© JUN 2026 | IRE Journals | Volume 9 Issue 12 | ISSN: 2456-8880
DOI: https://doi.org/10.64388/IREV9I12-1718762

Impact of an IoT-Enabled Hotel Management System with Embedded CCTV Security for Smart Hospitality Management

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Abstract- ***The hospitality industry is increasingly adopting smart technologies to improve operational efficiency, customer satisfaction, and security management. This study investigates the impact of an Internet of Things (IoT)-enabled Hotel Management System integrated with embedded Closed-Circuit Television (CCTV) security infrastructure on smart hospitality management. The proposed framework combines intelligent room management, automated reservation systems, real-time occupancy monitoring, environmental control sensors, smart access control, and CCTV-based surveillance into a unified platform. Using a quantitative research design with 250 respondents across hotel staff and guests, findings indicate significant improvements in operational efficiency, guest satisfaction, security effectiveness, and energy conservation. The integration enables centralized monitoring and data-driven decision-making, supporting sustainable and intelligent hospitality operations.***

Keywords: Internet of Things, Smart Hospitality, Hotel Management System, CCTV Security, Smart Hotels, Digital Transformation

I. INTRODUCTION

The hospitality industry has undergone significant transformation due to advancements in Information and Communication Technologies. Traditional hotel management systems are being replaced by intelligent digital platforms capable of automating operations and enhancing customer experiences. The Internet of Things (IoT) has accelerated this transformation by enabling interconnected devices to exchange data and support real-time decision-making within hospitality environments (Yang, Hlee, & Lee, 2018).

IoT-enabled hotel management systems integrate reservations, guest check-in/out, room access control, energy management, housekeeping coordination, and customer relationship management into a centralized digital ecosystem. Smart sensors automatically regulate temperature, lighting, and ventilation, enhancing guest comfort while reducing operational costs (Luo, 2024).

Security remains critical due to increasing incidents of theft, unauthorized access, and safety threats. CCTV systems have become essential components of modern hotel security. Integration of CCTV with IoT-enabled platforms creates opportunities for enhanced security intelligence and operational visibility (Mercan et al., 2020). This study examines the combined impact of IoT-enabled hotel management and embedded CCTV security on smart hospitality outcomes.

II. Literature Review

A. Smart Hospitality Management

Smart hospitality management applies advanced digital technologies to improve hotel operations, enhance guest experiences, and optimize resource utilization. Industry 4.0 technologies transform traditional systems into intelligent ecosystems characterized by connectivity, automation, and real-time information exchange (Yang et al., 2018). Modern guests expect contactless services, real-time communication, and personalized experiences.

B. IoT in Hotel Management

IoT refers to interconnected physical devices equipped with sensors and communication capabilities that collect and exchange data without

human intervention. In hotels, IoT facilitates smart room management, automated lighting, temperature regulation, occupancy monitoring, energy management, asset tracking, predictive maintenance, and smart access control (Luo, 2024). Key components include smart sensors, RFID/NFC, wireless networks, cloud platforms, mobile apps, smart locks, and intelligent energy management systems.

C. CCTV Security in Hospitality

Modern CCTV systems incorporate facial recognition, motion detection, behavioral analytics, automated alert generation, and video analytics. Strategic deployment locations include entrances, reception areas, corridors, parking, elevators, public spaces, conference halls, and storage facilities. CCTV contributes to crime prevention, evidence collection, and emergency response coordination (Mercan et al., 2020).

D. Integration of IoT and CCTV

Integration architecture comprises five layers: Perception (sensors, cameras, locks), Network (Wi-Fi, BLE, ZigBee), Processing (data aggregation, video analytics, AI), Application (management dashboards, mobile interfaces), and User (managers, staff, guests). Integrated systems enable automated alerts when unusual activities are detected while accessing operational information simultaneously.

E. Benefits and Challenges

Benefits include improved operational efficiency, enhanced guest experience (mobile check-in, personalized settings, faster response), enhanced security (continuous surveillance, rapid incident detection), energy efficiency (occupancy-based optimization), and data-driven decision making. Challenges include cybersecurity risks, privacy concerns, infrastructure costs, technical complexity, and maintenance requirements.

F. Theoretical Framework

This study is anchored on the Technology Acceptance Model (TAM) (Davis, 1989), which suggests that technology adoption is influenced by perceived usefulness and perceived ease of use. Hotel administrators are more likely to adopt IoT-enabled systems when they perceive them as beneficial and easy to operate.

III. Methodology

A. Research Design

A quantitative research design was adopted, involving system development, deployment of IoT devices and CCTV infrastructure, evaluation of operational performance, assessment of user satisfaction, and security effectiveness analysis.

B. Population and Sample

The target population for this study comprised hotel managers, ICT administrators, security personnel, front desk officers, housekeeping staff, and guests in selected hotels within Arochukwu Kingdom and Umuahia, both in Abia State, Nigeria. These stakeholders were selected because they are directly involved in hotel operations, ICT-based service delivery, and security management, making them suitable for assessing the impact of an IoT-enabled hotel management system with embedded CCTV security.

