International Journal of Spectrum Research in Environmental & Energy Studies (IJSREES)
2(1), January-March, 2026, Pages 9-26

 ISSN: 3092-9555

https://doi.org/10.5281/zenodo.18838204

Smart City Technologies and the Future of Designing Intelligent Hotels in Lagos Mega City

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ABSTRACT

The Lagos megacity is becoming more urbanized, and there is a growing need for sustainable Smart city technology being used more and more quickly because it helps with development and better service delivery in hospitality Architecture, especially when it comes to designing and running smart hotels. This research examined the amalgamation of smart city technology and intelligent building systems in architecture for hotels, especially high-end ones in Ikoyi and Victoria Island, Lagos. Based on a qualitative research methodology, the study employed an in-depth interviews and observational techniques. Interviews were conducted in line with a qualitative approach methodology to find out how modern technology solutions affect design of the building, how well it works, how well it protects the environment, and how well it works for guests. Building Management Systems (BMS), HVAC controls that work with the Internet of Things (IoT), and AI-operating platforms that run on, integrated access and security control systems, smart lighting, and Some of the technologies that are used are renewable energy integration and smart water management. Important smart systems that were also considered. The results indicate that by facilitating real-time monitoring, the strategic use of predictive maintenance and adaptive environmental management can help Smart building systems make operations much more efficient and cut down on carbon emissions, costs of running the business and energy use. This study found that automated HVAC and smart energy systems make the indoors more comfortable while cutting down on the need for diesel-powered. Generators are needed in Lagos because of its tropical climate, limited infrastructure, and high energy needs. Unpredictability Also, through personalized experiences, smooth service delivery, and more Safety, artificial intelligence, and digital service platforms all make passengers much happier satisfaction. Integrated security systems make hospitality settings safer, which are still very important in the busy business areas of Lagos. The study also stressed how Smart lighting, renewable energy systems, and smart ways to manage water all work together, to create long-lasting architectural results that improve long-term economic viability and performance in the environment.

Keywords: *smart city technology, mega city, urban development, hospitality architecture, smart buildings, and sustainability.*

INTRODUCTION

Urbanization and technological innovation are evolving so rapidly that they have fundamentally transformed the planning, design, and management of modern cities. The development of smart cities has emerged as a strategic response to complex urban challenges, leveraging digital technologies such as big data analytics, artificial intelligence (AI), and the Internet of Things (IoT). Cloud computing and smart infrastructure systems enhance efficiency and sustainability (Tan & Taeihagh, 2020; Kisseleff et al., 2020). These technologies enable real-time, data-driven decision-making, optimal resource management, and improved service delivery, thereby strengthening urban resilience and long-term sustainability. Smart city solutions are increasingly vital for addressing infrastructure deficits, resource shortages, environmental degradation, and socioeconomic inequalities in rapidly growing cities within developing countries (Olaoye, 2025).

Nigeria's Lagos megacity—the commercial nerve center and fastest-growing urban area in Africa—illustrates the urgent need for smart urban transformation. With a population exceeding 20 million, Lagos faces significant challenges, including traffic congestion, housing shortages due to rural–urban migration, energy inefficiency, waste management problems, security concerns, and service delivery constraints (Salami et al., 2024). In response, the Lagos State Government has intensified efforts toward smart city development through digital governance platforms, expanded ICT infrastructure, intelligent transportation systems, and data-driven public service delivery mechanisms. These initiatives align with global smart city frameworks that emphasize sustainability, technological integration, inclusivity, and economic competitiveness (Nguyen et al., 2024).

As Lagos advances in its digital transformation agenda, the hospitality industry—particularly hotel design—has become a critical domain for smart technology integration. Globally, the lodging and hospitality sector is shifting toward smart hotel environments, driven by technological advancements, evolving guest expectations, and sustainability imperatives. Smart hotels integrate interconnected systems to enhance operational efficiency and improve guest experiences. Examples include AI-driven personalization, IoT-enabled automation, smart energy management systems, contactless services, and intelligent security infrastructures (Osadare et al., 2024; Mercan et al., 2020). The integration of AI and IoT technologies has significantly improved operational performance, customer satisfaction, and service delivery (Osadare et al., 2024). IoT-based hotel solutions facilitate automation, energy optimization, and personalized guest interactions; however, they also raise security and privacy concerns that require careful consideration.

Smart hotel design plays a pivotal role in sustainability by reducing energy consumption, operational costs, and environmental impact. Evidence from Lagos demonstrates that integrating energy-efficient systems and smart technologies into hotel architecture enhances building performance and guest comfort. Studies indicate that the combined application of sustainable strategies and smart building technologies has improved energy efficiency by over 50% in some four-star hotels in Lagos, highlighting both the economic and environmental benefits of intelligent design integration (Adio, Ajayi, & Daramola, 2025). These findings underscore the importance of smart hotel architecture in addressing Lagos' environmental and infrastructural challenges.

Furthermore, smart hotels are increasingly becoming active components of the broader smart city ecosystem, interconnected with urban digital platforms, transportation systems, energy networks, and public service infrastructures. Through smart sensors, integrated building management systems, and urban data platforms, hotels can support real-time urban monitoring, predictive maintenance, and dynamic service optimization (Nguyen et al., 2024; Kisseleff et al., 2020). This interconnectedness fosters synergy between hospitality facilities and urban systems, thereby enhancing overall city efficiency, environmental management, and tourism attractiveness. Smart hotel design has therefore evolved beyond internal automation to become an integral part of comprehensive smart city systems.

Rising tourism, expanding international business activities, and the growth of the middle class are driving demand for technologically advanced hospitality facilities in Lagos. Guests increasingly expect seamless digital experiences, energy-efficient environments, enhanced security systems, and personalized services that meet international standards while reflecting local climatic, economic, and cultural contexts (Salami et al., 2024; Adio et al., 2025). This reality necessitates a holistic architectural and technological approach that integrates intelligent building systems, sustainable design principles, climate-responsive strategies, and user-centered planning methodologies.

The rise of smart technology has profoundly reshaped architectural practice, prompting a re-evaluation of hotel design toward flexible, adaptive, and user-centered spatial configurations. Intelligent façade systems, climate-responsive envelopes, automated shading devices, smart lighting controls, and responsive HVAC systems enable buildings to adjust dynamically based on occupancy levels and real-time performance data (Olaoye, 2025). This integration of architecture and digital technology facilitates the creation of smart hotel environments that seamlessly blend physical and digital spaces, enhancing comfort, functionality, safety, and environmental performance. Contemporary hotel architecture now extends beyond aesthetics to encompass digital infrastructure planning, cyber-physical system integration, and data-driven design methodologies. As Lagos advances toward smart urban development, the hospitality sector serves as a crucial bridge between global tourism standards, local cultural contexts, and emerging urban technologies.

