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The role of AI-powered big data analytics in enhancing firm ESG performance: mediating and moderating effects

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ABSTRACT

This study addresses a key debate among leaders, policymakers, and researchers regarding the extent to which AI-powered big data analytics capabilities effectively support and enhance environmental, social and governance performance. We investigate the underlying mechanism and boundary condition through a moderated mediation model. The model tests the relationships between AI-powered big data analytics capabilities, AI-enabled green learning capability, responsible leadership and environmental, social and governance performance. Data were collected from senior-level managers in United Arab Emirates hospitality organisations using a survey questionnaire. Hypotheses were tested using Hayes' PROCESS macro. The results reveal that AI-powered big data analytics capabilities have a significant positive impact on firm environmental, social and governance performance. Moreover, AI-enabled green learning capability mediates this primary relationship. Furthermore, responsible leadership positively moderates the link between AI-powered big data analytics capabilities and AI-enabled green learning capability. A significant moderated mediation effect was identified, demonstrating that the capabilities' indirect influence on environmental, social and governance performance through green learning is strongest when responsible leadership is high. These findings highlight the strategic necessity of integrating advanced analytical capabilities with learning initiatives and fostering responsible leadership to maximise positive environmental, social and governance outcomes.

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KEYWORDS
AI-powered big data analytics capabilities; AI-enabled green learning capability; Responsible leadership; ESG performance

1. Introduction

Artificial intelligence (AI) and big data analytical capabilities (BDAC), hereafter AI-powered BDAC, are rapidly transforming industries, empowering organisations to enhance efficiency, personalise services and drive innovation (Sarfraz, Khawaja, and Waheed 2026; Wang, Zhang, and Li 2025). However, this pervasive integration intensifies ethical and governance concerns, amplifying calls to align technological deployment with environmental, social and governance (ESG) goals (Alam, Ofli, and Imran 2020; Camilleri 2024). While AI-powered BDAC offers vast potential for improving ESG performance through enhanced data transparency and risk management (Pesqueira and Sousa 2024; Sun and Lim 2026), a critical theoretical gap persists. We lack understanding of the mechanisms and boundary conditions that translate these technical capabilities into systemic, measurable ESG outcomes. Drawing on dynamic capabilities theory (DCT), this study aims to investigate the holistic framework involving AI-enabled green learning capability as a mediator and responsible leadership as a moderator to fully elucidate how AI-powered BDAC drives ESG performance.

To ensure conceptual rigor, we define AI-powered BDAC as the integrated organisational capability to deploy advanced machine learning algorithms and big data infrastructure to automate and optimise decision-making with a direct bearing on sustainability outcomes, distinguishing it from simpler data management (Ahmad, Shafique, and Kalyar 2025; Brougham and Haar 2018). To address the critical gap identified above, this study empirically investigates the proposed moderated mediation model, focusing on the following research questions: (1) Does AI-powered BDAC positively influence ESG performance? (2) Does AI-enabled green learning capability mediate this relationship? (3) Does responsible leadership moderate the link between

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AI-powered BDAC and AI-enabled green learning capability? We investigate this model using survey data collected from resort hotels in United Arab Emirates (UAE). This context is particularly compelling because the UAE's high-growth resort hotel sector is actively utilising BDAC and AI to enhance guest experiences and achieve sustainability goals. This makes the region a critical testbed for examining the tensions between technological adoption and sustainability mandates in a high-profile service industry.

To bridge the capability-outcome divide, we theorise AI-enabled green learning capability as the pivotal mediating mechanism, defining it, based on Cohen and Levinthal (1990), as the organisation's ability to identify, internalise, and apply environmentally sustainable knowledge derived from AI outputs. This capability transforms AI's analytical outputs into actionable strategies, thereby explaining how the technical capacity of AI-powered BDAC drives substantive ESG improvements. The efficacy of this translation, however, depends on the critical boundary condition of responsible leadership. Defined as an ethical and social-relational phenomenon (Maak and Pless 2006), responsible leaders ensure that AI-derived insights are interpreted through an ESG lens, promoting a culture where sustainability is a shared purpose and fostering the inclusive environment necessary for green learning to thrive.

This study makes several contributions to advancing interdisciplinary scholarship on AI technologies, sustainability, and organisational governance. First, drawing on the DCT, we provide novel insights into how AI-powered BDAC drives ESG performance, addressing critical gaps in understanding the mechanisms that translate technical capabilities into systemic sustainability outcomes (Buzzao and Rizzi 2021; Ghobakhloo et al. 2021). Unlike prior work that prioritises AI's operational efficiencies (Soori, Arezoo, and Dastres 2023; Zamani et al. 2023), we challenge reductionist views of sustainability as mere data optimisation, instead positioning green learning capabilities as a transformative mediator that bridges BDA with ethical practice. In doing so, we respond to calls for frameworks that reconcile technological innovation with planetary and societal well-being (Sun et al. 2024; Zhou et al. 2025). Second, by conceptualising AI-enabled green learning capabilities, we extend organisational learning theory into the AI-ESG nexus. This advances scholarship beyond technical 'green IT' solutions, emphasising instead the role of adaptive learning in fostering regenerative business models (Hahn and Tampe 2021; Konietzko, Das, and Bocken 2023). Third, while existing leadership research focuses on responsible leadership's impact on internal sustainability metrics (Abraham 2024; Bisla, Prakash, and Bamel 2024; James and Priyadarshini 2021), we pioneer its role as a boundary condition that amplifies AI's ethical potential. By demonstrating how responsible leadership strengthens the link between AI-powered BDA and green learning, we offer a perspective on governance in the digital age, addressing pressures from regulators and civil society for transparent ESG operationalisation (Bhatti et al. 2022; Mooneeapen, Abhayawansa, and Mamode Khan 2022). The remainder of this article is organised into sections covering the theory and hypotheses, methodology, analysis and results and a final discussion encompassing theoretical and practical implications, limitations, future research directions and the conclusion.

