“Innovation and sustainability drivers of post-COVID tourism and hotel recovery in Jordan: Evidence from 2010–2024”

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INNOVATION AND SUSTAINABILITY DRIVERS OF POST-COVID TOURISM AND HOTEL RECOVERY IN JORDAN: EVIDENCE FROM 2010–2024

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Abstract

This study examines how innovation and sustainability influence the recovery of Jordan's tourism and hotel sector, and whether their combined effect accelerates recovery beyond separate contributions. Annual data for 2010–2024 are compiled from the United Nations World Tourism Organization, the World Bank World Development Indicators, the Jordan Ministry of Tourism and Antiquities, the Global Innovation Index, and the Environmental Performance Index. A recovery index tracks sector performance relative to the 2019 baseline, while conditions are controlled using gross domestic product per capita, inflation, and exchange rate stability. Fixed-effects regression results indicate that innovation is positively associated with recovery (coefficient 0.41, probability value 0.001), and sustainability is positive and statistically significant (coefficient 0.34, probability value 0.032). The interaction between innovation and sustainability is positive and statistically significant (coefficient 0.48, probability value 0.009), showing complementarity: innovation yields larger recovery gains when sustainability performance is stronger. Exchange rate stability supports recovery (coefficient 0.19, probability value 0.021), and the model explains variation in outcomes (adjusted coefficient of determination 0.72). Robustness checks with alternative specifications confirm stable coefficient signs and significance. The findings support policy packages that align innovation investment with sustainability improvements to strengthen resilience and speed recovery in Jordan for long-term competitiveness.

Keywords tourism, sustainability, innovation, recovery, hotels, resilience, Jordan

JEL Classification Z32, O33, Q56, C23

INTRODUCTION

Tourism and hospitality generate employment, support small and medium enterprises, and bring foreign currency into national economies. Yet demand is vulnerable to safety perceptions, mobility constraints, and declines in consumer confidence. When disruptions occur, losses spread rapidly to hotels, transport, food services, and local suppliers. The COVID-19 pandemic underscored this fragility by triggering contractions and revealing how difficult it is for destinations to adapt under uncertainty (Harb et al., 2025).

These realities raise a scientific problem: what enables durable tourism recovery? Recovery is not only the return of arrivals; it requires redesigning services, restoring trust, and maintaining continuity while meeting new expectations. Innovation is often positioned as a key driver because it enables new products, digital service delivery, and efficiency improvements that match changing preferences (Giannoukou & Kougia, 2025; Bingöl & Yang, 2025). Sustainability is

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also emphasized because environmental stewardship and social responsibility strengthen legitimacy and align tourism growth with long-term welfare (Elshaer et al., 2025; Rabbi, 2025).

However, prior research commonly treats innovation and sustainability as separate pathways. As a result, there is limited longitudinal evidence on whether they reinforce each other during recovery or whether one conditions the effectiveness of the other. This gap matters because recovery strategies are frequently implemented as parallel programs rather than integrated policy packages, which may weaken impact (Khassawneh et al., 2024). In resource-constrained settings, unclear complementarities can lead to misallocated investments and slower recovery trajectories overall.

Jordan offers a relevant setting to address this gap. The tourism and hotel sector is economically important, but it has repeatedly faced regional tensions, environmental pressures, and global shocks. Although initiatives related to digital transformation and cleaner energy have expanded, coordination between innovation-oriented actions and sustainability-oriented measures remains fragmented (Harb et al., 2025).

1. LITERATURE REVIEW

Tourism and hospitality are among the most dynamic sectors of the global economy, but they are also among the most shock-sensitive. The COVID-19 pandemic disrupted travel demand and exposed vulnerabilities in hotel operations, destination governance, and supporting service networks. In this context, recovery is increasingly viewed as a capability problem: destinations and hotels recover faster when they can adapt their service models while maintaining legitimacy, efficiency, and stakeholder trust. Two drivers are repeatedly emphasized in this respect – sustainability and innovation – and the most resilient recovery trajectories appear to occur when these drivers are integrated within the same management and policy logic. For Jordan, where tourism and hotels contribute substantially to national income and employment, understanding how sustainability and innovation jointly shape recovery is central to building competitiveness and crisis resilience. The literature reviewed below develops this argument by clarifying the meaning of sustainability and innovation in tourism and hospitality, synthesizing empirical evidence on their recovery effects, and identifying the gaps that motivate the present study.

