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Artificial Intelligence-Powered Smart City Transformation: A Framework and Comparative Case Study Analysis

Mazin Ismael Raheem [1]* and Maha Ismail Raheem [2]

[1] *University of Nottingham, Department of Architecture and Built Environment, Nottingham, United Kingdom.*
[2] *University of Information Technology and Communications, Baghdad, Iraq.*

ABSTRACT

Rapid urbanisation necessitates reconsidering conventional urban management strategies and embracing creative alternatives for sustainable development due to rapid urbanisation and growing environmental challenges, including climate change, air pollution, and resource scarcity, which are mounting environmental concerns. In this regard, the idea of "smart cities" has surfaced as a strategic framework for enhancing urban efficiency via data-driven governance, digital technology, and intelligent infrastructure systems.

This study looks at how digital infrastructure, artificial intelligence, and governance frameworks can be integrated into existing cities to create smart and sustainable urban systems. A comparative case study analysis of Barcelona, Singapore, Dubai, and Baghdad is used in conjunction with a conceptual integration technique. Infrastructure, data systems, artificial intelligence, and governance are the four interconnected layers that make up the study's Smart City Transformation Framework. The results emphasise how crucial data-driven decision-making, adaptive governance, and legacy infrastructure integration are to attaining sustainable urban change. The report also highlights important issues, such as data ethics, energy demands, and sociopolitical limitations. By presenting a multi-layered, context-sensitive model for changing existing cities, the suggested framework advances urban theory.

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1. INTRODUCTION

Cities all throughout the world are experiencing fast urbanisation and population growth. Global urban growth patterns indicate that more than half of the world's population already lives in cities, and that number is expected to increase significantly over the next few decades. In today's cities, there is increasing pressure on housing, infrastructure, energy resources, transportation systems, and environmental sustainability (Braun & Clarke 2006).

The traditional approaches to urban planning and management are increasingly unable to address these

* Corresponding author. Email address: alymr1@nottingham.ac.uk (Mazin Ismael Raheem)

complex problems. In recent decades, the concept of the "smart city" has emerged as a novel approach to improve urban sustainability, efficiency, and quality of life. Smart cities integrate digital technology, data analytics, and intelligent infrastructure into urban processes to enhance public services, optimise resource management, and fortify governance (Lund *et al*. 2021).

Cities have shown that they gather and examine vast amounts of data produced by urban activities because to technologies like artificial intelligence, big data analytics, cloud computing, the Internet of Things (IoT), and geographic information systems (GIS). With the use of these technologies, governments can better address social, economic, and environmental issues and keep an eye on urban systems in real time (Khan et al. 2017).

Although interest in creating smart cities is growing, most of the research that is now available focuses on freshly constructed smart cities rather than modifying pre-existing urban landscapes. However, the great majority of people on the earth live in cities with sophisticated infrastructure, complex social structures, and historical urban fabrics. Consequently, transforming existing cities into smart cities is one of the main issues facing contemporary urban development (Braun & Clarke 2006).

Through an integrated framework comprising three interrelated dimensions—digital information infrastructure, environmental urban systems, and social interaction and governance—this study seeks to investigate the requirements and procedures of converting current cities into smart cities.

2. LITERATURE REVIEW

The idea of "smart cities" has been explored in existing literature in the fields of sustainability, information technology, and urban planning. The influence of digital infrastructure and telecommunications networks on urban growth was highlighted in early research. Subsequent studies extended the idea to encompass citizen involvement, environmental sustainability, and government (Miloud *et al.* 2024).

Smart cities are urban areas that use digital technologies and intelligent systems to improve infrastructure performance, optimise resource management, and enhance service delivery. Information and communication technology enable cities to monitor and manage energy systems, transportation networks, waste management, and environmental quality (Kong & Chen 2025), (Hall 1999) & (Raheem *et al*. 2026).

Recent research indicates that artificial intelligence plays a significant role in the development of smart cities. Thanks to AI technologies, this study analyses urban data to provide anticipated insights. Applications including intelligent traffic management, energy optimisation, predictive infrastructure maintenance, and environmental monitoring are supported by these technologies (Shen & Yang 2026), (Zhang & Su 2026), (Sipahi & Saayi 2024) & (Qian *et al*. 2026).

