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Assessment of Smart City Technologies in Kano Economic City, Nigeria

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ABSTRACT

Background: Rapid urbanisation in Nigeria has increased the need for smarter and more efficient urban infrastructure. Kano Economic City (KEC), developed as a major commercial hub, was intended to integrate Smart City Technologies (SCTs) to enhance trade efficiency, safety, and sustainability. However, concerns remain about the extent of actual technological implementation.
Objective: This study assessed the integration and implementation of SCTs in KEC with the view to identifying gaps between planned provisions and current on-ground reality.
Method: A qualitative approach was used, involving planning document analysis and field observations. Content analysis was applied to determine the level of implementation of key SCT components.
Results: Foundational infrastructure including roads, CCTV surveillance, fire safety systems, and digital commerce platforms is in place. However, advanced technologies such as smart metering, renewable mini-grids, AI-enabled retail, and augmented reality navigation are partly implemented or absent, indicating KEC is still in a transitional stage of smart city development.
Conclusion: Although KEC demonstrates readiness through basic infrastructure, it has not achieved full smart city integration. The gap between planning and execution reflects common challenges in emerging economies moving toward digitally driven urban systems.
Unique Contribution: The study offers practical insights on bridging the gap between foundational infrastructure and advanced technological adoption in emerging urban centres like Kano.
Key Recommendation: Achieving full smart city transformation requires strengthened ICT frameworks, phased funding strategies, and active stakeholder involvement throughout planning and implementation.

Keywords: Smart City Tehnologies (SCT), Kano Economic City, Urban Planning, ICT

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INTRODUCTION

Urbanisation is a key driver of city expansion, but when unmanaged, it can strain infrastructure and degrade living conditions, especially in rapidly growing cities in developing countries (Komolafe *et al.*, 2019; United Nations, 2017). Nigeria, with its high urbanization rate, faces these challenges acutely, resulting in inadequate infrastructure, poor sanitation, and limited access to essential services (Biswas, 2019). In this context, smart city initiatives have emerged globally as innovative approaches leveraging information and communication technologies (ICT) to address urban challenges and improve the quality of life (Khadija, 2018; Peng, Nunes, & Zheng, 2017; Akpobo, & Nwafor**,** 2013). Smart cities integrate digital infrastructure with urban environments to enhance political, economic, social, and cultural development through networked systems (Silva, *et al.*, 2018; Clarke *et al.*, 2019). Commercial centers within smart cities, such as markets and business districts, are evolving through the integration of traditional and electronic commerce supported by advanced ICT applications (Helmy *et al.*, 2021). Successful smart city commercial environments require careful planning, design, and community participation to ensure accessibility, sustainability, and technological integration.

Kano city, Northern Nigeria's economic hub, hosts several busy markets facing challenges like overcrowding, poor infrastructure, and safety risks, including frequent fire outbreaks (Maigari, 2015; Punch, 2024). The emerging Kano Economic City (KEC) represents a modern marketplace with potential for smart city integration. However, little is known about how smart city technologies have been incorporated into its planning and development or the extent of their adoption and acceptance by stakeholders. Previous smart city efforts in Nigeria; such as in Lagos, have encountered implementation challenges, leading to skepticism about the feasibility of such projects (Ruhlandt, 2018& Ekwealor, 2016). This underscores the need for context-specific research addressing infrastructural, socio-cultural, and economic factors unique to cities like Kano. Understanding these dynamics is critical for tailoring smart city solutions to local needs and achieving sustainable urban growth **(**Nwafor, & Odoemelam, 2012). This study is guided by the following objectives; to assess the provisions for smart technologies in the planning and design of KEC, and to examine the extent of implementation of smart city technologies in KEC. The findings aim to inform strategies that enhance the effective adoption of sart technologies, fostering the sustainable development and economic vitality of Kano's commercial environment.

Concept of Smart City

Smart city concepts encompass ICT-based solutions for urban challenges. According to Peng, Nunes, & Zheng (2017), smart cities apply advanced technologies such as sensors, mobile networks, and data systems to resolve urban issues. Studies (e.g., Giffinger *et al.*,

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2007; Sharifi, 2019) have proposed frameworks for assessing smart cities based on components like economy, environment, governance, and ICT. However, in the Nigerian context, empirical studies on localized implementations such as KEC remain scarce, justifying this research.

Although different people have defined the concept of a smart city, no one definition has been widely accepted. This indicates the lack of a universally accepted definition for the concept (Schaffers *et al.*, 2012 & Chong *et al*., 2018). There are several terms used in different publications to describe the smart city, such as: digital city (Tan, 1999), wired city (Targowski, 1990), information city (Fietkiewicz *et al.*, 2017), ubiquitous city (Shin, 2009), sensing city (Mone, 2015). It has been observed that when defining the concept of a smart city, technology is given a lot of emphasis.

