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Analysis of IoT Technology Utilization and Inventory Management System on Operational Efficiency and Visitor Experience at Tourism Destinations in Bandung

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ABSTRACT

This study examines the impact of IoT technology utilization and inventory management systems on operational efficiency and visitor experience at tourism destinations in Bandung City. Employing a quantitative research approach, data were collected from 220 respondents using a structured questionnaire with a Likert scale (1–5). The relationships among variables were analyzed using Structural Equation Modeling-Partial Least Squares (SEM-PLS). The findings reveal that both IoT technology and inventory management systems significantly enhance operational efficiency, which in turn positively impacts visitor experience. IoT technology showed a stronger direct effect on visitor experience, while inventory management systems had a greater influence on operational efficiency. Operational efficiency also played a mediating role, linking technological and management practices to improved visitor satisfaction. These results highlight the importance of integrating advanced technologies and efficient management systems to enhance the competitiveness and service quality of tourism destinations. The study provides actionable insights for tourism stakeholders to prioritize technology investments and strategic planning for sustainable growth.

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1. INTRODUCTION

The tourism industry is a vital component of the global economy, driving economic growth, facilitating cultural exchange, and contributing significantly to national development through its adaptability to various socio-economic conditions. Tourism generates numerous employment opportunities, reducing the government's burden as the primary employer [1], while serving as a major source of foreign exchange, with countries like India ranking seventh globally in tourism's contribution to GDP [2]. The sector also enhances local revenue streams, particularly in developing nations, by improving hospitality services and facilities [3]. Beyond economic contributions, tourism fosters international relations and cultural understanding, acting as a platform for global education and collaboration [4]. Furthermore, it promotes the preservation of cultural heritage by leveraging local traditions for economic gain [2].

The tourism industry in Bandung City is a vital contributor to regional economic growth, fostering cultural exchange and generating employment, yet the increasing visitor numbers and demand for high-quality services present challenges that require innovative solutions. Tourism significantly boosts local economies by creating jobs and generating income, as evidenced by its role in global economic growth [5], and in Bandung, it stimulates various industries, enhancing economic development and contributing to foreign exchange earnings [6]. However, the rapid increase in visitors can strain local resources and infrastructure, leading to operational inefficiencies [5], while maintaining service quality amid rising demand necessitates effective management strategies to ensure visitor satisfaction [7]. To address these challenges, adopting technology such as digital booking systems and customer relationship management tools can enhance operational efficiency and improve visitor experiences [8]. Additionally, implementing sustainable tourism practices helps balance economic growth with environmental conservation, ensuring the industry's long-term viability [9].

The integration of Internet of Things (IoT) technology in tourism has significantly transformed operational capabilities, enhancing efficiency and visitor satisfaction through real-time monitoring, data-driven decision-making, and sustainable practices. IoT enables continuous tracking of tourist flows, allowing for timely adjustments in resource allocation [10], while automation reduces human error and enhances operational efficiency, resulting in improved visitor experiences [11]. Advanced data analytics powered by IoT supports predictive modeling for better management of tourist influx [12], and machine learning techniques aid in understanding complex tourism patterns, facilitating strategic planning [13]. Additionally, IoT technologies promote responsible tourism by optimizing resource use and minimizing environmental impacts [14]. Effective inventory management further ensures sustainable tourism operations by preventing shortages and surpluses [15].

Despite the promising prospects of IoT and inventory management systems, empirical evidence on their combined impact on operational efficiency and visitor experience in the context of tourism remains limited. Particularly in Bandung City, where tourism destinations vary widely in scale and complexity, understanding these relationships is crucial for stakeholders aiming to enhance competitiveness and service quality. This study seeks to bridge this gap by analyzing the utilization of IoT technology and inventory management systems and their influence on operational efficiency and visitor experience at tourism destinations in Bandung City.

