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Smarter Technologies, Innovation, and Managerial Capabilities Driving Hotel Sustainability: The Integration of Resource-Based View and Dynamic Capabilities Perspective

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Abstract

While prior research has examined the role of smart technologies (e.g., IoT and AI) in sustainability, the combined influence of IoT, AI, and organizational capabilities on hotel sustainable performance, particularly through the mediating roles of data-driven decision-making and innovation capability, remains underexplored. This study investigates how the integration of smart technologies, specifically the Internet of Things (IoT) and artificial intelligence (AI), as well as dynamic managerial capabilities focusing on data-driven decision-making (DDM) and innovation capability (IC), enhances hotel sustainable performance (HSP) within the context of Saudi Arabia's hospitality sector. Grounded in the Resource-Based View (RBV) and Dynamic Capabilities Theory (DCT), the research develops and tests a conceptual model that explores both the mediating roles of DDM and IC in the link between IoT and HSP and the moderating role of AI application in the relationships between IoT and DDM, IC, and HSP. Using data collected from 312 managers of four- and five-star hotels across Saudi Arabia, the study employed Partial Least Squares Structural Equation Modeling (PLS-SEM) to examine the hypothesized relationships. The results reveal that IoT has a significant positive effect on HSP, DDM, and IC. Further, the IoT-HSP relationship is partially mediated by both DDM and IC. Furthermore, AI significantly strengthens the relationships between IoT and DDM, IoT and IC, and IoT and HSP, highlighting AI's crucial role as an enabler of digital transformation and sustainability. The findings extend the RBV and DCT by demonstrating how technological resources, when combined with dynamic managerial capabilities, lead to superior sustainability outcomes. Practically, the study emphasizes that hotels must pair digital adoption with employee training, innovation culture, and AI-powered analytics to enhance HSP.

Keywords: Internet of Things (IoT); hotel sustainability; innovation; sustainable performance; artificial intelligence (AI); Dynamic Capabilities Theory; resource-based view; Saudi Arabia

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1. Introduction

Sustainability has emerged as a global imperative, guiding strategic priorities across industries, with the hospitality sector facing extreme pressure to adopt eco-friendly practices (Mansoor et al., 2025). Hotels have long been recognized as energy- and water-intensive, consuming large amounts of power, water, and materials while generating substantial waste (de Waal Malefyt, 2025; Abdou et al., 2022a). As consumers, regulators, and industry stakeholders become increasingly concerned about environmental issues, hotels are

being driven harder to minimize their environmental impact (Chang et al., 2025). The innovative technology solutions have been at the center of this revolution, with digital solutions offering significant potential for enhancing operational efficiency and promoting sustainability (Gajić et al., 2024). Digital and automation technologies can perform repetitive tasks automatically, optimize energy consumption, reduce waste, and provide optimal resource allocation, all of which add up to better sustainable performance (Mercan et al., 2021; Ozen et al., 2024). One of these digital and automation technologies is the Internet of Things (IoT).

The Internet of Things (IoT) has emerged as a transformative technology that enables hotels to monitor, optimize, and manage their resources more effectively, potentially revolutionizing sustainable performance in the hospitality sector (Nadkarni et al., 2020; Elkhwesky & Elkhwesky, 2023). IoT technology encompasses a network of interconnected devices, sensors, and systems that collect and exchange data in real-time, enabling automated decision-making and improved operational efficiency (Chung & Tan, 2025). In the hospitality context, IoT applications encompass a range of solutions, including smart energy management systems, water conservation technologies, waste monitoring solutions, and intelligent building automation (Shani et al., 2023; Sharma & Gupta, 2021). These applications have demonstrated significant potential to enhance environmental performance while simultaneously improving operational efficiency and the guest experience (Gajić et al., 2024; Chen et al., 2022).

Despite the growing interest in IoT applications within the hotel industry, several significant gaps remain in the current literature. First, most previous studies have primarily focused on identifying the opportunities, challenges, and benefits of IoT implementation to enhance service operations, improve customer experiences, and achieve competitive advantage (e.g., Mercan et al., 2021; Sharma & Gupta, 2021; Car et al., 2019). They have also examined the direct links between technology adoption and sustainability outcomes (e.g., Khatua et al., 2020; Poullas & Kakoulli, 2023), neglecting the intermediate processes that explain how the implementation of IoT translates into sustainable performance. More specifically, the mechanisms through which IoT influences sustainable performance remain inadequately understood.

In this study, the roles of data-driven decision-making (DDM), recognized as the hotel's capability to collect, analyze, and utilize data for making informed strategic and operational decisions (Malik, 2024), and innovation capability (IC) is described as the hotel's ability to develop, implement, and commercialize new ideas, processes, and technologies (Chandran et al., 2024) are proposed as mediating mechanisms in the relationship between IoT and sustainable performance. For instance, DDM can support IoT-generated operational data to reduce energy and resource consumption more efficiently (Nadkarni et al., 2020). Likewise, the capability for innovation enables organizations to learn and utilize IoT technology innovatively to improve operational and financial performance (Vafaei-Zadeh et al., 2025).

Second, while the benefits of IoT applications are clear, their integration into hotels, particularly in developing countries such as the Kingdom of Saudi Arabia (KSA), remains a relatively new area of research. While much of the existing research on IoT applications has focused on the manufacturing, healthcare, and logistics sectors (e.g., Kalsoom et al., 2021; C. Li et al., 2024; Zrelli & Rejeb, 2024), the specific implications of IoT for the hospitality sector in the developing countries—particularly with regard to sustainability indicators—remain less well studied. The KSA hospitality industry stands out due to its rapid growth, transparent regulatory framework, and increasing focus on sustainability aligned with Saudi Vision 2030 (Abdou et al., 2022b). Hence, there is a notable research gap concerning how IoT implementation affects hotel sustainable performance (HSP) in this regional context. Third, although AI and IoT are increasingly converging in practice, academic research has

not sufficiently examined how the applications of AI moderate the relationships between IoT and outcomes such as HSP, DDM, and IC. These gaps are particularly important given the potential of AI applications to greatly enhance the capabilities and effectiveness of IoT.

Based on these gaps and grounded on the lens of Resource-Based View (RBV) (Barney, 1991) as well as Dynamic Capabilities Theory (DCT) (Teece et al., 1997), the present study aims to investigate how the implementation of IoT contributes to sustainable performance in the hotel sector, with a particular focus on the mediating roles of DDM and IC, as well as the moderating role of AI application in the relationships between IoT and sustainable performance, DDM, and IC. Specifically, the study seeks to answer the following research questions:

1. How does IoT implementation influence sustainable performance, DDM, and IC in the hotel industry?
2. To what extent do DDM and IC mediate the relationship between IoT implementation and sustainable performance?
3. How does the AI application moderate the links between IoT and HSP, DDM, and IC?

This study enriches the existing literature in several ways. First, it addresses a notable empirical gap by exploring the less-studied field of sustainable hotel management through the adoption of IoT in KSA, a country experiencing rapid growth in sustainability (Abdou et al., 2022b). Second, by incorporating mediators such as DDM and IC, the study develops a comprehensive model that captures the complexity of technological adoption and its impact on sustainable performance. Third, exploring AI application as a moderator introduces a forward-looking perspective, reflecting the dynamic role of artificial intelligence in advancing green business practices, DDM, and IC in the hospitality sector context. Fourth, this study contributes to extending both the Resource-Based View (RBV) and Dynamic Capabilities Theory (DCT) by showing how IoT, when treated as a strategic technological resource, can support HSP. In particular, the findings are expected to demonstrate that the value of IoT lies not in the technology alone, but in the way hotels utilize it to enhance DDM and improve IC, especially when it is integrated with artificial intelligence. Ultimately, the findings offer valuable practical insights for hotel managers, technology developers, and policymakers seeking to leverage the potential of IoT and AI in promoting sustainability within the hospitality sector.

2. Theoretical Background and Hypothesis Development

2.1. Resource-Based View (RBV) and Dynamic Capabilities Theory (DCT)

This study draws on both the Resource-Based View (RBV) and Dynamic Capabilities Theory (DCT) to explain how hotels can utilize Internet of Things (IoT) technologies to enhance their sustainable performance. The RBV (Barney, 1991) argues that organizations gain an advantage when they control resources that are valuable, rare, difficult to imitate, and not easily replaced. In the hotel sector, IoT systems, digital infrastructure, data analytics, and IC can all be seen as strategic resources that help improve efficiency, enhance guest experiences, and support sustainability goals (Hassan & Eassa, 2025; Poullas & Kakoulli, 2023; Aziz et al., 2024; Al Aqad et al., 2025; Stankevičiūtė, 2024; Hernández-Perlines et al., 2019; Grissemann et al., 2013). From this perspective, IoT adoption gives hotels an important technological foundation that can set them apart from competitors. However, the RBV has been criticized for being rather static, since it focuses more on what resources a firm has than on how those resources are deployed and adapted in a fast-changing business environment such as the hospitality industry (El Shafeey & Trott, 2014; Lin & Wu, 2014).

To overcome this limitation, the study also draws on Dynamic Capabilities Theory (Teece et al., 1997), which emphasizes the processes that enable organizations to adapt and reconfigure their resources in response to change. DCT highlights three core activities:

sensing, seizing, and reconfiguring (Teece et al., 1997). In the context of this study, IoT implementation reflects the hotel's ability to sense opportunities by gathering data on operations, resource use, and customer behaviors (Mercan et al., 2021; Poullas & Kakoulli, 2023). DDM captures the seizing dimension, where managers interpret IoT data to guide strategic and operational choices, for example, reducing energy consumption or improving service quality (Hu, 2025). Innovation capability (IC) encompasses the reconfiguration process as hotels leverage IoT insights to redesign services, introduce new practices, and integrate sustainability into their operations (Chandran et al., 2024; Elkhwesky & Elkhwesky, 2023).