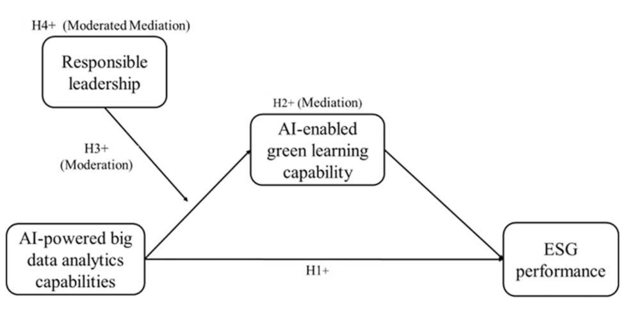

Figure 1. Conceptual framework. Source: Authors' proposal for the study.

2. Theory and hypotheses

2.1. Dynamic capabilities theory

DCT suggests that organisational success in turbulent environments depends on a firm's ability to adapt by sensing opportunities, seising them through strategic action, and transforming resources to stay competitive. Introduced by Teece, Pisano, and Shuen (1997), DCT shifts attention from static resources to the processes that enable firms to innovate, learn, and realign assets with changing conditions. These three capabilities – sensing, seising, and transforming – are iterative and interconnected, helping firms remain resilient in dynamic sectors like hospitality, where technological, regulatory, and social changes are constant (Chasapi et al. 2024; Saeed et al. 2023). DCT thus provides a solid lens for understanding how organisations convert agility into sustained value creation (Leonidou et al. 2015).

Our model (Figure 1) builds on this logic to explain how AI technology drives sustainable outcomes. The independent variable, AI-powered BDAC, represents the sensing capability, enabling firms to detect ESG-related opportunities and stakeholder needs through real-time data analysis. The mediator, AI-enabled green learning capability, reflects the seising process by converting sensed insights into actionable knowledge and routines that support eco-innovation and circular economy initiatives (Knoppen and Knight 2022). Finally, responsible leadership embodies transforming capability. It moderates the link between sensing and seising by ensuring that AI-driven insights are ethically prioritised and embedded in new structures and practices to enhance long-term ESG performance (Abbas 2024).

2.2. AI-powered BDAC and ESG performance

Drawing on DCT, we position AI-powered BDAC as a core sensing capability that significantly enhances hotels' ESG performance, defined as the systematic ability to identify, implement, and refine sustainability initiatives across operational, environmental, and governance dimensions. The rationale is that AI-powered BDAC equips hotels with the ability to integrate diverse sustainability-related data streams from internal operations and external stakeholders, thereby facilitating continuous sensing of ESG risks, compliance requirements, and socially responsible innovation opportunities (Chang and Ke 2024; Pesqueira and Sousa 2024). AI-powered BDAC-driven analytics underpin evidence-based strategic decision-making and dynamic resource reallocation, enabling hotels to not only respond effectively to emerging ESG challenges but also embed sustainable practices across functional areas such as energy management, employee well-being, and stakeholder transparency (Arici, Aladag, and Koseoglu 2025; Chang and Ke 2024; Da Hyun et al. 2024).

As the insights generated from BDAC circulate within and across hotel units (e.g. properties, corporate offices, partner networks), a collective and evolving understanding of sustainability performance standards is fostered, leading to a more resilient and proactive organisational ESG posture (Teece 2014). This transforms the entire process, wherein hotels adapt their processes, leadership mindsets, and cultural norms to embed sustainability, reinforced through BDAC-driven real-time metrics and predictive analytics on environmental footprint, social responsibility KPIs, and governance compliance benchmarks (Chiang 2024; Fu et al. 2023; Park et al. 2024; Yu et al. 2024). Consequently, AI-powered BDAC serves as a critical catalyst for advancing hotel ESG performance, not only enabling efficient monitoring and reporting but also sustaining an iterative cycle of sustainability-driven innovation and competitive differentiation. Therefore, we hypothesise:

> H1: AI-powered big data analytics capabilities are positively linked to hotel ESG performance.

