



ARTIFICIAL INTELLIGENCE AND SUSTAINABILITY IN HOSPITALITY: STRATEGIC APPROACHES TO INNOVATION AND GREEN TRANSFORMATION

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Abstract

The hospitality industry is increasingly confronted with the dual challenge of meeting sustainability goals and embracing rapid technological advancements. This paper explores the strategic application of artificial intelligence (AI) in fostering environmental, economic, and social sustainability in hotel management. Drawing on international case studies and a systematic literature review, the research highlights how AI can contribute to optimizing energy and resource consumption, reducing waste, and enhancing guest experience through smart, adaptive systems. However, the paper also emphasizes the barriers to effective AI integration, such as high investment costs, limited organizational readiness, and ethical concerns related to data privacy and service humanization. Based on the analysis, we propose a strategic framework for sustainable AI implementation in the hospitality sector, combining technological innovation with circular economy principles. The findings are particularly relevant for decision-makers seeking to future-proof hotel operations and align business models with sustainability imperatives.

Key words: *Artificial intelligence, sustainability, hospitality industry, green innovation, circular economy, smart hotels.*

Introduction

The global hospitality industry is undergoing a profound transformation driven by environmental imperatives, digital disruption, and shifting consumer expectations. Artificial Intelligence (AI), as a key enabler of this change, offers substantial opportunities for integrating sustainability into operational and strategic dimensions.

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However, adoption remains uneven and complex, especially in regions lacking digital readiness or investment capacity.

Hotels consume significant global resources and generate considerable greenhouse gas emissions. Gössling and Peeters (2015) estimate that accommodations account for approximately 21% of tourism-related CO₂ emissions. Therefore, managers must prioritize sustainable strategies where AI can play a pivotal role. From energy management systems to personalized guest communication, AI is transforming hotel operations. Yet, its integration requires careful planning to ensure it supports competitiveness rather than becoming an additional burden for owners.

This paper aims to understand and advance the use of AI to strengthen sustainable practices in hotels. It analyzes best practices, considers barriers, and proposes a framework for a strategic approach to AI integration in sustainable hotel management.

Literature review

Sustainability in hospitality

Sustainability in the hotel industry has evolved from a marginal topic to a core element of business strategy. Jones et al. (2016) define sustainable hospitality as a practice that aligns economic goals with community needs and environmental protection, while also considering future generations.

There are three pillars of sustainability in hospitality: environmental, economic, and social (Sloan et al., 2013). The environmental pillar focuses on reducing negative impacts through better resource usage. Economic sustainability relates to long-term profitability without compromising ecological or social standards. The social pillar involves relationships with employees, local communities, and cultural heritage preservation.

According to Gössling and Peeters (2015), hotels account for approximately 21% of all CO₂ emissions in tourism. Font et al. (2021) emphasize that proper resource management can reduce hotel costs by up to 30%, highlighting the economic benefits of green initiatives. Melissen et al. (2016) note that corporate social responsibility is crucial for competitiveness, given consumers' growing awareness of ecological issues. Legrand et al. (2017) confirm this, stating that 73% of travelers consider eco-friendly practices when booking hotels.

Artificial Intelligence in hospitality

AI is increasingly used in various aspects of hotel operations, including machine learning and natural language processing (Buhalis & Leung, 2018). Ivanov (2020) categorizes AI applications in hospitality into service personalization, process automation, predictive analytics, and enhanced customer experience.

Buhalis and Amaranggana (2015) describe how AI technology in hotels has evolved – from basic reservation systems to complex smart solutions enabling guest interaction.



Lukanova and Ilieva (2019) point out that the pandemic accelerated the use of AI in contactless services and automation.

Leung (2019) highlights that major hotel chains like Marriott and Hilton employ various AI tools, such as chatbots for guest communication and dynamic pricing systems. Ivanov and Webster (2019) predict that over 73% of hotels will use some form of AI technology by 2025.

Gretzel et al. (2020) identify four key areas where AI contributes to sustainability: energy savings, resource optimization, waste reduction, and data-driven decision-making. Stangl and Pesonen (2018) report that AI-based energy management systems can reduce consumption by 15–30%. Buhalis and Leung (2020) suggest that predictive analytics can decrease food waste by up to 40%.

Benckendorff et al. (2019) caution that AI alone does not guarantee sustainability. A holistic approach linking technological innovation with organizational culture is necessary for successful implementation. Tussyadiah and Miller (2019) propose a framework for evaluating AI's contribution to sustainability outcomes.

Methodology

A qualitative approach was adopted, involving a systematic literature review and case study analysis. The literature collection process included:

1. Searching academic databases (Scopus, Web of Science, ScienceDirect, Google Scholar) using keywords like "artificial intelligence" and "hospitality."
2. Applying inclusion criteria (publications in English or Serbian, between 2015–2025 focused on AI and sustainability in hotels), resulting in 84 sources.
3. Conducting content analysis to identify AI applications for sustainability, implementation challenges, and success stories.
4. Analyzing 15 case studies of hotels successfully using AI for sustainability, varying in size, location, and AI use.

