving their operations as well as the infrastructure development and management.

Integrated Command and Control Center

The Kanpur ICCC is an important center for monitoring digital services, organizing elements of smart cities, and ensuring departmental coordination. It combines information from

multiple systems to provide citizens with a unified platform to address issues and improve situational awareness. Advantages: The ICCC provides unified monitoring of all components developed within the Smart City project via a dedicated Barco video wall. This central customer service center improves coordination and efficiency. The city's sensors provide data to the ICCC, improving situational awareness.

Smart Parking System

Using a mobile application, car owners can find available parking spaces in the multi-story parking complexes in the industrial capital of Uttar Pradesh. Alternatively, they can reserve a parking space in advance via the mobile app for a fixed fee.

Smart Roads

The Smart Roads project renovates existing roads to provide equal convenience to all users, including drivers, pedestrians, and vendors, by creating smart walking and cycling paths and installing street furniture. Benefits The Smart Road project aims to widen roads, restore pedestrian paths, create tactile paths for the visually impaired, install smart poles and cycle paths, and plant trees on both sides of the road.

Beautification of the city and restoration of historic buildings

Kanpur has a rich historical heritage that includes restoration of historical buildings and beautification of the city. It was a central site of the 1857 uprising that launched India's independence movement. To preserve the historical charm of the city, Kanpur Smart City Limited is restoring historical places like Nana Rao Park, Ghanta Ghar and Clock Tower. Well-preserved historic sites are a major attraction for tourists, history buffs, and academics alike. Increasing tourism stimulates economic growth by generating revenue for regional businesses, tourists, and hotel providers. Historic buildings improve living standards in cities, create jobs, and serve as learning centers for visitors, scientists, and students. Benefits are in addition to restoring historic sites, parks are being made more aesthetically pleasing, and open gyms are being created. Currently, as many as six open gyms have been set up at the following locations: Kengil Park in Motijheel, Geeta Park in Kidwai Nagar, Water Park in Hanspuram, Mahapalika Park

in Ratanlal Nagar and Ramleela Park in Geeta Nagar KCSL.

Water Management KSC

KSC wants to store and purify rainwater for use in drinking water by installing rainwater harvesting systems in six government buildings throughout the city. Advantages In addition, KSCL is creating smart water meters, which will have the following features to prevent water waste and make the best use of the resources at hand.

Pune

Pune has embraced the smart city concept to improve the quality of life, sustainability, and the local economy. Pune is the epitome of the vibrancy and diversity of modern Indian cities. It is in the western state of Maharashtra. In 2015, the Government of India initiated the Smart Cities Mission to promote sustainable urban development across the country given the growing urbanization trend and increasing strain on infrastructure and essential services. Pune quickly recognized the opportunity this mission presented, given its rich history, growing IT sector, and dynamic cultural environment. Pune was chosen as the focus of study for several good and non-random reasons. First, Pune is a microcosm of India's larger urban problems such as air pollution, poor infrastructure, and traffic congestion. By examining smart governance and transport reforms in Pune, important insights can be gained about the effectiveness of smart city interventions in addressing these pressing issues. Pune has made bold efforts to create a multi-modal transport network integrating multiple modes of transport as part of its Smart City Mission (SPV called Pune Smart City Development Corporation Limited (PSCDCL)).

The Smart Pedestrian Street (SPS)

project in India aims to improve walkability and non-motorized transport in cities, thereby promoting sustainable, fair, and inclusive smart cities. The project includes redesigning road sections to facilitate pedestrian traffic, implementing dedicated infrastructure, improving the integrity of the transport network, and improving the aesthetic appeal of roads through native vegetation and decorative elements. Benefits include aesthetically pleasing streetscapes, a preference for non-motorized transportation,

reduced emissions, and increased pedestrian traffic for businesses along smart streets. The project also offers economic benefits, such as creating livelihood opportunities for street vendors and increased foot traffic for businesses.

Electric Buses

Pune, the second largest city in Maharashtra, faces challenges related to air pollution, traffic congestion, and dependence on fossil fuels for transportation. The Pune Municipal Corporation (PMC) recognized the need for sustainable mobility solutions to address these issues. The motivation was to reduce emissions, improve air quality, and improve public transport. Strategies Pune Smart City Development Corporation Limited (PSCDCL) played a crucial role in promoting smart solutions, including electric buses. Advantages By drastically reducing greenhouse gas emissions, electric buses help clean the air. Better public health outcomes are a direct result of improved air quality. Over time, electric buses have proven to be cost-effective due to lower fuel and maintenance costs. Public Feedback The entire journey from Vanaz to Ramwadi and then to the airport via PMPML shuttle service took about an hour and cost him just Rs 50. For the first time, I was so impressed by public transport in the city. I am a frequent flyer and the fare to the airport costs me around Rs 200 or more.

Pune Cycle Plan (Guidelines of BRT under JNNURM)

Create a preliminary plan for Pune's 300 km network of bike lanes. Cyclists will have access to safe and effective routes thanks to these dedicated cycle tracks. A public bicycle share program is planned, with the first phase consisting of over 3,000 bikes spread across 250 stations in the city. The public's ability to easily access bicycles is the goal of this system. Strategies are Measures such as deployment of cycle guards, installation of CCTV cameras, and issuance of e-challans to help maintain the integrity of cycle infrastructure. Benefits the bikes are specifically designed to be easy to ride for both women and men of different heights, robust, with mechanisms to protect against theft and vandalism, and with space for branding for easy identification and advertising, which helps reduce costs to compensate for the rental of bicycles.

One Pune NCMC Rupay Card

The One Pune Card is part of the One Nation, One Card initiative and can be used for various public transport across India as well as retail payments. It follows the National Common Mobility Card (NCMC) norms and offers benefits such as discounts on subway rides and contactless payments. The aim is for the card to make traveling on the subway easier by allowing passengers to get on and off without paper tickets or long queues. Beyond metro rides, the card can be used for contactless payments at various retail outlets in India. It offers a convenient and secure way to pay for goods and services. Strategies It does not generate direct revenue for the PMC, its benefits lie in improving convenience, promoting contactless payments, and contributing to environmental sustainability. The benefits are: Manage your card effortlessly through a single portal. Top up money, check your balance, and set spending limits - all in one place. It is accepted both online and in-store, offering flexibility for various payment needs.