2.3. AI-enabled green learning capability as a mediator

Based on DCT, we theorise AI-enabled green learning capability as the pivotal seising capability, which mediates the relationship between AI-powered BDAC and ESG performance. In an era where ESG expectations are intensifying globally, hotels must develop not only the technological means (Sensing) but also the organisational learning capabilities (Seising) to continuously adapt and excel. AI-powered BDAC offers the essential infrastructure by aggregating, analyzing, and forecasting insights from complex sustainability datasets (Lin et al. 2024). These capabilities enhance hotels' ability to sense emerging ESG risks and opportunities by leveraging AI-driven data synthesis, predictive modelling, and pattern recognition across diverse operational contexts (Gupta and Jaiswal 2024).

However, while AI-powered BDAC lays the technical groundwork for sustainability intelligence, its effectiveness in advancing ESG performance is explained by the development of AI-enabled green learning capability – the structured organisational capacity to acquire, interpret, and institutionalise sustainability knowledge generated through AI-based analytical processes (Chang and Ke 2024; Ferraris et al. 2019; Khan et al. 2024). This learning capability thus acts as a pivotal mediating mechanism, translating AI-powered BDAC outputs into actionable strategies and iterative organisational improvements.

Through AI-enabled green learning, hotels systematically identify ESG performance gaps by using machine learning algorithms to benchmark against global frameworks (e.g. UN SDGs), extract actionable insights from unstructured data via Natural Language Processing, and conduct adaptive experimentation through scenario modelling (Chiang 2024; Gupta and Jaiswal 2024). This learning process fosters cross-functional knowledge diffusion, cultivating a culture of continuous innovation and proactive ESG adaptation (Wang et al. 2024). Over time, such data-driven learning cycles enhance organisational agility, stakeholder alignment, and superior ESG performance outcomes. Therefore, we hypothesise:

> H2: AI-enabled green learning capability mediates the positive relationship between AI-powered big data analytics capabilities and hotel ESG performance.

2.4. Responsible leadership as a moderator

DCT emphasises that organisations achieve sustained competitive advantage not merely by possessing resources, but by dynamically sensing changes, seising emerging opportunities, and reconfiguring assets in response to shifting environments (Teece, Pisano, and Shuen 1997). Extending this framework to sustainability, AI-powered BDAC enables systematic detection of ESG risks and generation of data-driven green innovations (Abbas and Najam 2024; Sadeghian and Otarkhani 2024). A critical outcome of leveraging AI-powered BDAC for sustainability is the development of AI-enabled green learning capability – the systematic acquisition, dissemination, and application of sustainability knowledge through AI-enhanced analytics. However, DCT underscores that capabilities alone do not guarantee strategic outcomes; leadership agency plays a pivotal role in orchestrating capabilities into dynamic advantage (Teece 2007). Leadership behaviours, particularly responsible leadership, are crucial in bridging this gap, as these leaders are guided by ethical foresight, stakeholder stewardship, and systemic thinking (Maak, Pless, and Wohlgezogen 2021), enabling the effective alignment of AI-powered BDAC with AI-enabled green learning capability.

Responsible leaders, characterised by ethical commitment, long-term vision, and systemic orientation toward societal and environmental stewardship (Maak, Pless, and Wohlgezogen 2021), are uniquely positioned to strengthen the BDAC-green learning capability relationship in three ways. First, responsible leaders prioritise ESG objectives over narrow financial metrics, ensuring that AI-powered BDAC outputs are integrated into structured green learning systems (e.g. ESG-focused knowledge-sharing platforms and decision support systems). This is consistent with DCT's emphasis on the orchestration of capabilities into coherent strategic processes (Eurico Soares de Noronha et al. 2024). Second, driven by a commitment to multi-stakeholder well-being, responsible leaders foster governance environments where BDAC-driven sustainability insights are operationalised through ethical policies, cross-functional collaboration, and continuous capacity building (Elia, Margherita, and Petti 2020). These practices institutionalise data-driven green learning processes aligned with systemic organisational change. For responsible leaders, this manifests as a deep-seated commitment to leveraging BDAC for advancing green learning, ensuring that sustainability knowledge is not only acquired but also scaled and embedded across operations (Shafait and Huang 2024).

Conversely, in contexts where responsible leadership is weak, organisations may suffer from misaligned priorities, underinvestment in green analytics, and fragmented diffusion of sustainability knowledge. Leaders lacking responsible orientation may deploy BDAC solely for compliance or efficiency gains, undermining the broader institutionalisation of AI-enabled green learning. This violation of DCT's orchestration principle results in disjointed green learning efforts, where data exists but fails to translate into systemic, strategic adaptation. For example, absent responsible leadership, firms might use AI to measure emissions but neglect to develop cross-functional green learning frameworks that drive long-term decarbonisation. Thus, we hypothesise:

> H3: Responsible leadership moderates the positive relationship between AI-powered BDAC and AI-enabled green learning capability, such that the relationship is stronger (vs. weaker) when responsible leadership is high (vs. low).