Successful integration of smart technology into hotel design requires an architectural framework that considers cost efficiency, climatic conditions, cultural identity, infrastructure resilience, and regulatory compliance. Understanding how these technologies diffuse within Lagos' hospitality sector is essential for promoting sustainable design practices, guiding investment strategies, and informing evidence-based policy formulation (Ibitoye, 2025).

Accordingly, this study examines how emerging digital infrastructures, smart building systems, and adaptive architectural strategies are reshaping hospitality spaces in Lagos. By situating intelligent hotels within the broader smart city transformation agenda, the research highlights their significant contributions to urban sustainability, tourism competitiveness, and socioeconomic development. Ultimately, the study aims to provide architects, urban planners, policymakers, and hospitality developers with both conceptual and empirical foundations for leveraging smart technologies to create resilient, sustainable, and future-ready hotel environments in Lagos.

To Achieve the above aim, this article also seeks to investigate and evaluate the following objectives

1. To Identify Smart city technological trends and its involvement in Hospitality Architecture.
2. To evaluate how intelligent building technologies affect a few Lagos hotels' operational effectiveness, sustainability, and visitor experience.
3. This goal assesses the ways in which smart technologies improve user pleasure, safety, environmental sustainability, economic effectiveness, and energy efficiency in hospitality settings.
4. To provide a strategic framework for designing intelligent hotels that are appropriate for the megacity of Lagos while using smart city technology.

Problem Statement

The rapid urbanization of Lagos Megacity, along with an increase in tourism, business travel, and population growth, has made the need for modern, eco-friendly, and effective hospitality facilities even greater. Lagos, one of Africa's fastest-growing megacities, has a lot of issues with its cities right now. These include bad infrastructure, unreliable energy supplies, heavy traffic, pollution, security problems, and bad service delivery systems. These contemporary issues have a big effect on the city's hotel facilities' ability to compete, stay in business, and do well. Even though smart city technology and intelligent building systems have made big strides around the world, many hotels in Lagos still operate old-fashioned operating methods and traditional architectural styles that waste energy and resources and don't meet the needs of modern customers. As megacities like Lagos grow, using smart technology in the hotel industry has a lot of potential, but it also has some problems that are specific to the area. Smart technologies can help with problems that cities have, like unreliable energy supply, poor infrastructure, security risks, and service inefficiencies. However, they are often hard to use because of limited digital infrastructure, high implementation costs, regulatory barriers, and a lack of skilled workers (Salami et al., 2024; Osadare et al., 2024). Recent hotel developments in Lagos, however, show a slow shift toward smart building systems, energy-efficient technologies, and digitally enabled service models. This shows that more people are realizing how important smart hospitality design is for making businesses more competitive, sustainable, and satisfying for customers.

LITERATURE REVIEW

The emergence of smart city technology has fundamentally transformed urban development paradigms. Smart cities utilize data-driven systems, digital infrastructure, and advanced technologies to enhance efficiency, promote sustainable governance, and improve quality of life (Tan & Taeihagh, 2020; Kisseleff et al., 2020). These technologies create a contemporary framework that enables real-time monitoring, predictive decision-making, and optimal resource management, allowing cities to respond effectively to growing populations and expanding infrastructure demands. Smart city frameworks therefore provide a strategic approach to addressing persistent challenges such as energy inefficiency, traffic congestion, environmental degradation, and public service delivery in rapidly expanding megacities like Lagos (Ibitoye & Olaoye, 2025). Within this broader transformation, the hotel industry has emerged as a critical domain for the application of smart technologies.

Hotels are gradually transitioning from traditional operational models to smart service ecosystems powered by cloud-based management systems, the Internet of Things (IoT), artificial intelligence (AI), and big data analytics (Ivanov & Webster, 2020; Osadare et al., 2024). These innovations enable automated service delivery, personalized guest experiences, and real-time operational optimization. Digitally integrated hospitality spaces enhance customer satisfaction by providing seamless interactions, customizable comfort settings, and contactless services (Kim & Han, 2020). This transformation aligns with evolving consumer preferences for convenience, safety, and efficiency, particularly in the post-pandemic era when digital interaction has become central to service delivery (Tussyadiah, 2020).

Evolution of Smart City Technologies

Smart cities have evolved as a necessary response to challenges associated with rapid urbanization, population growth, environmental stress, and infrastructural inefficiencies. Over the past two decades, advancements in digital technologies have significantly reshaped how cities operate, plan, and interact with residents. Contemporary smart cities are conceptualized as interconnected urban ecosystems in which information and communication technologies (ICT), IoT, AI, cloud computing, and big data analytics work collectively to optimize urban processes, improve service delivery, and enhance overall quality of life (Tan & Taeihagh, 2020; Kisseleff et al., 2020). These technologies facilitate real-time monitoring, predictive analytics, and data-driven governance, thereby strengthening urban resilience and adaptability to social and environmental pressures.

Historically, urban development relied heavily on manual systems and conventional administrative practices, which were often inefficient and poorly coordinated. Key sectors such as transportation, electricity, housing, waste management, and governance operated in fragmented silos (Olaoye, 2025). Infrastructure design primarily emphasized functionality and aesthetics, with limited consideration for sustainability or technological integration. Governance systems were largely reactive, addressing short-term issues rather than anticipating long-term urban challenges (Ibitoye, 2025). This pattern was evident in Lagos, Nigeria's commercial hub and one of Africa's largest megacities, where early infrastructure development struggled to accommodate rapid population growth, increasing traffic congestion, and inadequate public service delivery (Salami et al., 2024).

The initial phase of technological integration in cities, often referred to as the "digital urban transition," introduced basic ICT tools such as computer-aided design (CAD), geographic information systems (GIS), electronic governance platforms, and surveillance systems. These tools improved administrative efficiency and provided data to support planning decisions. In Lagos, this phase included the introduction of electronic land registration systems, digital traffic monitoring, and early-stage urban service platforms (Nguyen et al., 2024). Although these initiatives marked significant progress, they were often limited in scope, fragmented in implementation, and lacking real-time integration.