Intelligent Street Lighting

Pune Municipal Corporation's (PMC) Smart Street Lighting initiative aims to improve street lighting infrastructure in the city. Upgrade existing lights to energy-efficient LEDs, improve safety and environment, maintain high power factor and quality, and ensure long-term maintenance and cost reduction. The project's strategies are to provide a much safer environment for commuters and pedestrians by producing higher-quality white light. Challenges Implementing smart street lighting in Pune faced several challenges. Technical Challenges: Broken lights, low wattage, cable issues, tree branches obstructing. Obstruction from branches: maintenance delays, coordination with stakeholders, privacy and security, and public engagement. Benefits Compared to traditional lighting, LED lights help save 30-50% of energy. By maintaining a high-power factor (>0.98), the project maximizes the energy efficiency of the LED lights. The initiative focuses on quality and strives to deliver reliable and consistent lighting. Benefits include savings on maintenance costs, energy efficiency, and a modern, maintenance-free lighting system.

Adaptive Traffic Management System (ATMS)

Adaptive Traffic Management System (ATMS)

aimed at improving traffic flow and reducing congestion in the city. The ATMs will be placed at 125 traffic signals along various routes, beginning in Kothrud and moving through Hadapsar, Pune Airport Road, SB Road, and Satara Road. The aim of this system is effective traffic management. In addition, these cameras will also detect vehicles violating traffic rules and the system will be integrated into the traffic authority. Strategies include ATMS using cameras and signal controls to detect vehicles up to 200 meters away and adjust times depending on queue size to reduce traffic flow and delays. Challenges The ATMs installed at 125 intersections on congested city streets face challenges in seamless integration and activation in these complex locations. The benefits of this project by optimizing signal times based on traffic conditions, congestion can be reduced, travel times shortened, and overall traffic efficiency improved. The system's cameras help detect traffic violations and provide the traffic authority with important data for law enforcement and planning purposes.

5. Discussion

In the digital era, the paradigm of urban governance has completely changed in the digital age. Ensuring sustainable development while improving the quality of life for their citizens is the goal of these technologically advanced cities. Of all the many aspects of smart cities, multimodal transportation is a crucial one that determines the effectiveness, accessibility, and sustainability of urban mobility in terms of the environment. In this regard, the cities of Pune, Bengaluru, Hyderabad, and Kanpur have set out on bold paths of astute governance and reform programs, each overcoming obstacles and making use of unique approaches.

A comparative analysis of the smart governance frameworks and reform initiatives that the four cities (Bengaluru, Hyderabad, Kanpur and Pune) have implemented in multi-modal transportation was done. Through an examination of the reforms implemented under the smart governance vehicles by their infrastructure developments within transportation domain and citizen-centric approaches implemented in Bengaluru, Hyderabad, Kanpur, and Pune by analyzing the major focusing features of those reforms. This

research aims to identify key takeaways, identify best practices, and pinpoint cities that require improvement in the pursuit of promoting sustainable and effective urban mobility.

The city of Bengaluru, which is frequently referred to as the Silicon Valley of India, has been at the forefront of innovative solutions for last-mile connectivity and intelligent traffic management systems due to its severe traffic congestion and environmental degradation. The Integrated Traffic Management System (ITMS) and Hyderabad's emphasis on encouraging non-motorized transport modes are two examples of the city's notable progress in utilizing technology to streamline transportation systems. Strong traffic jams in Kanpur, a historic industrial city, call for coordinated efforts to resurrect public transportation networks, promote multimodal connectivity, and adopt sustainable mobility options. Pune, known for its rich cultural legacy and growing IT industry, has tried to address its growing transportation challenges by combining technologically advanced projects, infrastructure augmentation, and citizen engagement activities.

This analysis aims to clarify the complexities of smart governance and reform initiatives within the multi-modal transportation domain across Bengaluru, Hyderabad, Kanpur and Pune through a methodical comparative analysis. We created a framework for this research analysis using all the findings from the individual reforms implemented in each city, emphasizing in green the main goals and functional aspects of the implementation and operation of the reform in that city. Based on the frequency and commonality, we were able to identify the important key features during our investigation such as safety, inclusivity, integration, quality of life, affordability, sustainability, technological advancement and digitization. A lot of work has gone into creating the framework for reform that is connected to its salient characteristics, such as their recent successes in multimodal transportation in a few chosen smart cities.

---Insert Figure 2 Bengaluru's framework of majorly focusing areas--

---Insert Figure 3 Hyderabad's framework of majorly focusing areas---

---Insert Figure 4 Kanpur's framework of majorly

focusing areas---

---Insert Figure 5 Pune's framework of majorly focusing areas---

The framework enumerates the reforms that have been put into place by the individual cities; these include a variety of policy interventions, infrastructure developments, technological deployments, and citizen engagement initiatives that are designed to improve multimodal transportation systems. In their search for clever urban mobility solutions, these reforms were painstakingly found and grouped according to their goals, reach, and methods of implementation. Every feature was ranked according to its importance within that specific reform to determine the overall score for each city. The present study employed a comprehensive framework to conduct an analysis that compared the smart governance reforms implemented in the multi-modal transportation domain of Bengaluru, Hyderabad, Kanpur and Pune. This framework provided a systematic means of assessing the effectiveness and consequences of different reforms, making it easier to compare the smart city projects that these cities undertook.

The graphs enable a comprehensive evaluation of the strengths, weaknesses, and relative efficacy of each reform initiative in the four cities that are being examined by assigning a score based on these focal features. With the help of this analytical technique, it is possible to identify emerging trends, areas for improvement, and best practices in the field of smart governance for multimodal transportation. This information can then be used to inform policy discussions, urban planning initiatives, and tactical interventions that are intended to promote resilient and sustainable smart cities.