Sustainable tourism has evolved from a narrow environmental orientation toward a multidimensional framework that links economic viability, social inclusion, and ecological preservation. Early definitions emphasized meeting present needs without compromising the ability of future generations to meet theirs (Deleryd & Fundin, 2025; Vijerathne et al., 2025). Subsequent evidence broadened the concept by highlighting governance quality, cultural heritage protection, and local participation as central pillars of sustainability in destination systems (Candeloro & Tartari, 2025; Della Spina, 2025). More recent studies directly link sustainability to resilience, conceptualizing resilience as the capacity of systems to absorb shocks, reorganize, and preserve essential functions during disruptions (Merino-Gaibor et al., 2025; Rabbi, 2025). From this perspective, sustainability serves as a practical foundation for recovery by strengthening system redundancy, fostering stakeholder cooperation, and reducing exposure to resource volatility. Empirical evidence supports this logic by showing that destinations with diversified value chains, renewable energy integration, and stronger stakeholder networks tend to recover faster after crises (Chen et al., 2025; Karsokienė et al., 2025).

At the hotel level, sustainability is frequently framed as both a normative commitment and an operational advantage. Energy-efficient buildings, waste-reduction programs, and water-saving systems can lower operating costs while improving reputation and customer trust (Elshaer et al., 2025; Khatter, 2025). In developing contexts, the adoption of structured sustainability standards such as Green Key or Leadership in Energy and Environmental Design certification is associated with stronger market differentiation and longer-run profitability, particularly when sustainability signals are credible and supported by verified

practices (I. Akin & M. Akin, 2025; Velaoras et al., 2025). At the same time, the literature cautions that sustainability is not automatically transformative. Where sustainability is treated as a branding exercise or a set of isolated projects, its contribution to recovery may be limited. For systemic effects, sustainability typically requires institutionalization through governance routines, performance monitoring, and cross-actor coordination (De Martino et al., 2025; Loedphacharakamon & Naruetharadhol, 2025).

Jordan's experience reflects both the promise and the constraints identified in the wider literature. Sustainability has been incorporated into tourism and hospitality policy through initiatives supporting eco-lodges, renewable-energy investment, and heritage conservation (Harb et al., 2025). Hotels have been encouraged to adopt solar systems, implement recycling and waste management practices, and build partnerships with local communities (Alramamneh et al., 2025; Bazi, 2025). However, many hotels still face financial, technical, and institutional barriers that slow sustainability uptake, especially when investment costs are front-loaded and managerial capabilities are uneven (Morshed, 2024a). Constraints related to limited expertise, weak inter-agency coordination, and insufficient incentives remain recurring themes (Alshoubaki et al., 2025). Comparable patterns are reported in other developing regions, where fragmented governance and inconsistent implementation reduce the effectiveness of sustainability policies (Djatmiko et al., 2025; Rosendal et al., 2025). This stream of research suggests that sustainability contributes most to recovery when embedded in institutional arrangements rather than pursued as a peripheral activity.

Innovation represents the second major pathway emphasized in tourism and hospitality recovery research. Rooted in Schumpeter's concept of creative destruction, innovation enables continuous renewal through technological, organizational, and service-based change (Dogan, 2025; Tindall et al., 2025). In hotel operations, innovation increasingly appears through smart-room systems, digital booking and payment tools, artificial intelligence-enabled demand forecasting, and contactless service delivery, all of which can improve efficiency and customer confidence in uncertain environments (Douglas et al., 2025; Liu, 2025). Benchmarking evidence similarly emphasizes digital readiness and innovation capacity as determinants of competitiveness and recovery performance in tourism economies (González-Rodríguez & Díaz-Fernández, 2025; Petrova et al., 2025). Importantly, studies report that hotels investing in innovation during crises tend to regain occupancy faster and strengthen customer satisfaction as demand returns, suggesting that innovation can convert disruption into an opportunity for service redesign and operational learning (González-Rodríguez & Díaz-Fernández, 2025; Petrova et al., 2025).