A stratified random sampling technique was employed to ensure fair representation across the different categories of respondents. This method was adopted to reduce sampling bias and to ensure that each stakeholder group contributed proportionately to the study findings.

A total sample size of 250 respondents was selected, distributed across the selected hotels as shown in Table 3.1.

Table 3.1: Distribution of Sampled Hotels and Respondents

S/N	Name of Hotel	Location	Category of Respondents	Number of Respondents
1	Ibom Waterfall Resort & Suites	Arochukwu	Managers, Staff, Guests	30
2	Winpher Hotel AA91	Arochukwu	Managers, Staff, Guests	25

3	Nmadiye Hotels	Arochukwu	Managers, Staff, Guests	20
4	Amangwu Guest House	Arochukwu	Managers, Staff, Guests	20
5	Vanderry Hotels and Suites	Umuahia	Managers, Staff, Guests	30
6	Apricot Hotels & Paviosca Hotels	Umuahia	Managers, Staff, Guests	25
7	Lelux Hotels	Umuahia	Managers, Staff, Guests	25
8	Concordia Hotels Limited	Umuahia	Managers, Staff, Guests	25
9	Hotel Royal Damgrete	Umuahia	Managers, Staff, Guests	30
10	Concordia Hotels Limited (Branch)	Umuahia	Managers, Staff, Guests	20
Total				250

The respondents comprised:

- 20 Hotel Managers
- 15 ICT Personnel
- 25 Security Officers
- 40 Front Desk Staff
- 50 Housekeeping Staff
- 100 Hotel Guests

This stratification ensured that all key operational and service delivery units within the selected hotels were adequately represented in the study. The inclusion of both management and service-level personnel, as well as guests, provided a balanced perspective on the implementation and impact of IoT-enabled hotel management systems with embedded CCTV security infrastructure.

C. System Architecture

The proposed architecture consists of five layers:

- Perception Layer: Smart door locks, RFID cards, motion/temperature/smoke/occupancy sensors, smart energy meters, CCTV cameras.
- Network Layer: Wi-Fi, Ethernet, BLE, ZigBee, Internet connectivity.
- Processing Layer: Data collection, filtering, event analysis, video analytics, AI-based decision support (cloud computing).
- Application Layer: Modules for reservation, guest management, room allocation, housekeeping, inventory, security monitoring, CCTV dashboard, energy management, CRM.
- User Layer: Hotel managers, security personnel, front desk staff, housekeeping staff, guests (via web portals and mobile apps).

D. Data Collection Instruments

Structured questionnaires measured system usability, operational efficiency, security effectiveness, and user satisfaction. Observation checklists evaluated system performance and security incident response. System logs analyzed occupancy patterns, energy consumption, security events, and response times.

E. Validity and Reliability

Content validity was established through expert review. Reliability testing using Cronbach's Alpha yielded a coefficient of 0.89, indicating high internal consistency.

F. Data Analysis

Data were analyzed using frequency distribution, mean scores, standard deviation, percentage analysis, and regression analysis (SPSS v27).

IV. Results and Discussion

A. Demographic Characteristics

The demographic distribution of respondents across stakeholder categories is presented in Table 4.1 to establish the representativeness of the sample and the breadth of perspectives captured in the study.

Table 4.1 : Demographic Characteristics

Category	Frequency	Percentage
Hotel Managers	20	8.0
ICT Personnel	15	6.0
Security Officers	25	10.0

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Front Desk Staff	40	16.0
Housekeeping Staff	50	20.0
Guests	100	40.0
Total	250	100

B. Impact on Operational Efficiency

Table 4.2 summarizes respondents' perceptions of operational efficiency improvements following the deployment of the IoT-enabled hotel management system, measured on a five-point Likert scale.

Table 4.2 : Impact on Operational Efficiency

Variable	Mean	SD
Faster Check-in/Check-out	4.52	0.63
Improved Resource Allocation	4.41	0.71
Reduced Administrative Workload	4.37	0.69
Improved Housekeeping Coordination	4.45	0.66

Approximately 89% of respondents reported noticeable improvements in service delivery speed and operational coordination.

C. Impact on Guest Satisfaction

Guest satisfaction levels across key service indicators are presented in Table 4.3 and visualized in Figure 4.1, highlighting the most valued aspects of the smart hospitality experience.

Table 4.3: Impact on Guest Satisfaction

Indicator	Positive Response (%)
Room Comfort	91
Service Responsiveness	88
Ease of Check-in	93
Security Confidence	90
Overall Satisfaction	92

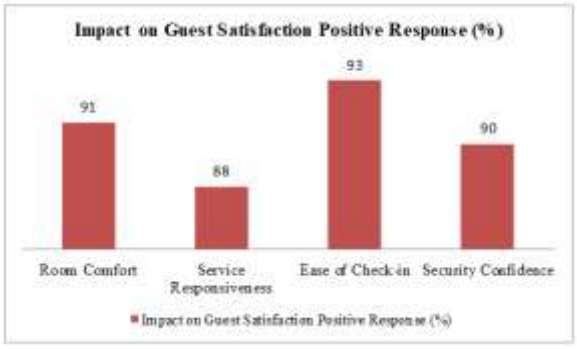

Figure 4.1: Impact on Guest Satisfaction

Figure 4.1 shows that all assessed hotel service factors had very high positive impacts on guest satisfaction, with ratings above 88%. Ease of Check-in recorded the highest positive response (93%), followed by Room Comfort (91%) and Security Confidence (90%). Service Responsiveness had the lowest rating (88%), although it still indicates a high level of guest satisfaction. Overall, the findings suggest that efficient check-in processes, comfortable rooms, and effective security measures significantly enhance guests' experiences, while service responsiveness offers room for further improvement.