2.5. Moderated mediation

Building on the above arguments, we propose a moderated mediation framework wherein responsible leadership not only moderates the direct relationship between AI-powered BDAC and AI-enabled green learning capability but also conditions the indirect effects on ESG performance. DCT emphasises that dynamic capabilities must be strategically orchestrated to generate higher-order advantages (Teece 2007), suggesting that the efficacy of BDAC in facilitating systemic green transformation depends on the leadership context. Specifically, when responsible leadership is high, the translation of AI-powered BDAC into AI-enabled green learning capability becomes more effective, which in turn strengthens the organisation's ability to achieve advanced sustainability outcomes i.e. ESG performance. Conversely, when responsible leadership is low, BDAC remains underutilised, weakening the pathway from technical capabilities to ESG performance. Therefore, responsible leadership serves as a critical boundary condition, shaping the extent to which AI-powered BDAC are leveraged to achieve systemic and sustained environmental learning and ESG performance. Therefore, we propose:

> H4: Responsible leadership moderates the indirect effect of AI-powered BDAC on ESG performance via AI-enabled green learning capability, such that the indirect effect is stronger (vs. weaker) when responsible leadership is high (vs. low).

3. Method

3.1. Context

The proposed research model is tested on the hospitality industry of the UAE. The UAE presents a strategically significant context for this research due to its aggressive national drive towards technological leadership, particularly in artificial intelligence and big data analytics, aligned with ambitious ESG targets (e.g. UAE Centennial 2071, n.d.; UAE Net Zero 2050, n.d.). The hospitality sector, a cornerstone of the UAE economy, is actively undergoing a technological revolution, leveraging BDAC and AI to transform operations, enhance guest experiences, and achieve sustainability goals (Gursoy 2025). This proactive integration positions the UAE hospitality industry as a pioneer in harnessing data-driven capabilities for measurable environmental impact reduction, enhanced social responsibility, and robust governance compliance. Consequently, the UAE offers an ideal empirical setting to investigate the relationships within our model.

3.2. Sample and procedure

This study employed a time-lagged design to collect data from senior-level representatives of resort hotels operating in the UAE. To ensure data quality, we utilised a targeted, non-probabilistic sampling approach, focusing on key decision-makers who possess comprehensive knowledge of both technological deployment and sustainability strategy. Our population was defined as all 4- and 5-star resort hotels operating across UAE. We developed a master list of 310 eligible properties based on industry databases and specialised directories.

Hotels were selected based on two primary criteria: (1) Classification as a 4- or 5-star resort, ensuring relevance to complex, resource-intensive operations; and (2) Evidence of current digital or sustainability initiatives. Respondents were selected based on their seniority (e.g. General Manager, Director of Operations, Director of Sustainability) to ensure their perceptual data was informed by strategic oversight. This targeted approach, while non-random, was necessary to access expert knowledge and mitigate the risk of collecting uninformed data.

Data collection was carried out in two phases, with a two-week interval between each round to mitigate common method bias. We contacted the 310 eligible hotels, and 207 agreed to participate in the study. In the first round (T1), we invited representatives of the 207 hotels to provide their responses on AI-powered BDAC (independent construct) and responsible leadership (moderating construct). We received 164 complete responses (T1 response rate: 79.2% of participants). In the second round (T2), we invited the 164 T1 respondents to provide their data on AI-enabled green learning capability (mediating construct), the hotels' ESG performance (dependent construct), and two hotel demographics (hotel age and size). We received 125 complete, matched responses (T2 response rate: 76.2% of T1 respondents).

Recruitment was managed via initial email contact to HR/General Managers, followed by personalised correspondence to the identified senior respondent. Hayes' PROCESS macro was used to perform the regression analysis.

3.3. Measures

AI-powered BDAC were assessed by adapting a 4-item scale from Srinivasan and Swink (2018). A sample item is: 'My hotel applies AI-driven analytical techniques (e.g. machine learning algorithms, predictive modelling, simulation, optimisation) to enhance and automate decision-making processes'. AI-enabled green learning capability was measured using a 4-item scale adapted from Mikalef and Pateli (2017). A sample item is: 'This hotel identifies, evaluates, and integrates new environmental information and knowledge using AI-driven techniques'. Responsible leadership was assessed by adapting a 5-item scale from Voegtlin (2011). A sample item is: 'At this hotel, top management carefully considers the consequences of decisions for all affected stakeholders, ensuring that actions align with ethical and sustainable practices'. ESG performance was measured by adapting a 16-item scale developed by Kim et al. (2024). A sample item is: 'This hotel purchases environmentally preferable materials that are more recyclable and reusable than others'. The complete list of items for each scale is provided in Appendix I.

All the scales were measured on a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5). The survey instrument was developed in English, the primary language of business communication in the UAE's hospitality industry and was reviewed by three academic experts and ten hotel managers for clarity and contextual relevance.

3.4. Analysis and results

Descriptive statistics and the correlations among the constructs have been portrayed in Table 1. The significant relationships among the variables allow us to perform regression analysis.

Table 1. Descriptive statistics and correlations.