A key development in the literature is the growing recognition that innovation and sustainability are not independent policy domains. Innovation can strengthen sustainability outcomes by enabling measurement, monitoring, and optimization of environmental performance. Smart-destination tools and hotel management systems can reduce energy consumption, track carbon emissions, and support real-time reporting and compliance routines (Bingöl & Yang, 2025; Zhang & Deng, 2024). This logic is reinforced by evidence that innovation mediates the relationship between environmental policy and realized sustainable performance, meaning that technology helps translate policy intent into measurable outcomes (Nasir et al., 2024). The relationship also runs in the opposite direction: sustainability goals can stimulate innovation by generating demand for eco-friendly technologies, green design, and new service models that reduce environmental pressure while maintaining service quality (Khassawneh et al., 2024; Mandal et al., 2025). This reciprocal relationship has produced the smart-sustainable hotel model, in which digital transformation and environmental responsibility evolve together as complementary sources of resilience (Das, 2025; Tormo et al., 2025). Evidence from Asia and Europe further suggests that hotels integrating innovation with sustainability build stronger reputational capital and achieve higher operational efficiency, especially when recovering from shocks that elevate expectations for safety, transparency, and responsibility (Huang et al., 2024; Prentice et al., 2024).

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Comparative insights from the Mediterranean region are particularly relevant to Jordan because several destinations share structural characteristics, including reliance on international arrivals, climatic vulnerability, and a hospitality sector dominated by small and medium enterprises. In Greece, renewable energy adoption in hotels and circular economy policy efforts are linked to reduced operating costs and improved competitiveness (Katsaros, 2025). Cyprus combined digital visitor management systems with innovation grants for tourism enterprises, thereby supporting a faster post-pandemic recovery (Socratous et al., 2025). Malta's integration of marine conservation, community tourism, and data analytics improved service quality while supporting ecological performance (Yeoman & Vella, 2024). These cases suggest that measurable recovery outcomes are more likely when destination governance aligns innovation and sustainability at both enterprise and system levels. In contrast, the Jordanian policy environment is frequently described as fragmented, with limited coordination across tourism, environmental, and energy institutions, which may reduce the effectiveness of otherwise well-intentioned reforms (Aktaş Çimen et al., 2024). The comparative implication is that Jordan's recovery capacity may depend not only on separate improvements in innovation and sustainability, but also on whether these domains are coordinated through coherent policy design and operational routines.

Despite broad conceptual agreement in the literature, several gaps remain. First, many studies addressing sustainability and innovation in tourism rely on qualitative designs that provide valuable conceptual insight but limited statistical validation of effect magnitude and stability (Giannoukou & Kougia, 2025; Neger et al., 2025). Second, empirical evidence is concentrated in developed regions, while longitudinal quantitative evidence from the Middle East and North Africa remains scarce (Mithen et al., 2025). Third, and most important for recovery theory, relatively few studies explicitly test whether innovation and sustainability interact, as most models estimate separate effects and may overlook synergy that amplifies recovery outcomes (Prates et al., 2025). These gaps constrain both theory development and policy guidance, particularly for destinations that must prioritize investments carefully under fiscal and institutional constraints.

Jordan provides an appropriate context for addressing these gaps because its tourism and hotel industries have experienced rapid digital and environmental transitions supported by national initiatives such as the Digital Transformation Agenda (2023–2027) and green energy incentives. The availability of national indicators enables a quantitative assessment of how innovation and sustainability jointly shape recovery performance over time, while the country's similarity to Mediterranean destinations allows the results to be interpreted in relation to comparable tourism structures. Testing these relationships empirically, therefore, offers clearer guidance on whether integrated strategies produce stronger recovery capacity than isolated initiatives.

In summary, the literature indicates that sustainability strengthens destination stability and long-term competitiveness, innovation accelerates adaptation through digitalization and service modernization, and their integration offers a credible pathway to resilient tourism and hospitality recovery in shock-exposed settings. However, quantitative evidence from the Middle Eastern tourism and hotel sectors remains limited, and the interaction between innovation and sustainability remains under-tested in longitudinal designs.

This study aims to explore the extent to which advancements in innovation and sustainability contribute to revitalizing Jordan's tourism and hospitality industries in the aftermath of the COVID-19 pandemic, while also assessing how the interplay between these two factors strengthens the sector's overall recovery capacity.

H1: Innovation positively influences hotel and tourism recovery in Jordan.

H2: Sustainability positively influences hotel and tourism recovery in Jordan.

H3: The combined effect of innovation and sustainability on recovery exceeds their individual impacts.

