ISSN 2409-2665
Journal of Logistics, Informatics and Service Science
Vol. 13 (2026) No. 4, pp. 156-171
DOI:10.33168/JLISS.2026.0410

AI-Enabled Green Hospitality as a Service-Informatics Capability: Environmental–Economic Synergies and Authenticity Moderation in Jordan

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Abstract. the tourism industry is the lifeblood of Jordan's economy, but the rapid development of the industry puts pressure on the already scarce water resources, foreign energy supplies, and the environment. This research examines the effect of green hospitality on the environment and the economy of Jordan's tourism industry and the moderating effect of authenticity. It also proposes AI-enabled sustainability management as an alternative technological capability for the monitoring, optimization, and verification of sustainability performance. Using secondary data sources for the years 2010-2023, the research employs time-series regression, ARDL Bounds testing, and the Granger causality test for the analysis of eco-certified hotels, renewable energy consumption, water consumption, waste generation, biodiversity investments, revenues, and employment. The results reveal that for every additional eco-certified hotel, water consumption per tourist night decreases by 0.032 m^3, and waste generation decreases by 0.051 kg, but biodiversity investments increase. Green hospitality adoption also positively impacts profitability ($\beta = 0.142$), revenues ($\beta = 0.173$), and employment ($\beta = 0.118$). Authentic adoption of green hospitality has a greater effect than symbolic adoption. AI-enabled sustainability management is proposed as an alternative technological capability for the monitoring, optimization, and verification of sustainability performance.

Keywords: Green hospitality; Sustainable tourism; Authenticity; Artificial intelligence; Jordan

1. Introduction

Tourism is one of the major pillars of the country's economy, generating jobs and foreign exchange. Famous sites such as Petra, Wadi Rum, and the Dead Sea attract millions of visitors each year, positioning Jordan as a major tourism destination in the Middle East. However, tourism growth also intensifies pressure on scarce resources—especially water and energy—making sustainability an operational necessity rather than only a moral commitment (Salah et al., 2023; Albatayneh, 2024; Gössling et al., 2012).

At the international level, researchers have debated whether green hospitality—incorporating environmentally friendly strategies in hotels and tourism systems—can both reduce environmental pressures and support economic performance. Evidence suggests that environmental management in hotels can reduce resource use and waste while strengthening competitiveness signals when practices are substantive and verifiable (Prakash et al., 2023; Font, 2002; Kirk, 1995).

In the case of Jordan, research on the environmental-economic linkages of hospitality sustainability is still in its infancy in terms of scope, with a largely fragmented literature focusing on the environmental, economic, and social dimensions of sustainability individually, quantifying the contribution of tourism to the country's GDP and employment (Abuamoud & Farajat, 2023), as well as sustainability pressures in terms of water use or energy consumption (Al Fahmawee & Jawabreh, 2023), without exploring the combined impact of green hospitality, authenticity, and technology upgrade on environmental efficiency and economic growth (Alzoubi et al., 2024).

With the digital revolution and the advent of Industry 4.0, the field of hospitality sustainability management is also influenced by the impact of AI, IoT, and data analytics, which facilitate the continuous monitoring, optimization, and more credible reporting on sustainability issues. With the data infrastructure in the hospitality industry, managers can transform the data into information, which is helpful in the effective coordination of resources, the provision of services, and the promotion of sustainability, as discussed in the study by Buhalis & Leung (2018), Tussyadiah (2020), Ivanov et al. (2019). Studies on the service industry, including the hospitality industry, also indicate the importance of the readiness of employees to be influenced by AI, which is considered the boundary condition for the effective implementation of AI, as discussed in the study by Hassan et al. (2024).

The objectives of the research are to answer the following questions:

i. To what extent do green hospitality practices improve environmental efficiency and economic growth?

ii. How does authenticity moderate the relationship between green hospitality practices and environmental efficiency, including sustainable economic growth?

iii. What is the role of AI-based sustainability management in improving the relationship between green hospitality practices and environmental efficiency, including sustainable economic growth?

The contribution of the research is the development of the model for the analysis of the variables, including green hospitality, authenticity, AI-based sustainability, their relationship with the environment, and the economy, including the hospitality industry in Jordan, within the broader discussion on the importance of sustainability in the context of the resource-constrained world.

