BUSINESS, TECHNOLOGY & INNOVATION STUDIES JOURNAL (BTISJ)
ISSN 3110-9411

Volume 2, Issue 1, January–March 2026

Volume 2	Issue 1	JAN – MAR 2026
Received	Accepted	Published
10 January 2026	24 March 2026	31 March 2026

AI-Enabled Sustainability Engagement and Organizational Resilience: The Mediating Role of Green Innovation Capability and the Moderating Effects of Managerial Capability and Environmental Turbulence

DOI: https://doi.org/10.66578/btis.v2i1.23

Mohammad Zahedipour

Department of Business Administration, UAE Branch, Islamic Azad University, Dubai, UAE, 502321

Corresponding Author: Mohammad Zahedipour **Email:** Mohammad.zahedipour@gmail.com

ABSTRACT

This study examines how AI-enabled sustainability engagement enhances organizational resilience through green innovation capability within a dynamic capabilities framework. Drawing on time-lagged survey data from 812 industrial firms across Canada, the United States, and Mexico, we test a moderated mediation model using partial least squares structural equation modeling (PLS-SEM). The findings show that sustainability engagement significantly strengthens green innovation capability, which in turn enhances organizational resilience. The direct effect of sustainability engagement on resilience is marginal, indicating that adaptive stability primarily emerges through innovation-based capability development. Furthermore, dynamic managerial capability strengthens the relationship between sustainability engagement and green innovation, while environmental turbulence amplifies the effect of green innovation on resilience. The model explains substantial variance in both green innovation capability (47%) and organizational resilience (43%). By conceptualizing sustainability engagement as a digitally augmented environmental capability rather than a symbolic commitment, this study advances understanding of how firms build resilience under technological and regulatory instability.
Keywords: Artificial intelligence; Environmental strategy; Organizational resilience; Green innovation; Dynamic capabilities.

INTRODUCTION

Sustainability has evolved from a peripheral corporate responsibility initiative to a central strategic concern for firms operating under increasing environmental, technological, and regulatory

BUSINESS, TECHNOLOGY & INNOVATION STUDIES JOURNAL (BTISJ)
ISSN 3110-9411

Volume 2, Issue 1, January–March 2026

pressures (Wang & Zhang, 2025). Organizations are now expected not only to reduce environmental impact (Zhou, Shu, Jiang, & Gao, 2019) but also to maintain operational continuity and adaptability amid climate volatility (Falaleeva et al., 2011), digital disruption (Ambrogio, Filice, Longo, & Padovano, 2022), and geopolitical instability (Warf & Sui, 2010). While prior research has examined the relationship between sustainability practices and firm performance, findings remain inconsistent and often dependent on contextual conditions or measurement choices (Hodge, Subramaniam, & Stewart, 2009; Pang & Zhang, 2019). Scholars increasingly argue that sustainability should be understood not solely as a financial performance driver but as a mechanism for enhancing long-term adaptive capacity and organizational resilience (de Medeiros & Saurin, 2025; Liang & Li, 2023).

Beyond operational continuity, sustainability strategy is increasingly viewed as a core element of environmental value creation and long-term ecological competitiveness (Medne & Lapina, 2019). Within the environmental strategy literature, firms generate sustained advantage when environmental initiatives are embedded in organizational capabilities that enable adaptive responses to ecological uncertainty, regulatory change, and stakeholder pressure (Singh, Singh, Daultani, & Chouhan, 2023). Consequently, understanding sustainability as a strategic environmental capability (rather than a compliance mechanism) has become central to contemporary research in business strategy and the environment (Esangbedo, Zhang, Perez, & Skitmore, 2024).

Building on the natural-resource-based view (NRBV) of the firm (Hart, 1995), environmental strategy can generate sustained competitive advantage when ecological initiatives are embedded in firm-level capabilities that reduce resource dependence, enhance pollution prevention, and foster innovation (Larabi, 2025). The NRBV argues that environmental challenges create strategic opportunities when firms develop rare and difficult-to-imitate environmental capabilities (McDougall, Wagner, & MacBryde, 2019). From this perspective, sustainability engagement is not merely a compliance mechanism but a strategic orientation that reshapes organizational routines and resource configurations (Butler, 2011). Accordingly, examining sustainability through a capability lens aligns environmental strategy with long-term competitive positioning rather than short-term financial performance (Peng, 2024).

At the same time, rapid advances in artificial intelligence (AI) are transforming how firms collect, analyze, and respond to environmental information (Godoy-Bejarano, Ruiz-Pava, & Téllez-Falla, 2020). AI-enabled systems enhance real-time monitoring, predictive analytics, and strategic experimentation, potentially strengthening firms' ability to sense opportunities and threats (Luo, Qian, Liu, Yu, & Liu, 2024). Within the dynamic capabilities framework, sensing, seizing, and reconfiguring processes are central to sustained adaptation (Teece, 2007). Yet, despite growing interest in digital transformation, limited empirical research has examined how AI-enabled sustainability engagement contributes to organizational resilience through capability development rather than immediate financial outcomes. Existing studies tend to treat digital technologies as operational tools rather than as enablers of sustainability-driven transformation.