However, concerns regarding potential risks associated with smart city technologies have also been voiced by Lartey & Law (2025). These concerns include the digital divide, data security, privacy, and technical inequality. As a result, many academics emphasise how important it is to find a balance between technical innovation, ethical governance, and social inclusion.

Despite the abundance of literature on smart cities, there is still a significant study gap regarding the transformation of existing cities into smart cities. Most metropolitan regions need to change their existing infrastructure, governance structures, and spatial configurations to accommodate digital technology and intelligent urban management.

The framework is created by conceptually integrating current smart city models, and it is then improved by comparing and contrasting a few chosen case studies.

3. RESEARCH METHODOLOGY

The qualitative research methodology used in this study is founded on conceptual analysis and a survey of the literature. There are three primary phases to the approach.

The first step was a thorough analysis of scholarly works on smart cities, digital urban transformation, artificial intelligence, and sustainable urban development. The primary theoretical underpinnings and conceptual frameworks utilised in smart city research were identified with the aid of this evaluation.

The study also looks at the key components required to transform existing cities into smart cities. These components were discovered by contrasting previous research with global smart city initiatives.

Third, a thorough conceptual framework is released to explain how existing cities could transition to smart city models. The idea emphasises the interplay between digital infrastructure, environmental sustainability

systems, and social involvement.

By using this method, the study is able to provide a comprehensive theoretical model that can support the development of further empirical research and policy.

The data gathered for this study is analysed using a qualitative theme analysis method. After selecting important themes and sub-themes pertaining to the transition of smart cities, the analysis is divided into major indicators, such as infrastructure, data systems, artificial intelligence, and governance.

This study uses a variety of data collection techniques, such as conceptual integration, case study analysis, and literature evaluation. Table 1 provides an overview of the data sources, analytical goals, and results related to each approach in order to improve clarity and openness.

This study adopts a comparative case study approach following established methodological frameworks (Yigitcanlar 2023).

Table 1. Synopsis of data gathering techniques and analytical strategy.

Method	Data Source	Purpose	Output
Literature review	Academic journals, books	Identify smart city concepts and frameworks	Theoretical foundation
Case study analysis	Barcelona, Singapore, Dubai, Baghdad	Compare smart city implementation	Comparative insights
Conceptual integration	Existing frameworks and models	Develop a proposed framework	Smart city transformation framework

The creation of the suggested framework for smart city transformation is supported by the methodical synthesis of theoretical and empirical insights made possible by the combination of different approaches.

4. FRAMEWORK FOR SMART CITY TRANSFORMATION

Infrastructure, data, artificial intelligence, and governance are the four interrelated layers that make up the suggested Smart City Transformation Framework. To improve analytical clarity and practical usefulness, each layer is further broken down into distinct sub-components (Khan *et al*. 2024) & (Machado *et al.* 2023).

Urban sensing technologies, energy infrastructure, and smart mobility systems are all part of the infrastructure layer. Urban data platforms, cloud-based systems, and digital twin technologies that facilitate real-time data integration and analysis make up the data layer (Rahbarianyazd 2024) & (Yigitcanlar 2023), (Xu *et al*. 2025) & (Angelidou *et al.* 2019).

Intelligent urban management is made possible by the artificial intelligence layer, which includes decision-support systems, machine learning algorithms, and predictive analytics. The governance layer consists of venues for citizen participation, smart governance processes, and techniques for integrating policies (Angelidou *et al.* 2019), & (Kitchin *et al*. 2019).

By combining institutional and technological aspects into a cohesive framework created especially for modernising cities, this multi-layered structure makes a unique contribution.

Figure 1 represents the framework for smart city components.