An additional element considered in this study is the role of artificial intelligence (AI). While IoT generates large volumes of data, AI enhances hotels' ability to analyze this information, identify patterns, and act on insights quickly (Limna, 2023; Jabeen et al., 2022). When aligned with sustainability goals, AI can amplify the impact of IoT by improving sensing (better data interpretation), seizing (smarter decision-making), and reconfiguring (continuous innovation in sustainable practices) (Liu et al., 2025; Shkalenko & Nazarenko, 2024; Bibri et al., 2023). By combining RBV and DCT, this study offers a more comprehensive understanding of the role of IoT in the hospitality industry. RBV helps clarify why IoT is a valuable resource, while DCT explains how hotels actually utilize that resource through informed decision-making and innovation.

2.2. The Impact of IoT on Hotel Sustainable Performance

The Internet of Things (IoT) is transforming the hospitality industry by introducing innovative solutions to enhance sustainability. Through smarter resource management and more efficient operations, IoT opens the door to performance improvements that were previously impossible (Liu et al., 2025; Mercan et al., 2021). IoT builds intelligent systems that adapt to changing environmental conditions in real time and enhance resource efficiency (Hassan & Eassa, 2025; Poullas & Kakoulli, 2023). From an environmental perspective, smart thermostats and lighting systems powered by IoT can be configured to the required level of energy consumption based on room occupancy levels. They can reduce energy use when rooms are vacant or when external weather conditions permit (Q. Li et al., 2020; Khatua et al., 2020). As a result, IoT minimizes human error and ensures that energy consumption remains low without compromising guest comfort. Similarly, IoT supports water conservation. Smart showerheads, faucets, and leak detection systems enable real-time monitoring and optimization of water use in hotel facilities (Ali et al., 2022). This not only prevents water wastage but also facilitates the rapid identification of leaks or inefficiencies that might otherwise go undetected (Kalsi et al., 2025). Further, IoT technologies play a significant role in waste management. With IoT systems, hotels can monitor waste generation in real-time, allowing managers to implement targeted recycling and waste minimization measures. Automated IoT-based waste sorting systems further reduce landfill contributions by separating recyclable materials, thereby promoting sustainability through improved resource management (Saha et al., 2017). Overall, these technologies reduce operational costs while having a positive impact on the environment (Singh et al., 2024). By reducing their carbon footprint, hotels adopting IoT become leaders in sustainability within the hospitality industry (Ali et al., 2022; Kalsi et al., 2025; Singh et al., 2024).

Additionally, utilizing IoT in the hospitality industry enables hotels to perform better both financially and socially. On the economic side, IoT reduces energy and resource costs, streamlines operations, and provides valuable data for smarter decisions on pricing, staffing, and services. This not only cuts expenses but also boosts profits and keeps hotels competitive (Sharma & Gupta, 2021; Rajesh et al., 2022). On the social side, IoT enhances the guest experience with personalized services, improves safety through smart monitoring,

and supports sustainability efforts that align with what today's customers expect from responsible businesses (Sharma & Gupta, 2021; Rajesh et al., 2022). Altogether, these benefits help hotels grow financially while also building trust, loyalty, and a positive reputation in their communities (Shani et al., 2023).

While IoT technologies have great potential to enhance hotel performance and sustainability, putting them into practice comes with several challenges. Setting up smart systems often requires large financial investments, along with ongoing maintenance costs (Poullas & Kakoulli, 2023). Their success also depends on how well employees understand and use these technologies, which means hotels must provide continuous digital training and support (Thakur & Sharma, 2026). In addition, managing data privacy and cybersecurity is a serious concern, as IoT networks collect and share large amounts of sensitive guest information (Shani et al., 2023; Saber et al., 2025). Another difficulty is that technology evolves quickly, and connecting new systems with older ones can be complex and costly (Jonathan, 2025; Kalsi et al., 2023).

Beyond these technical and financial barriers, digital technologies (e.g., IoT, AI, and robotics) adoption also brings social challenges that require careful management. Automation may reduce the need for certain hotel jobs, particularly routine or lower-skilled positions, potentially affecting the social dimension of sustainability unless employees are retrained or redeployed (Kang et al., 2024; Shasha & Weideman, 2025). Therefore, hotels should adopt these technologies in ways that complement, rather than replace, human roles, ensuring that innovation enhances both operational efficiency and social well-being (Budijono et al., 2024).

From a Resource-Based View, IoT serves as a valuable and inimitable asset that strengthens operational efficiency (Barney, 1991). In addition, Dynamic Capabilities Theory explains how hotels can use IoT to sense environmental needs, seize data-driven opportunities, and reconfigure operations for sustainability (Teece et al., 1997). Together, these perspectives suggest that IoT is both a strategic resource and a driver of adaptive change toward sustainable goals. Based on the previous, we assume that:

H1: *The implementation of IoT has a positive and significant impact on HSP.*

2.3. The Impact of IoT on Data-Driven Decision-Making

Through IoT technologies, vast amounts of data are collected on hotel processes and operations (Nadkarni et al., 2020). This data can then be processed to generate insights that inform strategic initiatives, improve process efficiency, and enhance customer interaction, ultimately promoting business performance (Malik, 2024). IoT sensors in hotels measure a wide range of parameters, such as energy and water consumption, guest preferences, room occupancy, and environmental conditions (Q. Li et al., 2020). Real-time data collection enables hotel management to make timely and informed decisions based on objective performance measures, rather than relying solely on historical or subjective reports (Phillips-Wren & Hoskisson, 2014). The aggregation and analysis of operational data provide an accurate view of a hotel's performance, illustrating one of the key ways IoT supports DDM (Mariani & Baggio, 2022). For example, IoT-based energy management systems provide real-time data that reveal when and where energy is being consumed most intensively (Ferreira, 2023). This enables hotel managers to identify inefficiencies, implement dynamic energy management, and anticipate peak demand periods, thereby reducing waste and lowering operating costs. IoT also facilitates predictive maintenance, a crucial domain of DDM (Shaik, 2019). By continuously monitoring the condition of hotel assets, including HVAC systems, elevators, and plumbing, IoT sensors help prevent costly downtime and reduce maintenance expenses (Domínguez-Cid et al., 2022). The combination of real-time data collection and advanced analytics has therefore revolutionized decision-making in the

hotel industry (Hu, 2025). Managers can now optimize efficiency and guest satisfaction by relying on objective, data-driven insights rather than historical trends or guesswork (Hu, 2025). From a theoretical perspective, RBV positions IoT and its data as strategic assets (Barney, 1991), while DCT emphasizes the hotel's ability to use this data to sense, seize, and reconfigure in response to changing conditions (Teece et al., 1997). Together, these theories explain how IoT strengthens data-driven decision-making and drives performance. Hence, we suggest that.

H2: *The implementation of IoT has a positive and significant impact on data-driven decision-making.*

2.4. The Impact of IoT on Innovation Capability

In the context of the hotel industry, innovation capability (IC) represents an organization's ability to develop and implement new ideas, processes, products, or services that create value for stakeholders (Pascual-Fernández et al., 2021). In hospitality settings, where guest expectations shift rapidly and operations are complex, innovation is essential. Earlier studies concluded that IoT serves as an innovation enabler by providing the technological infrastructure necessary for developing novel services, improving existing processes, and creating new business models (Mercan et al., 2021; Elkhwesky & Elkhwesky, 2023). The interconnected nature of IoT devices enables the emergence of smart hotel ecosystems, where various systems communicate and collaborate autonomously, resulting in innovative service delivery mechanisms (Mercan et al., 2021). A recent systematic review found that IoT in the hospitality sector has evolved significantly, offering both operational and strategic benefits that encourage further innovation (e.g., smart rooms enable hotels to offer customized guest experiences—automatically adjusting lighting, temperature, or entertainment settings—while also serving as platforms for novel services and amenities (Elkhwesky & Elkhwesky, 2023). Furthermore, Aslam et al. (2020) revealed in their review study that ongoing innovation is now a necessity rather than an option. They argue that the growth of IoT prompts organizations to innovate continually, offering new ways to manage operations and create value. Theoretically, drawn on the Resource-Based View, IoT serves as a unique and valuable asset that drives innovation in hotel services and processes (Barney, 1991). Dynamic Capabilities Theory adds that hotels can leverage IoT to identify new trends, act on opportunities, and adjust their operations, ultimately boosting their capacity to innovate (Teece et al., 1997). Accordingly, we suggest that.

H3: *The implementation of IoT has a positive and significant impact on innovation capability.*

2.5. The Impact of Data-Driven Decision-Making on Hotel Sustainable Performance

In the hospitality sector context, hotels that adopt data-driven approaches can identify operational gaps, improve resource management, and implement sustainability measures grounded in reliable data (Malik, 2024; Chaudhuri et al., 2024). Data-driven analysis promotes environmental sustainability by revealing how energy is consumed, where waste occurs, and how resources can be more effectively managed across operations and periods. Effective management, in turn, decreases environmental damage and raises sustainability performance (Huang et al., 2023; Nisar et al., 2021). Economically, DDM supports sustainable growth by strengthening revenue management, reducing costs, and streamlining operations (Chatterjee et al., 2023). Through analytics, hotels can refine their pricing, forecast demand, and plan resources more effectively, resulting in greater profitability while maintaining service excellence. Data insights also enable proactive maintenance, efficient scheduling, and inventory control, ensuring long-term stability (Aziz et al., 2024). Furthermore, social sustainability is supported when hotels utilize data to

personalize guest experiences, enhance employee well-being through workforce analysis, and foster stronger relationships with communities through local impact metrics (Xu et al., 2019; Al Aqad et al., 2025; Stankevičiūtė, 2024).