2. METHODS

This study employs a quantitative, secondary data design to examine how innovation and sustainability influence the recovery of Jordan's tourism and hotel sectors following the COVID-19 shock. The design supports an objective assessment of whether changes in technological capability and environmental performance are associated with measurable improvements in recovery outcomes over time, consistent with an economic view linking innovation, environmental management, and competitiveness (Vogklis, 2025). The study covers 2010–2024 to capture pre-shock conditions, the disruption period, and subsequent recovery using a consistent annual series, which improves comparability and allows longitudinal assessment of resilience dynamics. By relying on verified international and national datasets, the study strengthens data quality, comparability, and replicability while limiting measurement bias associated with perception-based approaches.

Data were compiled from authoritative sources. The United Nations World Tourism Organization provides annual measures of international arrivals, tourism receipts, and hotel occupancy, while the World Bank's World Development Indicators provide macroeconomic variables including gross domestic product per capita, inflation, and exchange rate stability. These indicators were cross-checked and complemented using data from the Jordan Ministry of Tourism and Antiquities. Innovation measures were obtained from the Global Innovation Index, which captures research and development expenditure, information and communication technology adoption, and digital readiness. Sustainability indicators were drawn from the Environmental Performance Index, reflecting renewable energy use, environmental policy implementation, and waste management performance. To ensure comparability across measures with different units and scales, variables were normalized to a 0–100 range following standard statistical procedures (Harb et al., 2025). Where required, logarithmic transformations were applied to correct skewness and support linearity assumptions in estimation (Hajilo et al., 2024).

The dependent variable is the Tourism Recovery Index, constructed to measure tourism and hotel performance relative to the 2019 baseline and adjusted for population changes. Innovation is represented by research and development expenditure as a share of gross domestic product, digital readiness scores, and information and communication technology adoption. Sustainability is reflected in renewable energy use, environmental policy effectiveness, and waste management indicators. Macroeconomic controls include gross domestic product per capita, inflation, and exchange rate stability to account for broad economic conditions that may influence recovery performance.

The empirical relationship is estimated using a fixed-effects specification intended to control for unobserved time-invariant structural characteristics that could bias coefficient estimates. The baseline model is:

$$TRI_t = \beta_0 + \beta_1 INN_t + \beta_2 SUS_t + \beta_3 \left(INN_t \cdot SUS_t\right) + \beta_4 CONT_t + \varepsilon_t, \quad (1)$$

where TRI_t denotes the Tourism Recovery Index in year t, INN_t denotes the innovation indicator, SUS_t denotes the sustainability indicator, and $\left(INN_t \cdot SUS_t\right)$ captures complementarity between innovation and sustainability. $CONT_t$ denotes the control-variable set, β_0 is the intercept, β_1-β_4 are parameters to be estimated, and ε_t is the idiosyncratic error term. Statistical significance is evaluated at $p < 0.05$. All estimations were conducted using STATA 17.

The analysis follows a structured sequence consistent with applied empirical practice. First, descriptive statistics were used to profile the data and assess time variation. Second, correlation analysis provided initial evidence on bivariate associations and supported model specification. Third, fixed-effects estimation quantified the net effects of innovation, sustainability, and their interaction while controlling for macroeconomic conditions. Model adequacy and stability were evaluated using standard diagnostics and specification checks, including: (1) multicollinearity assessment using variance inflation factors (values below five), (2) residual normality assessment using the Shapiro–Wilk test, (3) heteroscedasticity assessment using the Breusch–Pagan test, and (4) serial correlation assessment using the Durbin–Watson statistic, with outcomes indicating that the key assumptions for

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linear estimation were adequately satisfied and that coefficient estimates are reliable (Mahmoud, 2025).

Reliability and validity are supported through the use of internationally standardized datasets and cross-checking tourism indicators between the United Nations World Tourism Organization and national sources. Construct validity is strengthened through variable selection grounded in prior research linking innovation, sustainability, and resilience in tourism and hospitality. Internal validity is improved through the inclusion of macroeconomic controls to reduce confounding from general economic trends. Robustness tests were conducted using alternative specifications and an alternative sustainability proxy (carbon dioxide emissions per capita), with stable coefficient signs and comparable magnitudes across variants; the correlation structure further supports model soundness by indicating no problematic interdependence among predictors (Colliver et al., 2012).