Construct	Mean	SD	1	2	3	4	5	
1. Firm Age	26.26	6.27						
2. Firm Size	2.64	1.21	0.07					
3. AIBDAC	3.99	0.59	−0.04	0.12	**0.719**			
4. AIGLC	4.20	0.56	0.15	0.05	0.35***	**0.727**		
5. Responsible leadership	4.24	0.50	0.10	0.09	0.11	−0.04	**0.731**	
6. ESG performance	3.96	0.63	−0.08	−0.01	0.37***	0.33***	0.12	**0.814**

Notes: $*p < .05$. $**p < .0$ 1. $***p < .00$ 1 Sample size (N) = 125. AIBDAC = AI-powered big data analytics capabilities, AIGLC = AI-enabled green learning capability, ESG = environmental, social and governance.

Before testing the hypotheses, it was essential to verify the validity and reliability of the constructs. Table 2 presents the results of the convergent and discriminant validity assessments. The Average Variance Extracted (AVE) scores for all constructs exceeded the recommended threshold of 0.50, confirming convergent validity. As shown in Table 1, the square roots of the AVEs, bolded and presented diagonally, were greater than the inter-construct correlations, supporting discriminant validity. Additionally, in Table 2, both the Maximum Shared Variance (MSV) and Maximum Reliability (MaxR(H)) values are further confirmed discriminant validity. The Composite Reliability (CR) and Cronbach's alpha (α) values for all constructs were above 0.70, indicating that the measurement scales demonstrated strong reliability and validity.

The results of hypothesis testing are presented in Table 3. AIBDAC is positively associated with ESG performance (β = 0. 39, $p < 0.01$), supporting H1. Furthermore, AIBDAC demonstrates a positive association with AI-enabled green learning capability (β = 0.34, $p < 0.001$). AI-enabled green learning capability exhibited a positive association with ESG performance (β = 0.25, $p < 0.05$). AI-enabled green learning capability mediates the link between AIBDAC and ESG performance (β = 0.08), CI = [0.01, 0.21], supporting H2.

The moderation effects of responsible leadership on the hypothesised relationships (H3 and H4) were tested using the PROCESS macro (Model 14). PROCESS macro was instructed to create interaction terms by mean-centering AIBDAC and responsible leadership to reduce multicollinearity. The regression models included these interaction terms to test whether work centrality moderated the effects as hypothesised.

For H3, a simple slope analysis was conducted to examine the interaction further (Aiken et al., 1991). The results indicated that the positive association between AIBDAC and AI-enabled green learning capability was stronger at high levels of responsible leadership (β = 0.74, $p < 0.001$) and insignificant at low levels of responsible leadership (β = −0.06, $p = 0.38$). These findings, visualised in Figure 2, illustrate that high responsible leadership amplifies the positive impact of AIBDAC on AI-enabled green learning capability, thus partially supporting H3.

For H4, the moderated mediation effects were tested by examining conditional indirect effects at different levels of responsible leadership using the PROCESS macro. Results showed that the indirect effect of AIBDAC on ESG performance via AI-enabled green learning capability was significant when responsible leadership was high (β = 0.19, CI = [0.02, 0.38]), but

Table 2. Convergent and discriminant validity.

Construct	CR	Cronbach' α	AVE	MSV	MaxR(H)
AIBDAC	0.809	0.808	0.517	0.172	0.824
AIGLC	0.817	0.816	0.529	0.161	0.826
RL	0.846	0.848	0.534	0.025	0.891
ESG	0.969	0.969	0.662	0.172	0.97

Notes. CR = composite reliability, AVE = average variance extracted, MSV = maximum shared variance, MaxR(H) = maximum reliability, AIBDAC = AI-powered big data analytics capabilities, AIGLC = AI-enabled green learning capability, ESG = environmental, social and governance.

Table 3. Hypotheses results.

Total effect	B	SE	LLCI	ULCI
AIBDAC → ESG performance	0.39***	0.09	0.21	0.56
Direct path				
AIBDAC → ESG performance	0.30**	.09	0.12	0.49
AIBDAC → AIGLC	0.34***	.06	0.22	0.46
AIGLC → ESG performance	0.25*	.09	0.06	0.45
Indirect path				
AIBDAC → AIGLC → ESG performance	0.08	0.05	0.01	0.21
Moderated path				
AIBDAC * responsible leadership → ESG performance	0.34***	.06	0.22	0.46
AIBDAC * responsible leadership → ESG performance (On high responsible leadership)	0.74***	.07	0.60	0.89
AIBDAC * responsible leadership → ESG performance (On low responsible leadership)	−0.06	.07	−0.20	0.08
Conditional indirect effect				
Index of moderated mediation	0.20	0.12	0.02	0.51
AIBDAC * responsible leadership → AIGLC → ESG performance (On high responsible leadership)	0.19	0.09	0.02	0.38
AIBDAC * responsible leadership → AIGLC → ESG performance (On low responsible leadership)	−0.02	0.05	−0.15	0.03

Notes: $*p < .05$. $**p < .0$ 1. $***p < .00$ 1 Sample size (N) = 125. AIBDAC = AI-powered big data analytics capabilities, AIGLC = AI-enabled green learning capability, ESG = environmental, social and governance.