Empirical studies demonstrate positive relationships between DDM and various sustainability outcomes. For instance, results from Hindle and Vidgen's (2018) study demonstrate that advancing performance is closely linked to the promotion of data-driven cultural practices. Furthermore, the findings from Data-driven manufacturing firms in the Czech Republic revealed that DDM plays a crucial role in enhancing sustainable performance. By transforming big data into actionable insights, organizations can optimize resource use, minimize waste, and align operations with circular economy principles. This shift from intuition to evidence-based choices enhances both environmental outcomes and long-term competitiveness (Awan et al., 2021). In addition, a study conducted by Chaudhuri et al. (2024) on a sample of 416 Indian organizations concluded that an organizational data-driven culture significantly contributed to enhancing sustainable organizational performance.

Grounded on the lens of the Resource-Based View, data-driven decision-making (DDM) is a valuable and hard-to-imitate resource that supports sustainable advantage (Barney, 1991). However, its true impact emerges when paired with Dynamic Capabilities, as hotels use DDM to sense sustainability issues, seize improvement opportunities, and reconfigure operations (Teece et al., 1997). Together, RBV and DCT show that DDM is not just a tool but a dynamic process that drives long-term sustainable performance. Accordingly, we hypothesized that.

H4: *DDM has a positive and significant impact on HSP.*

2.6. The Impact of Innovation Capability on Hotel Sustainable Performance

In the hospitality sector, IC forms the foundation for developing and implementing novel solutions that address sustainability challenges, thereby creating a competitive advantage (Chandran et al., 2024; Njoroge et al., 2019). In this context, innovation capabilities are diverse, encompassing product and service development, process and operational improvements, organizational changes, and sustainability-driven initiatives. For example, eco-innovation practices (innovative energy systems and waste reduction technologies), service innovations (personalized guest experiences via IoT/AI and service robots), and organizational innovations (green HRM) directly support the triple bottom line of sustainability (Salem et al., 2025; Horng et al., 2018; Njoroge et al., 2019).

Earlier studies support the positive relationship between innovation capabilities and sustainable performance. For instance, grounded in the lens of dynamic capability theory, a study containing 115 hotels revealed that innovation capabilities significantly improve the three dimensions of sustainability performance (Aziz et al., 2024). Further, Pascual-Fernández et al. (2021) demonstrate that IC enables hotels to respond effectively to changing customer demands while simultaneously reducing costs and improving service quality, thereby increasing both profit margins and the overall value delivered to guests. Consistent with prior research (e.g., Hernández-Perlines et al., 2019; Grissemann et al., 2013), innovation capability (IC) is recognized as a key driver of market-related outcomes, profitability, and long-term competitiveness in the hospitality industry.

From the Resource-Based View, IC is a strategic asset that supports long-term sustainability. However, its full impact depends on the hotel's ability to adapt (Barney, 1991). DCT explains how IC helps hotels sense sustainability needs, seize innovation opportunities, and reconfigure resources (Teece et al., 1997). Together, these theories show that IC enhances sustainable performance by combining strategic value with ongoing adaptability. Based on the previous, we assume that.

H5: *IC has a positive and significant impact on HSP.*

2.7. Mediating Effect of Data-Driven Decision-Making in the IoT–Hotel Sustainable Performance Relationship

In the hospitality industry, IoT enables the collection and analysis of real-time data on energy consumption, guest activities, and resource usage, making environmental analysis a central component of sustainable operations (Mercan et al., 2021; Nadkarni et al., 2020). In addition, IoT implementation provides a data foundation necessary for DDM, which in turn enables more effective resource management, process optimization, and strategic planning for sustainability outcomes (Awan et al., 2021; Chaudhuri et al., 2024). In the recent investigation, Malik (2024) concluded that when organizations properly leverage IoT to support evidence-based decisions, they can improve operational efficiency, reduce environmental impact, and enhance their overall sustainable performance.

In this study, we propose that the mediating role of DDM in the IoT-sustainable performance relationship is theoretically supported by the Resource-Based View, which regards IoT as a valuable technological resource (Barney, 1991), and Dynamic Capabilities Theory, which explains how data-driven processes enable firms to reconfigure this resource into sustainable performance outcomes (Teece et al., 1997). Specifically, IoT provides hotels with real-time data that can be highly valuable, but it only leads to sustainability when managers know how to use it effectively. By developing DDM skills, managers can analyze and apply this data to conserve resources, reduce inefficiencies, and make smarter choices for both the environment and the business. In this way, DDM becomes the key mechanism for transforming IoT information into actionable practices that may enhance long-term sustainable performance. Thus, based on the above discussion, the following hypothesis is proposed:

H6: *DDM significantly mediates the impact of IoT on HSP.*

2.8. Mediating Effect of Innovative Capabilities in the IoT–Hotel Environmental Performance Relationship

IC serves as another critical mediating mechanism between IoT and sustainable performance. In the hotel sector context, IC is essential, as it enables hotels to adapt and refine operational procedures in response to shifting market demands and environmental management challenges. IoT provides the technological foundation that enhances innovation capabilities by enabling experimentation, facilitating new service development, and supporting process innovations (Chaudhuri et al., 2024; Mercan et al., 2021; Elkhwesky & Elkhwesky, 2023). These enhanced IC then drive sustainable performance improvements through the development and implementation of novel sustainability solutions (Njoroge et al., 2019; Aziz et al., 2024; Pascual-Fernández et al., 2021). Findings from a recent study by Chaudhuri et al. (2024) emphasize that organizations implementing Industry 4.0 technologies achieve higher performance by expanding their capacities for product and service innovation.

The mediating role of IC in the relationship between IoT and sustainable performance can also be explained through the integration of the RBV and DCT. From an RBV perspective, IoT technologies represent a valuable technological resource that provides hotels with real-time data, connectivity, and operational insights. However, resources alone do not automatically lead to competitive or sustainable outcomes unless it is processed effectively. This process is well explained by DCT (Teece et al., 1997), which highlights how organizations adapt through sensing, seizing, and reconfiguring. For hotels, IoT enables the constant gathering of data on guest preferences and operational performance, allowing for the identification of new opportunities. With strong innovation capabilities, hotels can then seize

these opportunities—transforming IoT insights into new services, eco-friendly solutions, and more efficient operational practices. The final step is reconfiguration, where hotels integrate these innovations into their business models, making sustainability a part of both everyday operations and long-term strategy. Hence, we suggest the following hypothesis.

H7: *IC significantly mediates the impact of IoT on HSP.*

2.9. Moderating the Role of AI Applications

Artificial Intelligence (AI) is emerging as a transformative force in the hospitality industry, providing powerful tools to embed sustainability into operations, services, and strategic decisions (Filimonau et al., 2025; Zahidi et al., 2024). AI plays a vital role in strengthening the connection between IoT adoption and sustainable performance. The IoT supplies raw data on energy use, guest preferences, and operational efficiency; however, without advanced analytics, such as AI, much of this data may go underutilized. AI can enhance the benefits of IoT by offering advanced analysis, predictive insights, and automated optimization (Gajić et al., 2024; Chung & Tan, 2025). For instance, AI-driven systems can adjust lighting and HVAC in real time, reduce waste of food and materials, and track carbon emissions against sustainability targets (Jabeen et al., 2022; Talukder et al., 2024). Besides environmental advantages, AI also promotes social sustainability by analyzing guest feedback, identifying training needs for staff, improving staff well-being through routine activity optimization, and fostering partnerships with local suppliers (Al-Romeedy & Alharethi, 2024; Limna, 2023). Additionally, AI supports economic sustainability by enhancing demand forecasting and supply chain management, which reduces waste and costs. Thus, AI not only amplifies IoT's impact but also helps hotels deliver smarter, greener, and more responsible hospitality practices (Liu et al., 2025; Shkalenko & Nazarenko, 2024). In their empirical study, Bibri et al. (2023) emphasize that deploying AI and IoT together enables new approaches to environmental sustainability, which is especially important for hotels, given their substantial contribution to urban energy consumption and carbon emissions. Their research indicates that innovative technologies can lead to significant energy savings by analyzing data in real-time and automating processes, thereby boosting hotels' green profiles.

From the Resource-Based View, AI is a strategic asset that enhances the value of IoT in achieving sustainable performance (Barney, 1991). Yet, its true impact lies in how hotels use it. Dynamic Capabilities Theory explains that AI enables hotels to sense, seize, and reconfigure in response to sustainability demands (Teece et al., 1997). By providing predictive insights and automation, AI helps optimize resources and adapt operations—making hotel practices more sustainable

Based on the previous discussion, we suggest that

H8: *AI application significantly moderates the impact of IoT on HSP, such that the impact is stronger when the AI application is high.*

As mentioned previously, in the context of the hospitality sector, adopting IoT enables hotels to collect large amounts of data on energy use, guest behavior, water consumption, and other resources (Nadkarni et al., 2020; Mercan et al., 2021). When used effectively, this data supports DDM, enabling hotels to improve efficiency, carry out predictive maintenance, and adopt more sustainable practices (Shaik, 2019; Domínguez-Cid et al., 2022). AI can play a critical role in enhancing DMM, as technologies such as machine learning, natural language processing, and predictive analytics can process vast amounts of IoT data more efficiently and accurately than traditional analytical methods, transforming them into actionable insights (Kavitha & Chinnasamy, 2021; Al-Okbi et al., 2025). AI algorithms can

identify complex patterns, predict future trends, and recommend optimal decisions based on IoT data, thereby strengthening the relationship between IoT implementation and DDM capabilities. For instance, by identifying patterns and generating predictive insights, the integration of AI with IoT enables organizations—such as hotels—to move from descriptive analytics (what happened) to prescriptive analytics (what should be done), leading to more effective decision-making (Kumar et al., 2023; Gandhi et al., 2024). This perspective aligns with the Resource-Based View (RBV), which posits that when valuable technological resources, such as IoT and AI, are effectively combined, they generate superior decision-making capabilities by enabling organizations to analyze information more efficiently and transform data into strategic actions (Barney, 1991). Hence, the following hypothesis is suggested.