Approaches for Planning and Design of Smart Commercial Centres

The planning and design of commercial centres in smart cities combine traditional urban commerce with modern electronic commerce, aiming to create sustainable, efficient, and user-friendly commercial environments. This approach leverages advancements in Information and Communication Technology (ICT) to enhance the commercial sector while addressing evolving urban challenges. However, transformation must be gradual to avoid disruptions often described as "urban amnesia" (AbdElhman & Mahmoud, 2015). Given the rapid pace of technological change, commercial planning must remain adaptable, following an iterative process of design, implementation, and evaluation (Barstad, 2002 & Umeda, 2015). Helmy *et al.* (2021) proposed a three-phase framework that guides decision-makers in balancing traditional and electronic commerce, emphasising fairness, sustainability, and ICT integration. The phases include - Planning and Design, Execution and Follow-up, and Evaluation and Feedback.

The development of smart commercial centers is pivotal in the transformation of urban environments, where traditional commerce increasingly converges with electronic and virtual platforms. The adoption of smart city technologies provides opportunities to create more efficient, sustainable, and user-centric commercial spaces. AbdElhman and Mahmoud (2015) caution that such transformation must be gradual to avoid losing the unique character and social fabric of urban commerce. The rapid evolution of ICT demands planning approaches that are flexible and iterative. Barstad (2002) and Umeda (2015) highlight the importance of iterative processes encompassing design, implementation, and continuous evaluation. Helmy *et al.* (2021) proposed a comprehensive framework to guide this transformation, emphasizing the integration of spatial, socio-demographic, and economic-legislative criteria during the planning phase.

Spatial considerations include site selection for both traditional retail and e-commerce logistics, accessibility for all users, the seamless merging of physical and virtual commerce, and the embedding of smart technologies like augmented reality and ICT

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infrastructure to enhance user experience. Social factors such as population density, consumer behavior, and the need for physical social interaction remain crucial in this digital era. Economic and legislative aspects, including land value changes, metadata utilization for targeted marketing, clear legal frameworks, and government e-governance initiatives, are essential to sustain growth and protect stakeholders (Kiba *et al.*, 2021 & United Nations, 2020).

Execution and follow-up require strong ICT support and the application of AI for predictive management and optimized operations. The establishment of centralised city management centers, such as the City Command Center model, supports real-time monitoring and coordination (Nordin, 2012).

Smart City Technologies Implementation

The concept of a smart city is multidimensional, requiring a comprehensive set of indicators to evaluate progress and performance. Giffinger *et al.* (2007) proposed one of the earliest and most widely adopted frameworks, categorizing smart city indicators into six dimensions: smart economy, smart people, smart governance, smart mobility, smart environment, and smart living. These dimensions offer a balanced approach to measuring technological, social, and environmental development within urban settings.

Building on this, Sharifi (2019) emphasized that in addition to the original six dimensions, the increasing role of digital technologies necessitates the inclusion of "Data" as a separate category. This acknowledges the growing importance of big data, open data systems, and ICT in supporting smart governance and service delivery. In contrast, Ibrahim *et al.* (2018) did not isolate data as a separate domain but viewed ICT as an enabler that cuts across all six dimensions.

Further, Birthe (2021) reviewed these models and noted that while technical infrastructure is critical, greater attention should be given to urban sustainability and human-centered development. Further argued that indicators should not only measure technological advancement but also reflect inclusivity, resilience, and environmental stewardship. These models and indicators provide a foundational basis for assessing the implementation of smart city features in new urban developments like Kano Economic City (KEC), where the alignment of planning and design with these dimensions is essential for achieving a truly smart and sustainable environment.

Finally, continuous evaluation with active community participation and adaptability to technological advancements ensures the commercial environment remains relevant and effective (Munoz *et al.*, 2019). This cyclical approach to planning and management is critical for smart city initiatives to succeed in the dynamic urban context. Moreover, table 1 presented a review summary of smart city technology provisions that can be formatted on checklist to assess the extent of implementation in KEC.

Table 1: Provisions for Smart City Technologies in Modern Markets/Commercial Centres

Smart City Provision	Description	Supporting Literature
Smart Infrastructure Utilities	IoT-based energy, water, and waste systems for efficient resource use	BehrTech (2021), Rukanov *et al.* (2021)
Intelligent Traffic & Parking Systems	Real-time traffic control, smart parking navigation, delivery geo-fencing	BehrTech (2021), Helmy *et al.* (2021)
Digital Payment Systems	Contactless payments, mobile wallets, blockchain for market transparency	BehrTech (2021), Kiba *et al.* (2021)
Environmental Monitoring	Sensors for air, noise, and temperature conditions in and around the market	BehrTech (2021), Munoz *et al.* (2019)
Smart Surveillance & Security	AI-based CCTV, facial recognition, access control, and emergency systems	BehrTech (2021), Helmy et al. (2021)
ICT Infrastructure & Connectivity	High-speed internet, IoT communication (LFWAN), and cloud platforms	BehrTech (2021), Rukanov et al. (2021)
Digital Wayfinding & Information Systems	Interactive kiosks, smart signage, footfall tracking, and alert systems	BehrTech (2021), Helmy et al. (2021)
Smart Waste Management	IoT waste bins, fill-level sensors, smart collection scheduling	BehrTech (2021)
Energy Efficiency & Sustainability Platforms	Solar lighting, green architecture, smart metering, carbon tracking	BehrTech (2021), Silva et al. (2018)