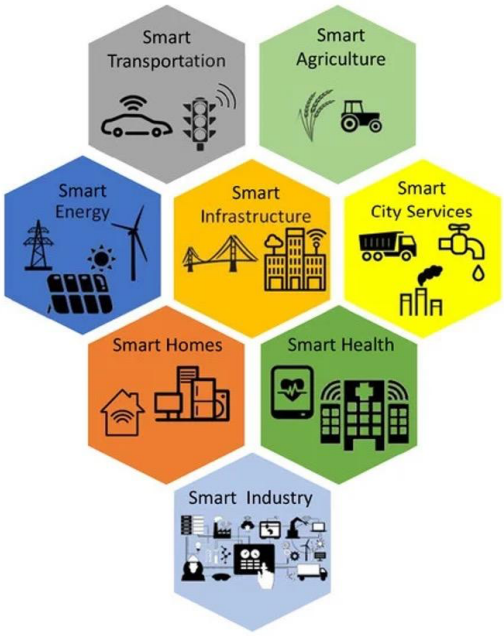

Figure 1. Integrated Smart City System Architecture (Pradhan *et al*. 2025) & (Li *et al.* 2023).

5. INFRASTRUCTURE FOR DIGITAL INFORMATION

The development of smart cities is based on digital information infrastructure. Communication networks, data platforms, cloud computing systems, geographic information systems, and digital governance platforms are all included (Anthopoulos *et al.* 2022) & (Raheem *et al.* 2026).

Large amounts of data are produced by sensors, mobile devices, surveillance systems, and digital platforms in modern cities. City officials can keep an eye on traffic patterns, energy usage, environmental conditions, and public service requests in real time by integrating AI and big data analytics (Yang *et al*. 2024).

Cities may build interconnected systems with data continuously flowing between infrastructure, government agencies, and individuals, thanks to digital infrastructure. Cities are able to enhance decision-making procedures and optimise urban services through this integration (Bibri 2022).

Additionally, digital platforms and broadband connectivity enable residents to engage with public institutions more successfully, access government services online, and take part in urban decision-making processes (Kong & Chen 2025).

6. INTELLIGENT SYSTEMS FOR THE ENVIRONMENT

One of the most important aspects of developing smart cities is environmental sustainability. Reducing pollution, increasing energy efficiency, and encouraging sustainable resource management are the goals of smart environmental systems.

Cities can monitor trash production, water use, noise levels, and air quality thanks to cutting-edge technologies like IoT sensors, environmental monitoring systems, and AI-based analytics. These technologies offer useful information that can help with policy creation and environmental planning (Khan *et al*. 2024).

Sustainable urban development also heavily relies on smart energy systems. The analysis highlights more successfully incorporate renewable energy sources and monitor electricity consumption thanks to intelligent energy infrastructures. Energy distribution may be optimised, and overall consumption can be decreased with AI-based energy management systems (Raheem *et al*. 2026).

Additionally, greenhouse gas emissions and traffic congestion are lessened by smart transportation systems. Urban mobility and environmental sustainability are enhanced by shared mobility services, intelligent traffic management, and intelligent public transit networks (Machado *et al*. 2023).

7. SMART GOVERNANCE AND SOCIAL INTERACTION

Two crucial aspects of the transition of smart cities are social interaction and governance. In addition to

relying on technology infrastructure, smart cities should encourage social inclusion, public participation, and open governance (Khan *et al*. 2017).

Citizens can interact with government agencies, obtain public services, and take part in urban decision-making processes thanks to digital platforms. E-governance systems lower bureaucratic obstacles and increase administrative effectiveness.

In order to make sure that smart city efforts address the needs of locals, citizen participation is crucial. Communities can offer suggestions and comments on urban development initiatives through participatory planning platforms (Miloud *et al*. 2024).

Furthermore, laws that guarantee cybersecurity, data privacy, and fair access to digital technology are necessary for smart governance. To avoid technological disparity across various social groups, it is imperative to address the digital gap (Sipahi & Saayi 2024).

8. THE FUNCTION OF AI IN SMART CITIES

Artificial intelligence is becoming important for managing and optimising urban systems. AI technologies enable cities to handle enormous volumes of data and generate predictive insights that support decision-making.

AI is capable of analysing traffic patterns and optimising signal timing in transportation systems to lessen congestion. Machine learning algorithms can increase power distribution efficiency and forecast electricity demand in energy systems (Li *et al*. 2023).

By evaluating sensor data from buildings, bridges, and highways, AI also helps with predictive maintenance of infrastructure. This lowers maintenance expenses and enables local officials to identify possible issues before they arise.