H9: *AI application moderates the impact of IoT on data-driven decision-making, such that the impact is greater when the AI application is high.*

In the context of the moderating role of AI in the link between IoT and IC, empirical research illustrated that AI plays a crucial role in fostering innovation and improving organizational learning. The integration of IoT and AI empowers organizations to embrace a learning mindset, adapt to changing environments, and drive sustainable growth through new technologies (Kumar et al., 2023). Using data gathered from 398 B2B companies operating internationally, Sahoo et al. (2024) concluded that AI capabilities significantly enhance open innovation practices, leading to improved business performance. More specifically, the integration of AI capabilities and IoT can lead to enhancing innovation capabilities. AI technologies, such as machine learning, predictive analytics, and natural language processing, allow firms to extract deeper insights from IoT data, identify hidden patterns, and predict future trends (Tariq, 2025). Through this integration, hotels can transform IoT-generated information into creative and practical innovations that improve performance and sustainability (Gajić et al., 2024). AI helps organizations experiment and make decisions faster, reducing uncertainty and encouraging a culture of continuous innovation (Gandhi et al., 2024; Zahidi et al., 2024). This perspective aligns with the RBV and DCT, which together suggest that when valuable technological resources such as AI and IoT are effectively integrated, they may enhance the hotel's capabilities by sensing emerging market trends and opportunities, developing creative service solutions, and continuously reconfiguring operations to sustain continuous innovation and delivering novel and value-added guest experiences. As a result. We hypothesized that.

H10: *AI application moderates the impact of IoT on IC, such that the impact is better when the AI application is high.*

Figure 1 represents the study's theoretical framework.

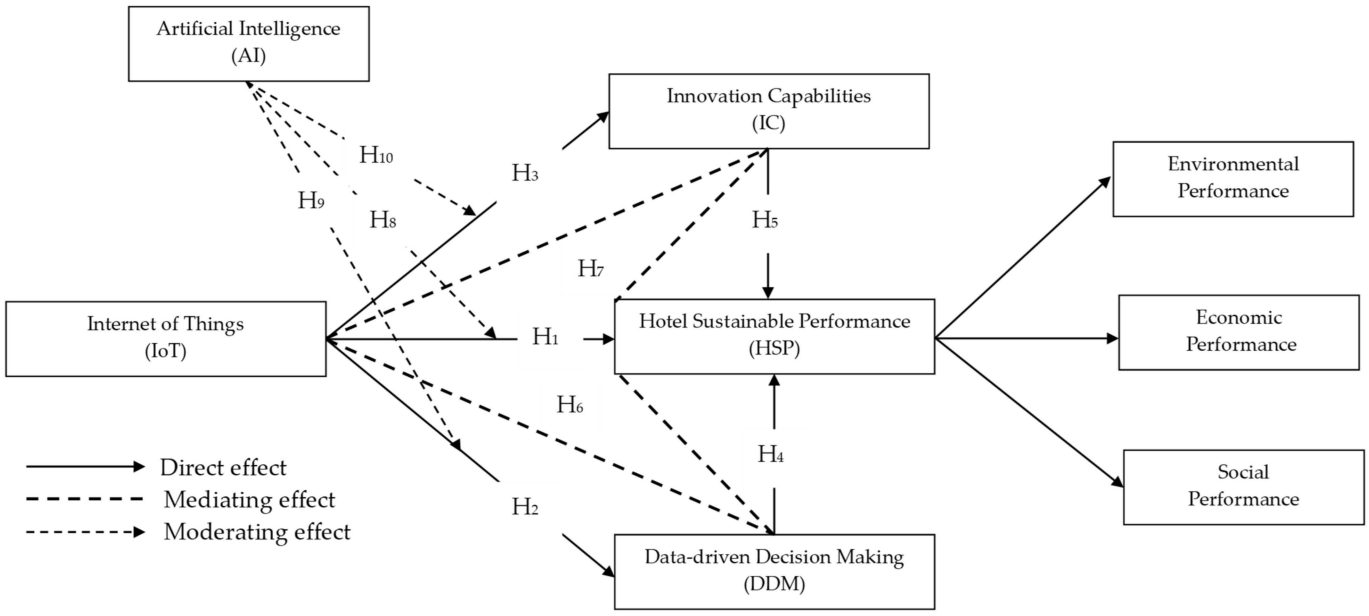

Figure 1. Theoretical framework.

3. Materials and Methods

3.1. Sampling and Procedure

This study focused on hotel managers, executives, assistant managers, and supervisors working in four- and five-star hotels across Saudi Arabia. Data were collected from the Western, Central, and Eastern regions, with an emphasis on Jeddah, Riyadh, and Dammam—cities identified in previous research as leading destinations in adopting eco-friendly and sustainable hospitality practices (Abdou et al., 2022a). The study targeted four- and five-star hotels as they are the most technologically advanced and sustainability-oriented segment of the Saudi hospitality sector. Consequently, managers and assistant managers in these hotels possess the technical knowledge and strategic experience required to provide informed insights into the integration of digital transformation and sustainability within hotel operations.

A purposive sampling approach was used, targeting managers, executives, and assistant managers from 4- and 5-star hotels to ensure respondents possessed the managerial knowledge and strategic insight needed to evaluate digital transformation and sustainability practices. These roles were chosen because they oversee technology adoption, strategic planning, and sustainability initiatives, providing informed perspectives on how IoT and AI contribute to hotel sustainability performance. Eligible participants met the following criteria: (1) working in a four- or five-star hotel, (2) having familiarity with or involvement in technology and sustainability activities within the hotel (e.g., IoT, AI, and environmental programs), (3) having at least one year of experience in their current position to ensure adequate operational and strategic understanding. This sampling approach ensured that the data were collected from qualified individuals with relevant expertise, thereby strengthening the study's internal validity and practical relevance.

To meet the study's aims, an online survey was designed and distributed to hotel managers, executives, and their assistants. Following Hair et al. (2019), a minimum of 155 cases is needed for SEM when the expected path coefficients (*Pmin*) range between 0.11 and 0.20 at a 0.05 significance level. Additionally, a minimum of 200 cases is recommended for structural equation modeling, as noted by Boomsma (1982). In this study, 450 participants were invited. All participants received an email invitation with a link to the survey, a welcome note, and a brief explanation of the study's purpose. To boost participation,

reminder emails were sent to those who had not completed the survey, two and four weeks after the initial invitation. Of the 450 invited, 312 valid responses were collected (69.3%). Therefore, we confirm that our sample is suitable for PLS-SEM analysis.

Table 1 shows the respondents' demographics. In terms of gender, the number of female respondents (40, 12.8%) was lower than males (272, 87.2%), reflecting the current workforce structure in the Saudi hospitality industry, where female participation remains relatively limited due to cultural patterns. Further, in terms of participants' experience in their current hotel, 60.9% reported having between one and five years of experience in their present organization, while 17.3% had 6–10 years, 13.8% had 11–15 years, and only 8% had more than 15 years. Regarding education, a large portion (70.8%) held a bachelor's degree, followed by 18.9% with a high school diploma and 10.3% with postgraduate qualifications. Concerning job roles, over one-third (34.6%) held the position of department director or executive, 24.4% served as department heads, 20.8% as assistant department heads or supervisors, 12.2% as assistant general managers, and 8% as general managers or hotel managers.

Table 1. Demographic information of the sample.

Category	Frequency (n = 312)	%
Gender		
Male	272	87.2
Female	40	12.8
Experience in the current hotel		
1–5 years	190	60.9
6–10 years	54	17.3
11–15 years	43	13.8
More than 15	25	8.0
Education		
High school/Diploma	59	18.9
Bachelor degree	221	70.8
Postgraduate degree	32	10.3
Position		
GM/Hotel Manager	25	8.0
Assistant GM	38	12.2
Department Director/Executive	108	34.6
Department heads	76	24.4
Assistant Dep. Heads/supervisor	65	20.8

In accordance with established ethical standards, this study was conducted in accordance with guidelines for research involving human participants. Before starting the online survey, participants were presented with an informed consent statement that explained the purpose of the research, their right to decline or withdraw at any time without penalty, and the assurance that their responses would remain anonymous and confidential. Participants were informed that the information they provided would be used only for academic research purposes. Participants were required to indicate their consent by clicking "I agree" before proceeding to the survey questions.

3.2. Measures of the Study and Data Analysis

To ensure clarity and reliability in the data collection process, well-established scales from previous research were used to measure each construct within the framework. The study employed a five-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), to assess participants' perceptions of IoT, DDM, IC, and AI. For HSP, the scale ranged from 1 (very low) to 5 (very high), as participants were kindly asked to answer the following question: "How would you rate your hotel's sustainable performance in terms of."