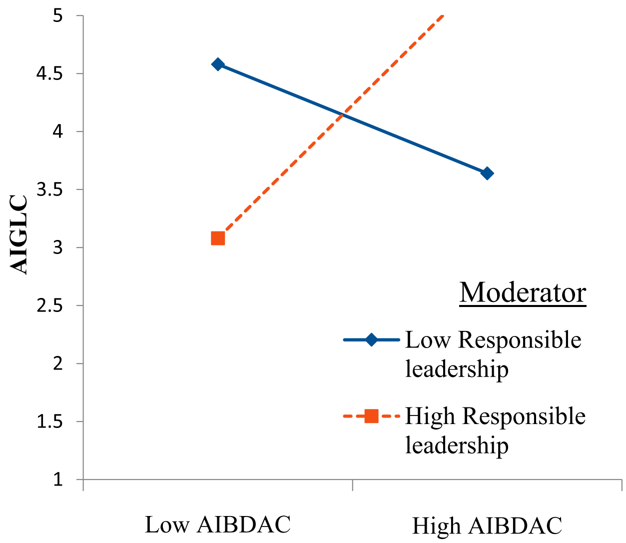

Figure 2. Responsible leadership moderates the relationship between AIBDAC and ESG performance. Source: Created by the authors based on the results.

not significant when responsible leadership was low (β = −0.02, CI = [−0.15, 0.03]). These results partially support H4, indicating that high responsible leadership strengthens the indirect relationship between AIBDAC and ESG performance behaviours through AI-enabled green learning capability.

4. Discussion

The primary objective of this study was to investigate the mechanisms and boundary conditions through which AI-powered BDAC translates into ESG performance within the turbulent context of the UAE resort hotel sector. Drawing on DCT, we tested a moderated mediation model involving AI-enabled green learning capability as a mediator (Seising) and responsible leadership as a moderator (Transforming). Our findings confirm a significant path from technological asset to sustained sustainability performance.

The findings confirm a significant positive direct relationship between AI-powered BDAC and ESG performance, supporting H1. This result represents the foundational Sensing capability of DCT in action. In the UAE hospitality context, AI-powered BDAC provides resort hotels with the ability to detect, in real-time, nuanced ESG-related opportunities and risks such as optimising water usage under high-stress conditions or forecasting energy demands based on projected occupancy and local climate changes. This capability moves beyond static reporting; it enables dynamic, evidence-based strategic decision-making required for immediate ESG improvement (Zhou et al. 2025). The support for this direct link affirms the increasing strategic value of AI infrastructure (Wang, Zhang, and Li 2025) and suggests that even without formal learning cycles, AI's analytical output is sufficient to spur initial, operational ESG gains.

While this finding aligns with global research suggesting that advanced analytics enhance strategic alignment (Lozada, Arias-Pérez, and Henao-García 2023), we posit that the cause of the particularly strong relationship in our study may be greater due to the specific, resource-intensive nature of the UAE hotel sector (high energy/water consumption) where minor AI-driven efficiencies yield major, visible ESG results. Thus, the turbulent, high-stakes local environment acts as an accelerant for the value derived from the AI-powered Sensing capability.

Our results confirm that AI-enabled green learning capability significantly mediates the relationship between AI-powered BDAC and ESG performance, supporting H2. This is a crucial finding, as it identifies the mechanism that converts technological potential into organisational impact. In DCT terms, AI-powered BDAC provides the initial Sensing output, but AI-enabled green learning capability is the necessary Seising routine that captures this information, interprets it contextually (Mikalef & Pateli, 2017), and institutionalises it. This represents the capacity to translate raw data (e.g. 'water usage spiked by 5% at 3 PM') into new, embedded, and adaptive protocols (e.g. 're-programming irrigation schedules and training staff'). This iterative learning cycle is what moves hotels from simply having data to becoming a sustainable organisation (Christensen, Hail, and Leuz 2021; Teece 2018). The necessity of this mediation indicates that the inherent value of the Sensing capability (AI-BDAC) is fundamentally constrained until the Seising capability (Green Learning) is formalised. This outcome extends the Green IT discourse by showing that investment in technical assets alone is insufficient; a formalised organisational learning climate is the cause of value realisation. This supports regenerative business models (Bresciani et al. 2021; Hahn and Tampe 2021), demonstrating that systematic knowledge absorption and feedback are essential for ESG transformation.

Supporting H3, we found that responsible leadership positively and significantly moderates the relationship between AI-powered BDAC and AI-enabled green learning capability. This result underscores the pivotal role of leadership agency as the Transforming/Reconfiguring capability in DCT. Responsible leaders, guided by ethical foresight and systemic thinking (Maak, Pless, and Wohlgezogen 2021), ensure that the outputs of the Sensing capability (AI-BDAC) are funneled ethically and consistently into the Seising capability (Green Learning). Their presence acts as a governance mechanism that prevents AI from being used solely for short-term financial gains, instead committing resources to the systemic knowledge-sharing and capacity-building that green learning requires (Elia, Margherita, and Petti 2020).