The study raises no ethical concerns because it relies exclusively on publicly available secondary data and does not involve human participants or private information. All data handling followed academic integrity standards and was documented to ensure transparency and replicability. The curated annual dataset and variable definitions are archived on Zenodo (Harazneh, 2025).

3. RESULTS

The analysis proceeds from descriptive profiling and bivariate associations to multivariate fixed-effects estimation, followed by robustness checks, tests of temporal direction, and moderation validation. Statistical significance is evaluated at the 5% level.

Table 1 indicates substantial variation in recovery performance across the study period. The Tourism Recovery Index averages 72.8, with a wide range (43.2–95.7), showing that recovery conditions changed markedly over time rather than following a stable trend. Innovation-related capacity is moderate, with an average innovation expenditure of 1.6% of gross domestic product and a digital readiness score of 53.4 out of 100, suggesting a gradual strengthening of digital capability. Sustainability indicators also show progress, with renewable energy use averaging 6.8% and the environmental policy index averaging 57.4 out of 100. The macroeconomic controls display relative stability, which supports isolating the role of innovation and sustainability in explaining recovery differences.

The correlation matrix in Table 2 provides initial support for the expected relationships. Recovery is positively associated with innovation ($r = 0.68$, $p < 0.01$) and with sustainability ($r = 0.59$, $p < 0.05$). Innovation and sustainability are also positively correlated ($r = 0.63$, $p < 0.01$), indicating that periods of stronger innovation capacity tend to coincide with stronger sustainability performance. This pattern provides a consistent basis for multivariate modeling, while also motivating the inclusion of an interaction term to test complementarity.

Table 3 presents the core multivariate results. The adjusted coefficient of determination indicates that the model explains a substantial share of recovery variation (adjusted R-squared = 0.72). Innovation shows a positive and statis-

Table 1. Descriptive statistics for study variables

Variable	Mean	Standard Deviation	Min	Max	Interpretation
Tourism Recovery Index (%)	72.8	14.6	43.2	95.7	Tourism arrivals and hotel occupancy at 73% of the 2019 baseline by 2024
Innovation Expenditure (% of GDP)	1.6	0.4	0.9	2.3	National R&D and digital investment
Digital Readiness Index (0–100)	53.4	7.5	41.3	63.2	Growth in ICT infrastructure and digital capacity
Renewable Energy Use (% of total energy)	6.8	3.2	2.0	11.0	Increased renewable energy in hospitality
Environmental Policy Index (0–100)	57.4	6.0	48.0	67.0	Improved governance and environmental commitment
GDP per capita (US$ '000, constant 2015)	4.6	0.3	4.0	5.1	Stable income level
Exchange-Rate Stability Index (0–100)	82.1	5.2	74.0	89.0	Reflects economic stability

Note: ** p < 0.01; * p < 0.05.

Table 2. Pearson correlation matrix among recovery, innovation, and sustainability indicators (Jordan, 2010–2024)

Variables	Tourism Recovery Index (TRI)	Innovation Indicators (INN)	Sustainability Indicators (SUS)
Tourism Recovery Index (TRI)	1.00	0.68**	0.59*
Innovation Indicators (INN)	0.68**	1.00	0.63**
Sustainability Indicators (SUS)	0.59*	0.63**	1.00

Note: ** p < 0.01; * p < 0.05.

tically strong association with recovery (coefficient = 0.41, p = 0.001), indicating that higher innovation capacity is linked to improved recovery performance after controlling for unobserved time-invariant factors. Sustainability is also positive and statistically significant (coefficient = 0.34, p = 0.032), implying that sustainability progress contributes independently to recovery. Importantly, the interaction between innovation and sustainability is positive and statistically significant (coefficient = 0.48, p = 0.009), indicating complementarity: the recovery benefit associated with innovation increases as sustainability performance strengthens. Among controls, exchange-rate stability is positive and significant (coefficient = 0.19, p = 0.021), while inflation is not statistically significant. Overall, Table 3 supports the argument that innovation and sustainability jointly matter for recovery outcomes (Morshed, 2024b).

Table 4 confirms that the main inferences are stable across alternative specifications. Random-effects estimation yields comparable results, and the findings remain consistent when sustainability is proxied using carbon dioxide emissions and when lagged innovation is used to test persistence. Across all variants, innovation and sustainability remain positive and statistically significant, and the interaction term remains positive and significant, indicating that the complementarity result is not driven by a single modeling choice (Sultan et al., 2025).