Fifteen items from Gajić et al. (2024) were adapted to measure IoT; sample items include "IoT monitors and optimizes water and resource usage" and "IoT sensors manage food and beverage supplies, reducing waste." Innovative capabilities were assessed with a three-item scale adapted from Agyapong et al. (2018), such as "Our hotel has the ability to support and drive new ideas and their implementation." Additionally, eight items from Gajić et al. (2024) measured participants' perceptions of AI application, for example, "AI algorithms optimize energy, reducing costs and environmental footprint." DDM was evaluated using a five-item scale from Ashaari et al. (2021), including items such as "Our hotel depends on data-based insights to support decision making." Finally, a 10-item scale adapted from Abdou et al. (2022a) was used to evaluate the HSP. In this study, HSP was modeled as a second-order construct comprising three dimensions: environmental, economic, and social performance. Sample items include "mitigating climate change and ecological degradation," "increasing the hotel's sales volume and profit margin," and "enhancing the employees' and customers' quality of life."

To ensure the content validity of the study items, all constructs and measurement indicators were assessed by a panel of experts consisting of three university professors and two senior hotel managers. Their feedback was used to refine the wording, clarity, and relevance of each item before distributing the final questionnaire. Based on their feedback, minor revisions were made. Using PLS-SEM, content validity was also established through cross-loadings (See Table 2). The results show that all items are loaded higher on their respective constructs than on any other constructs, confirming that the items appropriately represent their intended constructs. Additionally, reliability, convergent, and discriminant validity were evaluated using the Cronbach alpha alongside Composite Reliability (CR), Average variance Extracted (AVE), and HTMT criteria, respectively.

Table 2. Cross loadings.

Construct	Item	AI	DDM	Environmental	Economic	Social	IC	IoT
AI application	AI1	0.917	0.462	0.695	0.704	0.514	0.550	0.505
	AI2	0.935	0.380	0.668	0.688	0.491	0.508	0.471
	AI3	0.925	0.417	0.686	0.712	0.476	0.515	0.471
	AI4	0.909	0.443	0.683	0.675	0.514	0.539	0.494
	AI5	0.928	0.366	0.643	0.662	0.467	0.502	0.445
	AI6	0.920	0.408	0.665	0.691	0.454	0.507	0.453
	AI7	0.922	0.360	0.638	0.655	0.462	0.488	0.437
	AI8	0.884	0.382	0.612	0.650	0.429	0.469	0.430
Data-driven decision-making	DDM1	0.373	0.868	0.545	0.442	0.502	0.463	0.465
	DDM2	0.391	0.787	0.460	0.362	0.491	0.547	0.403
	DDM3	0.350	0.847	0.505	0.412	0.482	0.436	0.447
	DDM4	0.371	0.847	0.562	0.455	0.489	0.509	0.430
	DDM5	0.312	0.730	0.504	0.466	0.461	0.405	0.427
Environmental performance	HP1	0.466	0.576	0.768	0.533	0.551	0.627	0.482
	HP2	0.447	0.535	0.791	0.566	0.567	0.595	0.502
	HP3	0.736	0.515	0.899	0.869	0.526	0.497	0.507
	HP4	0.720	0.512	0.883	0.718	0.523	0.520	0.471
Economic performance	HP5	0.682	0.487	0.738	0.914	0.528	0.525	0.472
	HP6	0.702	0.488	0.816	0.963	0.530	0.482	0.510
	HP7	0.731	0.519	0.748	0.976	0.550	0.508	0.513
Social performance	HP8	0.343	0.433	0.447	0.363	0.769	0.420	0.548
	HP9	0.358	0.430	0.436	0.443	0.760	0.428	0.601
	HP10	0.486	0.503	0.585	0.488	0.784	0.642	0.488
Innovation capabilities	IC1	0.504	0.464	0.528	0.444	0.532	0.804	0.505
	IC2	0.486	0.503	0.585	0.488	0.784	0.842	0.488
	IC3	0.338	0.426	0.471	0.336	0.468	0.781	0.362

Table 2. *Cont.*

Construct	Item	AI	DDM	Environmental	Economic	Social	IC	IoT
Internet of Things (IoT)	IOT1	0.343	0.433	0.447	0.363	0.669	0.420	0.748
	IOT2	0.411	0.452	0.485	0.402	0.602	0.481	0.752
	IOT3	0.358	0.430	0.436	0.443	0.760	0.428	0.801
	IOT4	0.469	0.363	0.464	0.427	0.562	0.451	0.761
	IOT5	0.352	0.399	0.416	0.435	0.719	0.390	0.779
	IOT6	0.449	0.334	0.455	0.398	0.541	0.441	0.737
	IOT7	0.332	0.419	0.429	0.345	0.639	0.407	0.723
	IOT8	0.383	0.442	0.458	0.373	0.552	0.462	0.717
	IOT9	0.338	0.391	0.410	0.410	0.694	0.384	0.776
	IOT10	0.303	0.399	0.414	0.330	0.625	0.385	0.708
	IOT11	0.378	0.434	0.445	0.367	0.564	0.450	0.729
	IOT12	0.333	0.405	0.411	0.412	0.714	0.419	0.774
	IOT13	0.464	0.337	0.439	0.405	0.536	0.424	0.739
	IOT14	0.331	0.383	0.391	0.402	0.691	0.360	0.750
	IOT15	0.436	0.326	0.425	0.368	0.527	0.434	0.714

4. Results

4.1. Common Method Bias

The study variables were measured using an online questionnaire administered at a single point in time. In behavior-focused research, common method bias (CMB) is often considered a potential concern (Kock, 2015). To address this, both procedural and statistical measures were implemented. Specifically, participants were informed that their identities and responses would remain anonymous and confidential, and that the data collected would be used solely for research purposes (Nancarrow et al., 2001). Statistically, the most common diagnostic techniques, including Harman's single-factor test and the variance inflation factor (VIF) test, have been used. Results showed that the variance explained by a single factor was below the 50% threshold (39.421%) (Podsakoff et al., 2003). In addition, all variables had VIF values under the recommended cutoff of 3.3, ranging from 1.000 to 1.983, which falls within the acceptable limits. These findings confirm that the dataset is free from CMB (Kock, 2015) (see Table 3).

Table 3. Collinearity statistics (VIF).

Construct	DDM	Environmental	Economic	Social	HSP	IC
AI	1.443				1.793	1.443
DDM					1.733	
HSP		1.000	1.000	1.000		
IC					1.983	
IoT	1.355				1.806	1.355
AI × IoT	1.143				1.241	1.143

4.2. Measurement Model Assessment

Partial Least Squares Structural Equation Modeling (PLS-SEM) was used to assess measurement and structural models and test the study's hypotheses. PLS-SEM is a non-parametric, variance-based statistical method that is suitable for both simple and complex models (Hair et al., 2019). It is particularly appropriate when the data are not normally distributed, the sample size is relatively small, or some data is missing, as it provides more accurate estimates than simple least squares (Becker et al., 2023).

For measurement model assessment, item loading and significance, reliability, convergent and discriminant validity should be considered (Hair et al., 2019). An item is acceptable if its standardized loading is significant and greater than 0.708. As presented in Table 4 and Figure 2, all standardized item loadings exceed 0.708 and are statistically

significant at the $p > 0.001$ level. Furthermore, reliability was assessed using Cronbach's alpha and Composite Reliability (CR). According to Hair et al. (2019), both values should exceed the threshold of 0.70. As shown in Table 4, the results indicate that all study constructs have alpha and CR values above this cutoff, confirming the internal consistency and reliability of the study's constructs. Moreover, to assess convergent validity, the AVE was calculated. AVE values greater than 0.50 are considered acceptable. The results show that no concern exists with the AVE, as all study constructs have values exceeding 0.50, indicating satisfactory convergent validity.

Table 4. Constructs' validity and reliability.

First-Order Construct	Second-Order Construct	Items	Factor Loading	VIF	α	CR	AVE
Internet of Things		IOT1	0.748 ***	1.105	0.944	0.950	0.559
		IOT2	0.752 ***	1.896			
		IOT3	0.801 ***	1.711			
		IOT4	0.761 ***	1.579			
		IOT5	0.779 ***	2.338			
		IOT6	0.737 ***	1.406			
		IOT7	0.723 ***	1.941			
		IOT8	0.717 ***	1.578			
		IOT9	0.776 ***	1.855			
		IOT10	0.708 ***	1.473			
		IOT11	0.729 ***	2.110			
		IOT12	0.774 ***	1.441			
		IOT13	0.739 ***	1.706			
		IOT14	0.750 ***	1.332			
		IOT15	0.714 ***	1.302			
Data-driven decision-making		DDM1	0.868 ***	1.875	0.874	0.909	0.668
		DDM2	0.787 ***	1.624			
		DDM3	0.847 ***	1.227			
		DDM4	0.847 ***	1.458			
		DDM5	0.730 ***	1.114			
Innovation capability		IC1	0.804 ***	1.397	0.739	0.851	0.655
		IC2	0.842 ***	1.511			
		IC3	0.781 ***	1.678			
Environmental performance		HSP1	0.768 ***	1.448	0.857	0.903	0.701
		HSP2	0.791 ***	1.593			
		HSP3	0.899 ***	1.346			
		HSP4	0.883 ***	1.239			
Economic performance		HSP5	0.914 ***	1.758	0.947	0.966	0.905
		HSP6	0.963 ***	1.299			
		HSP7	0.976 ***	1.887			
Social performance		HSP8	0.769 ***	2.111	0.785	0.815	0.594
		HSP9	0.760 ***	2.421			
		HSP10	0.784 ***	1.909			
	Hotel Sustainable Performance	Environmental performance	0.963 ***	2.211	0.921	0.936	0.602
		Economic performance	0.939 ***	2.412			
		Social performance	0.762 ***	1.975			
AI application		AI1	0.917 ***	1.392	0.937	0.977	0.842
		AI2	0.935 ***	1.312			
		AI3	0.925 ***	2.548			
		AI4	0.909 ***	1.453			
		AI5	0.928 ***	2.848			
		AI6	0.920 ***	1.789			
		AI7	0.922 ***	2.695			
		AI8	0.884 ***	2.474			

Note: *** $p < 0.001$.