The contemporary phase of smart city development is characterized by fully integrated, data-driven urban ecosystems. Modern smart city technologies incorporate IoT infrastructure, AI-powered analytics, intelligent automation, and cloud-based management platforms to enable responsive and predictive governance systems. Cities equipped with these technologies can optimize energy distribution, monitor environmental conditions, strengthen security systems, manage traffic flows, and deliver public services in real time (Kisseleff et al., 2020; Nguyen et al., 2024). In Lagos, initiatives such as smart traffic management systems, CCTV-based surveillance networks, digital public service platforms, and intelligent transportation solutions demonstrate the city's transition toward a more integrated and technologically advanced urban framework (Salami et al., 2024). These developments represent not merely technological upgrades but a broader paradigm shift in governance, planning, and urban management aimed at addressing structural and socioeconomic challenges more effectively.

The advancement of smart city technologies has had significant implications for the hospitality sector, particularly in hotel design and operations. Traditionally, hospitality architecture in Lagos emphasized passive climate design, cultural expression, and communal spatial arrangements, with limited technological integration. Early inns, guest houses, and colonial-era hotels primarily focused on providing accommodation and social interaction spaces, relying on natural ventilation, simple building forms, and manual service delivery systems (Adio, Ajayi, & Daramola, 2025).

The late twentieth century witnessed the introduction of modernist architectural principles and mechanical systems, marking the beginning of technological integration in hospitality facilities. However,

such integration was largely confined to energy supply systems, security infrastructure, and administrative functions (Ibitoye, 2025). With the advancement of smart city technologies, hospitality architecture has increasingly adopted integrated digital systems, adaptive building management platforms, and user-centered design approaches.

Contemporary smart hotels now deploy IoT-enabled sensors, automated climate control systems, occupancy detection technologies, predictive maintenance tools, and digital concierge services to enhance operational efficiency, reduce energy consumption, and improve guest experiences (Osadare et al., 2024). These innovations signify a shift from purely functional or aesthetic considerations toward flexible, sustainable, and digitally mediated environments that address both user needs and broader urban sustainability objectives. High-end hotels in Victoria Island, Ikoyi, and Lekki exemplify this transformation, incorporating smart energy management systems, automated service platforms, and digital guest interfaces to align with Lagos' evolving smart infrastructure and global hospitality standards.

Smart City Technological Integration in Hospitality Architecture

As cities increasingly adopt digital infrastructure, intelligent systems, and data-driven frameworks, hospitality design has evolved from conventional service-oriented environments into digitally mediated, flexible, and interconnected spaces. Smart city integration enables hotels to function as intelligent urban nodes within broader digital ecosystems. This integration enhances service efficiency, environmental protection, urban mobility, and economic development (Ibitoye & Olaoye, 2025). Globally, the incorporation of smart city principles into hospitality architecture has been driven by rapid technological innovation, shifting consumer expectations, and the demand for sustainable urban growth.

In technologically advanced cities such as Singapore, Dubai, Barcelona, and Seoul, hotels are increasingly deploying Internet of Things (IoT)-enabled room automation, artificial intelligence (AI)-powered concierge systems, smart energy management platforms, and integrated security infrastructures to improve operational efficiency and enhance guest experiences (Ivanov & Webster, 2020; Kim & Han, 2020). These technologies support predictive maintenance, dynamic resource allocation, and personalized service delivery through real-time monitoring of energy consumption, occupancy patterns, indoor environmental conditions, and security systems.

Consequently, hospitality architecture has shifted toward flexible spatial configurations, responsive building envelopes, intelligent façade systems, and digitally integrated public spaces that align architectural design with evolving urban digital infrastructures (Olaoye, 2025). Beyond building-level applications, smart city integration allows hotels to connect seamlessly with urban transportation networks, energy grids, waste management systems, security platforms, and tourism databases. This interconnectedness enables intelligent mobility planning, dynamic pricing strategies, coordinated service delivery, and improved safety management, positioning hotels as integral components of smart urban ecosystems rather than isolated commercial establishments (Kisseleff et al., 2020; Nguyen et al., 2024). These global experiences provide a conceptual foundation for understanding how hospitality architecture can actively contribute to broader smart city objectives, including sustainability, efficiency, resilience, and inclusivity.

In Lagos, emerging hotels—particularly in key commercial and tourism districts such as Victoria Island, Ikoyi, and Lekki—are increasingly adopting smart city integration principles. These hotels utilize intelligent Building Management Systems (BMS) to regulate lighting, air conditioning, energy consumption, water usage, and security operations in real time, thereby enhancing operational efficiency and environmental performance (Adio, Ajayi, & Daramola, 2025; Osadare et al., 2024). IoT-enabled sensors and automation technologies allow buildings to dynamically adjust to occupancy levels, climatic conditions, and guest preferences, resulting in improved indoor comfort, reduced energy consumption, and enhanced service reliability.

Smart city integration has also strengthened safety and security measures within Lagos' hospitality sector. Advanced surveillance systems, biometric access controls, AI-driven video analytics, and centralized security management platforms are increasingly incorporated into hotel architecture and integrated with wider urban security networks. These technologies enable real-time threat detection, rapid emergency response coordination, and seamless collaboration with citywide security infrastructures, thereby improving guest safety and public confidence (Nguyen et al., 2024; Kisseleff et al., 2020). In a megacity like

Lagos, where security concerns significantly influence hospitality investment decisions and tourist perceptions, the integration of intelligent security systems is a critical design priority.

Sustainability is another essential dimension of smart city integration in Lagos' hospitality architecture. In response to persistent electricity supply challenges and environmental vulnerabilities, hotels are increasingly adopting smart energy storage systems, automated lighting controls, high-performance building envelopes, water recycling technologies, and renewable energy solutions to enhance operational resilience and environmental performance (Ibitoye, 2025). Empirical studies indicate that hotels implementing smart energy management systems contribute to reduced carbon emissions, lower operational costs, and decreased reliance on fossil fuel-powered generators (Salami et al., 2024; Osadare et al., 2024). These developments align hotel architecture with Lagos' broader climate adaptation and sustainable development strategies.

Despite these advancements, challenges persist in integrating smart city technologies into hospitality architecture in Lagos. Limited financial resources, inadequate technical expertise, inconsistent regulatory frameworks, and infrastructural constraints hinder widespread adoption, particularly among small and medium-sized hotels. In contrast, luxury hotels and international brands are more likely to implement advanced smart systems due to stronger capital bases and global operational standards (Osadare et al., 2024). This disparity underscores the need for supportive policies, capacity-building initiatives, and inclusive architectural frameworks that promote equitable smart hospitality development across different hotel categories.