---Insert Figure 6 Bar graph showing Bengaluru's framework score---

---Insert Figure 7 Bar graph showing Hyderabad's framework score---

---Insert Figure 8 Bar graph showing Kanpur's framework score---

---Insert Figure 9 Bar graph showing Bengaluru's framework score---

A significant component of this research was measuring indices, which were essential benchmarks for assessing the overall performance

and liveability factor of these smart cities. These indices included the Municipal Performance Index, the Ease of Mobility Index, and the Ease of Living Index. For each city, the accessibility, affordability, and effectiveness of the transportation systems were evaluated quantitatively by the Ease of Mobility Index. The four cities' residents' general quality of life and the urban amenities they have access to are evaluated using the Ease of Living Index, which also functions as a barometer. A comparative assessment of the governance efficacy and service delivery methods used by local authorities in each city was also made easier by the Municipal Performance Index. The objective of our study was to identify best practices, and identify patterns in the quest to realize the vision of smart reforms that are workable in urban environments by comparing the performance metrics derived from these indices with the specific smart governance reforms that arise from our comparative study of smart governance and transportation reforms in these four vibrant urban centres, building on the analysis summary that serves as a basis for those conversations. The following are the graphs obtained from the recent indices released through the government website sources related to the four cities chosen.---Insert Figure 10 Bar graph showing Ease of Mobility Index---

---Insert Figure 11 Bar graph Municipal Performance Index---

---Insert Figure 12 Bar graph showing Ease of Living Index---

Examining the years of reform implementation and initiation was a crucial component of this analysis, as it offered insightful information about the dynamics and development of smart transportation projects over time in these metropolitan areas. Through a detailed understanding of the temporal dynamics influencing the cities' smart governance agendas in the multimodal transportation domain, the analysis reveals the chronological sequence of reforms implemented in each of the chosen cities. The trajectory of transportation reform initiatives in the cities can be identified with the help of this temporal lens. The present analysis provides a basis for the synthesis of significant findings and the identification of feasible routes to achieve the

goal of creating intelligent, just, and habitable urban spaces in the chosen cities.

---Insert Figure 13 Timeline of the reforms implemented in Bengaluru Smart City---

---Insert Figure 14 Timeline of the reforms implemented in Hyderabad Smart City---

---Insert Figure 15 Timeline of the reforms implemented in Kanpur Smart City---

---Insert Figure 16 Timeline of the reforms implemented in Pune Smart City---

The investigation's key findings during this research show that Pune has the highest framework score among the four cities taken into consideration, indicating that almost all of the objectives within the framework should be prioritized equally. These key findings show that Pune will rank highest out of the four cities. With the exception of Bengaluru's top ranking in the ease of living index, the measurement index graphs also demonstrate the same characteristics in terms of affordability, sustainability, user feasibility, and inclusivity.

Bengaluru is focused on most aspects of the reforms it has undertaken with the calculated score being 41. It is still lagging in the feasibility that the reforms offer to customers, which is why it can be said that this may be the reason why it is comparatively ranked third in the mobility-riendliness indices. Also, compared to the reforms undertaken in Bengaluru, integration is the lowest priority, while quality of life comes first. Therefore, the city's quality of life index ranks first among the four cities.

The city that rose above the bottom spot on the selected list is Hyderabad. In my opinion, the reason it is in second place and showcasing its best municipal performance index and mobility index is that it prioritizes affordability, technological advancement, and user-feasible features in all of its initiated reforms.

Conversely, Kanpur has the lowest overall score of 20 points and the lowest ranking across all measurement indices, coming in at number four overall. Nonetheless, when compared to other cities, its goal of giving equal weight to safety, integration, technology use, and user feasibility in its reforms is nearly achieved. Because Kanpur has upgraded its infrastructure and implemented new initiatives or reforms for its transportation

development, it continues to be ranked lowest despite this.

The findings of the study conducted to ascertain how frequently reforms are implemented in the chosen cities make it evident how infrequently Kanpur implements new reforms and introduces new technologies to support infrastructure expansion and urban development. The competition between Hyderabad and Pune, on the other hand, is in how frequently they operate, apply cutting-edge technologies, and expand their infrastructure particularly in the transportation sector in order to bring about positive changes in their places.

Urbanization is a global phenomenon that poses significant challenges in governance, sustainability, and mobility. As cities expand and populations grow, the need for efficient transportation systems becomes increasingly apparent. Integrating multi-modal transportation with smart city initiatives presents a promising solution to address these challenges. However, achieving this integration requires cogent and context-sensitive approaches that consider the unique characteristics of each city. This research problem is important because it tackles the urgent issues that cities around the world are facing and investigates the possible advantages of multi-modal transportation integration in the context of smart cities. Urban planning and policy decisions can be made with greater knowledge, and thorough understanding it offers of the effects on sustainability, equity, efficiency, technology, and governance. In more detail, an unprecedented amount of people is moving to cities around the world because of urbanization. Transportation-related issues like traffic, pollution, and wasteful resource use are made worse by this rapid urban growth. Through the integration of multi-modal transportation systems, smart cities seek to address these issues. Two of the most important global issues are climate change and environmental degradation. Greenhouse gas emissions are primarily caused by transportation. It is possible to lower the carbon footprint of urban transportation systems and raise environmental sustainability overall by integrating multimodal transportation in smart cities and by great practice through mobility and governance reforms. By

incorporating multimodal transportation reforms, we can provide improved mobility options for everyone, even underserved communities, lower the carbon footprint of urban transportation networks, increase the sustainability of the environment overall, and integrate multiple modes of transportation to increase the effectiveness and accessibility of urban transportation. This research has laid the groundwork for understanding the obstacles, gaps, and research goals concerning smart city governance and multi-modal transportation. It offers insights into the methodology and unique findings, highlighting the importance of cohesive strategies in addressing the challenges posed by urbanization and paving the way for the development of smarter, more sustainable cities.

The findings appraised the bridges between smart city governance and smart mobility, emphasizing the necessity for governance reforms within the realm of multi-modal transportation. It has underscored the importance of amalgamation of smart cities and multi-modal transportation reforms, stressing the crucial need for cohesive strategies in developing smart cities. The comparison of various multimodal transportation initiatives and smart city governance reforms in different cities highlighted the importance of cohesive strategies in developing smart cities. The research identified practical models that integrate multi-modal transport planning with seamless governance structures, emphasizing the significance of governance and intelligent mobility in the creation of smart cities. The findings exemplified through specific instances, such as smart bus stops, various transportation services, and other smart reforms, showcasing the implementation of smart city projects.

By distilling key features, measurement indices, and timeline frequencies of the reforms under infrastructure development program learned from the experiences of Pune, Bengaluru, Hyderabad, and Kanpur, this study informed the ranking of the cities by comparing the above-mentioned features of governance strategies aimed at fostering safe, inclusive, affordable and sustainable smart cities in the years to come. The comparative analysis undertaken in this thesis shed light on the multifaceted landscape of smart governance and

reform initiatives within the domain of multi-modal transportation across the vibrant urban centers of Pune, Bengaluru, Hyderabad, and Kanpur. Through a systematic examination of policy reforms' features which include, infrastructure developments, technological interventions, and citizen engagement endeavors, this study elucidated the diverse pathways in comparing more than one smart city.