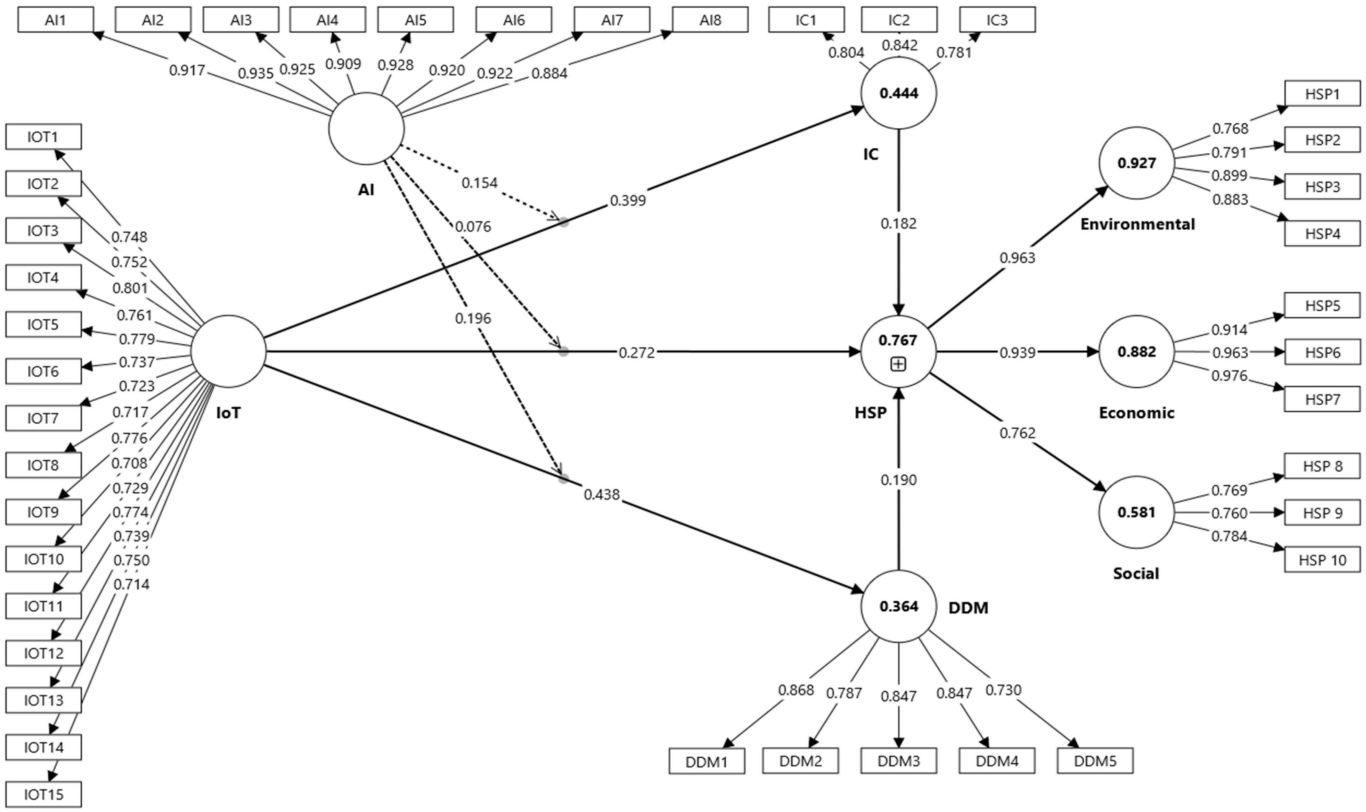

Figure 2. The Measurement Model.

Finally, the discriminant validity of the measurement model is assessed using the heterotrait–monotrait (HTMT) ratio of correlations to ensure robustness of the study model (Henseler et al., 2015). Henseler et al. (2015) suggested that the HTMT value should be below 0.85 for conceptually distinct constructs and below 0.90 for conceptually similar constructs. As shown in Table 5, all HTMT values are below 0.85, confirming that the model successfully distinguishes between the study's constructs.

Table 5. Heterotrait–monotrait ratio (HTMT).

Constructs	AI	DDM	HSP	IC	IoT	AI × IoT
AI						
DDM	0.476					
HSP	0.782	0.728				
IC	0.642	0.714	0.849			
IoT	0.528	0.584	0.770	0.666		
AI × IoT	0.349	0.011	0.177	0.125	0.256	

4.3. Structural Model Assessment

Table 6 and Figure 3 present the structural model results generated from 5000 bootstrapped subsamples. The findings show that IoT has a significant positive effect on hotel sustainability performance (HSP) (β = 0.272; t = 6.797), indicating that hotels that adopt and integrate IoT systems are more likely to achieve better environmental, social, and operational sustainability outcomes. IoT also exerts a strong influence on data-driven decision-making (DDM) (β = 0.438; t = 9.006), supporting H1 and H2, and suggesting that IoT provides real-time data that enables hotels to make more informed and efficient strategic decisions. Likewise, IoT significantly enhances innovation capability (IC) (β = 0.399; t = 7.806), confirming H3 and demonstrating that technology adoption contributes to new service improvements and operational innovation in hotels.

Table 6. Test of hypotheses.

Paths	Path Coefficient	*t*-Values	*p*-Values	f^2	2.5%	97.5%	Remarks
Direct paths							
IoT -> HSP	0.272	6.797	0.000	0.176	0.195	0.352	Accepted
IoT -> DDM	0.438	9.006	0.000	0.222	0.342	0.534	Accepted
IoT -> IC	0.399	7.806	0.000	0.211	0.301	0.500	Accepted
DDM -> HSP	0.190	4.029	0.000	0.089	0.099	0.287	Accepted
IC -> HSP	0.182	3.567	0.000	0.072	0.079	0.278	Accepted
Mediation paths							
IoT -> DDM -> HSP	0.083	3.387	0.001		0.040	0.137	Accepted
IoT -> IC -> HSP	0.073	3.393	0.001		0.032	0.115	Accepted
Moderation paths							
AI × IoT -> HSP	0.076	2.436	0.015	0.024	0.016	0.136	Accepted
AI × IoT -> DDM	0.196	5.406	0.000	0.065	0.128	0.270	Accepted
AI × IoT -> IC	0.154	3.579	0.000	0.046	0.069	0.237	Accepted

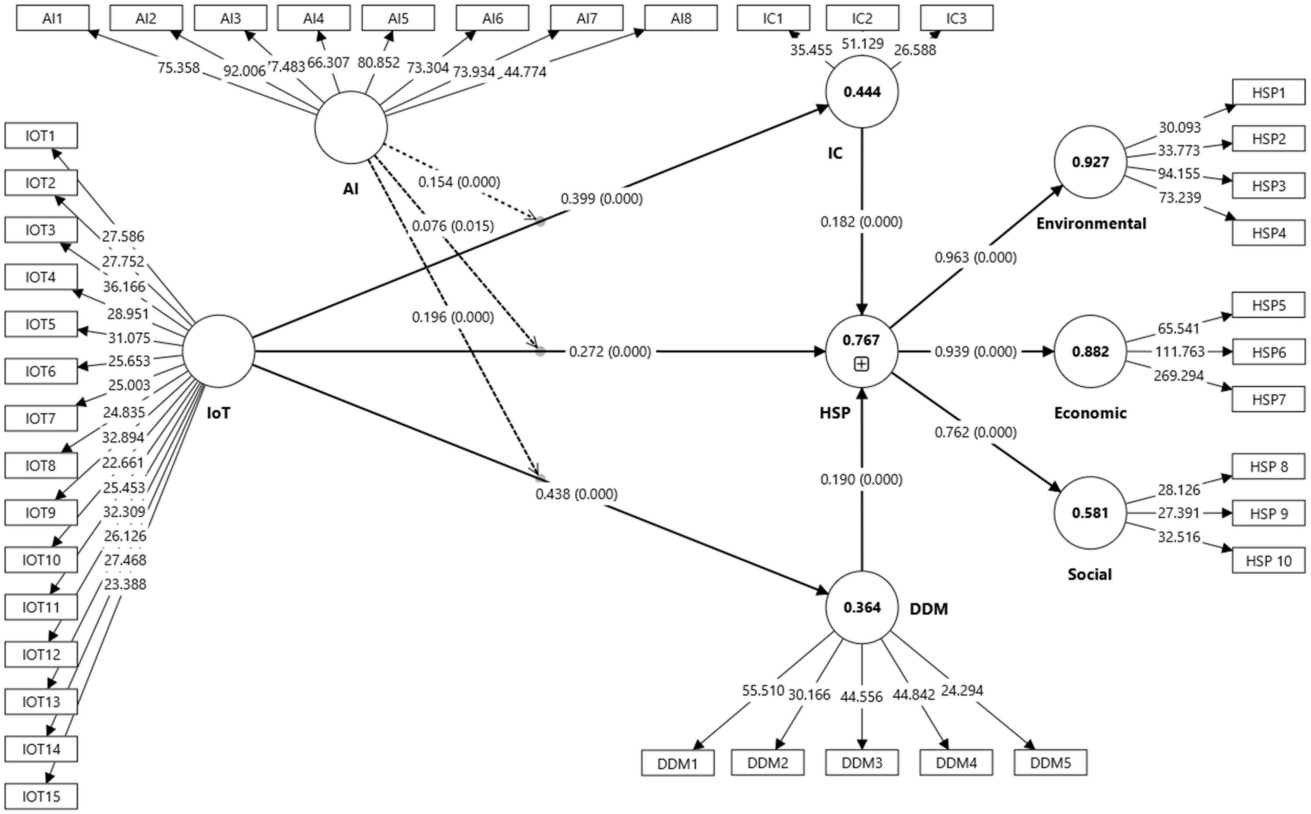

Figure 3. Structural Model.