2. LITERATURE REVIEW

2.1 Internet of Things (IoT) Technology in Tourism

The Internet of Things (IoT) is significantly transforming the tourism industry by enhancing operational efficiency and personalizing visitor experiences through applications such as smart ticketing and real-time navigation, which facilitate seamless interactions between tourists and their environments. This integration improves resource management, enables predictive maintenance, and optimizes energy usage, as evidenced by studies on smart cities and tourism [16], [17]. Key applications of IoT in tourism include smart ticketing and navigation, which streamline the visitor experience by providing real-time updates and personalized itineraries, as well as crowd monitoring using smart sensors to track visitor movements and manage overcrowding efficiently [18]. Environmental monitoring further enhances safety and visitor satisfaction by providing real-time updates on conditions [19]. However, IoT adoption faces challenges such as high implementation costs, particularly in developing regions [20], data privacy concerns related to the collection and management of personal data [21], and a lack of technical expertise to deploy and maintain these technologies effectively [22].

2.2 *Inventory Management Systems in Tourism Operations*

Inventory management systems are essential for optimizing resource utilization in tourism, enhancing operational efficiency, and ensuring high-quality service delivery by leveraging advanced technologies like IoT and AI for real-time visibility and predictive analytics, enabling proactive decision-making. Effective inventory management reduces operational costs by minimizing waste and preventing stockouts or overstocking [23], with real-time tracking and automated processes streamlining operations, as demonstrated in restaurant inventory systems that enhance profitability and reduce overhead costs [24]. Sustainable inventory practices, such as waste minimization and ethical sourcing, align with global trends in sustainable tourism, contributing to environmental stewardship and meeting growing demands for responsible tourism [15]. Furthermore, improved inventory management directly correlates with enhanced customer satisfaction, as timely fulfillment of orders and resource availability are critical in the tourism industry [25], [26].

2.3 *Operational Efficiency in Tourism*

Operational efficiency in tourism destinations is crucial for enhancing competitiveness and profitability, driven by process automation, workforce management, and the adoption of advanced technologies such as IoT and inventory management systems. These technologies facilitate real-time monitoring and resource optimization, essential for improving service delivery and visitor experience [27], [28]. Process optimization through techniques like Lean and Six Sigma streamlines operations, reduces waste, and enhances quality, leading to improved efficiency [5]. IoT and inventory management systems enable real-time data analysis, optimizing resource allocation and minimizing costs [29], [30]. Workforce management further contributes by fostering a culture of continuous improvement, engaging employees to enhance overall performance [31], [32]. Efficient operations also impact visitor experience positively by reducing waiting times and ensuring timely service delivery, directly enhancing satisfaction [6]. Additionally, effective inventory management ensures resource availability, improving service quality and overall visitor satisfaction [27].

2.4 *Visitor Experience in Tourism*

The visitor experience is increasingly shaped by the integration of smart technologies, which enhance service quality, accessibility, and overall satisfaction, aligning with the "experience economy" that emphasizes memorable interactions as key to attracting and retaining tourists. Smart tourism leverages IoT and inventory management systems to create personalized and engaging experiences. IoT technologies facilitate real-time management of tourism services, improving operational efficiency and visitor experiences through solutions like automated energy management and smart parking systems [33], [34]. Mobile applications and interactive kiosks further enhance convenience by providing personalized recommendations and facilitating seamless transactions [35]. Additionally, continuous customer support, particularly 24/7 services, significantly boosts tourist satisfaction by addressing needs promptly [35]. However, the implementation of smart technologies brings challenges such as data privacy and security concerns, requiring robust measures to protect user information (Nugroho et al., 2024). Ensuring user-friendly interfaces is also critical, as complex systems may deter engagement and limit the effectiveness of these technologies [36].

2.5 *Research Gap*

While the benefits of IoT and inventory management systems in tourism are well-documented, limited studies have explored their combined impact on operational efficiency and visitor experience, particularly in the context of tourism destinations in Bandung City. This research seeks to fill this gap by examining the relationships among these variables using empirical data, providing actionable insights for tourism stakeholders.