Intelligent Building Systems and Sustainable Hospital Architecture Design

The rapid growth of intelligent building systems (IBS) has transformed hospitality architecture, particularly in terms of sustainability. Intelligent building systems utilize digital technologies, automation, sensor networks, and data-driven management platforms to improve building performance, enhance occupant comfort, reduce environmental impact, and increase long-term operational efficiency, thereby minimizing environmental pollution. These technologies are essential in hospitality design because they address the growing demand for energy efficiency, environmental responsibility, and personalized guest experiences. Smart and sustainable hotel design is increasingly prevalent, integrating architectural planning with intelligent operational frameworks to create hotel environments that are adaptable, resilient, and resource-efficient (Ibitoye, 2025).

Smart building technologies also enhance security and resilience in hotels in Lagos. AI-powered surveillance systems, biometric access controls, digital fire safety management platforms, and real-time monitoring systems improve safety and emergency preparedness. In a megacity with complex security challenges and infrastructural weaknesses, smart security systems are crucial for ensuring guest safety, protecting assets, and maintaining operational continuity. Integrated digital security systems significantly improve incident response times, predictive threat detection, and centralized management within hotel complexes, thereby strengthening trust and investor confidence in Lagos' hospitality sector (Zakka & Lee, 2025).

BUILDING MANAGNMENT SYSTEM (B.M.S)

Building Management Systems (BMS) have become an essential component of modern hospitality design, particularly in rapidly growing commercial cities such as Lagos, Nigeria. A Building Management System (BMS) is a digital platform that monitors, controls, automates, and optimizes building services, including heating, ventilation, and air conditioning (HVAC), lighting, power distribution, water supply, security, fire protection, vertical transportation, and energy management. In the hospitality industry, especially in hotels, BMS enhances guest comfort, improves operational efficiency, promotes environmental sustainability, strengthens safety, and reduces operational costs (Ibitoye, 2025).

BMS integrates sensor networks, automation controls, data analytics, and artificial intelligence to enable real-time monitoring and adaptive building performance based on key performance indicators. Globally, modern BMS frameworks are increasingly data-driven, enabling predictive maintenance, fault detection, energy optimization, and performance benchmarking. Sophisticated semantic and machine-learning-based BMS models significantly enhance operational intelligence by automating the analysis of large building data streams, resulting in reduced energy consumption and improved system reliability (Iddianozie & Palmes, 2020). This technological advancement is particularly important for hotels in Lagos,

where power supply is unreliable, operational costs are high, and infrastructure limitations necessitate advanced automation systems capable of dynamically regulating energy loads and optimizing equipment performance.

For hotels in Lagos, BMS plays a crucial role in ensuring operational stability and cost-effectiveness. Hotels operate continuously, with energy demand generated by guest rooms, public spaces, commercial kitchens, conference halls, elevators, and security systems. The integration of centralized BMS platforms allows facility managers to control these subsystems through a unified interface, leading to enhanced performance and reduced reliance on manual operations. Automated energy control systems can reduce electricity consumption by 20% to 35%, representing significant savings in a city where energy expenses constitute a substantial portion of hotel operating costs (Akinwale et al., 2020; Adebayo & Oladapo, 2021).

Additionally, BMS contributes significantly to Lagos' sustainability objectives. Sustainable hotel design increasingly prioritizes carbon footprint reduction, water conservation, improved indoor environmental quality, and enhanced energy efficiency. Real-time monitoring of energy consumption, lighting loads, air quality, and water usage supports continuous performance optimization and facilitates compliance with green building certification standards (Olaoye, 2025). Artificial intelligence-driven anomaly detection systems demonstrate that smart energy analytics integrated into BMS can identify irregular consumption patterns, detect equipment inefficiencies, and prevent system failures before escalation, thereby supporting long-term sustainability and operational resilience. These capabilities are especially valuable in Lagos, where infrastructural instability and environmental pressures require robust building solutions.

Security and safety management is another critical dimension of BMS adoption in Lagos hotels. Large hotels with high occupancy levels require centralized monitoring of surveillance systems, access control, fire detection, and emergency response protocols. Modern BMS platforms integrate closed-circuit television (CCTV), biometric access systems, fire alarm networks, and emergency evacuation controls within a unified system. This integration enhances real-time threat detection, accelerates emergency response, and ensures regulatory compliance. In Nigerian urban contexts where security concerns remain significant, such integration provides an essential layer of operational resilience and guest safety assurance (Olawale & Ajayi, 2019; Adebayo & Oladapo, 2021).

Despite the increasing adoption of BMS, its implementation in Lagos hotels remains constrained by structural and operational challenges. High initial investment costs, limited technical expertise, maintenance complexities, and unstable power supply continue to hinder comprehensive integration. Research on smart building adoption in emerging economies indicates that the financial burden of BMS implementation and the scarcity of skilled personnel often restrict full system utilization, resulting in suboptimal performance and fragmented automation strategies (Akinwale et al., 2020; Olanrewaju et al., 2022). Nevertheless, growing awareness of life-cycle cost benefits, energy savings potential, and sustainability imperatives is gradually accelerating the adoption of BMS within Lagos' hospitality sector.

Figure 1: Building Management system paradigm

Automated Hvac and Environmental Control via Internet of Things (IoT)

The Internet of Things (IoT) has significantly transformed modern hospitality architecture in terms of functionality, design, and user experience, particularly through automated HVAC and environmental control systems. IoT-enabled HVAC systems utilize smart sensors, wireless networks, cloud computing, and artificial intelligence algorithms to monitor, analyze, and regulate temperature, humidity, air quality, and energy consumption in real time. This shift from traditional manual or semi-automated systems to intelligent automation is especially important in tropical megacities such as Lagos, Nigeria, where rising energy costs, sustainability imperatives, and increasing guest comfort expectations are critical concerns (Olaoye & Ibitoye, 2025).

IoT-enabled building systems are increasingly recognized as essential infrastructures for sustainable urban development within the broader smart city framework. Nikpour et al. (2023) argue that smart buildings form the operational foundation of smart cities, as networked HVAC systems reduce energy consumption, lower carbon emissions, and enhance urban environmental resilience. Hospitality buildings are particularly energy-intensive due to continuous operations, fluctuating occupancy levels, and high comfort requirements. Consequently, hotels that adopt IoT-based HVAC automation contribute not only to broader urban sustainability objectives but also to improved operational efficiency.

In Lagos, persistent climate challenges, infrastructural limitations, and energy supply constraints further underscore the importance of IoT-based HVAC systems (Olaoye, 2025). High temperatures, elevated humidity levels, and prolonged cooling demands place significant pressure on hotel energy systems. Thermal discomfort remains a major concern in tropical Nigerian buildings, necessitating climate-responsive technologies capable of maintaining indoor comfort while minimizing energy consumption. In response, leading hotels in Lagos—particularly in high-end districts such as Victoria Island, Ikoyi, Ikeja, and Lekki—have begun integrating smart HVAC controls, occupancy sensors, and centralized building management systems to enhance operational efficiency and environmental performance.