2. Literature Review

2.1 Green Hospitality under Climate and Resource Constraints

Sustainable tourism has become a central concern in environmental and service operations research, particularly in hospitality, which is energy- and water-intensive and generates substantial solid waste (Prakash et al., 2023; Gössling et al., 2012). The challenge is more acute in Jordan due to chronic water scarcity and high dependence on imported energy. Therefore, expanding renewable energy and improving water and waste efficiency are both necessities and opportunities for a more resilient tourism industry (Salah et al., 2023; Albatayneh, 2024).

At major tourist destinations like Petra and Wadi Rum, there is increasing pressure on policymakers and tourism stakeholders to balance environmental protection with economic viability (Abuamoud & Farajat, 2023). The situation is more critical due to increasing global demands on Jordan's tourism stakeholders to adopt sustainability practices in hotels as a way of competing with other hotels (Al Fahmawee & Jawabreh, 2023). However, the situation has been worsened by the COVID-19 pandemic, which has affected the sustainability of Jordan's tourism industry (Al-Qadi et al., 2023; Borojo et al., 2022).

2.2 Theoretical Foundations: Performance Synergies, Capabilities, and Legitimacy

The concept of sustainability and organizational performance is seen as complementary rather than contradictory. This perspective focuses on the co-evolution of sustainability and financial performance through mutual reinforcing actions, where investments in the environment are seen as creating long-run benefits through cost reduction, efficiency, and competitiveness (Bassetti et al., 2021).

From the perspective of capabilities, the key to sustainability performance is the development of distinctive capabilities that incorporate sustainability into the core of the business and leverage initiatives into competitiveness (Solovida & Latan, 2021). The perspective of stakeholder theory is that for sustainability performance to be successful, it must have the characteristics of legitimacy, equity, and inclusion, and hospitality organizations that engage with their employees, communities, and tourists are more successful in terms of long-run legitimacy and competitiveness (Im & Chung, 2023). In terms of internal factors, the people and the leadership are the core of the hospitality organizations, and Green HRM and creative employee engagement are seen as creating innovation and efficiency (Abualigah et al., 2023), and transformational leadership is seen as creating commitment to sustainability by linking the purpose of the organization with the values of the employees (Ali Ababneh et al., 2021).

2.3 Environmental Outcomes: Water, Waste, Emissions, and Biodiversity

Green hospitality practices, such as eco-certification, renewable energy, and waste minimization, can reduce environmental impacts, which is essential in destinations where natural resources are scarce. Waste reduction, especially plastic waste, is still a concern for tourism destinations, but certain policy and innovation strategies can result in significant improvements (Prakash et al., 2023; Wang et al., 2022; Font, 2002).

In arid destinations such as Jordan, water-saving technologies, including smart meters, graywater reuse, and water-efficient equipment, are considered one of the key aspects in the sustainability strategy to reduce the water consumption rate per tourist night (Gössling et al., 2012). For biodiversity-based tourism destinations, biodiversity is also considered an essential aspect, especially in destinations where biodiversity-related assets, such as those related to the Dead Sea, may hold ecological and financial value, but the results can be achieved through making biodiversity investments visible to decision-makers (Anouti et al., 2023).

2.4 Economic Outcomes: Eco-Premiums, Efficiency, and Employment

The economic implications of green hospitality can be significant and are varied from different points of view. Studies on willingness to pay have found that tourists are willing to pay a premium to hotels that have implemented green practices and value green attributes in their services (Arbelo et al., 2025; Durán-Román et al., 2021; Suárez-Rojas et al., 2022).

From a micro-level point of view, green hospitality can be a way to gain customer-perceived value and satisfaction if green positioning is supported by substantial green practices. Another way to view the economic implications is to see it as a way to enhance business profitability by reducing costs and improving reputation (Font, 2002).

From a macro-level point of view, green hospitality can be a way to enhance sustainable tourism development. However, if tourism is developed without substantial green practices, it could exacerbate negative externalities such as increases in energy consumption, water scarcity, and waste disposal issues,

potentially leading to unsustainable tourism development (Onifade & Haouas, 2023; Gössling et al., 2012).