AI is used by environmental monitoring systems to assess pollutant levels and pinpoint environmental hazards. Cities can enhance urban sustainability and enact proactive environmental regulations thanks to these systems (Angelidou *et al.* 2019).

9. RESEARCH CONTRIBUTION

This study presents a revolutionary multi-layered framework created especially for the transformation of existing cities, in contrast to earlier smart city frameworks that mainly concentrate on freshly planned urban developments. In order to create a dynamic and adaptable system, the suggested model incorporates infrastructure systems, urban data platforms, artificial intelligence, and governance mechanisms.

Additionally, by adding well-defined sub-indicators and bidirectional feedback loops, the framework expands on previous research, allowing for a more thorough comprehension of smart city transformation processes. The topic of sustainable urban development benefits from this integrated approach's theoretical and practical contributions.

By putting forth a Culturally Responsive Smart City Transformation Model that incorporates institutional, sociocultural, and technological aspects, this study advances urban theory. This method places more emphasis on context-specific adaptation than traditional smart city models, especially in developing and post-conflict cities.

10. SMART CITY TRANSFORMATION CASE STUDIES

This section looks at a few foreign case studies that illustrate various strategies for smart city development and urban digital transformation in order to better understand how smart city ideas are applied in practical settings. These examples show how artificial intelligence, digital technologies, and sustainable planning techniques can be incorporated into current urban settings.

10.1. SMART URBAN INFRASTRUCTURE IN BARCELONA

Barcelona is regarded by many as one of Europe's top smart cities. The city has put in place a thorough smart city plan that incorporates open data platforms, digital governance systems, and Internet of Things (IoT) technology.

The installation of smart sensors across Barcelona's urban infrastructure is one of the city's most noteworthy projects. These sensors keep an eye on things like waste management systems, traffic movement, noise levels, and air quality. Centralised data systems are used to process the gathered information, enabling city officials to enhance urban efficiency and optimise service delivery.

Additionally, Barcelona has installed smart parking systems that use real-time data and mobile applications to direct drivers to open spots. The city's automobile emissions and traffic congestion have greatly decreased as a result of this project (Angelidou *et al.* 2019).

10.2. AI-POWERED URBAN MANAGEMENT IN SINGAPORE

One of the most developed smart city initiatives in the world is Singapore. The city-state has incorporated digital infrastructure, artificial intelligence, and big data analytics into almost every facet of municipal management through its national Smart Nation Initiative.

Public transportation networks are optimised, traffic congestion is predicted, and transportation trends are analysed using AI technologies. Singapore has also used digital twins, which are virtual city models that mimic urban settings and aid in long-term planning choices.

Singapore has improved urban resilience, sustainability, and public service efficiency through the integration of digital governance tools, environmental monitoring platforms, and smart surveillance systems (Sipahi & Saayi 2024).

10.3. DIGITAL GOVERNANCE AND SMART SERVICES IN DUBAI

Dubai has adopted a bold smart city strategy that emphasises smart governance and digital transformation. The goal of the city's Smart Dubai effort is to make Dubai one of the most sustainable and technologically advanced cities in the world.

Many digital government services have been developed in Dubai, enabling citizens to fulfil administrative tasks completely online. These consist of transportation management, healthcare services, financial systems, and licensing services.

Furthermore, public services like predictive traffic management, smart police systems, and AI-powered customer care platforms are increasingly incorporating AI. These actions have significantly improved government effectiveness and citizen satisfaction (Khan *et al*. 2017).

10.4. EMERGING SMART CITY TRANSFORMATION IN BAGHDAD

Iraq's capital, Baghdad, is a complicated example of a city undertaking modernisation and digital transformation projects while dealing with major urban difficulties. Baghdad, one of the biggest cities in the Middle East, faces environmental issues, traffic jams, infrastructure strain, and fast population expansion. The shift to smart city plans is especially pertinent in light of these circumstances.

The Iraqi government has started several programs in recent years to promote contemporary urban management and digital transformation. Digital infrastructure systems, electronic government services, and data management platforms are some of these endeavours. As part of its larger plan to incorporate digital technologies and artificial intelligence into the administrative and commercial sectors, the government has also established a Digital Transformation and Automation Centre in Baghdad (Sipahi & Saayi 2024).