From an architectural and design perspective, IoT-enabled HVAC systems are reshaping spatial planning and building form. Contemporary hotel designs in Lagos increasingly incorporate adaptable mechanical zones, interconnected sensor networks, centralized control hubs, and responsive façade systems that adjust according to real-time weather data. These architectural strategies enable consistent environmental management while reducing mechanical redundancies and spatial inefficiencies. Dimuna et al. (2025) assert that intelligent environmental control enhances not only thermal comfort but also spatial quality, acoustic performance, and indoor air quality—factors that significantly influence user experience in hospitality environments.

Despite the transformative potential of IoT-driven HVAC systems, several contextual challenges hinder their widespread adoption in Lagos hotels. These include high installation costs, limited technical expertise, cybersecurity concerns, and infrastructural constraints. Adio et al. (2025) note that financial and regulatory barriers continue to restrict technology adoption, particularly among mid-range hotels. Nevertheless, increasing awareness of sustainability imperatives, rising energy costs, and evolving guest expectations are steadily driving the expansion of smart environmental management systems within Lagos' hospitality sector.

Integrated Security Via Access Control

Access control has become an important part of modern hotel management systems and hospitality architecture, especially in big cities with a lot of people, complicated travel patterns, and a greater need for security. Access control systems incorporates technology that uses biometric authentication, smart cards, radio-frequency identification (RFID), face recognition, mobile credentials, and centralized monitoring platforms to control entrance, movement, and exit within built environments. In the hospitality industry, especially hotels, integrated access control goes beyond traditional lock-and-key systems to become part of a complete digital security ecosystem that protects guests, assets, and operations while also following the law (Ibitoye, 2025). Smart access control systems are the basis for intelligent building security infrastructures, which allow for real-time monitoring, threat detection, and adaptive response mechanisms in high-occupancy facilities (Zhang et al., 2020; Azeez & Misra, 2023). Due to these technologies, access control can work perfectly with digital guest services, emergency response networks, building management platforms, and surveillance systems AI-driven access control systems enhance the accuracy of identity verification, reduce occurrences of unauthorized access, and augment operational intelligence through predictive risk assessment. Zhang et al. (2020). Access control is especially important in the hospitality industry in Lagos, Nigeria's biggest megacity and commercial nerve center. Lagos as an economic hub is privy to numerous amounts of guests from other countries, including business people, tourists, and people who are going to events. This means that hotels are always full and people are always moving around. At the same time, the city is having major security problems because of more people moving to cities, more pressure on infrastructure, differences in wealth and crime rates, and the way crime works in cities. These circumstances necessitate contemporary, reliable, and flexible security infrastructures that can safeguard visitors, employees, and physical assets while ensuring operational efficiency and spatial comfort.

Figure 2; Access control Implementation

In terms of Architecture design in relation to hotels, putting access control systems together can directly influence the design of circulation, spatial planning, and building morphology. (Olaoye, 2025). Controlled entry points, layered security levels, and smart elevator zoning, corridors that are monitored digitally by computers, and spatial features that have sensors built into them are becoming more common in modern hotel design. These design Solutions let authorized users move around easily while keeping access to important areas limited places. Smart turnstiles, staff entrances with biometric technology, and automated vehicle access. Architectural changes include things like gates and lobbies with surveillance built in. Lagos hotels that show how digital security gear is built into form and logic in space. This kind of integration makes things better not only for Security effectiveness, as well as spatial efficiency and user experience, can be improved by finding a balance between openness and controlled accessibility (Zhang et al., 2020; Azeez & Misra, 2023).

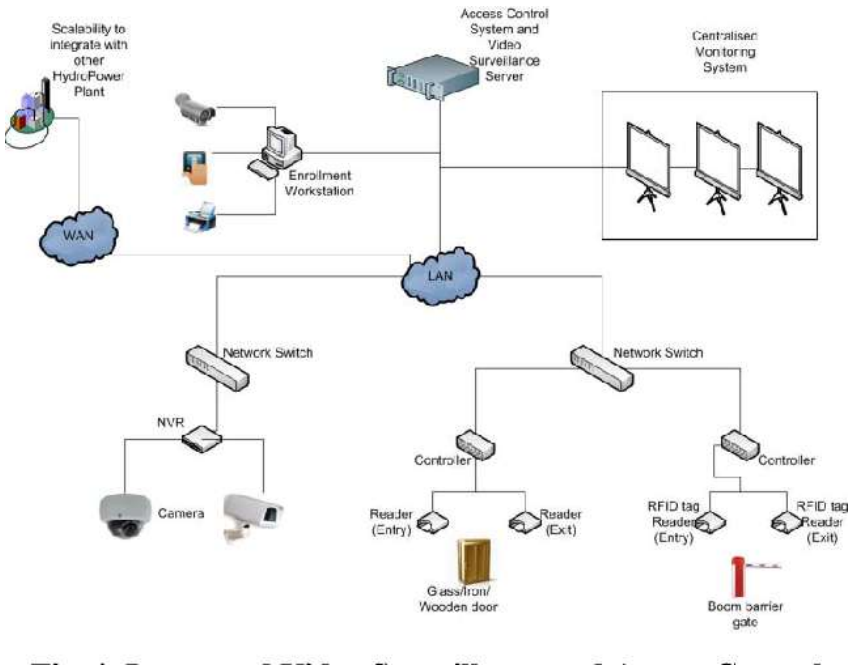

Figure 3; Access control paradigm

The way access control systems work together in Lagos hotels helps with bigger goals for building management and sustainability. Smart access control platforms generate valuable occupancy and movement data that can be integrated into building management systems (BMS) and energy management platforms. This information makes it possible to manage HVAC based on how many people are in the building, change the lighting based on how many people are in the building, and plan maintenance based on how many people are in the building. This all makes the building more energy-efficient and long-lasting. Oladapo and Adebayo (2021) say that integrating data-driven access control improves operational intelligence, which helps facility managers make the most of their space, cut down on energy waste, and respond more quickly to service requests. In Lagos, where energy prices and the reliability of infrastructure are always problems, these kinds of integrative skills make operations much more resilient and sustainable.