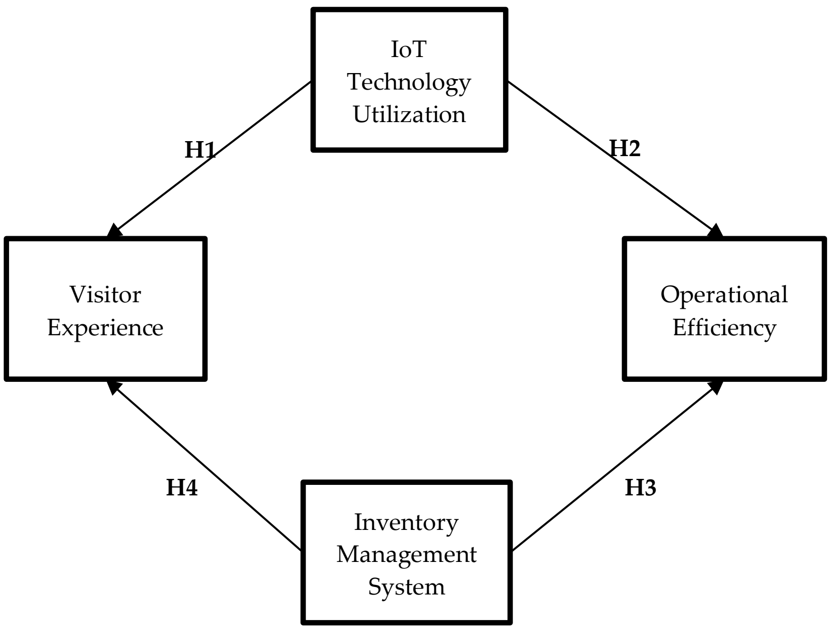

Figure 1. Conceptual Framework

3. METHODS

3.1 Research Design

This study adopts a quantitative research design to examine the impact of IoT technology utilization and inventory management systems on operational efficiency and visitor experience at tourism destinations in Bandung City. The research employs a cross-sectional survey approach, collecting data from respondents at a single point in time to analyze relationships among the variables. Structural Equation Modeling-Partial Least Squares (SEM-PLS) is used for data analysis, which allows for the examination of complex relationships between multiple independent and dependent variables.

3.2 Population and Sample

The target population for this study comprises stakeholders involved in managing and operating tourism destinations in Bandung City, including managers, employees, and service providers. To ensure robust and generalizable results, a total of 220 respondents were selected using purposive sampling. This sampling technique was chosen to include individuals with knowledge or experience related to IoT technology, inventory management systems, and operational processes in tourism.

3.3 Data Collection

Data were collected through a structured questionnaire distributed to the respondents. The questionnaire was designed to measure the key variables using items adapted from validated scales in existing literature. A Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) was employed to capture the perceptions and attitudes of respondents. The questionnaire was divided into four sections:

3.4 Data Analysis

The collected data were analyzed using SEM-PLS Version 3, a method chosen for its ability to handle complex models and relationships while accommodating smaller sample sizes. The analysis involved several steps: descriptive statistics were used to summarize the demographic characteristics of respondents and key variables; the measurement model evaluation assessed the reliability and validity of constructs through composite reliability (CR) and average variance extracted (AVE); the structural model evaluation tested the hypothesized relationships among variables using path analysis, with significance levels determined through bootstrapping techniques; and hypothesis testing was conducted to evaluate the direct and indirect effects of IoT technology and inventory management systems on operational efficiency and visitor experience.

4. RESULTS AND DISCUSSION

4.1 Demographic Characteristics of Respondents

The demographic characteristics of the 220 respondents in this study provide insights into the diversity of individuals contributing to tourism operations in Bandung City, including gender, age, educational background, work experience, and roles in tourism operations. The sample comprised 60% male and 40% female respondents, indicating a slight male dominance in managerial and operational roles. Age distribution revealed that 40% of respondents were aged 25–34 years, followed by 30% aged 35–44 years, 20% under 25 years, and 10% aged 45 years and above, highlighting a young and dynamic workforce. Regarding educational background, 40% held a bachelor's degree, 30% a diploma, 25% a high school or equivalent qualification, and 5% a master's degree, reflecting a moderately educated workforce. In terms of work experience, 45% of respondents had 6–10 years of experience, 25% had 1–5 years, 20% had more than 10 years, and 10% had less than 1 year, demonstrating substantial professional expertise in the tourism sector. The roles of respondents included 40% managers, 45% operations staff, 10% IT specialists, and 5% in other roles, with 85% directly involved in implementing and managing IoT technologies and inventory systems.