Limitations include reliance on existing literature and lack of quantitative data on AI effectiveness. Future research could combine primary data collection for direct impact measurement.

Key applications of AI in sustainable hospitality

Energy and resource efficiency

AI improves building energy management through cognitive systems and machine learning. Building Management Systems (BMS) optimize energy consumption, potentially reducing usage by 20–30% (Nižić et al., 2019). Predictive maintenance extends equipment lifespan and reduces maintenance costs by 15–20% (Ivanov & Webster, 2020).

Smart water management systems have helped luxury hotels in Dubai reduce water consumption by 37% (Rahman et al., 2021). Adaptive lighting and temperature control further cut operational expenses.



Waste and circular economy

AI-powered waste sorting systems increase recycling rates by 40–60% (Filimonau & De Coteau, 2019). Predictive analytics helps hotels forecast food demand, reducing food waste by up to 50%.

Service personalization

Personalized menus reduced food waste by 37% in a luxury chain (Tussyadiah & Miller, 2019). In-room assistants inform guests about sustainability efforts, increasing participation by 27% (Buhalis & Leung, 2020).

Business process optimization

Dynamic pricing algorithms help maximize occupancy rates. AI-driven supply chain optimization reduces waste and supports local producers (Gretzel et al., 2020).

Challenges of AI adoption in sustainable hospitality

Technical and infrastructure barriers

High initial costs pose a challenge, especially for small independent hotels. Buhalis and Leung (2020) estimate AI implementation at €100,000–€500,000 per mid-sized hotel, with ROI taking 3–5 years. Compatibility issues and data quality concerns further complicate adoption.

Organizational and human resource challenges

Lack of AI skills among staff hinders successful implementation (Lukanova & Ilieva, 2019). Resistance to change and fear of job loss slow down AI adoption (Stangl & Pesonen, 2018). Leadership support and cultural adaptation are essential (Buhalis, 2020).

Ethical and privacy issues

Guest data privacy becomes critical with AI-driven personalization (Tussyadiah & Miller, 2019). Over-automation risks diminishing guest experience (Benckendorff et al., 2019). The digital divide may exclude certain groups (Font et al., 2021).



Strategic framework for AI integration in sustainable hotels

Holistic sustainability approach

Align AI initiatives with all sustainability pillars—ecological, economic, and social (Gretzel et al., 2020). Balance short-term investments with long-term gains (Font et al., 2021).

Phased implementation

Start with simple AI applications like smart energy management before scaling to more complex systems (Ivanov & Webster, 2020). Pilot projects allow testing before full rollout (Buhalis & Leung, 2018).

Table 1. Strategic framework for Artificial Intelligence implementation in sustainable hospitality

Implementation phase	Key activities	ESG/ESD contribution	Technological tools
1. Diagnosis	Process analysis, identification of AI potential	ESG: waste reduction; ESD: staff education	AI audit tools, IoT sensors
2. Planning	Goal definition, selection of AI solutions	ESG: energy efficiency; ESD: stakeholder engagement	Digital twin, simulations
3. Piloting	Controlled environment testing	ESG: emission reduction; ESD: participatory learning	Chatbots, predictive analytics
4. Scaling	Expansion of AI solutions across departments	ESG: resource optimization; ESD: institutional learning	Machine learning, RPA
5. Evaluation	Monitoring outcomes, corrective actions	ESG: transparency; ESD: reflective practice	Dashboards, AI monitoring systems

Human capital and cultural development

Continuous training and skill development are essential (Lukanova & Ilieva, 2019). Transparent communication about AI goals reduces resistance (Buhalis, 2020). Encourage innovation culture and employee involvement (Benckendorff et al., 2019).

Collaborative ecosystem

Collaboration with tech providers and academic institutions fosters innovation (Buhalis & Amaranggana, 2015; Gretzel et al., 2020). Knowledge exchange within the industry supports mutual learning (Melissen et al., 2016).



Conclusion

Research shows AI can transform the hospitality industry toward sustainability. These technologies enable hotels to improve resource efficiency, reduce emissions, lower costs, and strengthen ties with local communities.

Through literature analysis, the authors highlight key areas of AI application for enhancing sustainability in hotels—energy and resource management, waste reduction, and service personalization. However, major challenges remain, such as high costs and skill shortages.

A proposed framework for strategic AI integration includes a holistic approach, phased implementation, human resource development, and collaborative ecosystem building. Future research should focus on evaluating the effectiveness of different AI solutions and the social implications of automation.

Successful integration of AI into sustainable hospitality requires transformation in business models, culture, and stakeholder relationships. Hotels that strategically approach this transformation can better leverage AI's advantages.

Further research should focus on the longitudinal evaluation of AI interventions in the hotel industry, with the active involvement of industrial partners and educational institutions in the co-creation of sustainable innovations

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