Source: Author (2025)

EMPIRICAL REVIEW AND RESEARCH GAP

Several studies have explored the potential and challenges of implementing smart city technologies across different urban contexts, particularly in developing countries. Adejuwon

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(2021) emphasized the transformative role of IoT in enhancing public service delivery in Nigeria, identifying smart cities as key to improving urban efficiency and quality of life. Similarly, Ezeugwu and Isah (2021) highlighted the urgency of smart city adoption in response to Nigeria's rapid urbanization, recommending proactive planning to accommodate future growth. Yasmin *et al.* (2016) proposed an initiative-based framework for assessing smart city performance, addressing limitations in data availability. Their study, however, focused on broader regional comparisons and not on specific commercial infrastructure. In a more technical approach, Aghimien (2019) used fuzzy synthetic evaluation to assess the challenges of smart city realization in Nigeria, identifying environmental, technological, and legal constraints, but did not examine implementation at project-level developments.

Studies such as Johnson (2019) and Ogunseye *et al.* (2023) underscored the infrastructural and policy limitations that hinder smart city success in Lagos, calling for greater stakeholder collaboration and policy clarity. Okeke (2021) also noted that despite government interest in smart initiatives, challenges such as housing deficits and poor utility systems remain critical barriers. While these studies provide valuable insights, most are conceptual, city-wide, or policy-focused. There is limited empirical work assessing how smart city technologies are embedded into specific commercial developments such as integrated markets and how these technologies are implemented and accepted by end-users at the micro-level.

This study fills that gap by focusing on KEC, a major smart commercial hub in Northern Nigeria. It uniquely examines the planning and design provisions for smart technologies and the extent of actual implementation. This micro-level focus provides practical evidence on how smart city principles are being operationalized in real-world projects, helping inform more grounded urban development strategies in similar contexts.

The Study Area

KEC is a flagship public-private partnership development located along Zaria and Maiduguri Roads in Kano State, Nigeria. Designed as a modern commercial hub, KEC is structured to enhance trade, attract investment, and integrate smart technologies into urban economic infrastructure. The city is organized into several zones including the ICT market, pharmaceutical hub, retail and wholesale shops, logistics center, and hospitality areas. With smart city ideals at its core, KEC incorporates features such as CCTV surveillance, solar streetlights, and designated spaces for digital services, positioning it as a potential model for smart commercial development in sub-Saharan Africa. Figure 1 presents the location map of the study area (KEC) which is under Kumbutso local government area Kano state Nigeria

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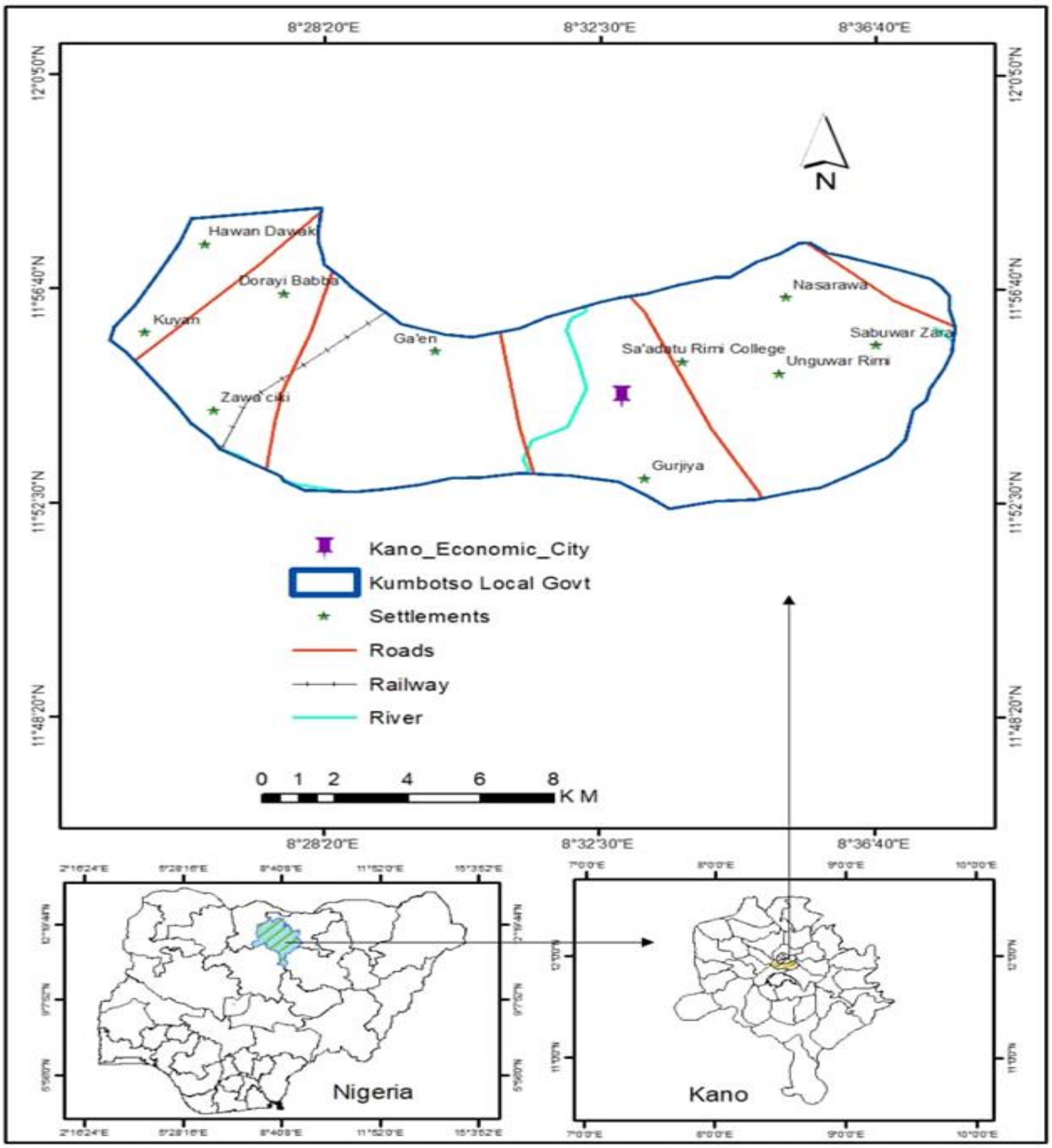