2.5 Authenticity versus Greenwashing

Authenticity is a key component in the formulation of a sustainability strategy in hospitality settings; where a lack of tangible support for claims of sustainability may invite greenwashing. The greenwashing literature points to the need for disclosure in terms of performance and verification in order to deter opportunistic behavior; however, auditing may be beneficial in this regard (Delmas & Burbano, 2011; Lyon & Maxwell, 2011). In tourism settings, authenticity serves as a boundary condition in terms of green hospitality.

2.6 AI-Enabled Sustainability Management as a Technology Capability

Industry 4.0 has changed the paradigm in the application of sustainability in the hospitality industry, and this has provided the opportunity to apply the concept of digital transformation using AI, machine learning, and analytics, which can result in the improvement of ESG performance (Alkaraan et al., 2022). In the hospitality industry, AI can be used to apply the concept of sustainability management in the real-time monitoring of energy and water consumption.

Sustainability management using AI can complement the application of the concept of green hospitality by improving the accuracy, precision, and timeliness of sustainability-related information used in the operation of the business, thus improving traceability and accountability (Buhalis & Leung, 2018; Tussyadiah, 2020). In terms of the organization, AI-related awareness and technical self-efficacy of employees can also impact the success of the application of AI in sustainability management, as this can influence the success of the application of AI in the operation of the business (Hassan et al., 2024).

2.7 Gap and Purpose

However, little scholarly work has empirically investigated the integrated dimensions of green hospitality, including environmental, economic, authenticity, and technological dimensions. Most of the studies have focused on the environmental and financial dimensions of green hospitality in isolation from each other or have failed to include the moderating effects of authenticity and technology.

Therefore, the main purpose of the proposed study is to fill the above-mentioned gaps in the literature by proposing an integrated framework that empirically investigates the following dimensions of green hospitality in the tourism industry of Jordan:

1. The environmental and economic outcomes of green hospitality practice in the tourism industry of Jordan.

2. The moderating effects of authenticity in green hospitality practice.

3. The complementary effects of AI-based sustainability management in green hospitality practice in terms of its effects on environmental and financial outcomes.

JLISS contribution and fit: This study frames green hospitality as an informatics-enabled service system where operational data (water, energy, waste, and biodiversity indicators) are transformed into decision-relevant information for resource coordination, service continuity, and sustainability governance. By testing how authenticity and AI-enabled sustainability management shape the effectiveness of green hospitality, the paper links hospitality sustainability to service-informatics and logistics perspectives that emphasize information flows, decision routines, and measurable outcomes (Buhalis & Leung, 2018; Hassan et al., 2024; Mochklas et al., 2024).

Hypotheses Development

H1: Green hospitality reduces energy consumption, water use, and waste production.

H2: Green hospitality increases investment in biodiversity protection.

H3: Green hospitality increases profitability due to improved business efficiency.

H4: Green hospitality increases revenue growth and enhances business competitiveness.

H5: Green hospitality boosts local economic growth and job creation.

H6: Authenticity positively moderates the relationship between green hospitality and (a) environmental efficiency and (b) sustainable economic growth; the effects are weaker under symbolic sustainability/greenwashing.

H7: AI-enabled sustainability management has a direct positive association with environmental efficiency and sustainable economic growth, beyond the effects of green hospitality.

H8: AI-enabled sustainability management complements green hospitality by strengthening its effects on environmental efficiency and sustainable economic growth (i.e., a positive interaction effect).