In recent years, the Iraqi government has launched several initiatives to support modern urban management and digital transformation. Among these initiatives are data management platforms, digital infrastructure technologies, and electronic government services. The government has also set up a Digital Transformation and Automation Centre in Baghdad as part of its broader strategy to integrate digital technologies and artificial intelligence into the commercial and administrative sectors.

Initiatives for urban development are also helping to update Baghdad's infrastructure. Rehabilitating metropolitan areas, modernising transport networks, and enhancing public services are the goals of a number of significant projects. Government initiatives like the "Baghdad is More Beautiful" campaign concentrate on enhancing the city's infrastructure, public areas, and urban restoration projects.

In order to alleviate the burden of a growing population on the city and build contemporary residential areas with cutting-edge infrastructure, new urban development projects are also being planned around Baghdad. The

Ali Al-Wardi City project, a massive residential development created using smart city technologies and contemporary urban planning ideas, is one prominent example (Bibri 2022).

These programs show how Baghdad is progressively becoming a smart urban development model. But there are still many obstacles to overcome, such as data integration, infrastructure modernisation, governance changes, and funding. In order for Baghdad to eventually fully deploy smart city systems, several issues must be resolved. The following table shows: Smart city case studies: A comparative study. A comparative analysis of a few foreign case studies was carried out in order to have a better understanding of the various routes toward smart city transformation. Barcelona, Singapore, Dubai, and Baghdad are among the cities examined. From sophisticated smart city ecosystems to new digital transformation projects, these cities reflect various phases of smart city development.

Table 2. Comparative evaluation of Baghdad and other smart city case studies.

City	Strategy for smart cities	Key technologies	Notable accomplishments	Present challenges
Barcelona	IoT-based urban management, or "smart city strategy"	Open data platforms, smart parking, smart lighting, and IoT sensors	Strong open-data ecosystem, better traffic control, and lower energy usage	Legacy infrastructure integration and data privacy issues
Singapore	The Smart Nation Initiative	Smart mobility, national data platforms, digital twins, and AI analytics	Advanced urban planning, effective public services, and a well-integrated digital infrastructure	High implementation costs and cybersecurity oversight
Dubai	Intelligent Dubai Approach	AI systems, digital governance platforms, and blockchain-based government services	Completely digital government services and cutting-edge smart transportation initiatives	Rapid technology integration and urban growth
Baghdad	New projects aimed at digital transformation	Digital data systems, early smart infrastructure initiatives, and e-government platforms	Programs for infrastructure restoration and initial changes to digital governance	Modernisation of infrastructure, restricted digital capacity, and investment needs

10.5. CASE SELECTION CRITERIA

These cities were chosen based on:

1. Diversity in geography.
2. Various phases of smart city development.
3. Policy and infrastructure data accessibility.
4. The portrayal of both developed and emerging environments.

11. OVERALL READINESS FOR SMART CITIES

A comparative readiness evaluation was carried out to further examine the degree of smart city development across the chosen case studies. Digital infrastructure, governance systems, artificial intelligence integration, urban data platforms, transportation systems, environmental monitoring, and citizen involvement are among the important factors taken into account in the assessment. Challenges related to infrastructure modernization and data integration have also been examined in previous studies on smart cities. However, this study contributes by structuring these challenges into a multi-layered framework with clearly defined indicators and sub-indicators.

The findings show notable differences between cities that are still in the early phases of digital

transformation, like Baghdad, and towns with established smart city ecosystems, like Singapore and Barcelona. The following table represents case study cities' smart city readiness evaluation.

Table 3. Evaluation of smart city preparedness for particular case study towns.

Indicator	Barcelona	Singapore	Dubai	Baghdad
Infrastructure for digital	4	5	4	2
Smart governance	4	5	4	2
Integration of AI	3	5	4	1
Platforms for urban data	4	5	4	2
Intelligent transportation systems	4	5	4	2
Monitoring of the environment	4	5	3	1
Digital participation of citizens	4	4	2	2
Overall readiness for smart cities	4	5	4	Emerging

*Based on IMD Index *Score (1-5)

12. DISCUSSION

Infrastructure, artificial intelligence, urban data systems, and governance are the four main indicators that comprise the study's findings. Through theme analysis, several sub-components were found for each of these indicators.