This finding validates the relational leadership perspective (Maak and Pless 2006) and aligns with recent calls for ESG-conscious AI deployment (Camilleri 2024). The moderating effect confirms that even the best technology and learning routines fail if the leadership lacks the responsible mandate to orchestrate and institutionalise them for societal (ESG) goals. The high-stakes, image-conscious nature of luxury resort leadership in the UAE may further amplify this effect, as ethical governance is a key differentiator in attracting global stakeholders (Mooneeapen, Abhayawansa, and Mamode Khan 2022).

4.1. Theoretical implications

Our study offers the following key theoretical contributions, drawing on the DCT lens in the context of sustainability-driven digital transformation. First, we conceptualise and empirically validate the role of AI-powered BDAC as the technological driver of the Sensing capability. We extend traditional analytics by showing how the incorporation of machine learning and automated decision-making fundamentally enhances the organisation's ability to sense, interpret, and detect latent sustainability-related opportunities and risks in real time. This finding establishes AI-powered BDAC as a crucial, technologically augmented micro-foundation for strategic ESG intelligence, aligning with recent research (Graziano, Petroccione, and Siggia 2025; Siebel 2017). Second, we contribute to the organisational learning perspective by establishing AI-enabled green learning capability as the dedicated Seising mechanism. By confirming its mediating role, we demonstrate that technical AI capabilities alone are insufficient; instead, organisational success hinges on the cognitive and absorptive capacity to seise the AI-derived data and transform it into actionable, firm-specific sustainability knowledge (Dzhengiz and Niesten 2020; Zhang et al. 2025). This clarifies the necessary link between technological potential and ESG outcomes.

Finally, our findings integrate the critical role of leadership by positioning responsible leadership as the orchestrating, Transforming meta-capability. We show that leaders who exhibit ethical sensitivity and stakeholder commitment are essential for strengthening the positive relationship between technological sensing AI-powered BDAC and subsequent learning (green learning). This demonstrates how responsible leadership acts as the governance mechanism required to prioritise and sustain the integration of AI-derived insights into long-term strategic and ethical ESG performance (Abraham 2024; Krambia-Kapardis, Stylianou, and Savva 2023; Zahari et al. 2024).

4.2. Practical implications

We have translated our theoretical findings into concrete, actionable guidance for senior managers, policymakers, and sustainability strategists in the UAE hospitality sector, ensuring they can optimise AI investment for demonstrated ESG performance. First, managers must treat AI-powered BDAC not just as an efficient tool but as a strategic asset for ESG intelligence. We recommend mandating the establishment of AI-driven real-time monitoring systems for critical resource utilisation (e.g. water, energy, waste) and using the resulting predictive analytics for ESG scenario planning (George, Merrill, and Schillebeeckx 2021; Wamba-Taguimdje et al. 2020). This ensures AI output is strategically aligned with the hotels' net-zero and social responsibility targets, moving the hotel beyond basic compliance. Second, to effectively seise the insights generated by AI, organisations must formalise the learning mechanism. Establish cross-functional Green Learning Task Forces (including Operations, IT, and HR) charged with interpreting AI outputs and translating them into new, adaptive protocols (e.g. revising standard operating procedures based on AI-identified waste spikes). Implement a closed-loop feedback system to ensure continuous learning and institutionalisation of sustainability knowledge (Cepeda and Vera 2007; Zhang et al. 2023). Third, given the powerful moderating role of responsible leadership, organisations must prioritise ethical stewardship. Integrate AI ethics, responsible innovation, and multi-stakeholder governance into mandatory leadership development programmes for top and middle management (Maak and Pless 2006; Waldman and Siegel 2008). This training ensures leaders possess the ethical mandate and systemic thinking necessary to consistently leverage AI-derived insights for the good of all stakeholders, mitigating risks of greenwashing or AI misuse.

Fourth, organisations must ensure internal systems reward the responsible use of AI. Establish ESG-aligned performance metrics for all digital initiatives (e.g. tying IT budget efficiency to verifiable CO_2 reductions or social impact KPIs). This reinforces the connection between technological capability, learning, and organisational accountability, ensuring the ESG mandate is fully embedded across the organisation (Appelbaum et al. 2017; Grover et al. 2018).

4.3. Limitations and future directions

Despite its valuable contributions, this study has limitations. First, the cross-sectional design constrains causal inferences about capability evolution; future research should conduct longitudinal studies to track iterative capability development, persistence, and generalizability and the evolution of AI-enabled learning. Second, the focus on the UAE hospitality sector limits generalizability due to its unique regulatory, technological, and cultural context; comparative studies across industries or institutional environments with varying ESG regulations and digital infrastructure are needed to test these boundary conditions. Moreover, constructs like AI-enabled green learning capability and responsible leadership are abstract and complex; future studies are necessary to develop clear empirical indicators and robust scale validation methods for these concepts.