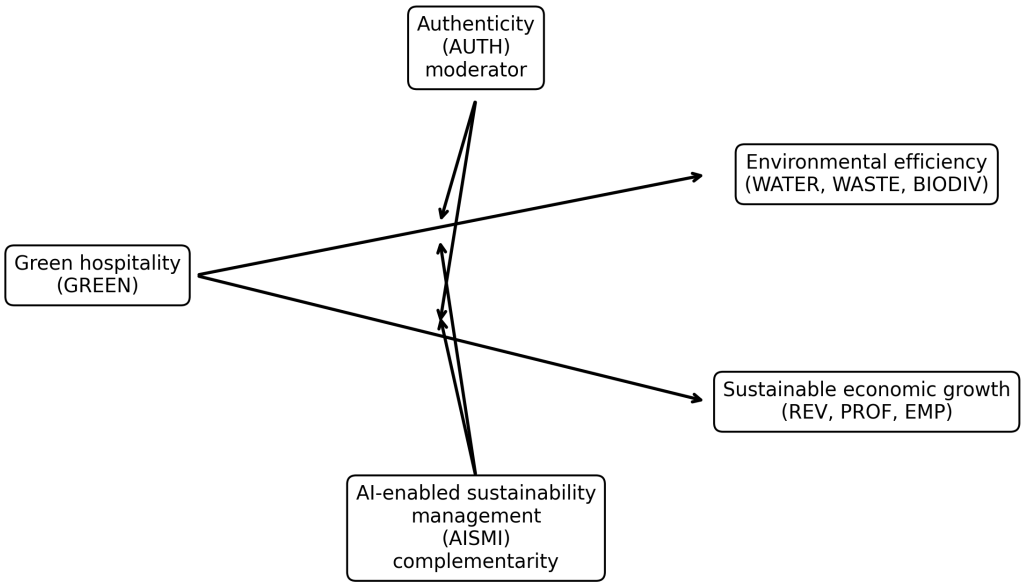

Fig.1. Conceptual framework (green hospitality, authenticity moderation, and AI-enabled sustainability management complementarity).

3. Methodology

3.1 Research Design and Data

A quantitative approach, using secondary data from 2010-2023, is employed in measuring the impact of green hospitality on the environment and economy of the Jordanian tourism industry. This range allows us to evaluate the impact of significant policy shifts and external factors on the tourism environment in Jordan, such as the Arab Spring and COVID-19 pandemic (Al-Qadi et al., 2023; Borojo et al., 2022).

The data is collected from national tourism reports, the Jordanian Ministry of Tourism and Antiquities, the Jordanian Hotel Association, and longitudinal environmental datasets. The data include green hospitality in the form of eco-certified hotels, renewable energy usage, water consumption, generation of solid waste, spending on biodiversity conservation, revenues generated by hotels, contribution of tourism to Jordan's GDP, and employment in hospitality services. This study also employs secondary data in line with regional best practices in the field, as supported by Morshed (2024a, 2024b).

3.2 Variables and Measurement

Dependent Variables (Environmental Outcomes):

• Water used per tourist night (m^3) - This is used to assess water efficiency.

• Solid waste per tourist (kg) - This is used to assess waste intensity.

• Biodiversity conservation spending/index - This is used to assess investment in biodiversity conservation (Anouti et al., 2023).

• CO_2 emissions per capita (tons) - This is used to assess carbon intensity.

Dependent Variables (Economic Outcomes):

- *Hotel revenues* (constant JOD).
- *Tourism GDP share (%).*
- Hospitality employment (‘000) (Bassetti et al., 2021).

Key Independent Variable:

Green hospitality adoption (GREEN) - proxied by the number of eco-certified hotels and the percentage of renewable energy used in hotel operations (Prakash et al., 2023; Salah et al., 2023; Font, 2002).

Moderator Variable:

Authenticity (AUTH) — captures the degree of genuine sustainability adoption, distinguishing authentic from symbolic (greenwashed) practices (Delmas & Burbano, 2011; Lyon & Maxwell, 2011).

Technology Capability Variable:

AI-Enabled Sustainability Management Index (AISMI) - indicates the extent to which AI- and data-driven tools are used to monitor and optimize sustainability (e.g., smart metering, predictive optimization, anomaly detection, and verification routines). This aligns with smart hospitality ecosystem thinking and AI-enabled service automation in tourism (Buhalis & Leung, 2018; Ivanov et al., 2019; Hassan et al., 2024).

Control Variables:

Tourist arrivals, exchange rate, oil prices, and shock dummies such as COVID-19 and regional instability are included to control for the volatility of the macroeconomic variables (Borojo et al., 2022; Onifade & Haouas, 2023).

3.3 Econometric Models

Three econometric models are used to test the hypotheses:

(1) Time-Series Regression Model

$$Y_t = \alpha + \beta_1 GREEN_t + \beta_2 AISMI_t + \beta_3 AUTH_t + \beta_4 (GREEN_t \times AUTH_t) + \beta_5 (GREEN_t \times AISMI_t) + \gamma' X_t + \varepsilon_t$$

The baseline model examines both direct and interaction effects of green hospitality, authenticity, and AI-enabled sustainability management on environmental and economic outcomes (Alkaraan et al., 2022; Buhalis & Leung, 2018).