Across the four cities under scrutiny, a myriad of smart governance reforms were implemented/initiated to address the burgeoning challenges of transportation congestion, environmental degradation, and socio-economic disparities. From Pune's innovative digitization initiatives to Bengaluru's pioneering use of intelligent traffic management systems, from Hyderabad's emphasis on technological integration to Kanpur's revitalization of public transit systems, each city charted a distinctive trajectory in its quest for smart urban mobility solutions. Considering all of the major goals of the implemented reforms, Pune would come out on top among the four cities examined, followed by Bengaluru, Hyderabad, and Kanpur. Moreover, the comparative assessment of indices such as the Ease of Mobility Index, Ease of Living Index, and Municipal Performance Index provided valuable insights into the holistic performance and livability dimensions of these smart cities. By correlating these performance metrics with specific smart governance reforms, this study explained the interplay between transportation infrastructure, urban governance, and quality of life outcomes, thereby offering a comprehensive perspective on the transformative potential of the chosen smart cities' initiatives.

The analysis underscored the importance of aligning policy interventions with local socio-economic dynamics, demographic trends, technological advancements, and governance capacities to ensure the relevance, sustainability, and impact of smart governance initiatives within the transportation sector. The findings underlined in the nuanced understanding of the contextual factors which are contributing towards the success graph of the individual cities under the reforms that are being operational and the effectiveness of smart transportation reforms across diverse urban

landscapes.

Through continued collaboration, innovation, and adaptability, the journey towards smart cities of tomorrow promises to be one defined by progress, resilience, and shared prosperity, transcending geographical boundaries and fostering a brighter future for generations to come. The reforms, which were supposed to play a catalytic role in changing the processes, culture, efficiency etc. have not yielded much results. While some of the reforms were underway and were completed during the course of the Mission, some remained completed only on paper. This research further calls for fostering comparative, data-driven, and quantitative approaches to smart governance within the multi-modal transportation domain.

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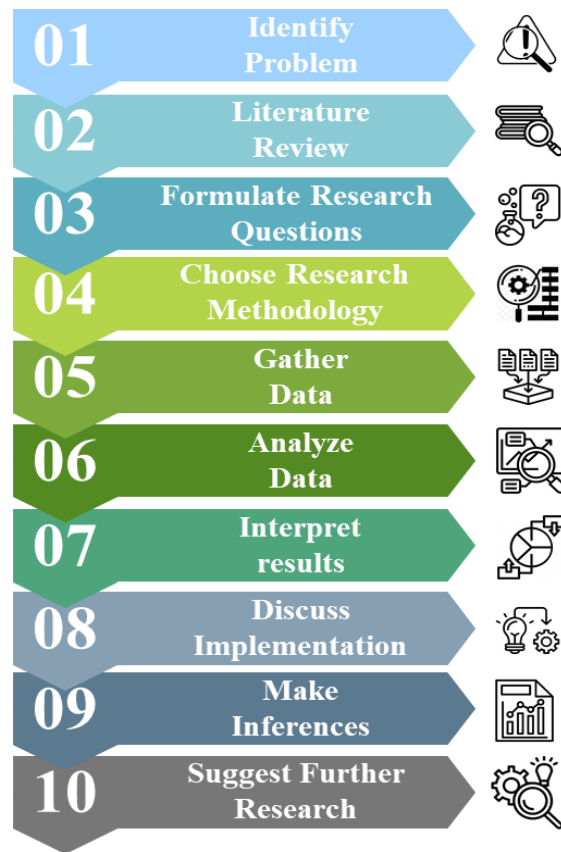


Figure 1 Research Process

BENGALURU									
Features	Safety	Inclusivity	Integration	Quality of life in Urban	Affordability	Sustainable	Technology	Digitization	Feasibility / User ease
Type of Reforms									
Smart Bus stop									
Shakti Smart Card									
Bengaluru Bus Corporation									
Footpath and Bicycle track									
Smart Street lights									
Waste management service									
Bengaluru Smart City portal (BengSCL)									

Figure 2 Bengaluru's framework of majorly focusing areas

HYDERABAD									
Features	Safety	Inclusivity	Integration	Quality of life in Urban	Affordability	Sustainable	Technology	Digitization	Feasibility / User ease
Type of Reforms									

Hyderabad Road Development Corporation Limited (HRDCL)									
HEALTHWAY Hyderabad's New Cycling Destination									
Metro transportation & smart metro cards									
Public Wi-fi									
Multi Level Parking									
Smart Parking Under Flyover									

Figure 3 Hyderabad's framework of majorly focusing areas

KANPUR									
Features	Safety	Inclusivity	Integration	Quality of life in	Affordability	Sustainable	Technology	Digitization	Feasibility/
Type of Reforms									
Integrated command and control center (ICCC)									
Smart Parking System									
Smart Roads									
Beautification of city and restoration of historic buildings									

Figure 4 Kanpur’s framework of majorly focusing areas

PUNE									
Features	Safety	Inclusivity	Integration	Quality of life in Urban	Affordability	Sustainable	Technology	Digitization	Feasibility / User ease
Type of Reforms									
SMART Pedestrian Street									
Electric Buses									
Pune Cycle Plan									
Intelligent Street Lighting									
Adaptive Traffic Management System (ATMS)									
One Pune NCMC Rupay Card									