The results of this study demonstrate that converting current cities into smart cities is a complex process that calls for the integration of environmental management systems, governance mechanisms, technology infrastructure, and public participation. The suggested Smart City Transformation Framework demonstrates how governance systems, data platforms, digital infrastructure, and artificial intelligence must function as integrated parts rather than separate technology solutions.

The case studies examined in this study show that long-term urban planning techniques and effective institutional coordination are essential to the success of smart city programs. Intelligent urban management systems, data analytics, and sensor networks have all been incorporated into digital platforms in cities like Barcelona and Singapore. These cities provide examples of how the strategic application of urban data can enhance public service delivery, environmental monitoring, and transportation efficiency.

In a similar vein, Dubai's experience demonstrates how digital governance and e-government services facilitate effective citizen-government communication. The use of AI-supported decision-making tools and digital government platforms has greatly improved public service accessibility and administrative efficiency.

Baghdad, on the other hand, is an example of a city that is just beginning to develop into a smart city. Baghdad has fundamental issues with the coordination of governance, development of digital capabilities, and modernisation of infrastructure. Ongoing measures for digital transformation, however, point to a slow transition to technology-enabled urban management systems.

The evaluation framework is informed by ISO 37120 indicators related to urban services and quality of life.

Applications of artificial intelligence in smart cities go beyond simple data analysis. For example, adaptive signal control based on real-time traffic circumstances is made possible by the growing usage of reinforcement learning in traffic flow optimisation systems. Convolutional neural networks (CNNs) are also commonly used in environmental monitoring, especially in image-based urban analysis and air quality prediction.

Integrating contemporary IoT systems with outdated infrastructure is one of the main obstacles to modern city transformation. Technical friction brought about by this "brownfield" situation includes compatibility problems, inconsistent data, and more difficult maintenance.

Data sovereignty issues, power grid instability, and the long-term effects of post-conflict reconstruction are just a few of the intricate socio-political issues that are highlighted in the Baghdad example and have a big impact on digital adoption.

The suggested paradigm includes bidirectional feedback loops, which allow for adaptive policy-making by continuously informing governance decisions with data generated from infrastructure systems.

Simulation-based urban planning is made possible by new technologies like digital twins and GeoAI. Specifically, long-term resilience modelling for large-scale urban projects can be supported by agent-based digital twins.

Smart city technologies present sustainability issues despite their advantages, such as the high energy consumption of AI data centres and the production of electronic garbage from sensor networks.

Critical issues with algorithmic bias, data privacy, and monitoring are brought up by smart city technologies. For AI-driven urban systems to be transparent, accountable, and equitable, a "Ethics-by-Design" strategy is necessary.

By using decentralised renewable energy networks and satellite-linked IoT devices, developing cities may be able to avoid traditional infrastructure.

Large sums of money are needed to transform existing cities. Initiatives for smart cities can be greatly aided by financial tools like green bonds and Public-Private Partnerships (PPP).

The comparison of these cities indicates that institutional preparedness and governance competence are just as important to the success of smart city programs as technology investment. Because organisational capabilities and governance frameworks sometimes lag behind technical improvements, many cities find it difficult to convert technological innovation into sustainable urban outcomes.

Additionally, the use of AI in urban government presents both fresh opportunities and difficulties. Predictive urban management, traffic optimisation, environmental monitoring, and public safety can all be supported by AI-enabled technologies. However, the deployment of AI also raises concerns related to data privacy, cybersecurity, algorithmic bias, and public trust.

Another important conclusion is that social inclusion and citizen participation must be given top priority in the transition of smart cities. According to research, technology innovation by itself cannot provide sustainable urban growth unless it is bolstered by citizen participation, trust, and flexible governance frameworks.

Further institutional and financial reforms are needed in developing nations to turn existing cities into smart cities. Urban governments need to create human capital, invest in digital infrastructure, and create regulatory frameworks that can handle new technology. Smart city projects might continue to be disjointed pilot projects rather than fully connected metropolitan systems in the absence of certain structural changes.