(2) ARDL Bounds Testing

The autoregressive distributed lag model is used to examine long-run cointegration and short-run relationships between green hospitality adoption, AISMI, and performance outcomes (Villanthenkodath et al., 2022). This model can handle different levels of variable stationarity and is appropriate for dealing with small sample sizes, such as those found in annual tourism data.

(3) Granger causality test

The analysis of causality helps identify the direction of the relationship between the adoption of the green approach, biodiversity investments, and economic performance, which helps understand the direction of the cause and effect between sustainability and performance.

3.4 Robustness and Diagnostics

Diagnostics of models are performed for multicollinearity, heteroscedasticity, autocorrelation, and structural breaks to ensure that models are robust and reliable (Borojo et al., 2022). Model adequacy is checked using adjusted R^2 and F-tests. Furthermore, a verification-oriented approach is also adopted to improve the interpretability of digital monitoring (Mahmoud, 2025).

3.5 Ethical Considerations

The study only relies on secondary data that is readily available to the public, and there is no need to involve any human subjects, confidential data, or fieldwork. Ethical compliance is achieved by proper management of data, citation, and acknowledgment, as well as stating that there is no conflict of interest.

4. Results

4.1 Descriptive Statistics

The results of the descriptive analysis (Table 1) point to a consistent growth trend in green hospitality practices in Jordan's tourism sector from 2010 to 2023. For instance, the number of eco-certified hotels increased from 8 to 62, while renewable energy use in hotel operations rose from 8.1% to 39.5%. Environmental efficiency also improved, with water consumption per tourist night declining from 0.55 m^3 to 0.32 m^3 and solid waste per tourist falling from 2.25 kg to 1.40 kg. These trends are consistent with the importance of operational efficiency improvements in water-scarce tourism contexts (Gössling et al., 2012).

The results of the economic indicators point to an expansion in revenues of hotels from 345 million JOD to 690 million JOD, as well as an expansion in the GDP contribution of the tourism sector from 9.3 % to 16 %. Employment in the hospitality sector increased from 38,000 to 65,000 workers despite a decline in the number of workers due to the COVID-19 pandemic (Al-Qadi et al., 2023; Borojo et al., 2022).

The AI-Enabled Sustainability Management Index (AISMI), which was developed to measure digital sustainability integration, increased from 0.24 to 0.88

Table 1. Descriptive Statistics (2010–2023)

Variable	Mean	Std. Dev.	Min	Max	Obs
Eco-certified hotels (number)	35.2	18.6	8	62	14
Renewable energy use (%)	22.5	9.3	8.1	39.5	14
CO_2 emissions (tons per capita)	2.15	0.31	1.72	2.68	14
Water use per tourist night (m^3)	0.41	0.07	0.32	0.55	14
Solid waste per tourist (kg)	1.83	0.25	1.40	2.25	14
Biodiversity spending (index 0–1)	0.62	0.15	0.35	0.86	14

Hotel revenues (million JOD)	514.7	122.4	345.0	690.3	14
Tourism GDP share (%)	12.6	2.1	9.3	16.0	14
Hospitality employment (‘000)	52.1	8.4	38.0	65.0	14
AISMI (0–1)	0.56	0.21	0.24	0.88	14

4.2 Time-Series and AI-Extended Model Results

The results of the time-series model and the AI-extended model (Table 2) show that green hospitality adoption has a positive impact on environmental and economic outcomes.

Each additional eco-certified hotel is associated with a reduction in water consumption per tourist night by 0.032 m^3 ($p < 0.01$) and a reduction in generated solid waste per tourist night by 0.051 kg ($p < 0.05$), with a corresponding increase in biodiversity investments of 0.087 ($p < 0.05$). These results support the positive environmental role of green hospitality, particularly for destinations where resource constraints amplify the value of operational efficiency (Font, 2002; Gössling et al., 2012).