In addition, both DDM (β = 0.190; t = 4.029) and IC (β = 0.182; t = 3.567) positively and significantly affect HSP, supporting H4 and H5. This indicates that hotels that rely on analytical decision-making and continuous innovation are more likely to improve energy efficiency, enhance guest satisfaction, and support sustainable operations. The mediation analysis further shows that IoT indirectly improves HSP through both DDM (β = 0.083; t = 3.387) and IC (β = 0.073; t = 3.393), supporting H6 and H7. These mediation effects suggest that IoT technologies do not automatically translate into sustainability benefits unless hotels actively use the data produced by these systems to guide decisions and foster innovation.

The moderating role of AI was also confirmed. The interaction term AI × IoT significantly moderated the effect of IoT on HSP (β = 0.076, t = 2.436, p = 0.015, f^2 = 0.024), suggesting that hotels with higher AI adoption benefit more from IoT technologies in improving the sustainable performance of the hotel. Furthermore, AI also enhanced the influence of IoT on DDM (β = 0.196, t = 5.406, $p < 0.001$, f^2 = 0.065), showing that the synergy between AI and IoT enables hotels to make more efficient, data-driven decisions. Finally, AI strengthened the effect of IoT on IC (β = 0.154, t = 3.579, $p < 0.001$, f^2 = 0.046), implying that AI capabilities amplify the innovative outcomes of IoT adoption. Overall, all hypothesized relationships in the model were supported, confirming the robustness of the proposed framework. Consequently, hypotheses H8, H9, and H10 are supported.

In addition, Table 6 presents the effect size (f^2) values, categorized following Cohen's (1988) guidelines as small (≥0.02), medium (≥0.15), and large (≥0.35). Although the f^2 values fall within the small-to-medium range, they still indicate meaningful practical effects. These results suggest that the relationships in the model hold real managerial relevance for hotel sustainability and digital transformation strategies. Moreover, the support for all hypothesized relationships confirms the robustness and reliability of the proposed research framework.

4.4. Explanatory Power and Predictive Relevance of the Structural Model

In this study, the explanatory power as well as predictive relevance of the structural model were assessed by examining the coefficient of determination (R^2) and predictive relevance ($Q^2_{predict}$) values. Following the guidelines proposed by Hair et al. (2019), the R^2 values are classified into three categories as follows: substantial 0.75, moderate 0.50, and weak 0.25. As shown in Table 7, the structural model results revealed that IoT and AI jointly explained 44.4% of the variance in IC, and 36.4% of the variance in DDM, indicating a moderate level of explanatory power. For HSP, the influence was significantly more substantial, with IoT, AI, IC, and DDM explaining 76.7% of its performance, highlighting the explanatory power of these factors.

Table 7. Predictive power and relevance of the study's model.

Constructs	R^2	$Q^2_{predict}$
Innovation capability	0.444	0.423
Data-driven decision-making	0.364	0.342
Hotel sustainable performance	0.767	0.701

Additionally, the $Q^2_{predict}$ statistic was used to assess the model's predictive validity, with Hair et al. (2019) suggesting that $Q^2_{predict}$ values must exceed zero to establish predictive relevance. Using the $PLS_{predict}$ procedure in SmartPLS v. 4.1.1.4, all $Q^2_{predict}$ values for the constructs surpassed this threshold. Specifically, IC recorded a Q^2_{prdict} value of 0.423, DDM achieved 0.342, and HSP reached 0.701, confirming that the model has strong predictive relevance, particularly for sustainability outcomes.

5. Discussion and Implications

5.1. Discussion

The main aim of this study was to examine how the integration of the Internet of Things (IoT), data-driven decision-making (DDM), innovation capability (IC), and artificial intelligence (AI) can collectively enhance hotel sustainable performance (HSP). Guided by the Resource-Based View (RBV) and Dynamic Capabilities Theory (DCT), the research explored not only the direct influence of IoT on hotel sustainability but also the mediating roles of DDM and IC, and the moderating role of AI.

While RBV and DCT are often seen as complementary, they differ in focus: RBV emphasizes owning valuable and rare resources (Barney, 1991), while DCT explains how hotels sense, seize, and reconfigure those resources to sustain advantage in dynamic environments (Teece et al., 1997). This study bridges the two by showing how digital resources (IoT and AI) gain value when activated through dynamic capabilities (DDM and IC). In this sense, IoT and AI provide the technological foundation (RBV), whereas DDM and IC transform these assets into strategic action and innovation (DCT). This synthesis reveals that the true value of smart technologies lies not in their possession, but in how effectively hotels use them to sense, seize, and reconfigure for sustainable performance.

More specifically, the study findings illustrate that IoT significantly affects HSP. This positive effect corroborates previous research emphasizing the transformative role of smart technologies in sustainability (Mercan et al., 2021; Liu et al., 2025; Sharma & Gupta, 2021; Rajesh et al., 2022). IoT enables real-time monitoring of energy, water, and waste, leading to measurable efficiency gains and environmental benefits (Saha et al., 2017; Singh et al., 2024). This aligns with the RBV's assertion that technological infrastructure can be a valuable, rare, and inimitable resource that strengthens competitive advantage (Barney, 1991). The current findings extend this notion by showing that IoT's contribution to sustainability is not limited to environmental metrics but also encompasses economic efficiency and social value creation.

Further, the findings reveal a significant relationship between IoT and DDM. Similar results have been reported in recent research, emphasizing that digital connectivity enhances the precision and speed of managerial decision-making (Q. Li et al., 2020; Ferreira, 2023; Domínguez-Cid et al., 2022). This means that when hotels adopt IoT systems to track energy use, guest preferences, and maintenance needs, managers can make informed decisions rather than relying solely on intuition or experience. This finding aligns with the Dynamic Capabilities Theory (DCT), as it demonstrates the hotel's ability to sense opportunities and seize them through data-driven insights.

The results also show that IoT has a significant and positive effect on IC. In simple terms, IoT not only makes hotel operations more efficient but also inspires creativity and the development of new services. By connecting systems and sharing real-time data, hotels can test and introduce innovative ideas—such as smart rooms, energy-saving technologies, and eco-friendly operations. This finding aligns with the DCT, which highlights the importance of constantly adapting and reconfiguring resources to remain competitive. It also supports the view of earlier research (e.g., Mercan et al., 2021; Elkhwesky & Elkhwesky, 2023), which emphasized that IoT helps hospitality businesses evolve into innovative and technology-driven ecosystems.

Furthermore, the findings reveal that both DDM and IC play crucial roles in improving hotel sustainability. Hotels that base their decisions on data are better able to manage resources, reduce waste, and improve efficiency. By utilizing IoT-generated data, managers can identify problems early, allocate resources effectively, and make smarter sustainability investments that benefit both the environment and profitability (Chaudhuri et al., 2024). At the same time, IC has a similarly positive effect on sustainable performance. Hence, we conclude that when hotels encourage creativity and flexibility, they become better equipped to design eco-friendly services, use renewable energy, and offer more satisfying guest experiences. This finding supports the RBV and DCT, which emphasize that organizations must constantly adapt and reconfigure their valuable resources to stay competitive. Consistent with earlier research (Aziz et al., 2024; Pascual-Fernández et al., 2021), the results show that data-driven management and innovation are central to achieving sustainability across all three dimensions—environmental, social, and economic.

In terms of the mediation effects, the findings confirm that DDM partially explains how IoT improves hotel sustainability. In other words, the findings reveal that through DDM, hotels can transform IoT data into practical insights—helping them allocate resources efficiently, anticipate maintenance needs, and strengthen their sustainability strategies. These findings align with recent studies showing that data literacy and analytical skills are essential for turning digital transformation into sustainable business practices (Mercan et al., 2021; Malik, 2024; Chaudhuri et al., 2024; Awan et al., 2021). Similarly, IC also acts as a partial mediator in the IoT–HSP. This means IoT contributes to sustainability by stimulating innovation, helping hotels create new eco-friendly solutions and business models. This is especially relevant in an industry that faces rapid technological change and high expectations. The finding supports earlier studies that link IC to sustainable performance (Pascual-Fernández et al., 2021; Aziz et al., 2024). It reinforces the idea that IoT is not only a technological asset but a catalyst for creative problem-solving that drives long-term environmental and social value.

The moderating analysis highlights the important role of AI applications across all major pathways. AI strengthened the relationship between IoT and HSP ($\beta = 0.076$, $t = 2.436$), between IoT and DDM ($\beta = 0.196$, $t = 5.406$), and between IoT and IC ($\beta = 0.154$, $t = 3.579$). These findings support previous research and emphasize AI's ability to enhance hotels' sensing and seizing functions by automating data analysis, predicting trends, and supporting adaptive innovation. Specifically, AI significantly amplifies the relationship between IoT and HSP. This suggests that hotels utilizing both AI and IoT achieve better sustainability outcomes than those relying solely on IoT. These results corroborate earlier studies showing that the synergy of IoT and AI enables hotels to operate more efficiently, reduce emissions, and align operations with environmental, social, and economic goals (Gajić et al., 2024; Chung & Tan, 2025).

Further, AI significantly strengthens the linkage between IoT and DDM, indicating that AI assists hotels in processing large volumes of IoT data to generate predictive insights. For instance, AI can identify energy usage patterns or detect maintenance needs before failures occur. This supports earlier findings (e.g., Kavitha & Chinnasamy, 2021; Al-Okbi et al., 2025), which show that combining AI and IoT promotes faster, more accurate, and sustainable decision-making—shifting from descriptive to prescriptive analytics.