Figure 5 Pune’s framework of majorly focusing areas

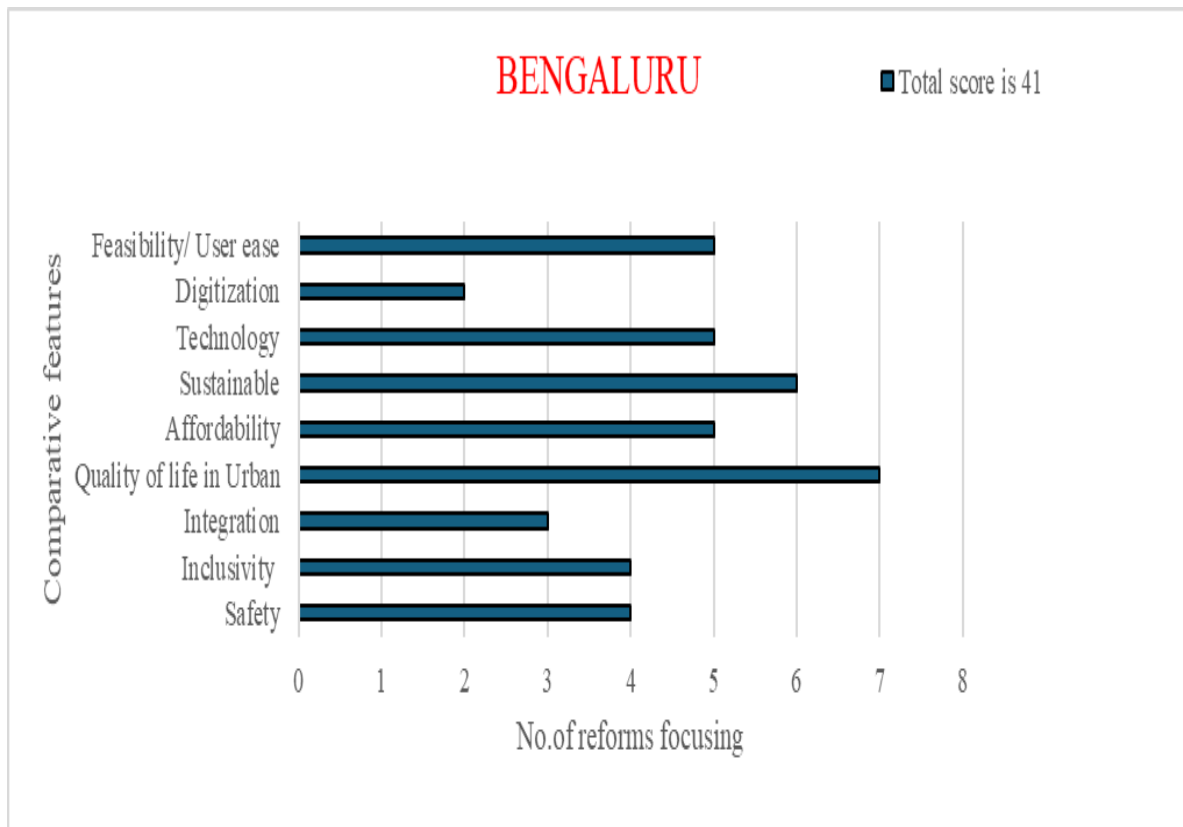


Figure 6 Bar graph showing Bengaluru’s framework score

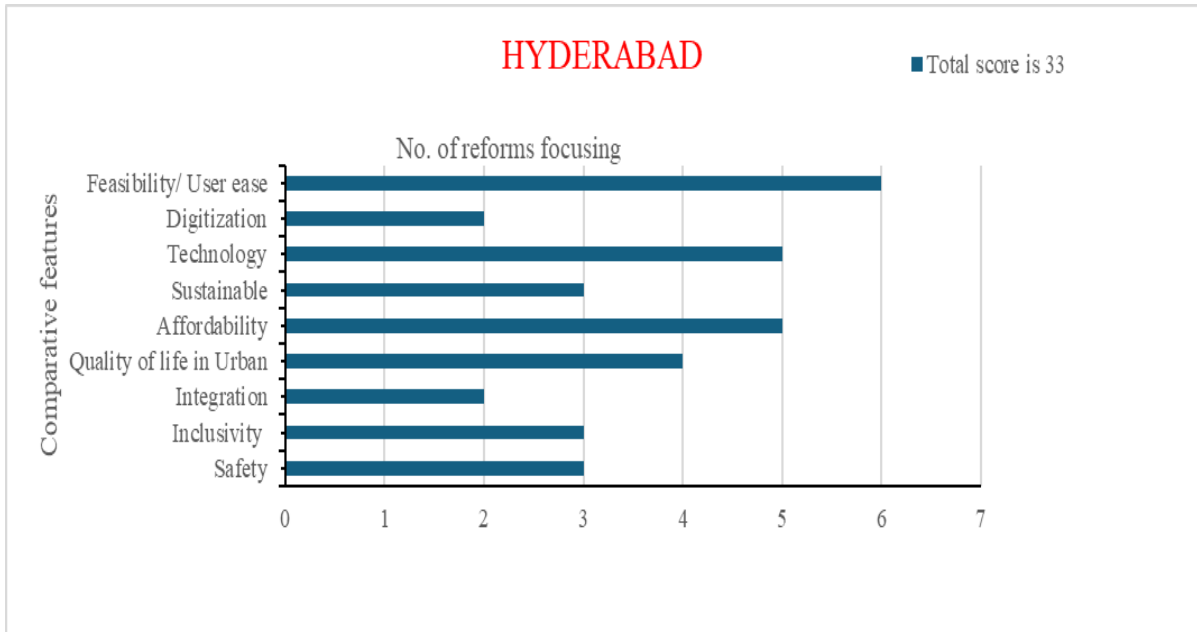