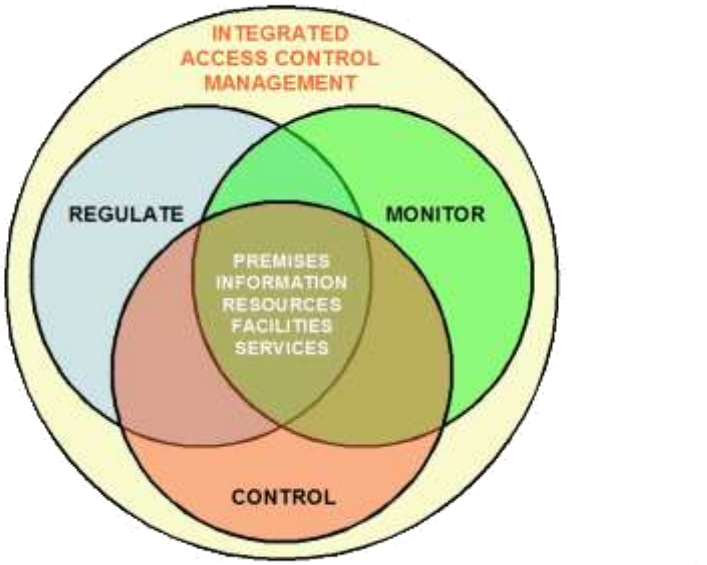

Figure 4; Integrated Access control Management

Artificial intelligence integration in hospitality architecture

Artificial intelligence integration (A.I) in hospitality architecture is the systematic incorporation of intelligent digital technologies into hotel planning, design, construction, and operational management in order to improve efficiency, guest satisfaction, safety, sustainability, and overall performance. AI is changing modern hospitality architecture into smart, flexible, and responsive spaces that communicate with people in real time, make better use of resources, and give businesses more information about how to run their operations. Rapid urbanization, high guest turnover, more hotel competition, and higher expectations for comfort, safety, and personalized services have all led to a big increase in the use of AI-driven architectural solutions in Lagos, Nigeria's commercial and tourism center. More and more top-tier hotels in Lagos, especially those in Ikoyi, Victoria Island, Ikeja, and Lekki, are using AI-powered solutions to make their services better, keep their guests safe, control the environment, and save energy. Artificial intelligence is at the crossroads of smart technologies, human-centered design, and building automation in hospitality architecture. AI-enabled buildings use cloud computing, sensors, machine learning algorithms, and data analytics to keep an eye on, predict, and improve how buildings work. Unlike traditional systems, AI-based systems change how buildings work in real time by learning from how people use them, how many people are in them, how the weather changes, and how they are used. Automated

systems that rely on programming that doesn't change. From an architectural point of view, AI integration affects the planning of mechanical and electrical systems, the design of circulation, the layout of security, the arrangement of space, and sustainability efforts. Smart rooms, adaptive lighting, biometric access control, predictive HVAC systems, robotic service zones, and data-driven facility management platforms are all changing the way hotels are designed, built, and run. AI-based architectural systems offer solutions to long-standing problems like power instability, high operating costs, security issues, and varying occupancy levels in Lagos, where energy efficiency, safety, and service customization are all very important. AI-powered room automation systems let hotel rooms change to fit each guest's needs, such as the temperature, entertainment systems, curtain control, and lighting levels. These systems use machine learning to watch how visitors act and change the room's environment to make it more comfortable for each person. Smart room technologies in luxury hotels in Lagos make guests happier by giving them voice-activated assistants, temperature systems that respond to occupancy, and controls that work through mobile apps. These features not only make things more comfortable, but they also cut down on unnecessary energy use, which is in line with environmental goals for building design. Because Lagos relies heavily on diesel generators and public power supplies that are not always reliable, energy use is a major operational issue. AI-powered energy management systems make the most of electricity use by predicting how much energy will be needed, keeping backup power systems running, and controlling how much light and HVAC is used. To architecturally integrate these systems, intelligent control units and predictive

The infrastructure of buildings must include smart sensors, analytics platforms, and other smart devices. AI systems keep track of occupancy trends and weather data to control ventilation, lighting, and cooling. This lowers operating costs and makes the environment more sustainable. Because of the city's traffic, famous visitors, and complicated socioeconomic dynamics, security is very important in Lagos's hospitality architecture. (Olaoye, 2025). AI-powered surveillance systems use behavioral analytics, motion detection, and facial recognition to make real-time monitoring and finding threats better. Architects use these technologies in smart lobbies, biometric entry points, digitally controlled circulation pathways, and cameras that are placed in the right places. This keeps the beauty of the building while making sure that people can move around safely, be more aware of their surroundings, and be safer. AI integration is an important part of smart and sustainable hotel design because it links automation, security, energy management, and user experience. In Lagos, where hotels have to find a balance between luxury, safety, sustainability, and cost-effectiveness, AI-driven design is a smart way to improve the overall performance of a building.

RESEARCH METHODD

This study employs a qualitative method approach. The qualitative method is appropriate for looking into how people really feel, think, and act about the integration of multiple smart city technologies in hospitality architecture. A multiple-case study methodology will be employed, focusing on selected upscale and mid-tier hotels in Lagos, particularly in Ikoyi, Victoria Island, Ikeja, and Lekki. This method lets you look closely at contextual factors, architectural styles, operational strategies, and user experiences. This study employs a qualitative research methodology to examine the increasing relevance of smart city technologies in shaping the future of hospitality design, specifically targeting premier hotels in the Lagos megacity. Lagos, Nigeria's economic center and Africa's fastest-growing megacity, has a complicated urban environment that is changing quickly due to rapid urbanization, poor infrastructure, the digital revolution, and a growing number of high-end hotels. These traits give us a one-of-a-kind setting to look into how smart technologies are thought of, used, and put into practice in hotel design and management. The qualitative method is the best way to get detailed professional opinions, experiential insights, and contextual realities that can't be fully measured by numbers. This study examines leading hospitality establishments in Ikoyi, Victoria Island, Lekki, and Ikeja to investigate how notable hotels adapt architecturally and operationally to smart city paradigms, ultimately assessing the future of intelligent hospitality design in Lagos. The research utilizes a multiple case study design, facilitating a comparative and context-sensitive examination of selected premier hotels that have integrated smart technology into their architectural and operational frameworks. This design allows for a thorough examination of architectural choices, methods for putting technology into use, environmentally friendly practices, and ways to make the visitor experience better. The many case study method is very helpful in Lagos because

the types of hotels, the quality of the infrastructure, the readiness of the technology, and the level of management all vary a lot. By looking at a lot of high-end hotels, the researcher can find best practices, contextual changes, and implementation problems. This gives them useful comparisons of how to design intelligent hospitality in a megacity. Purposive sampling is employed to select upscale hotels in Lagos that exemplify advanced levels of architectural sophistication, technological integration, and service innovation. This qualitative research methodology provides a robust factual basis for forecasting the future direction of intelligent hotel design within the Lagos megacity. The research employs in-depth interviews and experiential inquiry to collect context-sensitive insights, professional expertise, and user perspectives, facilitating a thorough comprehension of the impact of smart city technologies on hospitality design.