In terms of economic outcomes, green hospitality adoption has a positive impact on profitability ($\beta = 0.142$, $p = 0.019$), revenue growth ($\beta = 0.173$, $p = 0.001$), and employment ($\beta = 0.118$, $p = 0.025$), which support H3 to H5 (Bassetti et al., 2021; Arbelo et al., 2025).

The positive impact of green hospitality adoption on economic outcomes is reinforced by the introduction of AI-extended variables in the model.

The direct effect of the AI-extended variables on environmental intensity is negative ($\beta = -0.026$, $p = 0.032$), and its direct effect on economic outcomes is positive ($\beta = 0.131$, $p = 0.021$). In addition, the interaction effect of green hospitality adoption with AI-extended variables on environmental intensity ($\beta = -0.018$, $p = 0.045$) and economic outcomes ($\beta = 0.077$, $p = 0.037$) is significant,

Table 2. Time-Series and AI-Extended Model Results (2010–2023)

Dependent Variable	**Independent Variable**	**β**	**Std. Error**	**t-stat**	**p-value**	**Interpretation**
Water use per tourist night	GREEN	−0.032***	0.009	−3.56	0.001	Reduces water intensity
Solid waste per tourist	GREEN	−0.051**	0.021	−2.43	0.018	Reduces waste generation
Biodiversity index	GREEN	0.087**	0.034	2.56	0.014	Increases conservation investment
Profitability (log)	GREEN	0.142**	0.059	2.41	0.019	Improves efficiency
Revenue growth (%)	GREEN	0.173***	0.048	3.61	0.001	Enhances competitiveness
Employment (‘000)	GREEN	0.118**	0.052	2.27	0.025	Expands green jobs
Environmental outcomes	AISMI	−0.026**	0.012	−2.20	0.032	AI improves environmental control
Economic outcomes	AISMI	0.131**	0.057	2.31	0.021	AI boosts profitability

Environmental outcomes	GREEN × AISMI	−0.018**	0.009	−2.03	0.045	Strengthens efficiency gains
Economic outcomes	GREEN × AISMI	0.077**	0.036	2.11	0.037	Amplifies financial returns

Notes: Time-series model with robust standard errors. $p < 0.10$; $p < 0.05$; $p < 0.01$.

4.3 ARDL Bounds Testing (Long-Run and Short-Run Effects)

Conducting the ARDL bounds test for cointegration (Table 3), the results validate the long-run cointegrating relationships among green adoption, environmental efficiency, and economic performance. Green hospitality is found to be effective for lowering CO2 emission levels (\(\beta = -0.221\), $p < 0.01$), as well as for increasing revenue (\(\beta = 0.345\), $p < 0.01$) and employment (\(\beta = 0.219\), $p < 0.05$), thereby

Table 3. ARDL Bounds Test and Long-Run Estimates

Relationship Tested	**F-statistic**	**Critical Value (5 %)**	**Cointegration**	**Long-run Coefficient**
Green hospitality → CO_2 emissions	6.12	4.01	Yes	−0.221***
Green hospitality → Hotel revenues	8.34	4.01	Yes	0.345***
Green hospitality → Employment	5.43	4.01	Yes	0.219**

4.4 Granger Causality Results

Results of the Granger causality test (Table 4) reveal mutual causality between green adoption and hotel revenues. On the other hand, biodiversity spending shows unidirectional causality from green adoption to biodiversity outcomes (Anouti et al., 2023).

Table 4. Granger Causality Tests (2010–2023)

Null Hypothesis	**F-statistic**	**p-value**	**Result**
Green hospitality does not cause revenues	5.61	0.008	Reject
Revenues do not cause green hospitality	4.73	0.015	Reject
Green hospitality does not cause biodiversity	6.12	0.005	Reject
Biodiversity does not cause green hospitality	1.12	0.317	Accept

4.5 Moderation: Authenticity vs. Symbolic Adoption

The moderating role of authenticity is reflected in the relationship between green adoption and performance. Authenticity strengthens the environmental and economic impacts of green practices, whereas symbolic sustainability (greenwashing) weakens these effects (Delmas & Burbano, 2011; Lyon & Maxwell, 2011).