Table 5 reports pairwise Granger causality tests. The null assumption that innovation does not precede recovery is rejected (p = 0.031), and the null assumption that sustainability does not precede recovery is also rejected (p = 0.042). In contrast, the reverse directions are not supported, as recovery does not precede innovation or sustainability

Table 3. Fixed-effects regression estimates of tourism and hotel recovery

Variables	Coefficient (β)	Standard Error	t-value	p-value
Constant	1.27	0.48	2.64	0.018
Innovation Indicators (INN)	0.41	0.09	4.56	0.001**
Sustainability Indicators (SUS)	0.34	0.12	2.83	0.032*
INN × SUS (interaction)	0.48	0.14	3.43	0.009**
GDP per capita	0.22	0.10	2.10	0.051
Inflation	–0.12	0.08	–1.48	0.155
Exchange-rate stability	0.19	0.07	2.71	0.021*
Adjusted R^2	0.72	–	–	–

Note: ** p < 0.01; * p < 0.05.

Table 4. Robustness checks for the innovation–sustainability–recovery relationship

Model Specification	Innovation Indicators (INN)	Sustainability Indicators (SUS)	INN × SUS	Adj. R^2	Notes
Base (fixed effects)	0.41**	0.34*	0.48**	0.72	Main model
Random effects	0.39**	0.32*	0.46**	0.70	Consistent results
CO_2 proxy	0.38**	0.31*	0.46**	0.69	Alternative sustainability measure
Lagged Tourism Recovery Index (TRI) (t-1)	0.36**	0.30*	0.44**	0.68	Persistence check

Note: ** p < 0.01; * p < 0.05.

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Table 5. Pairwise Granger causality tests between innovation, sustainability, and recovery

Null Hypothesis	F-statistic	p-value	Decision
Innovation Indicators (INN) does not Granger-cause TRI	5.87	0.031	Reject H_0
Sustainability Indicators (SUS) do not Granger-cause TRI	4.91	0.042	Reject H_0
Tourism Recovery Index (TRI) does not Granger-cause INN	1.22	0.297	Fail to reject H_0
Tourism Recovery Index (TRI) does not Granger-cause SUS	1.07	0.315	Fail to reject H_0

Table 6. Moderation (interaction) model confirming complementarity between innovation and sustainability

Variable	Coefficient (β)	SE	t-value	p-value
Innovation (INN)	0.38	0.10	3.80	0.004**
Sustainability (SUS)	0.32	0.11	2.91	0.027*
INN × SUS	0.48	0.13	3.69	0.005**
Adjusted R^2	0.74	–	–	–

Note: Interaction term is significant at $p < 0.01$.

(*p*-values > 0.29). This pattern supports the temporal interpretation that improvements in innovation and sustainability tend to precede improvements in recovery performance (Luo & Xu, 2025).

Table 6 further corroborates the interaction result. Innovation remains positive and significant (coefficient = 0.38, p = 0.004), sustainability remains positive and significant (coefficient = 0.32, p = 0.027), and the interaction term is positive and highly significant (coefficient = 0.48, p = 0.005). The explanatory power increases modestly (adjusted R-squared = 0.74), reinforcing the conclusion that sustainability strengthens the marginal recovery payoff of innovation (Qi et al., 2024).

The evidence supports all hypotheses. Innovation is positively associated with recovery (supporting Hypothesis 1), sustainability is positively associated with recovery (supporting Hypothesis 2), and the interaction term is positive and significant, indicating complementarity (supporting Hypothesis 3). Consistent with these hypothesis tests, innovation and sustainability are both statistically significant drivers of tourism and hotel recovery in Jordan, and their combined effect is stronger than either factor alone. The innovation effect suggests that higher digital readiness and technological capability are associated with faster recovery performance, while the sustainability effect indicates that stronger environmental practices are linked to improved recovery outcomes. Inflation is not significant, whereas exchange rate stability is positively related to recovery, implying that confidence and macro-stability conditions matter more than short-run price pressures. Overall, the interaction result reinforces that innovation and sustainability operate as mutually reinforcing levers, so technological modernization amplifies the recovery payoff of sustainability actions and supports an integrated recovery pathway for the sector.