Figure 7 Bar graph showing Hyderabad’s framework score

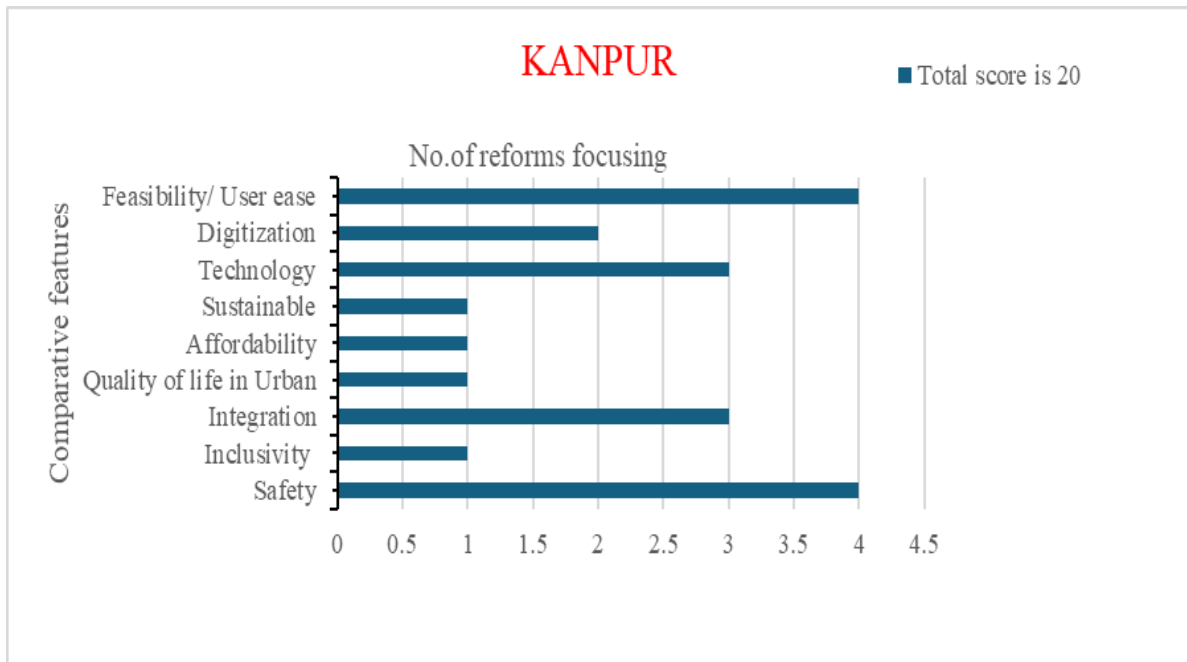


Figure 8 Bar graph showing Kanpur’s framework score

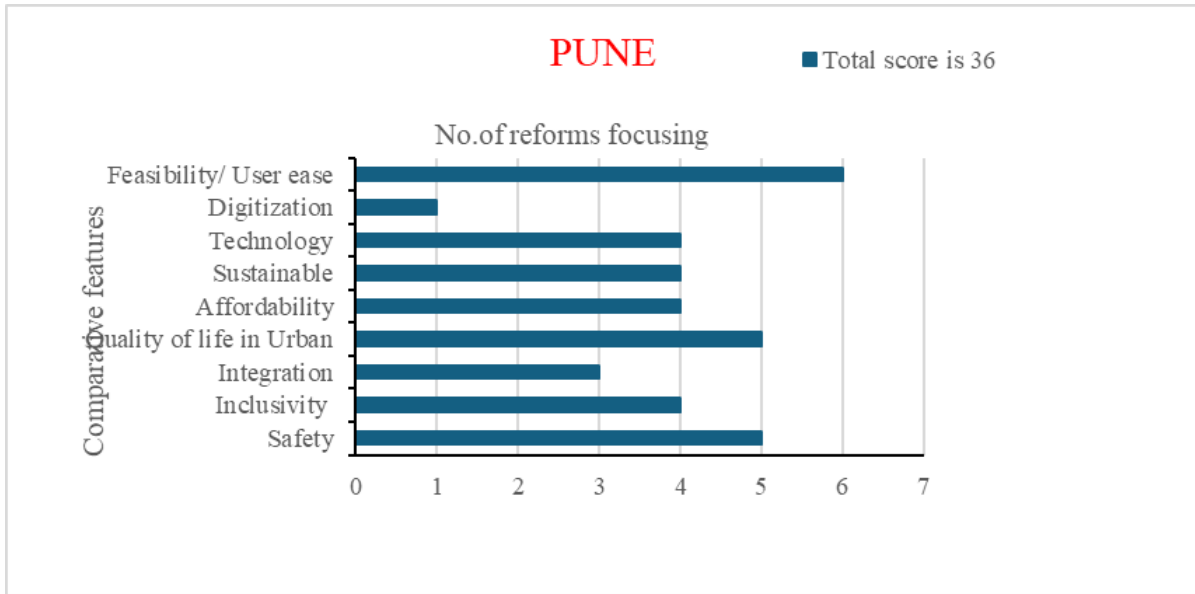