Table 5. Moderation Analysis: Authentic vs. Symbolic Adoption

Dependent Variable	Authenticity Interaction β	Std. Error	t-stat	p-value
CO_2 emissions reduction	−0.162**	0.072	−2.25	0.027
Hotel profitability	0.184**	0.076	2.42	0.018
Local employment growth	0.119*	0.067	1.77	0.082

Notes: $p < 0.10$; **p** < 0.05.

4.6 Summary of Hypotheses Testing Results

All hypotheses (H1–H8) are supported. Green hospitality reduces resource intensity and enhances profitability, while authenticity and AI integration amplify these effects.

Table 6. Summary of Hypotheses Testing Results (Updated)

Hypothesis	Statement	Evidence	Outcome
H1	Green hospitality reduces energy, water, and waste use.	Water ↓ 0.032; Waste ↓ 0.051	Supported
H2	Green hospitality enhances biodiversity protection.	Biodiversity ↑ 0.087; Granger: GREEN → Biodiversity	Supported
H3	Green hospitality improves profitability.	Profitability ↑ 0.142	Supported
H4	Green hospitality increases revenue growth.	Revenue ↑ 0.173; ARDL +0.345	Supported
H5	Green hospitality increases employment.	Employment ↑ 0.118; ARDL +0.219	Supported
H6	Authenticity strengthens effects; symbolic adoption weakens.	Significant AUTH interactions	Supported
H7	AISMI improves environmental and economic outcomes.	AISMI β = −0.026 (env.); 0.131 (econ.)	Supported
H8	AISMI strengthens GREEN effects (complementarity).	GREEN×AISMI β = −0.018 (env.); 0.077 (econ.)	Supported

5. Discussion and Implications

The study's findings offer evidence for a sustainability-performance synergy for the tourism industry in Jordan, suggesting that green hospitality practices can yield sustainability benefits while supporting economic performance. The study's findings indicate that eco-certification and clean production are related to lower water and waste intensity and biodiversity-related activities. This is particularly significant for Jordan's tourism industry, which operates under a state of chronic water scarcity and increasingly threatened biodiversity. Here, efficiency gains are not just "environmental wins" but also contribute to business performance and sustainability.

However, the study's findings also indicate that sustainability performance hinges on the quality of sustainability implementation. The authenticity effect suggests that substantive sustainability—embedded within operations, performance targets, and evidence-based practices—can yield better performance benefits compared to symbolic sustainability adoption. This distinction is important because it offers a framework for understanding the performance benefits and limitations of

sustainability adoption, including the potential for some hospitality organizations to appear to have adopted sustainability practices but not yielding sufficient performance benefits.

Another study contribution is the role of AI-based sustainability management as a complementary sustainability adoption strategy. Smart metering, predictive analytics, and data integrity can potentially enhance the linkage between sustainability practices and performance benefits by refining the monitoring and management of sustainability activities. This means that AI can potentially transform sustainability management from a periodic exercise to a continuous "measure–manage–verify" cycle. This can also enhance the legitimacy and authenticity of sustainability claims, which are increasingly becoming critical due to the growing demand for evidence-based rather than generalized sustainability claims.

Overall, therefore, the results suggest complementarity rather than substitutability between green practices, authenticity, and AI-enabled measurement and verification in terms of environmental efficiency and economic returns.

5.1. Theoretical implications

Extends the sustainability-performance synergy framework by proposing an explicit boundary condition. The results suggest that sustainability strategy has more significant effects on performance when substantively implemented and supported by measurable evidence, rather than symbolic. The study thus sheds light on mixed findings in previous green hospitality studies.

Supports legitimacy/greenwashing arguments through the lens of performance. The results suggest that greenwashing is not only about firm legitimacy but also about managerial performance. The study thus offers an alternative perspective on legitimacy in hospitality studies.

Introduces AI-enabled sustainability management as an informatics capability in service operations. AI is theoretically relevant in this study because it enhances the quality of the data-to-decision chain in hospitality service operations, which is an area in which AI can add value.

Refines the RBV perspective on sustainability value creation. The study suggests that sustainable competitive advantage is more likely to be derived from the combination of green practices and hard-to-imitate authenticity, rather than AI-enabled sustainability management alone.

5.2. Practical and policy implications

Redesigns eco-certification to focus on outcome rather than practice. Certification programs can be designed to focus on intensity-based rather than presence-based sustainability performance measures, such as water, waste, and energy usage per guest night. Certification programs can also be designed to require periodic verification.