Figure 1: The Study Area

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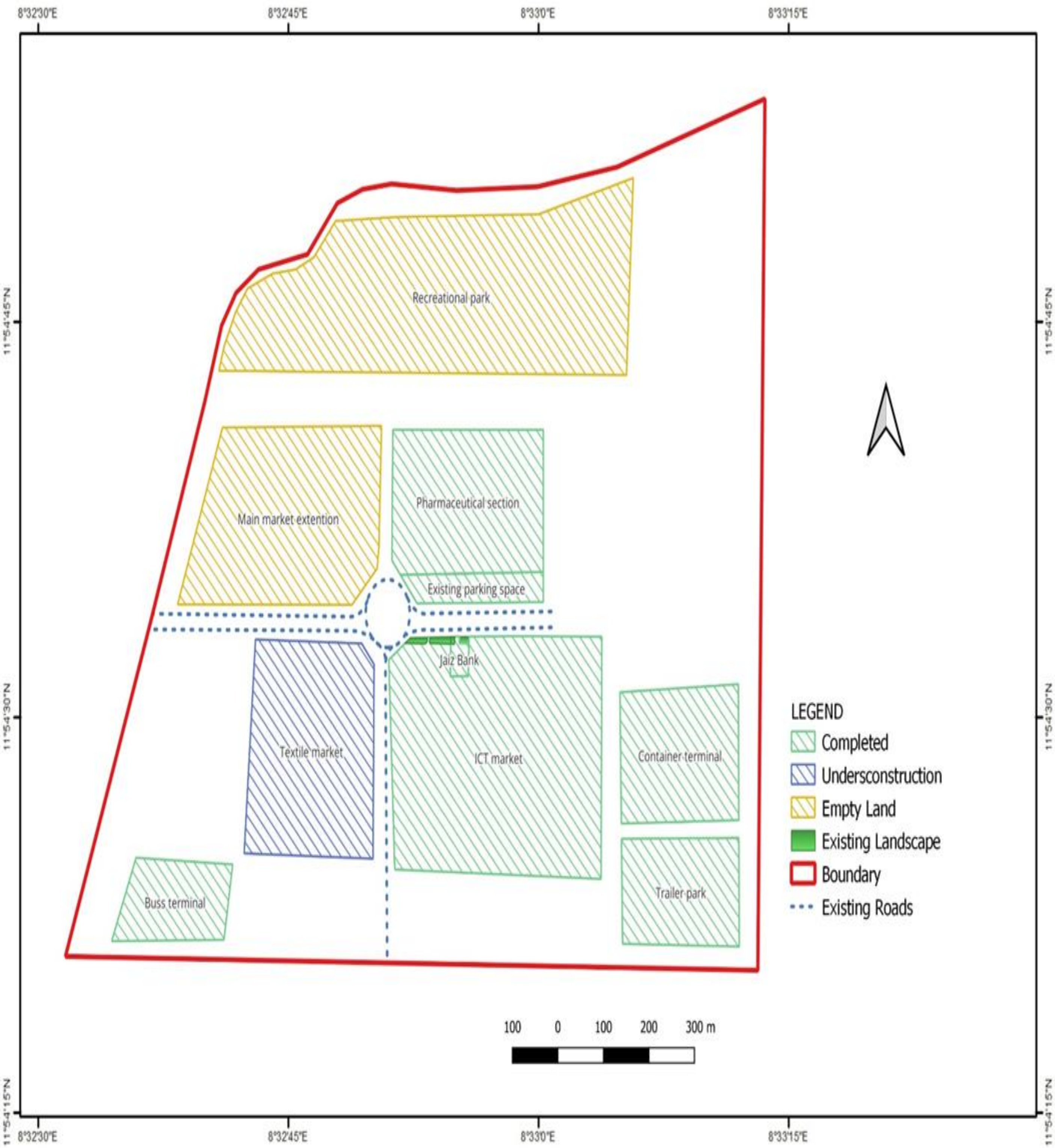
Source: Author (2025)

Figure 3: Existing Land Uses in the Study Area **Source:** Author (2025)



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This study adopted a qualitative content analysis approach to assess the integration and implementation of smart city technologies in Kano Economic City (KEC). A document review checklist was used to evaluate the presence and development stage of smart technologies across various sectors, including power, telecommunications, safety, waste management, and transportation. Data collected from both the document review and field observations were analysed using content analysis, allowing for comparison between planned provisions and actual implementation.