Figure 9 Bar graph showing Bengaluru’s framework score

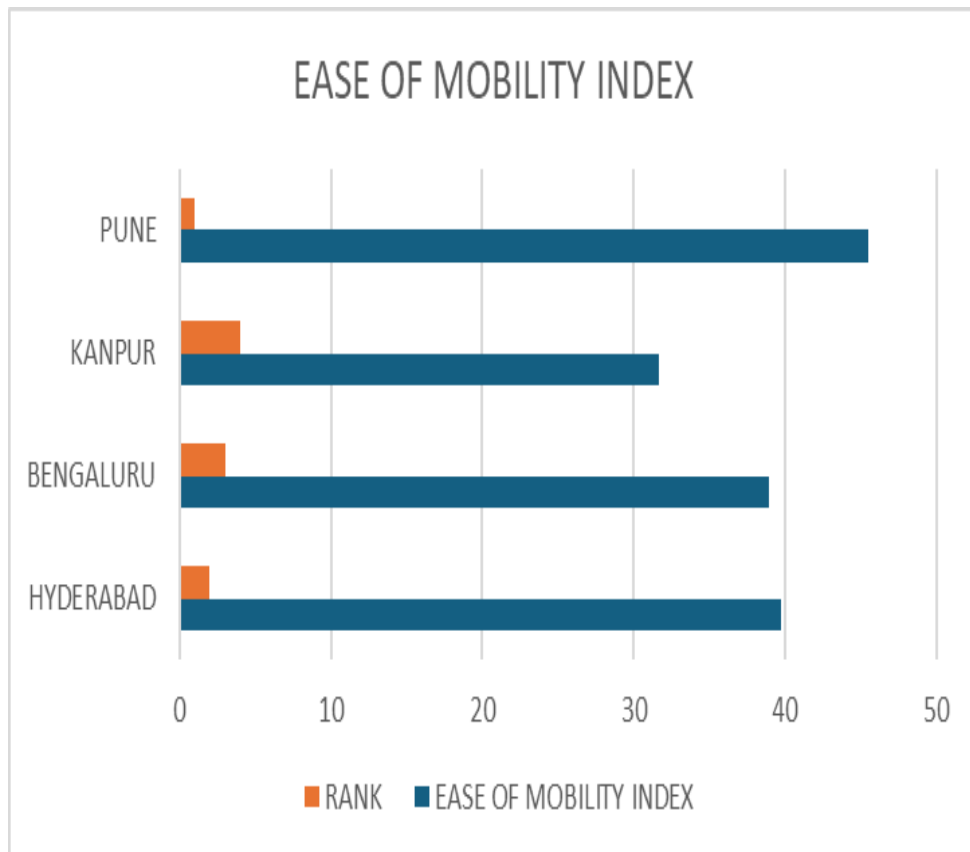
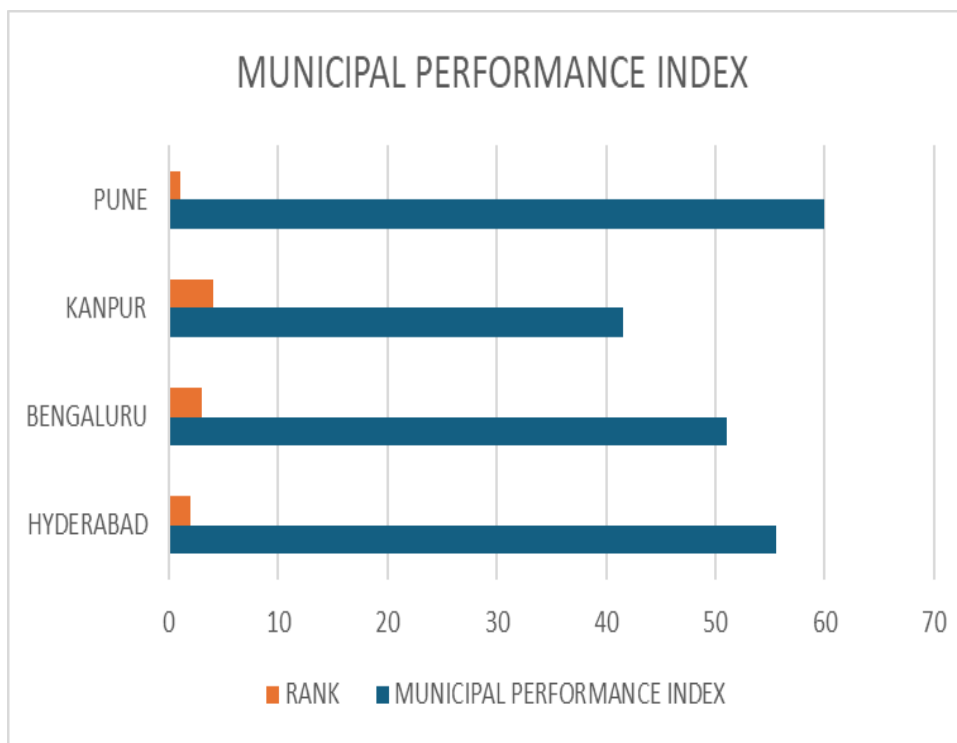
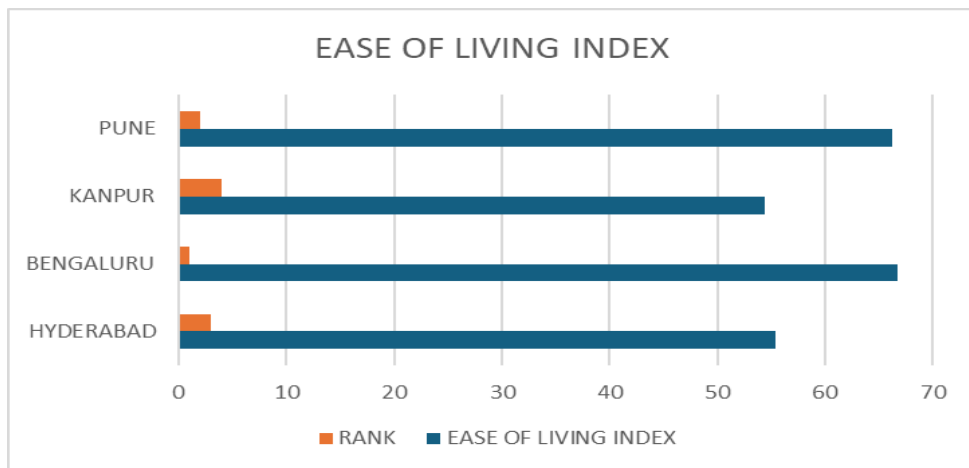