While the governance indicator stresses the need of institutional capacity and citizen involvement, the infrastructure indicator draws attention to issues with legacy systems.

Thus, the findings of this study indicate that the transformation of smart cities should be viewed as a long-term socio-technical shift that incorporates digital technologies with sustainable urban governance and participatory planning procedures.

13. CONCLUSIONS

In the framework of sustainable urban development, this study investigated the need for and methods of converting current cities into smart cities. Digital infrastructure, urban data platforms, artificial intelligence technologies, and governance mechanisms are all included in the study's proposed integrated Smart City Transformation Framework.

The results show that implementing cutting-edge technologies alone is not enough to make the shift to smart cities. Rather, the interplay of technical innovation, institutional capability, governance systems, and public participation is necessary for successful change.

Cities that have effectively adopted smart city initiatives, like Barcelona, Singapore, and Dubai, have created integrated digital infrastructures backed by robust governance frameworks and long-term strategic planning, according to a comparative examination of worldwide case studies. On the other hand, cities like Baghdad that are in the early phases of digital transformation encounter difficulties with financial investment, institutional coordination, and infrastructure modernisation.

The study also emphasises how artificial intelligence is becoming a more important tool for data-driven urban governance. By monitoring environmental conditions, optimising transport networks, and assisting with evidence-based policy decisions, artificial intelligence (AI) technologies have the potential to increase urban efficiency. To guarantee data security, accountability, and public confidence, however, the incorporation of AI into municipal administration must be underpinned by clear legal frameworks and moral standards.

From a policy standpoint, the study recommends that governments take a comprehensive approach to the creation of smart cities, combining technical innovation with environmental management, sustainable urban

planning, and citizen involvement. In order to ensure that all facets of society benefit from technological breakthroughs, future smart city policies should place a high priority on inclusive digital transformation.

Future studies should concentrate on empirical assessment of smart city transformation processes, especially in developing nations where infrastructure constraints and institutional capacity may have a major impact on the success of smart city projects. The long-term effects of artificial intelligence on social justice, sustainability, and urban governance require further investigation.

14. POLICY SUGGESTIONS FOR THE TRANSFORMATION OF SMART CITIES

In order to facilitate the effective conversion of current cities into smart cities, several policy proposals can be put up based on the results of this study and the comparison of global smart city projects. Governance, technology infrastructure, data management, environmental sustainability, and public involvement are the main topics of these suggestions.

Policy recommendations are structured according to the four key layers identified in the proposed framework: infrastructure, data systems, artificial intelligence, and governance.

14.1. CREATING STRATEGIES FOR INTEGRATED SMART CITIES

Governments should create all-encompassing smart city plans that match long-term urban development objectives with technological innovation. Initiatives for smart cities should be executed as integrated urban transformation plans that include public services, energy systems, transportation, and environmental management rather than as stand-alone technological projects.

Measurable indicators, implementation schedules, and institutional coordination mechanisms between national governments, local governments, and business sector partners should all be included in strategic planning frameworks.

14.2. MAKING DIGITAL INFRASTRUCTURE INVESTMENTS

The development of smart cities is based on digital infrastructure. Governments need to make investments in data management infrastructure, cloud computing platforms, urban sensor systems, and high-speed communication networks.

Cities may get real-time data about urban activity and enhance decision-making processes thanks to these expenditures. Additionally, dependable digital infrastructure facilitates the growth of e-government services, enhancing citizen access to and transparency of governmental services.

14.3. SETTING UP SYSTEMS FOR URBAN DATA GOVERNANCE

Ensuring the responsible and secure use of urban data requires effective data governance. Cities should create legal frameworks that deal with matters like data ownership, cybersecurity, and privacy.

Additionally, open data platforms can be extremely important for fostering citizen participation and innovation. Cities may encourage technological innovation and cooperative problem-solving by making urban data accessible to researchers, companies, and civil society organisations.

14.4. USING ARTIFICIAL INTELLIGENCE IN URBAN ADMINISTRATION

Urban management systems could be greatly enhanced by artificial intelligence technologies. Predictive infrastructure maintenance, intelligent traffic management, environmental monitoring, and disaster risk management can all be supported by AI-based analytics.