Empirical Review

The qualitative findings of this study indicate that smart city technologies have emerged as a pivotal catalyst for architectural innovation, operational efficiency, environmental sustainability, and enhanced guest experience within Lagos' premium hotel sector. The research utilizes data from prestigious hotels, including Eko Hotel & Suites, Movenpick Hotel Ikoyi, Sheraton Lagos, and Four Points by Sheraton Victoria Island, to demonstrate that intelligent building systems have transitioned from supplementary features to essential infrastructural frameworks that define modern hospitality architecture. The results also show that Lagos, which is a megacity that is growing quickly but has a lot of infrastructure problems, is a unique place for smart technologies to be used are both strategically useful and necessary for the job. The results show that these hotels' use of Building Management Systems (BMS) has completely changed how their facilities work by making it possible to control everything from one place, monitor everything in real time, and make decisions based on data. At Eko Hotel & Suites and Movenpick Ikoyi, integrated BMS systems manage HVAC, lighting, security, and energy use. This makes the systems more reliable, reduces downtime, and makes them more energy efficient. Facility managers said that these systems' predictive maintenance algorithms help find problems early, which cuts down on service interruptions and long-term maintenance costs. Wang et al. (2021) and Bibri and Krogstie (2020) say that BMS-driven smart infrastructures make buildings work better by integrating data in real time and automatically responding to operational needs. Due to Lagos' hot and humid climate and unreliable power supply, automated HVAC and IoT-based environmental control systems were the most common technical feature among the hotels that were looked at. The Sheraton Lagos and Four Points by Sheraton Victoria Island use occupancy-based climate control technologies to automatically change the temperature, humidity, and ventilation inside the building. This keeps guests comfortable while also saving energy. These adaptive methods cut down on cooling loads by a lot during off-peak times and make the most of energy efficiency during peak occupancy. The results show that using IoT to optimize HVAC systems in large hotels and other hospitality facilities is a big step toward better energy management, better indoor air quality, and lower carbon emissions. Integrating artificial intelligence was shown to have a revolutionary effect on both operational intelligence and customizing the guest experience. AI-powered guest service platforms at Movenpick Ikoyi and Eko Hotel let guests control their rooms, set their own climate, get digital concierge services, and get service before they need it.

Hotels can use these tools to predict what guests will want, make service more efficient, and cut down on mistakes made by people. Interviews with hotel management revealed that AI analytics significantly improve resource allocation, demand forecasting, and service efficiency, leading to increased customer satisfaction and profitability. These results align with the studies conducted by Ivanov and Webster (2020), Mariani and Borghi (2021), and Buhalis and Leung (2023), which emphasize the pivotal role of artificial intelligence in transforming service innovation and competitive advantage within the global hotel industry. Security and access control systems are another important part of smart hospitality design in Lagos, especially because big cities have a lot of crime and problems with safety. All four hotels relied heavily on centralized monitoring platforms, integrated surveillance networks, biometric access control, and RFID-enabled room key systems. These technologies make it safer for visitors, limit movement in restricted areas, and let people respond to events in real time. The security managers at the Sheraton Lagos and Eko Hotels reported that they had made a lot of progress in threat detection, emergency management, and overall security governance. These results align with the research conducted by Kitchin (2021) and Silva et al. (2022), which asserts that intelligent security infrastructures are essential for enhancing resilience, public trust, and urban safety within smart city ecosystems. Intelligent building

systems have a big effect on sustainability, especially when it comes to managing energy, using water efficiently, and protecting the environment. Both Movenpick Ikoyi and Four Points by Sheraton have solar photovoltaic systems, advanced lighting systems, and hybrid energy systems that help them use less diesel generators. Smart lighting systems that use motion sensors, daylight harvesting, and changing light levels significantly reduced energy use while making the space more visually comfortable and improving the overall feel of the building. These results align with the sustainability frameworks proposed by the United Nations Habitat (2022) and Sharifi et al. (2021), which emphasize energy efficiency and renewable integration as crucial components of sustainable urban development. Smart water management systems that use sensors to control fixtures, find leaks, and recycle greywater have also been shown to greatly reduce water waste and operating costs. In megacities like Lagos, where the water infrastructure is still lacking, these solutions make the city more resilient, environmentally responsible, and compliant with the law. The results corroborate earlier studies by GhaffarianHoseini et al. (2020) and Bibri (2022), which recognized smart water technologies as essential elements of sustainable building ecosystems in climate-sensitive urban environments.

Adoption of Intelligent Building Systems in Lagos Hotels (2020-2024)

Adoption of Intelligent Building Systems in Lagos Hotels (2020-2024) Year	Market Adoption Rate of Intelligent Systems (%)	Average Energy Efficiency Improvement (%)	Primary Operational Focus
2020	15.0	10.5	Basic Lighting and HVAC Automation
2021	22.5	14.0	Security and Access Control Integration
2022	34.0	19.5	Centralized Building Management Systems (BMS)
2023	47.5	24.0	IoT-Connected Guest Experiences
2024	60.0	29.5	AI-Driven Energy Sustainability and Workflows

Data Source: All Top Hotels

The use of smart technology has changed the way luxury hotels in Lagos are designed. Building forms now focus on flexible floor plans, modular service areas, integrated service cores, and digitally coordinated building envelopes. Interview respondents reported that intelligent systems are very important for making early design decisions, especially when it comes to things like facade orientation, ventilation methods, energy modeling, and space optimization. This movement marks a transition from conventional hospitality architecture to data-driven, performance-oriented design methodologies, consistent with the theoretical frameworks established by Batty et al. (2021) and Townsend (2020). The results show that smart city technologies are changing how hotels are designed in Lagos in many ways, such as making them more environmentally friendly, using digital intelligence, coming up with new ways to provide service, and connecting people in the city. The Eko Hotel, Movenpick Ikoyi, Sheraton Lagos, and Four Points by Sheraton are examples of how smart technology can help Lagos' infrastructure problems while also raising the standards of hospitality around the world. This smart mix of technology and architecture makes Lagos's high-end hotel industry a model for smart urban hospitality growth in Africa.