Figure 10 Bar graph showing Ease of Mobility Index

Figure 11 Bar graph Mu



municipal

Performance Index

Figure 12 Bar graph showing Ease of Living Index

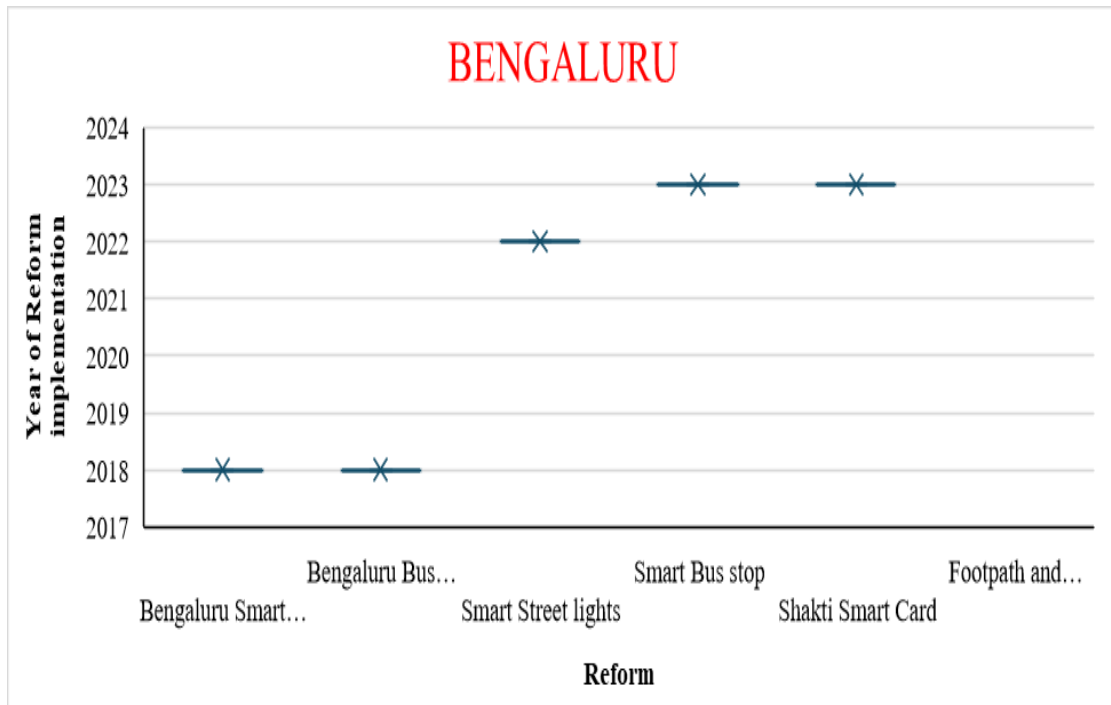


Figure 13 Timeline of the reforms implemented in Bengaluru Smart City

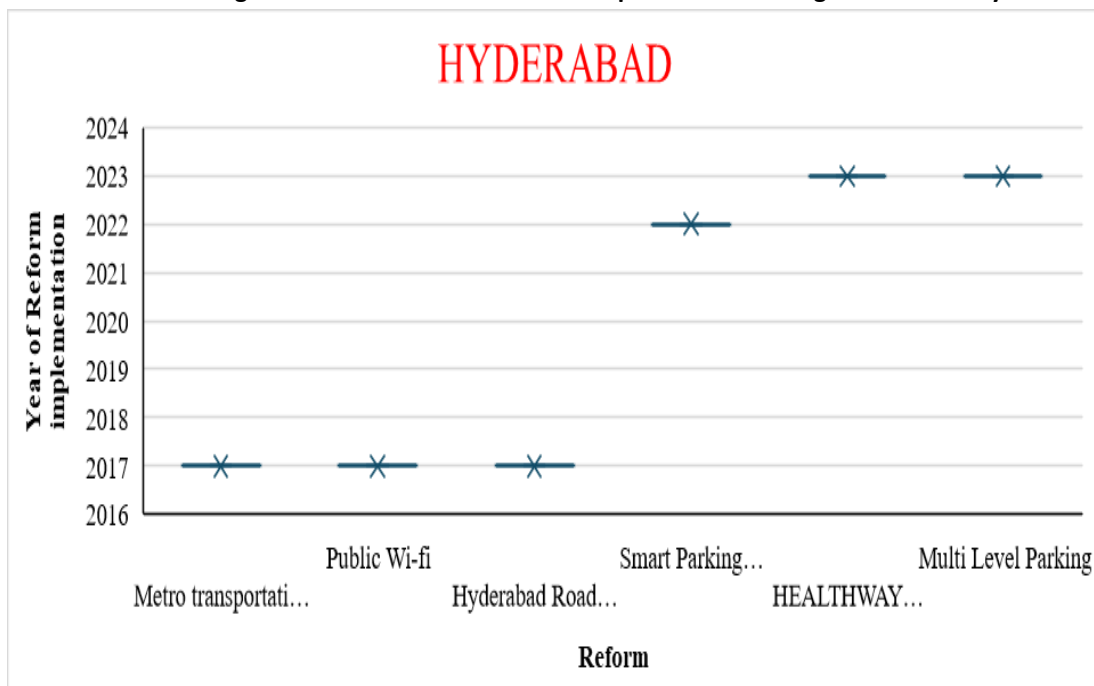


Figure 14 Timeline of the reforms implemented in Hyderabad Smart City

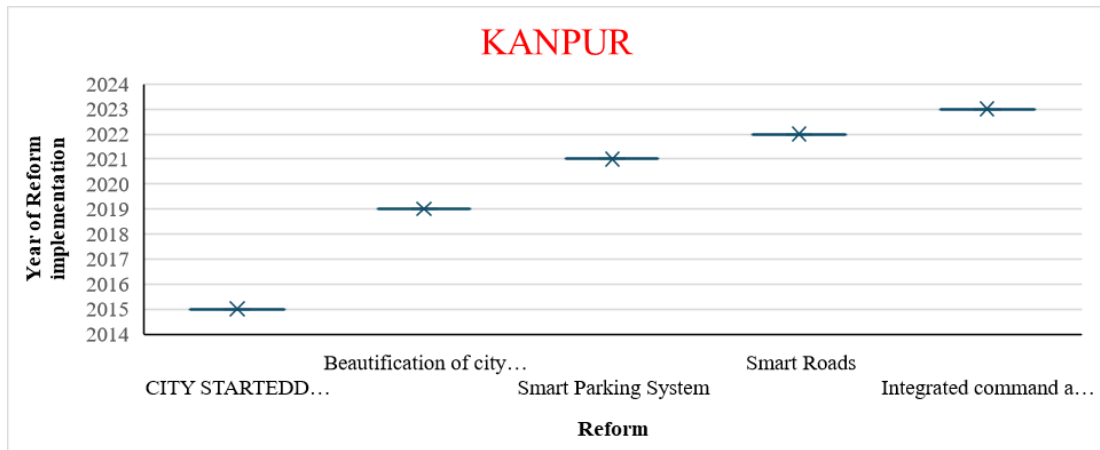


Figure 15 Timeline of the reforms implemented in Kanpur Smart City

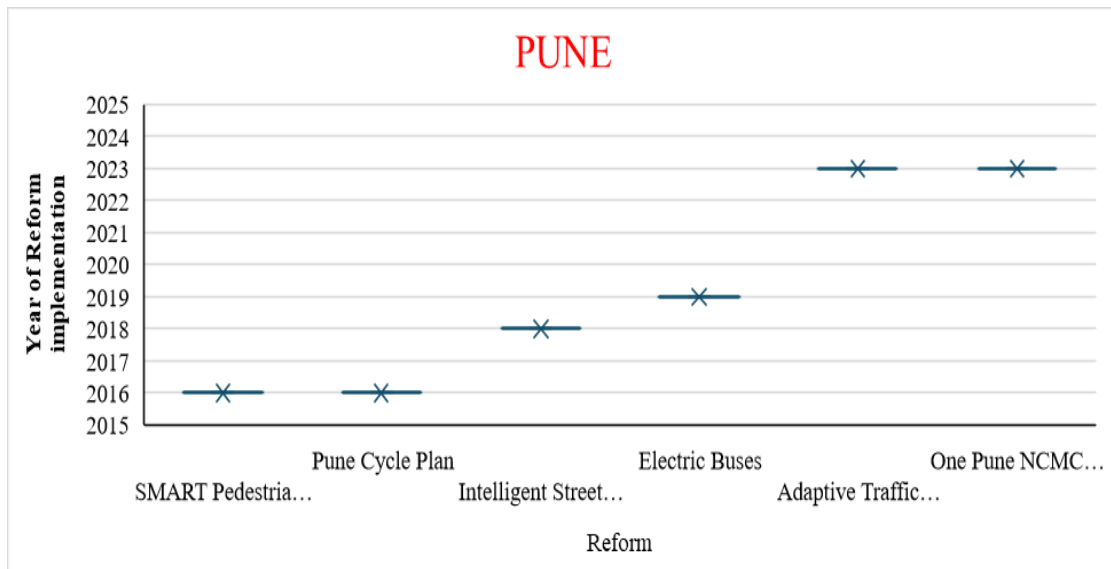


Figure 16 Timeline of the reforms implemented in Pune Smart City