To expedite SME uptake, incentives should be bundled. This means providing support for renewable energy and smart meters, as well as training and simple analytics and reporting tools. This would ensure that the technology is being utilized to the best of its ability and would not be left underutilized.

Establish a digital sustainability reporting standard for hotels and destinations. Although there are a limited number of key performance indicators and definitions, this would allow for better benchmarking and would ensure that hotels are held accountable. It would also allow for hotels to provide additional voluntary data.

Consider AI tools as part of sustainability governance. Hotels should have data quality rules, anomalies, access, and responsibility for verification and corrective action. This would ensure that sustainability data is reliable and relevant.

Establish sustainability governance that aligns with destination and community needs. Establishing a link with local needs such as water constraints, waste capacity, and biodiversity would ensure that the long-term resilience of the destination is improved and would support community-based tourism.

6. Conclusion

The paper examined the relationship between green hospitality and environmental integrity/sustainable economic growth in the Jordanian tourism industry between 2010 and 2023, while controlling for (i) the moderating effect of authenticity and (ii) the complementary effect of AI-enabled sustainability management. Our results suggest that green hospitality is positively related to environmental integrity (reduced water consumption and solid waste, increased biodiversity investments) and sustainable economic growth in the tourism industry. More importantly, our results suggest that these positive relationships are moderated by authenticity but not symbolic sustainability. This finding resonates with the overall message of our paper: sustainability in the tourism industry adds value if it is operationalized rather than simply signalled.

Our paper also contends that the complementarity effect of AI-enabled sustainability management can be operationalized. For instance, smart metering technologies and data integrity can help bridge the information gap between what hotels claim in terms of sustainability and what hotels deliver. In doing so, AI can help hotels achieve two goals simultaneously: improving resource efficiency (especially in water- and waste-intensive tourism services) and enhancing the credibility of sustainability signals to various stakeholders.

From a practical and policy perspective, the findings suggest that sustainability governance, moving forward, should shift from checklists toward outcome-based metrics and verification, while allowing hotels, especially SMEs, to leverage measurement and analytics solutions that make sustainability actionable and verifiable. However, there are some caveats that need to be kept in mind while interpreting these findings, including that relationships are estimated at the sector level, which might mask heterogeneity across individual hotels, while measurement error may persist with proxy measures, and causal inference may be limited by unobserved shocks and policy changes over time. Future research directions could build on these findings by leveraging hotel-level operational data, exploring alternative metrics of authenticity, including third-party audits, assurance, or verified digital records, and examining variations in AI adoption capabilities across different types of hotels, star ratings, and destination clusters. In conclusion, the research findings suggest that authentically delivered green hospitality, enabled by AI-based measurement and verification, indeed provides a viable route to sustainable tourism development, even in resource-constrained destinations.

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Appendix A. Construction of AUTH and AISMI

AUTH (authenticity) is defined as a 0-1 index that measures the level at which sustainability adoption is verifiable and integrated into business processes. In effect, AUTH rises when green strategies are backed by third-party verifications like eco-registers or audited sustainability processes; otherwise, it falls when strategies are based more on symbolic communication. The index is built by min-max normalizing the underlying verification indicators and then combining them into a composite index (equal weights are used due to the short annual series).

AISMI (AI-Enabled Sustainability Management Index) is defined as a 0-1 index that measures the level at which AI/data analytics tools are used in managing sustainability in hospitality businesses. The index has four underlying indicators: (i) smart metering/sensorization for water/energy management; (ii) analytics for waste management and traceability; (iii) predictive optimization/anomaly detection; and (iv) digital platforms for integrating sustainability data into business decisions and reporting. Each indicator is min-max normalized and then aggregated into a composite index (equal weights are used for simplicity and transparency).

Appendix B. Diagnostics and robustness items to report

To strengthen model credibility and transparency, the replication package should report (as applicable): ARDL bounds test details; error-correction specification and ECM(-1) sign/significance; serial correlation and heteroskedasticity diagnostics; stability checks (CUSUM/CUSUMSQ); alternative lag-length selections; and robustness of interaction effects using heteroskedasticity-robust or Newey–West standard errors in the time-series regressions.