RESULTS AND DISCUSSION

Table 2: Provisions for Smart City Technologies in the Planning and Design of KEC

S/N	Smart City Technology (SCT)	Scale	
		Available	Not available
1	Smart Mobility Infrastructure (Well-structured Road networks, transport terminals, roundabouts)	√	
2	Intelligent Traffic Management Systems (Potential at intersections and roundabouts)	√	
3	Smart Parking (Designated parking areas within markets and malls)	√	
4	Waste Management Technologies (Designated utility/waste service zones)	√	
5	Smart Utility Management{Power/Water/ICT} (Utility clusters likely to host digital infrastructure)	√	
6	Smart Surveillance & Security Systems (Clustered zones with controlled access points)	√	
7	Smart Energy Solutions {solar, grid, etc.}	√	
	(Large roof surfaces, utility areas)	√	
8	Digital Commerce / Smart Retail (Centralized shopping malls and markets)	√	
9	Smart Environmental Monitoring (Open spaces and utility zones)	√	
10	Public Wi-Fi & Digital Access Points	√	
11	Emergency Response Integration (fire, health) (Fire service and health facility provisions)	√	
12	Smart Pedestrian & Street Lighting Systems (Defined pedestrian walkways and road network)	√	
13	Environmental monitoring sensors		√
14	AI-enabled retail operations		√
15	Augmented reality navigation		√
16	Smart signage and wayfinding systems		√
17	Dynamic pricing and digital payment platforms		√

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S/N	Smart City Technology (SCT)	Scale	
		Available	Not available

The assessment of smart city technology provisions in KEC shows a deliberate effort to integrate modern infrastructure into its commercial environment. Planning documents indicate that several foundational Smart City Technologies—such as smart mobility infrastructure, intelligent traffic management, parking systems, utility management, surveillance/security, and public Wi-Fi—are already in place. However, more advanced or AI-driven systems, including AI-enabled retail, augmented reality navigation, dynamic pricing, and smart signage, are not yet incorporated.

These gaps reflect trends noted in smart city and retail technology literature. Dynamic pricing, for example, has been widely studied in Intelligent Transport Systems (ITS), yet implementation often lags because it requires real-time data, adaptive algorithms, stakeholder coordination, and adequate regulatory frameworks. Saharan, Bawa, and Kumar (2019) show that although dynamic pricing can reduce congestion and manage peak loads, deployment remains limited by technological, socioeconomic, and policy constraints. Sarker et al. (2020) demonstrate that smart parking combined with dynamic pricing, edge/cloud computing, and LoRa can improve revenue and parking efficiency.

Similarly, research on AI-enabled retail highlights benefits in demand forecasting, inventory management, customer personalisation, logistics, and cost reduction. Cao (2021) identifies value creation mechanisms such as automation, hyper-personalisation, and innovation. Other empirical studies also confirm AI’s role in improving predictive analytics and customer service. These findings justify the “Not available” gaps in Table 2 for AI retail operations, dynamic pricing, AR navigation, and smart signage.

Transitioning from basic digital infrastructure (roads, utilities, mobility systems) to advanced intelligent systems is complex and depends on institutional capacity, technical expertise, governance structures, maintenance ability, regulatory support, financing, and public acceptance. These challenges hinder adoption of AR navigation (requiring accurate mapping and user devices), smart signage (requiring updated digital content), and dynamic digital payment systems (requiring trusted financial ecosystems). The presence of foundational SCTs aligns with global smart-city practice, where cities typically prioritize visible basic infrastructure such as roads, utilities, surveillance, and lighting before advancing to more technically intensive and user-centric technologies noted as “Not available” in Table 2.