To guarantee responsible AI deployment, governments must also create moral standards and legal frameworks. These frameworks ought to cover algorithmic fairness, accountability, and transparency in automated decision-making systems.

14.5. ENCOURAGING DIGITAL INCLUSION AND CITIZEN PARTICIPATION

A key element of effective smart city efforts is citizen participation. Digital platforms for citizen involvement should be established by governments so that people can report urban problems, offer comments, and participate in decision-making.

In order to guarantee that every citizen has access to digital services and technologies, digital inclusion rules are also required. Smart city programs may inadvertently widen socioeconomic divides if they don't address digital inequality.

14.6. ENCOURAGING THE TRANSFORMATION OF SMART CITIES IN DEVELOPING CITIES

Cities in underdeveloped nations confront particular difficulties with regard to institutional capability, financial restrictions, and infrastructure limitations. As a result, international collaboration and knowledge-sharing initiatives might be crucial to the development of smart cities.

This study adopts best practices and modifies smart city policies to fit local circumstances with the aid of capacity-building programs, international alliances, and technology transfer initiatives.

Cities like Baghdad, for instance, can profit from phased smart city policies that put institutional capacity building, digital infrastructure development, and urban data management ahead of more sophisticated artificial intelligence systems.

15. PROSPECTS FOR FURTHER RESEARCH

Even if our understanding of smart city development has advanced significantly, there are still many areas of turning existing cities into smart cities that need more research. Future studies should concentrate on a number of important topics that can enhance the sustainability and efficacy of smart city projects.

15.1. SMART CITY FRAMEWORKS: AN EMPIRICAL ASSESSMENT

Future research should evaluate smart city transformation models empirically in actual metropolitan settings. Conceptual models offer helpful theoretical direction, but real-world application frequently highlights additional institutional, social, and technical difficulties. The efficacy of smart city policies and technologies can be evaluated through empirical research utilising field data, urban performance indicators, and quantitative modelling.

15.2. THE USE OF AI IN URBAN GOVERNANCE

It is anticipated that artificial intelligence will become more significant in urban management systems. Future studies should look at how AI may help with energy optimisation, intelligent transportation systems, environmental monitoring, and predictive urban design.

However, further investigation is needed to comprehend the moral ramifications of AI-based governance systems, including concerns about algorithmic transparency, data security, and public accountability.

15.3. THE TRANSFORMATION OF SMART CITIES IN DEVELOPING NATIONS

Most research on smart cities focuses on technologically advanced communities in affluent countries. However, cities in developing countries face unique challenges in terms of infrastructure limitations, governance capacities, and financial resources.

Future studies should look into how smart city models might be modified to fit the socioeconomic circumstances of increasingly urbanising metropolitan areas like Baghdad and other growing cities. Research comparing developed and emerging cities may yield important information for flexible and scalable smart city tactics.

15.4. COMBINING CLIMATE RESILIENCE AND SUSTAINABILITY

For contemporary cities, climate change and environmental sustainability pose significant problems. Future studies on smart cities should examine how artificial intelligence and digital technologies may help sustainable urban ecosystems, resource efficiency, and climate adaptation plans.

Future smart city models should incorporate climate-resilient urban planning, green infrastructure, and smart energy systems to guarantee long-term environmental sustainability.

15.5. SMART CITIES FOCUSED ON CITIZENS

The creation of citizen-centred smart city models is another crucial area for future study. Early smart city projects were mostly focused on technology, frequently ignoring social aspects and citizen involvement.

Future research should examine co-creation strategies, digital democracy platforms, and participatory governance models that let people actively participate in urban innovation and decision-making.

AUTHOR CONTRIBUTIONS

Mazin Ismael Raheem: responsible for the conceptualisation, methodology development, data analysis, and manuscript writing. **Maha Ismail Raheem**: provided expert guidance and consultation in the fields of computer science and artificial intelligence, contributing to the development and refinement of the study.

COMPETING INTERESTS

The authors have no competing interests to declare.

DATA ACCESSIBILITY

The data supporting the findings of this study are available within the article. Additional simulation data can be provided by the corresponding author upon reasonable request.

ETHICAL APPROVAL

This study does not involve human participants or animals, and therefore, ethical approval was not required.

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