Furthermore, this study's narrow focus on AI-enabled green learning and responsible leadership as micro-foundations overlooks other organisational factors; future investigations should examine additional micro-foundational elements such as digital mindset, team-level routines, and absorptive capacity. Moreover, the absence of process-based or qualitative approaches prevents insight into how frontline actors interpret and enact AI-derived insights; subsequent research should employ qualitative or mixed-methods designs to reveal how dynamic capabilities are socially constructed in practice. Finally, we recommend that future research investigate interactions between dynamic capabilities and algorithmic bias, data governance, and AI ethics to build a more normative account of responsible, sustainability-oriented AI adoption.

5. Conclusion

This study provides an integrated and empirically grounded perspective on how AI-powered BDAC can serve as a strategic lever for advancing ESG performance in the hospitality industry. By identifying AI-enabled green learning capability as a key mediating mechanism and responsible leadership as a critical boundary condition, the research contributes to a more nuanced understanding of how technological, cognitive, and ethical dimensions interact to drive sustainability outcomes. Drawing on DCT, the findings highlight that the successful deployment of AI for ESG impact requires more than advanced technical infrastructure; it depends equally on an organisation's ability to absorb, interpret, and act on ESG-related knowledge and the presence of leadership committed to responsible governance. Practically, the results underscore the importance of aligning digital investments with ethical leadership development and organisational learning systems. For hospitality organisations and other ESG-sensitive industries, the implications are clear: responsible leadership acts as the transformative meta-capability, converting AI-powered BDAC from a merely technical tool into a strategic ESG catalyst. Future research can build on these findings by exploring how these dynamics unfold in different cultural or industry contexts.

Author contributions

CRediT: **Imran Shafique:** Software, Validation, Visualization, Writing – original draft; **Tamania Khan:** Data curation, Formal analysis, Investigation, Methodology, Project administration; **Sudhir Rana:** Data curation, Formal analysis, Validation, Visualization; **Alberto Ferraris:** Conceptualization, Writing – review & editing.

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Appendix I

AI-powered big data analytics capability (Srinivasan and Swink, 2018)

My hotel:

1. Applies AI-driven analytical techniques (e.g. machine learning algorithms, predictive modelling, simulation, optimisation) to enhance and automate decision-making processes.
2. Integrates and synthesises large volumes of data from multiple sources (e.g. sales systems, ERP platforms, customer interactions, IoT devices) using AI technologies to support data-driven decision-making.
3. Employs AI-powered data visualisation tools (e.g. AI-augmented dashboards, real-time analytics platforms like PowerBI, Tableau, or custom AI systems) to help decision-makers interpret complex and dynamic data.
4. Provides AI-enhanced dashboard applications on managers' communication devices (e.g. smartphones, tablets, computers) for real-time, predictive, and prescriptive insights to support strategic and operational decisions.

AI-enabled green learning capability (Mikalef & Pateli, 2017)

This hotel:

1. Identifies, evaluates, and integrates new environmental information and knowledge using AI-driven big data analytics techniques.
2. Transforms large-scale environmental data into actionable green innovations through AI-powered analytical models and machine learning insights.
3. Assimilates and adapts to emerging green advancements by leveraging AI systems that detect, learn from, and predict sustainability trends.
4. Utilises AI-enhanced analysis of environmental information to support strategic and operational decision-making processes focused on sustainability and ESG goals.

ESG performance (Kim et al. 2024)

Our hotel:

Environmental

1. Has purchased environmentally preferable materials that are more recyclable or reusable than others.
2. Has prioritised water-efficient equipment and appliances (e.g. automatic faucets for sinks and high-performance dishwashers).
3. Has incorporated energy efficiency into facility operations (e.g. efficient heating, ventilation, and air- conditioning).
4. Is committed to reducing its emissions by fostering climate change awareness/action among employees.

Social

5. Ensures fair and equitable treatment for all people regardless of individual backgrounds.
6. Has equally given leadership role opportunities to all employees.
7. Has prioritised the health and safety of its employees and guests.
8. Has provided education or services to promote employees' wellbeing.
9. Is committed to encouraging and reinforcing responsible gaming strategies and practices.
10. Has provided employees with professional development opportunities.

Governance

11. Has established governance-related policies including its code of business conduct and ethics.
12. Is committed to full compliance with legal and regulatory requirements.
13. Is devoted to preventing and detecting crimes through its operations.
14. Has established policies and guidelines with respect to risk assessment and management (e.g. cybersecurity risk).
15. Has taken a proactive approach to risk prevention.
16. Has transparently informed its stakeholders (e.g. investors, customers, and employees) of activities and progress toward its ESG goals to demonstrate its impact.

Responsible leadership (Voegtlin, 2011)

At this hotel, top management:

1. Demonstrates strong awareness of the needs and concerns of relevant stakeholders, including guests, employees, suppliers, the local community, and environmental groups.
2. Carefully considers the consequences of decisions for all affected stakeholders, ensuring that actions align with ethical and sustainable practices.
3. Actively involves key stakeholders such as staff members, guests, and community representatives in important decision-making processes.
4. Thoughtfully weighs different stakeholder claims and interests before making strategic or operational decisions.
5. Strives to achieve consensus among affected stakeholders, promoting fairness, transparency, and shared understanding in decision-making.