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Table 3: Extent of Implementation of Smart City Technologies in Kano Economic City (KEC)

(Data populated from field observations against the checklist framework)

S/N	Smart City Component	Indicators (Checklist Items)	Extent of Implementation		
			Fully Implemented	Partially Implemented	Not Implemented
1	ICT Infrastructure	Dedicated ICT hub & digital infrastructure	✔		
		High-speed internet/fiber connectivity		✔	
		Central data center			✔
		Smart metering (power/water)			✔
2	Energy & Sustainability	Provision for solar streetlights	✔		
		Renewable energy (solar panels, mini-grids)		✔	
		Smart energy management system			✔
3	Security Systems	CCTV surveillance & monitoring	✔		
		Access control systems	✔		
		Emergency response integration	✔		
4	Fire Safety	Fire stations, fire exits, safety signage	✔		
		Fire alarms & sprinklers	✔		
		Self-sustaining fire features per shop	✔		
5	Mobility & Transport	Smart parking system			✔
		Intelligent traffic flow systems			✔

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S/N	Smart City Component	Indicators (Checklist Items)	Extent of Implementation		
			Fully Implemented	Partially Implemented	Not Implemented
		Designated trailer/container parks	✔		
6	Waste & Environmental Management	Central waste collection system		✔	
		Smart bins & tracking			✔
		Green spaces & landscaping	✔		
7	Health & Safety	Pharmaceutical/health center	✔		
		Public health regulation (NAFDAC/NDLEA) offices	✔		
8	Planning & Governance	Phased implementation strategy		✔	
		Land use zoning & building controls	✔		
		Integration with urban masterplan	✔		
9	Commercial & Market Systems	E-payment & digital platforms	✔		
		Centralized logistics/warehousing	✔		
		Business registration/monitoring systems		✔	

The second assessment framework shows the level of implementation of smart city components across nine domains: ICT, energy and sustainability, security, fire safety, mobility, waste and environment, health, planning and governance, and commercial systems. The results indicate that while basic infrastructure and regulatory structures are largely in place, most advanced or technology-intensive systems are only partly implemented or entirely absent.

In ICT infrastructure, the presence of an ICT hub and digital backbone provides an essential foundation for smart city development, consistent with literature describing ICT as the "nervous system" of smart cities (Komninos et al., 2019). However, incomplete high-speed internet, central data centers, and smart metering indicate a developmental gap. Without strong connectivity and data platforms, advanced smart services such as predictive analytics and demand-responsive utilities cannot function effectively (Anthopoulos, 2017).

In energy and sustainability, solar streetlights are fully deployed, reflecting global low-cost, sustainable lighting practices (Yadav & Chandel, 2014). Yet renewable energy systems and smart energy management are limited or missing, restricting gains in carbon reduction and resilience. Studies highlight the importance of renewable mini-grids and integrated energy systems for sustainable smart cities (Khan et al., 2021).

Security and fire safety show strong implementation: CCTV, access control, and emergency response systems reflect the "safe city" model (Zanella et al., 2014), while fire stations, alarms, and sprinklers demonstrate adherence to risk management standards. The inclusion of self-sustaining fire equipment per shop indicates micro-level preparedness often missing in smart city plans (Shah et al., 2020).

Mobility systems are weaker. Although container parks exist, smart parking and intelligent traffic systems are absent. This is notable because smart mobility is central to reducing congestion and supporting urban efficiency and competitiveness (Silva et al., 2018). The lack of such systems highlights the need for investment in intelligent transport technologies.

Waste and environmental management is partially implemented. While centralized waste collection and green landscaping exist, no smart bins or tracking technologies are present. This corresponds with Ajay et al. (2020), who note that developing cities commonly rely on conventional waste systems and struggle to adopt IoT-based waste solutions.

Health systems, including pharmacies and regulatory agencies (NAFDAC/NDLEA), are fully implemented, demonstrating strong institutional capacity. Effective health regulation is essential for urban resilience and governance (Bibri & Krogstie, 2017).

Planning, governance, and commercial systems show mixed outcomes: zoning, building control, and alignment with master plans are fully implemented, but phased implementation strategies and business monitoring systems remain partial. Digital payments function effectively, consistent with global fintech trends (Ozili, 2018), yet centralized logistics and warehousing remain incomplete, limiting the development of smart commercial ecosystems.

Overall, the findings show that the city has prioritized foundational infrastructure, safety, and regulatory systems but lags behind in complex, technology-driven components such as smart energy management, intelligent mobility, and IoT-based waste management. This pattern mirrors global trends where smart city development typically progresses from basic infrastructure toward more integrated and AI-enhanced systems over time (Albino, Berardi, & Dangelico, 2015).

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DISCUSSION

The comparative analysis of the two assessment frameworks reveals important insights into the evolutionary trajectory of smart city development within the study context. Although Tables 2 and 3 suggest significant progress has been made in implementing foundational infrastructures and safety systems, there remains a considerable gap in the deployment of advanced, data-driven, and AI-enabled technologies.

The first table emphasizes the breadth of smart city technologies across domains such as mobility, utilities, energy, surveillance, digital commerce, and environmental monitoring. Here, most basic systems such as smart mobility infrastructure, surveillance, waste zones, and public Wi-Fi are already available, suggesting a solid foundation. However, it also reveals a conspicuous absence of advanced services such as AI-enabled retail, augmented reality navigation, dynamic pricing systems, and smart signage. These gaps underscore the transitional stage of development, while the physical and digital backbone exists. The higher-order “smart services” that personalize, optimize, and automate urban life remain underdeveloped. However, the partial implementation of digital commerce and surveillance systems in KEC agreed with Agboola et al. (2023) study, which found ICT limitation, weak digital infrastructure, and general governance/implementation issues hinder smart-city and sustainable urban development in Nigeria.This suggests that KEC, while incomplete, reflects a more progressive model, possibly due to its public-private partnership framework.