Key Applications of IoT Sensors in Lagos Hospitality Sector

Application Area	Core Functionality	Strategic Benefit
Real-Time Monitoring	Continuous data collection across building systems	Enhanced operational efficiency through actionable insights
Predictive Maintenance	Early detection of equipment anomalies	Prevention of system failures and reduced downtime
Energy Efficiency	Automated control of lighting and HVAC systems	Significant energy savings and cost reduction
Personalized Guest Services	Analysis of guest preferences and behavior	Tailored experiences and improved customer satisfaction

Data Source: All Top Hotels

CONCLUSION

This study has critically examined the future of intelligent hotel design in the Lagos megacity, focusing on notable hospitality establishments such as Eko Hotel & Suites, Movenpick Hotel Ikoyi, Sheraton Lagos, and Four Points by Sheraton Victoria Island. The results clearly show that integrating cutting-edge digital technologies into hospitality architecture is now a strategic necessity rather than an optional enhancement in order to achieve operational efficiency, environmental sustainability, superior guest experience, and long-term competitiveness in an increasingly dynamic urban environment. The study's conclusion underscores the significance of smart technologies, including Building Management Systems (BMS), automation driven by the Internet of Things (IoT), analytics enhanced by artificial intelligence (AI), intelligent energy and water management systems, and integrated security solutions. Smart Infrastructures have fundamentally transformed the managerial, functional, and architectural paradigms of hotel design in Lagos. These technologies have helped hotels move beyond traditional ways of doing business by encouraging real-time responsiveness, predictive maintenance, personalized service delivery, and efficient resource use. Because of this, intelligent hotels are now dynamic ecosystems that can adapt to the changing social, cultural, economic, and environmental conditions that define Lagos as a megacity. The study also shows that using smart city technology has made hotel buildings stronger and better for the environment. By using water conservation systems, automatic lighting, smart energy management, and renewable energy integration, hotels have been able to cut down on carbon emissions, save money on unnecessary operating costs, and support sustainable development practices. This is especially important in Lagos, where energy instability, climate change, and poor infrastructure make it hard for big business projects to get off the ground. By making hotels more environmentally friendly, smart technology helps Nigeria keep its promises to fight climate change and supports the larger global sustainability agenda. The study also found that using smart security and surveillance technologies has made hotel safety, access control, and risk management frameworks much better. These solutions are very important for building visitor confidence, operational stability, and public trust in Lagos because the city is very crowded and security is becoming more of a concern. Combining smart security infrastructure with smart architectural planning makes buildings more resilient, ready for emergencies, and efficient in terms of space.

The study shows that smart technologies are changing the way hotels are designed. Instead of using traditional static models, they are now using dynamic, performance-driven frameworks. Smart hotels support adaptable building envelopes, flexible room layouts, digitally coordinated service centers, and internal environmental systems that respond to changes. This model Change is part of a bigger revolution in how architects work today. This revolution is based on principles of data-driven decision-making and design that focuses on sustainability. These principles guide how spaces are planned, materials are chosen, and environmental performance is improved.

RECOMMENDATIONS

Based on the findings of this study, stakeholders in the Lagos hospitality sector should strategically prioritize the incorporation of smart city technology into hotel design, construction, and operations.

Architects and developers should add intelligent systems like Building Management Systems (BMS), Internet of Things (IoT)-enabled environmental controls, artificial intelligence-driven analytics, and smart security infrastructures early on in the design process to make buildings work better, run more smoothly, and give guests a better experience. To be more environmentally friendly and save money in the long run, hotel owners should invest in renewable energy sources, smart water management systems, and climate control technology that can adapt to changing conditions. Also, Lagos's policymakers and urban planning authorities should make the rules and incentives that will help smart the use of technology in hotel construction. Training hotel staff and facilities managers on how to use and maintain intelligent systems is another important part of making sure that systems are reliable and long-lasting. To encourage innovation, reduce financial barriers, and speed up implementation, government agencies, business developers, and technology suppliers should work together more. These methods will work together to build smart, strong, and long-lasting hotels that will make Lagos a competitive smart tourist destination in Africa and the global hospitality industry.

After the conclusion, these are some suggestions that are in line with the research. They are not limited to but include

1. **Strategic Integration of Smart City Technologies in Hotel Design** Instead of adding smart city technologies to hotels after they are built, Lagos hotel developers and architects should make sure to include them in the design process from the beginning. This plan makes sure that the building is cost-effective, that all the systems work together perfectly, and that the space is set up in the best way possible. All of these things make the building work better and make visitors happier.
2. **Adoption of Centralized Building Management Systems (BMS)** Hospitality facilities should use centralized BMS platforms to manage HVAC, lighting, security, and energy systems. This is especially important in crowded areas like Ikoyi and Victoria Island. This will lead to fewer operational problems, real-time monitoring, and predictive maintenance.
3. **Promotion of IoT-Driven Environmental Control Systems** Because Lagos has a tropical climate and unreliable power supply, hotels should install IoT-enabled HVAC and lighting control systems to make the indoors more comfortable, cut down on energy waste, and make climate control more adaptable.
4. **Investing in Renewable and Hybrid Energy Systems** Hotels in Lagos should invest in hybrid renewable energy solutions like solar photovoltaic systems combined with smart grids and energy storage technologies to make sure that power is reliable, sustainable, and businesses can keep running despite the city's ongoing energy problems.
5. **Using AI for operational optimization** AI-driven analytics should be used to predict occupancy patterns, improve guest services, personalize experiences, and make better operational decisions in order to improve service delivery and financial performance.
6. **Improving Smart Security and Access Control Systems** Hotel designs should include the latest biometric access control, facial recognition, and real-time surveillance systems to make them safer, more private, and better at responding to emergencies, especially in busy cities.
7. **Building Capacity and Technical Training for Hotel Staff** To make sure that the system works well and lasts a long time, hospitality management should pay for ongoing professional training programs to help staff learn how to manage and maintain smart building systems.
8. **Making rules for smart hospitality infrastructure** The government and city planning groups in Lagos should make technical rules and guidelines that encourage the use of smart technology in hospitality projects. These should include rewards for following the rules and punishments for not doing so.
9. **Encouragement of Public-Private Partnerships (PPP)** To encourage new ideas, lower costs, and speed up the building of smart infrastructure, government agencies, IT companies, and hotel developers should work together more often.
10. **Smart technology solutions** Should be tailored to Lagos' socioeconomic conditions, weather patterns, and infrastructure constraints to enhance adaptability, reduce costs, and ensure long-term viability.

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