4.2 Measurement Model Analysis

The measurement model evaluates the reliability, validity, and strength of the constructs used in this study. The analysis focuses on the factor loadings, Cronbach's Alpha, Composite Reliability (CR), and Average Variance Extracted (AVE) to confirm the robustness of the measurement model.

Table 1. Measurement Model Assessment

Variable	Code	Loading Factor	Cronbach's Alpha	Composite Reliability	Average Variant Extracted
IoT Technology Utilization	ITU.1	0.896	0.900	0.930	0.769
	ITU.2	0.873			
	ITU.3	0.868			
	ITU.4	0.871			
Inventory Management System	IMS.1	0.764	0.862	0.901	0.645
	IMS.2	0.813			
	IMS.3	0.859			
	IMS.4	0.817			
	IMS.5	0.758			
Operational Efficiency	OEF.1	0.806	0.850	0.893	0.626
	OEF.2	0.819			
	OEF.3	0.766			
	OEF.4	0.797			
	OEF.5	0.764			
Visitor Experience	VEP.1	0.736	0.906	0.924	0.604
	VEP.2	0.750			
	VEP.3	0.731			
	VEP.4	0.805			
	VEP.5	0.767			
	VEP.6	0.772			
	VEP.7	0.814			
	VEP.8	0.835			

Source: Data Processing Results (2024)

The measurement model assessment confirmed the robustness of the constructs, with all factor loadings exceeding the threshold of 0.7, indicating strong relationships between observed items and their latent variables. Factor loadings ranged from 0.868 to 0.896 for IoT Technology Utilization, 0.758 to 0.859 for Inventory Management System, 0.764 to 0.819 for Operational Efficiency, and 0.731 to 0.835 for Visitor Experience. Reliability analysis showed high internal consistency, with Cronbach's Alpha values of 0.900 (ITU), 0.862 (IMS), 0.850 (OEF), and 0.906 (VEP), and CR values above 0.9 for all constructs. Convergent validity was established as all Average Variance Extracted (AVE) values exceeded 0.5, confirming the constructs' reliability and validity and providing a strong foundation for structural model analysis.

4.3 HTMT Analysis

Discriminant validity assesses the extent to which constructs are distinct from one another. One of the most robust approaches to evaluate discriminant validity is the Heterotrait-Monotrait Ratio (HTMT) criterion. For constructs to exhibit adequate discriminant validity, the HTMT values between constructs should generally be below 0.90.

Table 2. Discriminant Validity

	Inventory Management System	IoT Technology Utilization	Operational Efficiency	Visitor Experience
Inventory Management System				
IoT Technology Utilization	0.698			
Operational Efficiency	0.814	0.630		
Visitor Experience	0.783	0.848	0.824	

Source: Data Processing Results (2024)

The HTMT values indicate that all constructs meet the discriminant validity criteria, with values below the threshold of 0.85, confirming that the constructs—IoT Technology Utilization, Inventory Management System, Operational Efficiency, and Visitor Experience—are distinct and measure separate aspects of the study's framework.