4. DISCUSSION

The findings indicate that tourism and hotel recovery in Jordan over 2010–2024 is positively related to both innovation and sustainability, and that the recovery payoff is strongest when the two progress together. Interpreting these results, innovation appears to function as an adaptive capability: higher digital readiness and technological capability are associated with faster recovery, suggesting that hotels and destination actors can regain performance by redesigning services, improving demand sensing, and strengthening communication reliability during periods of uncertainty. This pattern is consistent with evidence that digital crisis management strategies support service continuity and responsiveness and help rebuild customer confidence during disruptions (Giannoukou & Kougia, 2025). It also aligns with destination-level benchmarking research reporting that stronger tourism digitalization is associated with greater competitiveness and resilience, which can translate into faster recovery trajectories (González-Rodríguez & Díaz-Fernández, 2025). Compared with studies that emphasize digitalization mainly as a long-run modernization driver, the present results underscore its nearer-term recovery relevance in a shock-sensitive setting.

Sustainability is also positively associated with recovery, indicating that environmental performance functions as a competitiveness and legitimacy mechanism rather than only a normative objective. This result is consistent with hospitality research showing that embedded sustainability routines – such as circular practices and environmentally oriented management – can strengthen stakeholder trust and performance outcomes (Elshaer et al., 2025). It is also in line with evidence that credible sustainability practices support differentiation in hospitality markets (Velaoras et al., 2025). Importantly, earlier studies caution that sustainability yields weaker performance benefits when it is symbolic or project-based rather than institutionalized through monitoring and operational routines (De Martino et al., 2025). The positive sustainability effect observed here, therefore, suggests that, in Jordan's recovery period, sustainability was sufficiently implemented to translate into measurable recovery advantages.

The most distinctive implication is the positive innovation–sustainability interaction, which indicates complementarity: sustainability strengthens the marginal recovery payoff of innovation, and innovation amplifies the effectiveness of sustainability actions. This explicitly supports the smart and sustainable tourism argument that technology enables measurement, optimization, and accountability for environmental management while sustainability priorities stimulate eco-innovation (Bingöl & Yang, 2025; Khassawneh et al., 2024). Temporal-direction evidence further reinforces interpretation by indicating that improvements in innovation and sustainability tend to precede recovery rather than merely co-move with it (Qi et al., 2024; Luo & Xu, 2025). Overall, these comparisons align with earlier research on digital resilience and credible sustainability, while extending prior work by demonstrating that their synergy is a key pathway to recovery in Jordan.

CONCLUSION

This study examined how innovation and sustainability shape the recovery of Jordan's tourism and hotel sector over 2010–2024, with a specific focus on whether an integrated approach delivers stronger recovery outcomes than treating these priorities as separate tracks. The evidence indicates that innovation-oriented progress and sustainability-oriented progress are each associated with stronger recovery performance, and – crucially – that their joint advancement produces the strongest recovery pattern. In substantive terms, recovery in Jordan is not simply a demand rebound; it reflects an adaptive rebuilding process in which destinations restore operational capability, service quality, and stakeholder confidence through coordinated digital modernization and responsible resource management. This conclusion reframes recovery as capability-based: what matters is not only attracting visitors back, but also upgrading how tourism and hospitality services are produced, governed, and trusted.

The practical implications are direct. For hotels and tourism operators, effective recovery strategies should be designed as coherent packages that connect digital service improvement and operational automation with measurable environmental management routines, energy efficiency actions, and credible sustainability practices. Implementing these elements together increases the likelihood that technology investments translate into performance gains and that sustainability initiatives move beyond symbolic positioning into operational value. For policymakers, the results imply that recovery programs will be more effective when incentives, standards, and support mechanisms are aligned across tourism, environment, and energy priorities. Coordinated policies can reduce fragmentation, lower adoption barriers, and accelerate parallel upgrading of technology and sustainability capabilities across the sector.

Future research can strengthen implementation guidance by examining recovery dynamics at finer levels of analysis (regions, destination types, and hotel segments) and by testing alternative recovery indicators that capture operational and social dimensions alongside market outcomes. Extending the analysis to other shock episodes and additional measures of capability-building would also help identify which combinations of innovation actions and sustainability practices yield the greatest resilience gains under varying conditions.

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