D. Impact of Embedded CCTV Security

Table 4.4 compares security performance metrics before and after the integration of embedded CCTV security, demonstrating the system's effectiveness in reducing incidents and improving response capabilities.

Table 4.4: Impact of Embedded CCTV Security

Security Metric	Before	After
Security Incidents	24	9
Unauthorized Access Cases	18	5
Response Time (minutes)	14	5
Incident Resolution Rate (%)	68	95

Security incidents decreased by approximately 62.5%; response times improved by over 64%.

E. Impact on Energy Efficiency

Table 4.5 and Figure 4.2 present the percentage reductions in electricity, water, and HVAC energy consumption, illustrating the contribution of IoT-enabled automation to sustainable hotel operations.

Parameter	Reduction (%)
Electricity Consumption	27
Water Consumption	19
HVAC Energy Usage	31

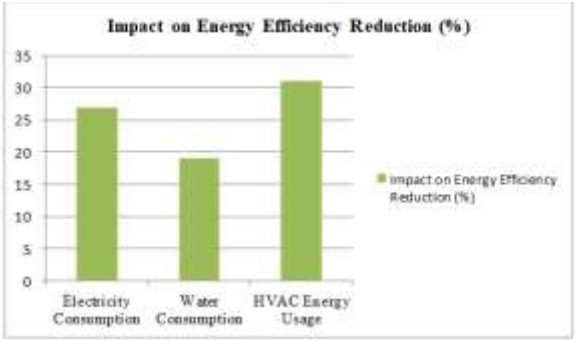

Figure 4.2: Impact on Energy Efficiency

Figure 4.2 illustrates the impact of smart hotel technologies on energy efficiency through reductions in resource consumption. The highest reduction was recorded in HVAC energy usage (31%), indicating that intelligent climate control systems significantly lower energy demand. This was followed by electricity consumption (27%), demonstrating the effectiveness of automated lighting and energy management systems. Water consumption recorded the lowest reduction at 19%, although it still reflects a notable improvement in resource conservation. Overall, the findings suggest that the adoption of IoT-enabled hotel management systems contributes substantially to energy efficiency and sustainable hotel operations by reducing energy and water usage.

F. Regression Analysis

Multiple regression analysis showed $R^2 = 0.81$, indicating that 81% of variations in hospitality performance can be explained by IoT automation, smart monitoring, embedded CCTV security, and real-time data analytics ($p < 0.05$).

V. CONCLUSION

A. Finding :

The findings demonstrate that IoT-enabled systems substantially improve operational efficiency, guest satisfaction, security effectiveness, and resource management. Results support Yang et al. (2018) regarding interconnected smart hospitality ecosystems and align with Mercan et al. (2020) on integrated IoT-surveillance frameworks. The reduction in security incidents highlights the effectiveness of embedded CCTV for proactive security management. Smart energy management contributed significantly to sustainability.

B. Conclusion

This study examined the impact of an IoT-enabled Hotel Management System with embedded CCTV security on smart hospitality management. The integrated system significantly improves operational efficiency, guest satisfaction, security effectiveness, and resource utilization. IoT technologies facilitate real-time monitoring, automation, and intelligent decision-making, while embedded CCTV enhances surveillance, threat detection, and emergency response. Smart hospitality environments supported by interconnected digital technologies provide substantial strategic advantages for hotel organizations

C. Recommendations

1. Hotels should adopt IoT-enabled management systems to improve operational efficiency and service delivery.
2. Embedded CCTV systems should be integrated with hotel management platforms to enhance security intelligence.
3. Hospitality organizations should invest in cybersecurity measures to protect connected devices and guest information.
4. Hotel personnel should receive continuous training on smart hospitality technologies.
5. Governments should develop standards for IoT implementation and surveillance system management.
6. Future research should investigate AI and machine learning integration within smart hospitality ecosystems.
7. Hotels should deploy predictive analytics for maintenance planning and resource management.
8. Smart hospitality solutions should support sustainability initiatives for environmental conservation and cost reduction.

D. Conflict of Interest Statement

The author declares that there is no conflict of interest regarding the research, authorship, and publication of Impact of an IoT-Enabled Hotel Management System with Embedded CCTV Security for Smart Hospitality Management.The research was conducted independently for academic purposes, and no external organization or sponsor influenced the study design, data collection, analysis, interpretation, or publication of the findings. All costs associated with the research were personally funded by the author.

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