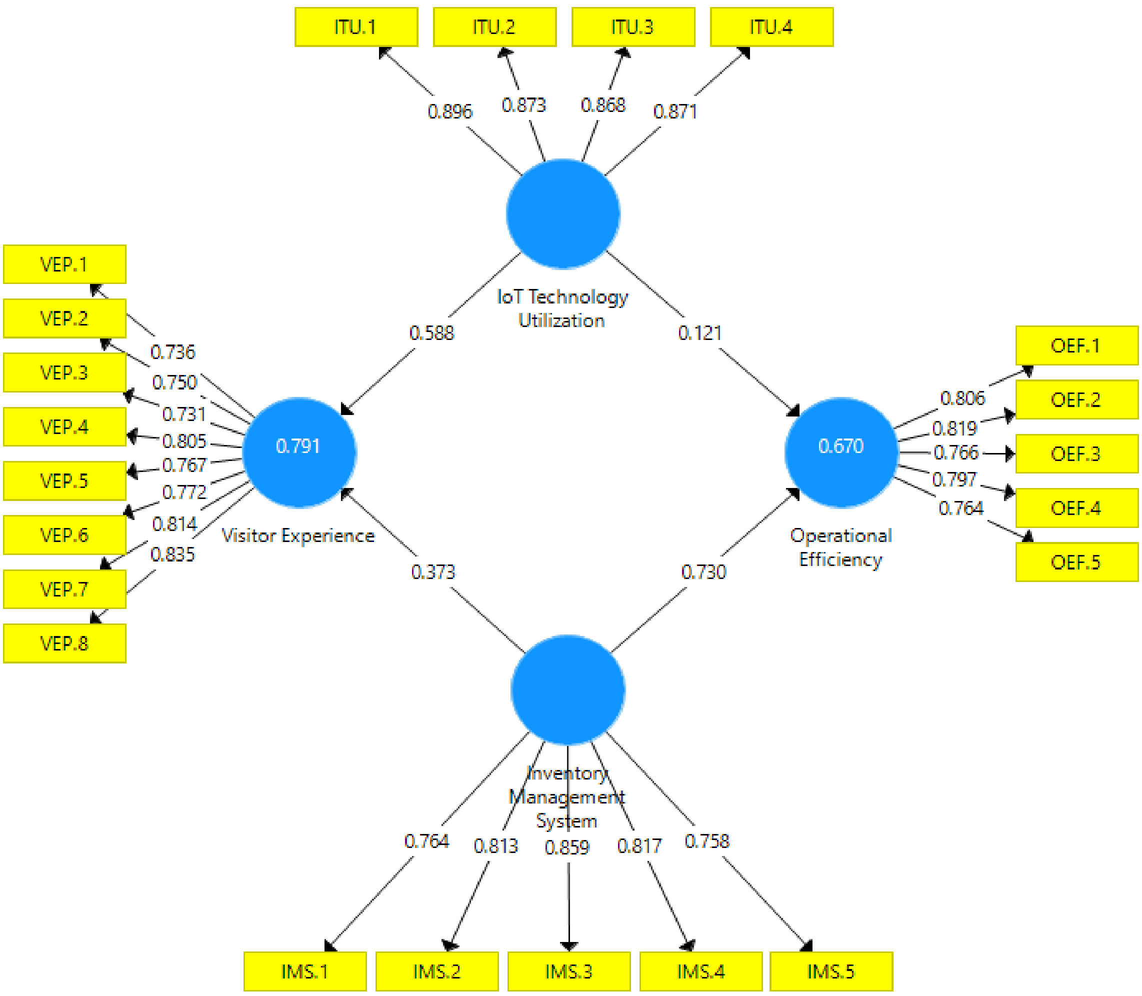

Figure 2. Model Results

Source: Data Processed by Researchers, 2024

4.4 Model Fit Evaluation

The evaluation of model fit assesses how well the hypothesized model aligns with the observed data. Various indicators, such as Standardized Root Mean Square Residual (SRMR), d_ULS, d_G, Chi-Square, and

Normed Fit Index (NFI), are used to determine the adequacy of the model

Table 3. Model Fit Results Test

	Saturated Model	Estimated Model
SRMR	0.092	0.099
d_ULS	2.120	2.462
d_G	1.462	1.553
Chi-Square	827.398	857.912
NFI	0.660	0.647

Source: Process Data Analysis (2024)

The Standardized Root Mean Square Residual (SRMR) measures the difference between observed and predicted correlations, with values below 0.08 typically considered acceptable for a good fit. In this study, the Saturated Model SRMR was 0.092, and the Estimated Model SRMR was 0.099, both slightly above the ideal threshold. These results indicate a moderate fit, suggesting that the model approximates the observed data well, although there may be room for improvement in specifying certain relationships.