By contrast, Table 3 offers a granular assessment of implementation levels within core smart city components (ICT, energy, governance, mobility, health, and commerce). It reveals that essential safety and regulatory systems such as CCTV surveillance, fire safety features, health centers, and land-use zoning are fully implemented. However, many technologically intensive features (e.g., smart metering, central data centers, renewable mini-grids, intelligent traffic systems, smart bins, and energy management) are either partially implemented or not implemented. This suggests that while institutional and physical provisions are strong, digital integration and real-time data systems lag behind.These findings align with those of Ojo et al. (2022), who observed that smart city projects in Nigeria often emphasize physical infrastructure over digital innovation. These findings align with those of Kadiri et al. (2019) In Nigerian cities, smart-city adoption faces major constraints including institutional, infrastructural, land-use/regulation, and implementation bottlenecks

Taken together, the two assessments reflect a city that has successfully established foundational infrastructures and regulatory frameworks but remains in the early-to-intermediate stages of smart transformation. The key contrast lies in the levels of readiness:

The Table 2 presents an availability matrix, showing that most conventional infrastructures are already present but that frontier technologies have not been adopted. Table 3 goes further, showing the extent of actual implementation, revealing that many technologies are not fully realized but exist in partial form. This contrast highlights a critical implementation gap: while cities may report availability of infrastructure (e.g., roads, surveillance, utilities), the operationalization of truly "smart" systems requires higher levels of integration, interoperability, and technological maturity (Albino *et al.,* 2015; Bibri & Krogstie, 2017).

The findings further suggest that the smart city under review has prioritized security, safety, and governance mechanisms, followed by digital commerce and connectivity, while lagging in mobility, energy sustainability, and AI-driven services. This developmental trajectory is consistent with global patterns, where smart city initiatives often begin with visible infrastructure and governance reforms before scaling into data-intensive and AI-enabled services (Silva *et al.,* 2018; Komninos *et al.,* 2019).

This study extends existing knowledge by showing that even within a PPP arrangement often praised for efficiency smart city execution can falter if digital components are not explicitly phased, financed, and monitored. The findings indicate that the implementation gap is not solely due to financial constraints but also to low ICT capacity, limited technical expertise, and a possible focus on visible infrastructure for political or commercial gain.

Therefore, the overall conclusion is that the city is in transition from a "digitally supported city" toward a "data-driven smart city." The successful adoption of next-generation smart services such as AI-enabled retail, augmented reality navigation, dynamic pricing, smart waste tracking, and integrated energy systems will require targeted investments in ICT infrastructure, stronger data governance, and stakeholder collaboration. Without these, the city risks remaining in a foundational stage of smart city development, unable to achieve the full benefits of urban intelligence, sustainability, and citizen-centric innovation.

CONCLUSION

The conclusion of this study is that Kano Economic City (KEC) has not yet achieved its smart city vision. Despite having a well-structured plan and basic infrastructure in place, the poor implementation of advanced Smart City Technologies reveals a serious disconnect between ambition and execution. This failure stems from limited digital capacity, weak institutional coordination, and the absence of sustained policy enforcement. Without urgent corrective action, KEC risks remaining a conventional commercial centre, rather than evolving into the smart, tech-driven hub it was envisioned to be. The phased implementation strategy and the public-private partnership (PPP) structure between the Kano State Government and Brains & Hammers Ltd provide a strong foundation for gradual expansion of smart components. However, the current level of implementation does not fully reflect the plan's aspirations, suggesting a gap between design intent and on-ground execution. To ensure the realization of KEC vision as a smart commercial hub, strategic efforts must be made to close this gap.

RECOMMENDATIONS

Based on the assessment of smart city technology provisions and the extent of their implementation in Kano Economic City (KEC), the following recommendations on Figure 3 are proposed to enhance the effectiveness, scalability, and user-centered impact of the smart city initiative:

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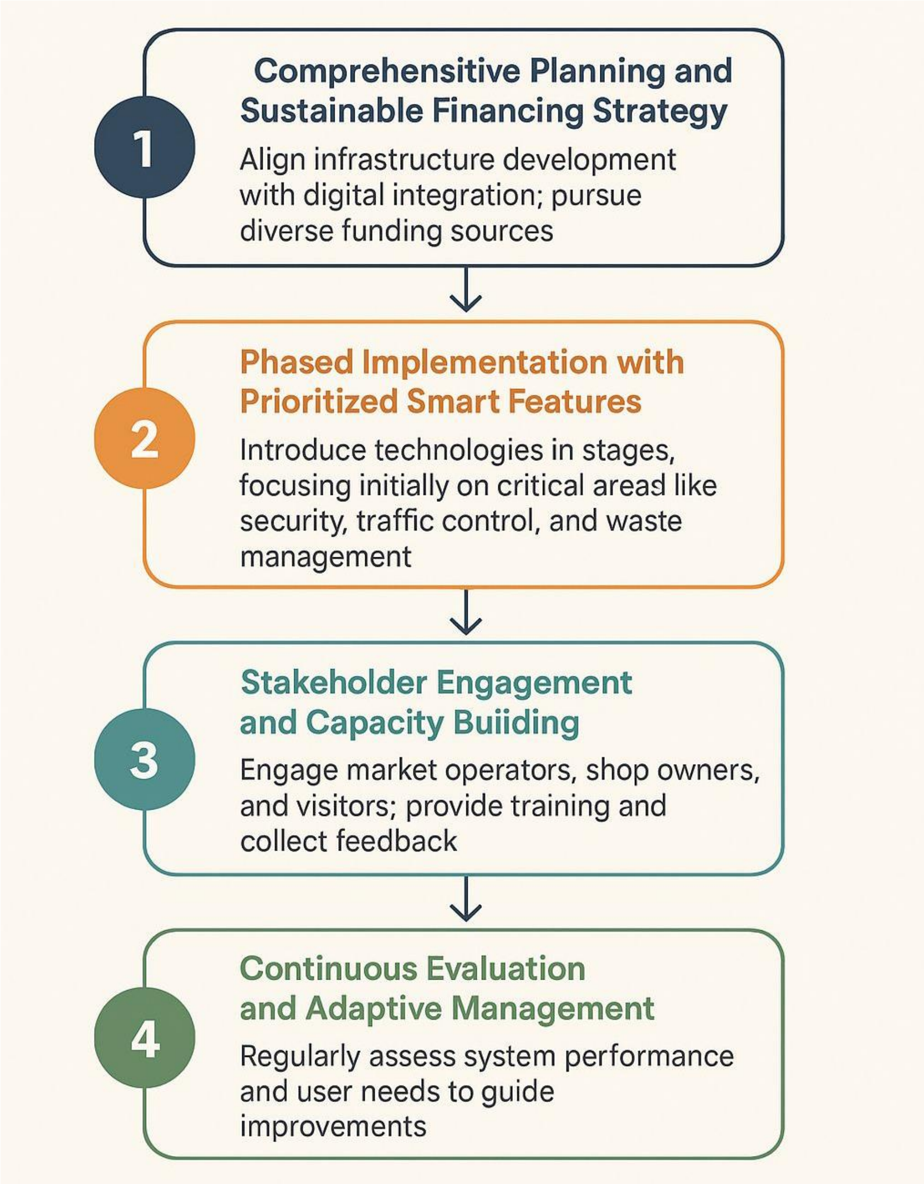

Figure 4: Framework for Smart City Integration in Kano Economic City

Source: The Author (2025)

FRAMEWORK FOR SMART CITY INTEGRATION IN KEC

1. **Comprehensive Planning and Sustainable Financing Strategy**

KEC should adopt a comprehensive planning model that not only includes core smart infrastructure but also plans for enabling environments such as reliable electricity, robust internet connectivity, and technical support systems. Leveraging Public-Private Partnerships (PPP) as already evident in KEC should be expanded by exploring additional funding avenues like green

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bonds and international urban development grants to support large-scale infrastructure deployment.

2. **Phased and Prioritized Implementation**

As observed in KEC, where implementation is partial and varies, continuous evaluation mechanisms should be institutionalized. Regular system performance reviews, user feedback collection, and adaptive upgrades will ensure that smart technologies remain efficient, relevant, and aligned with the evolving needs of users. This will also help address operational gaps, reinforce accountability, and sustain long-term growth.

3. **Stakeholder Engagement and Capacity Building**

Given the diverse user base of KEC including shop owners and customers' stakeholder engagement should be approached in well-planned phases. Initial engagement should focus on awareness and education about smart technologies, followed by interactive sessions to gather feedback and understand concerns. As implementation progresses, stakeholders should be involved in co-designing solutions and testing pilot features. This approach builds trust, promotes acceptance, and ensures that technological solutions are aligned with real user needs. Engagement should be inclusive, continuous, and adapted to the unique operational dynamics of commercial environments like KEC.

4. **Continuous Monitoring and Evaluation and Adaptive management**

In response to the observed partial implementation and varied user acceptance in KEC, an ongoing monitoring and evaluation (M&E) system is crucial. This should include both technical assessments of deployed infrastructure (e.g., internet connectivity, power reliability, smart waste systems) and user feedback mechanisms to gauge satisfaction and usability. Data should be collected regularly and used to refine system performance, close operational gaps, and plan phased upgrades. Such adaptive management ensures the longevity, effectiveness, and user-centered growth of smart city initiatives in dynamic commercial hubs like KEC.

Ethical clearance

Ethical consent was sought and obtained from the participants used in this study. They were made to understand that the exercise was purely for academic purposes, and their participation was voluntary.

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Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Authors' Contributions
Muhammad Muhammad, R O Oladosu and S J Dukku conceived the study, including the design, Muhammad and Muhammad Abdulkadir collated the data, and Lumi Haruna Zamani handled the analysis and interpretation, while Muhammad Abdulkadir and S J Dukku the initial manuscript. All authors have critically reviewed and approved the final draft, and are responsible for the content and similarity index of the manuscript.

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