Moreover, AI enhances the connection between IoT and IC. By automating analysis and delivering predictive insights, AI fosters creativity and experimentation. Hotels can leverage AI-driven insights to develop new services, personalize guest experiences, and create green innovations. This aligns with DCT (Teece et al., 1997), where AI functions as a dynamic enabler supporting continuous resource reconfiguration. These findings are consistent with the previous results, suggesting that AI and IoT integration form an intelligent, adaptive system that empowers hotels to innovate sustainably and sustain a competitive advantage (Sahoo et al., 2024; Tariq, 2025).

While the moderating effects of AI on the relationships between IoT, DDM, IC, and HSP were statistically significant, the effect sizes ($f^2 = 0.024$–0.065) suggest that the strength of these effects is relatively small. This means that although AI does enhance IoT-driven outcomes, its current practical influence is still limited. One likely reason is that many Saudi hotels are in the early stages of AI adoption, using these technologies mainly for specific operational tasks rather than as part of fully integrated strategic systems. As such, the results reflect an emerging rather than a mature phase of digital transformation. With time and continued investment in AI integration, its impact on sustainability performance, IC, and DDM is expected to become stronger and more substantial.

Lastly, the substantially high R^2 value for Hotel Sustainable Performance (0.766) reflects the theoretically coherent and empirically strong integration of IoT adoption, inno-

vation capabilities, and data-driven decision-making, together with the moderating role of AI applications. These elements are recognized in the literature as mutually reinforcing mechanisms that can jointly shape sustainable outcomes in hotels, which supports the magnitude of the predictive power observed in this study. Nevertheless, despite the theoretical justification for such a strong effect, it is important to acknowledge that part of the explained variance may still be influenced by the single-source, cross-sectional design, which inherently carries the risk of Common Method Bias (CMB). While statistical tests indicated no severe CMB issues, the possibility of partial inflation cannot be fully ruled out. Therefore, the high R^2 should be interpreted as a combination of genuine theoretical explanatory strength and potential minor methodological enhancement.

5.2. Theoretical Implications

This study makes important contributions to theory by increasing our understanding of how digital transformation promotes sustainability in the hospitality industry and by advancing the Resource-Based View (RBV) and Dynamic Capabilities Theory (DCT) in significant ways. First, our results expand the scope of the RBV. Traditionally, RBV research has seen technologies like IoT and AI mainly as tools to improve efficiency and cut costs. This study supports the discussion further by showing that these technologies do much more; they serve as strategic resources for sustainability. In other words, IoT and AI enable hotels not only to operate more efficiently but also to enhance their environmental, social, and economic performance. By illustrating this, we extend the RBV beyond just competitiveness and demonstrate how digital tools can support long-term sustainable advantages, especially when integrated into the core functions of hotel operations.

Second, this study brings more clarity to how DCT operates in real-world hospitality settings. Instead of treating dynamic capabilities as broad or abstract concepts, we identify two specific capabilities—data-driven decision-making (DDM) and innovation capability (IC) that explain how hotels transform technological investments into sustainability results. DDM helps hotels make better decisions based on evidence rather than intuition, while IC allows them to adapt, redesign processes, and innovate in ways that support sustainability. By demonstrating these pathways, this study shows how hotels sense, seize, and reconfigure resources, making DCT more concrete and actionable in service contexts.

Third, our results highlight the role of AI in strengthening both theories. Rather than viewing AI as just another technology, this research positions it as a higher-order capability, one that enhances sensing abilities, speeds up decisions, and enhances innovation. In this way, AI works as a catalyst that amplifies the benefits of other digital resources and organizational capabilities. This adds a new layer to both RBV and DCT by illustrating how AI can elevate and multiply value, rather than merely contributing to it.

Fourth, this study offers a unified model that brings together digital technologies, managerial and innovation capabilities, as well as sustainability outcomes. This integrated approach provides a new lens for understanding digital sustainability in hospitality and lays the groundwork for future studies seeking to explore how technology and organizational learning shape sustainable competitive advantage. It moves beyond simply adopting technologies and emphasizes how hotels can use them intelligently and creatively to build a more responsible and competitive future.

Finally, these findings provide a deeper understanding of how digital transformation takes shape in Saudi Arabia's luxury hotel sector. While the results align with previous studies, they reveal how the Resource-Based View and Dynamic Capabilities Theory function differently within Saudi Arabia's unique cultural and institutional context. The particularly strong role of AI in boosting data-driven decision-making reflects the country's rapid digital progress and its proactive investment in smart technologies under Vision 2030.

This suggests that IoT and AI adoption in Saudi hotels is not merely a technological choice but a strategic response to national transformation goals.

5.3. Practical Implications

This study offers practical, evidence-based guidance for hotel managers and policymakers in Saudi Arabia who aim to enhance sustainability performance through digital transformation. The findings show that the most effective pathway to improved sustainability lies in combining the Internet of Things (IoT) with data-driven decision-making ($\beta = 0.438 \rightarrow 0.190$), followed by developing innovation capability ($\beta = 0.399 \rightarrow 0.182$). In simple terms, hotels should first invest in strengthening their data-driven management systems before moving toward broader innovation initiatives. Hotels can start by building a solid data foundation that links IoT systems with decision-making tools. Developing real-time dashboards to monitor key sustainability indicators—such as energy, water, and waste—can yield measurable results with relatively low costs. Holding regular performance reviews and encouraging managers to use data instead of intuition will help demonstrate early success, building confidence in digital systems before larger-scale investments are made.

Introducing IoT and AI systems can be costly and may require organizational change. However, these challenges can be managed through a phased approach. For instance, hotels might begin with IoT-based energy management systems that deliver quick savings, using those results to justify further investment. Collaborating with technology partners or joining government innovation programs under Vision 2030 can also help offset costs. Because digital change can meet internal resistance, leaders should communicate openly, involve staff early, and highlight how technology makes their work easier and more impactful.

Technology only creates value when people know how to use it effectively. Continuous training, digital upskilling programs, and the creation of "digital champion" teams can help staff feel confident using smart systems. Recognizing employees who propose data-driven solutions or sustainability ideas can further strengthen this culture of innovation. The study's results show that when employees are empowered to experiment and learn, innovation capability grows—and with it, the hotel's overall sustainability performance.

From a policy perspective, the government can play a key role by encouraging hotels to invest in IoT and AI through tax incentives, sustainability grants, or public–private partnerships. Establishing a national certification framework that rewards hotels for digitally enabled sustainability achievements could further motivate participation and promote industry-wide standards.

In short, digital transformation in hospitality should follow a clear and realistic roadmap. Managers should begin with projects that strengthen data-driven decision-making and deliver visible results, then progressively scale up to AI-enabled innovation. This strategic, step-by-step approach helps hotels balance ambition with practicality, ensuring that investments in technology, people, and processes lead to lasting sustainability improvements. Collectively, these actions align closely with the ambitions of Saudi Vision 2030—creating a hospitality sector that is more efficient, innovative, and globally competitive.

6. Limitations and Future Research

The current study has a few limitations that point the way for future research. First, the data were collected through a cross-sectional design, which limits the ability to establish causal relationships among the studied variables. Future studies could adopt a longitudinal approach to examine how IoT, AI, and organizational capabilities develop over time and how they continue to influence hotels' sustainability performance.

Second, this study used purposive sampling to target hotel managers, executives, assistant managers, and supervisors working in four- and five-star hotels in Saudi Arabia. While this approach ensured access to knowledgeable participants involved in digital initiatives and sustainability efforts, it may limit the generalizability of the findings. The results may not fully apply to smaller hotels, hotels with different organizational cultures, lower digital readiness, or those located in other regions. Future studies could improve generalizability by including different types of hotels or conducting cross-country comparisons to examine how cultural, policy, and technological differences influence the relationship between IoT, AI, and sustainability performance. Further, future studies may also consider a multi-level sampling strategy or stratified samples including various employee levels to provide a more comprehensive view of digital transformation and sustainability practices across hotel operations.

Third, the sample showed an imbalance in gender and experience levels, which may influence the results. The number of female respondents was lower than males, reflecting the current workforce structure in the Saudi hospitality industry, where female participation remains relatively limited due to cultural patterns. As female participation increases under Saudi Vision 2030, future studies could compare gender-based perspectives more closely. Similarly, differences in managerial experience may affect perceptions of technology and sustainability. More experienced managers might have different views from newer or younger staff. Future research could use stratified sampling or subgroup analysis to explore differences across gender and experience levels.

Fourth, this research centered on IoT, AI, DDM, and IC as the key variables. Other potential mediators and moderators—such as green human resource management, digital leadership, environmental dynamism, or organizational learning—could be examined to provide a deeper understanding of the mechanisms that drive sustainable performance. Fifth, while this study was grounded in the RBV and DCT, future studies could incorporate other theoretical perspectives—such as Institutional Theory or the Technology–Organization–Environment (TOE) framework—to explore how external pressures and contextual factors shape digital sustainability practices in the hospitality sector. Sixth, although this study employed both Harman's single-factor test and full collinearity VIFs to assess common method bias, these techniques may not eliminate the possibility of such bias. Future studies should consider using the marker variable approach (Lindell & Whitney, 2001) or collecting data from multiple sources and at different points in time to provide a more rigorous assessment of common method bias and strengthen the robustness of the findings. Finally, although the study used a validated three-item scale from Agyapong et al. (2018) to measure innovation capability, this instrument captures mainly the technological and process aspects of innovation. Future research could use a more comprehensive scale that includes product, process, administrative, and marketing innovation to provide a broader understanding of how different types of innovation contribute to hotel sustainability performance.

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