The d_ULS (Unweighted Least Squares Discrepancy) and d_G (Geodesic Discrepancy) metrics assess the alignment between the observed and implied correlation matrices, where lower values indicate a better fit. For d_ULS, the Saturated Model scored 2.120, while the Estimated Model scored 2.462, showing an acceptable level of fit with the Saturated Model performing slightly better. Similarly, for d_G, the Saturated Model achieved 1.462, and the Estimated Model 1.553, both reflecting low discrepancy values and indicating that the model effectively captures the relationships among variables.

Other fit indices, such as Chi-Square and Normed Fit Index (NFI), provided additional insights. The Chi-Square statistic was relatively high for both models (827.398 for the Saturated Model and 857.912 for the Estimated Model), which is expected given the sample size (n=220). The NFI values were below the ideal threshold of 0.90, with 0.660 for the Saturated Model and 0.647 for the Estimated Model, indicating moderate fit. While these values suggest potential areas for model refinement, they are acceptable for exploratory research in complex models. Together, these fit indices confirm the adequacy of the model for further analysis and interpretation.

Table 4. Coefficient Model

	R Square	Q2
Operational Efficiency	0.670	0.665
Visitor Experience	0.791	0.787

Source: Data Processing Results (2024)

The R^2 and Q^2 values highlight the explanatory and predictive strength of the model. The R^2 value for Operational Efficiency is 0.670, indicating that 67% of its variance is explained by IoT Technology Utilization and Inventory Management System, reflecting their significant role in optimizing operations at tourism destinations. For Visitor Experience, the R^2 value is 0.791, showing that 79.1% of its variance is explained by the independent variables and the mediating variable, Operational Efficiency, demonstrating a strong explanatory power in linking operational improvements to visitor satisfaction. Similarly, the Q^2 values confirm the model's predictive relevance, with Operational Efficiency scoring 0.665 and Visitor Experience scoring 0.787, indicating robust predictive accuracy. The higher Q^2 for

Visitor Experience emphasizes the critical role of operational efficiency in shaping visitor outcomes, validating the theoretical framework that operational improvements directly influence visitor satisfaction and experience. Together, these findings affirm the model's capacity to both explain and predict key variables in tourism destination performance.

4.5 Hypothesis Testing

Hypothesis testing evaluates the significance and strength of relationships between variables in the structural model. The table summarizes the relationships, their standardized coefficients (Original Sample, O), means (M), standard deviations (STDEV), t-statistics (T), and p-values (P). These metrics are critical for determining whether the hypothesized relationships are supported.

Table 5. Hypothesis Testing

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics	P Values
Inventory Management System -> Operational Efficiency	0.730	0.730	0.085	8.573	0.000
Inventory Management System -> Visitor Experience	0.373	0.372	0.084	4.453	0.000
IoT Technology Utilization -> Operational Efficiency	0.221	0.220	0.101	2.200	0.003
IoT Technology Utilization -> Visitor Experience	0.588	0.590	0.080	7.333	0.000

Source: Process Data Analysis (2024)

The hypothesis testing results highlight the significant relationships between the constructs. Inventory Management System strongly influences Operational Efficiency (O = 0.730, T = 8.573, P = 0.000), indicating that improvements in inventory management systems substantially enhance operational processes. Additionally, it moderately impacts Visitor Experience (O = 0.373, T = 4.453, P = 0.000), indirectly improving visitor satisfaction by ensuring smooth operations and consistent service delivery. IoT Technology Utilization also positively affects Operational Efficiency (O = 0.221, T = 2.200, P = 0.003), although with a weaker effect compared to inventory systems, suggesting its role in real-time monitoring and automation. Furthermore, IoT Technology Utilization exhibits a strong direct effect on Visitor Experience (O = 0.588, T = 7.333, P = 0.000), significantly enhancing visitor satisfaction through personalized services and seamless interactions. These findings underscore the complementary roles of inventory systems and IoT technology in optimizing operations and improving visitor experiences.

Discussion

1. The Role of Inventory Management Systems

Inventory management systems significantly impact both operational efficiency and visitor experience, playing a critical role in tourism destination management. With a strong positive influence on Operational Efficiency (coefficient = 0.730), these systems streamline resource allocation, reduce waste, and prevent stockouts or overstocking, as highlighted by [25], [26], [37]. This emphasizes the importance of robust inventory practices in ensuring smooth operations, where well-maintained inventories directly enhance service reliability and sustainability. Additionally, the moderate positive effect on Visitor Experience (coefficient = 0.373) underscores their indirect role in shaping customer satisfaction by ensuring consistent resource availability and uninterrupted services. This aligns with Pine and Gilmore's theory "experience economy" theory, emphasizing how operational efficiency contributes to memorable visitor experiences. In practical terms, effective inventory systems prevent delays and improve service quality, fostering a positive perception among visitors.

2. The Role of IoT Technology Utilization

IoT technology utilization significantly impacts both operational efficiency and visitor experience, with distinct effects on each. Its positive influence on Operational Efficiency (coefficient = 0.221) aligns with Buhalis and Leung's (2018) findings, emphasizing IoT's role in real-time monitoring and process automation. However, its relatively smaller effect compared to inventory systems suggests that IoT's potential is maximized when integrated with complementary systems like inventory management or workforce optimization. In contrast, IoT technology has a strong positive impact on Visitor Experience (coefficient = 0.588), highlighting its central role in enhancing customer engagement and satisfaction. Features such as interactive kiosks, real-time navigation, and personalized services enable seamless and enjoyable visitor experiences, supporting [16], [20], [38] assertion of IoT's transformative role in modern tourism. By tracking visitor behavior and preferences, IoT empowers managers to tailor services efficiently, meeting diverse visitor needs and expectations.

3. Practical Implications

To maximize operational efficiency and visitor satisfaction, tourism stakeholders should integrate IoT technology with inventory management systems, leveraging the strengths of both to achieve optimal outcomes. Initial investments should prioritize enhancing inventory management systems, given their stronger influence on operational efficiency, followed by IoT adoption to address visitor-centric needs. Successful implementation also requires workforce training, ensuring staff are well-equipped to operate and adopt these technologies seamlessly, thereby enhancing their impact and sustainability. Additionally, IoT solutions should be tailored to the specific needs of tourism destinations in Bandung City, ensuring scalability and adaptability to evolving visitor expectations.

4. Theoretical Contributions

This study contributes to the smart tourism literature by empirically demonstrating the combined impact of IoT technology and inventory management systems on operational and experiential outcomes, extending existing frameworks in the field. Additionally, the findings highlight the mediating role of operational efficiency, offering a deeper understanding of how technological and management practices collectively influence visitor satisfaction, thereby enriching theoretical perspectives on smart tourism and operational effectiveness.

5. Limitations and Future Research

This study's cross-sectional design limits causal interpretations, suggesting that future research should adopt longitudinal approaches to examine long-term effects. Additionally, the focus on Bandung City may restrict the generalizability of the findings, highlighting the need to expand the study to other tourism hubs for broader insights. Incorporating additional variables, such as workforce training or organizational culture, could further enhance the model's explanatory power, providing a more comprehensive understanding of the factors influencing operational efficiency and visitor satisfaction.

5. CONCLUSION

This study highlights the critical role of IoT technology and inventory management systems in enhancing operational efficiency and visitor experience at tourism destinations in Bandung City. Key findings reveal that IoT technology strongly influences visitor experience through personalized and seamless service delivery while moderately contributing to operational efficiency. Inventory management systems significantly improve operational efficiency and indirectly enhance visitor satisfaction by ensuring uninterrupted service quality. Operational efficiency acts as a mediating factor, linking technological adoption and resource management to improved visitor outcomes. These results underscore the importance of integrating IoT technology and inventory management systems to address operational challenges and meet visitor expectations. For tourism stakeholders, strategic investments in advanced technologies, effective staff training, and scalable solutions tailored to specific operational needs are essential. Future research should adopt longitudinal studies to explore long-term effects and expand the geographic scope to gain broader insights. By addressing inefficiencies and leveraging IoT-driven innovations, tourism destinations can improve service quality, maintain competitive advantage, and create memorable visitor experiences, contributing to the sustainable growth of the tourism industry in Bandung City and beyond.

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