Green innovation capability represents a critical mechanism linking sustainability orientation to adaptive outcomes (Aboelmaged & Hashem, 2019). Eco-innovation research suggests that environmental initiatives yield strategic benefits when embedded within innovation processes that

BUSINESS, TECHNOLOGY & INNOVATION STUDIES JOURNAL (BTISJ)
ISSN 3110-9411

Volume 2, Issue 1, January–March 2026

reshape products, routines, and resource configurations (Dangelico, Pujari, & Pontrandolfo, 2017; Ding, 2023). However, the pathways through which sustainability engagement translates into resilience remain underexplored. In particular, it is unclear whether sustainability initiatives directly strengthen resilience or operate indirectly through innovation-based capability development. Addressing this gap is essential for clarifying how environmental strategy contributes to long-term organizational stability.

Furthermore, contextual and managerial conditions likely shape the effectiveness of sustainability-driven transformation (Zada, Khan, Zada, & Dhar, 2025). Dynamic managerial capability, defined as leaders' ability to orchestrate resources and reconfigure organizational assets, may amplify the conversion of sustainability engagement into innovation outcomes (Bianchi, Testa, Tessitore, & Iraldo, 2022; Browder, Dwyer, & Koch, 2024). Similarly, environmental turbulence (characterized by rapid technological and regulatory change) may intensify the value of innovation for resilience (Qalati, Jiang, Gyedu, & Manu, 2024). While contingency perspectives emphasize that capabilities generate greater returns under instability, empirical evidence integrating sustainability, AI, and turbulence remains limited.

To address these gaps, this study develops and tests a moderated mediation model in which AI-enabled sustainability engagement enhances organizational resilience primarily through green innovation capability. Dynamic managerial capability and environmental turbulence are proposed as boundary conditions that strengthen key relationships within the model. Using survey data from 812 industrial firms across Canada, the United States, and Mexico, the study employs partial least squares structural equation modeling to examine these mechanisms.

This study integrates the natural-resource-based view and dynamic capabilities theory to explain how AI-enabled sustainability engagement contributes to organizational resilience. The NRBV provides the strategic foundation by viewing sustainability engagement as a firm-specific environmental capability that can generate adaptive advantage when embedded in organizational routines. Dynamic capabilities theory explains the process through which this capability is enacted, as firms sense environmental challenges, seize sustainability-related opportunities, and reconfigure resources in response to change. Within this process, artificial intelligence does not operate as a separate technological resource; rather, it functions as a digital augmentation mechanism that strengthens sustainability-related sensing, analysis, and resource reconfiguration. Green innovation capability represents the intermediate transformation outcome through which sustainability engagement is translated into new products, processes, and knowledge integration routines, while organizational resilience reflects the broader adaptive result of these capability-building processes under environmental turbulence (Hart, 1995)

This research makes three contributions. First, it reframes sustainability engagement as a resilience building mechanism rather than a direct performance driver, responding to calls for long-term strategic perspectives on sustainability (de Medeiros & Saurin, 2025; Mwansasu & Mwagike, 2025; Sakina & Dou, 2025). Second, it integrates AI-enabled digital intelligence into dynamic capabilities theory, highlighting how technological systems enhance sensing and reconfiguration processes. Third, it identifies managerial and environmental contingencies that shape the sustainability–innovation–resilience pathway, offering a more nuanced understanding of adaptive transformation under turbulence.

BUSINESS, TECHNOLOGY & INNOVATION STUDIES JOURNAL (BTISJ)
ISSN 3110-9411

Volume 2, Issue 1, January–March 2026

By repositioning sustainability within a capability-based and digitally enabled resilience framework, this study advances both sustainability strategy and dynamic capabilities research while offering practical insights for firms navigating environmental and technological disruption.

Literature Review and Hypotheses Development

Sustainability Engagement and Organizational Resilience

Sustainability strategy has increasingly shifted from a peripheral responsibility toward a core mechanism of long-term organizational adaptation. Earlier research primarily evaluated sustainability through financial or market performance indicators, producing inconsistent empirical conclusions because such outcomes often capture short-term efficiency rather than adaptive capacity (Hodge et al., 2009; Medne & Lapina, 2019; Moore & Manring, 2009). Recent scholarship therefore reframes sustainability as a driver of organizational resilience, defined as the ability to anticipate, respond to, and recover from disruption while maintaining core functioning (Liang & Li, 2023; Wang & Zhang, 2025). From this perspective, sustainability engagement contributes to resilience when it strengthens learning processes, stakeholder trust, and resource flexibility rather than serving symbolic compliance (Takyi, Gyimah, & Danquah, 2025). This view aligns with arguments that sustainability generates enduring value through capability development and long-term strategic orientation rather than immediate profitability (de Medeiros & Saurin, 2025).

Recent studies highlight the growing role of digital technologies in supporting sustainability strategies. Artificial intelligence and advanced analytics enable organizations to monitor environmental performance, optimize resource usage, and support data-driven sustainability decisions. Emerging research suggests that AI-driven sustainability initiatives allow firms to integrate environmental goals with operational processes and strategic decision-making (Mwansasu & Mwagike, 2025; Oshilalu, 2024; Singh et al., 2023). These technologies facilitate the analysis of complex environmental data and help firms identify opportunities for eco-efficient innovations and sustainable resource management.

Dynamic Capabilities, Artificial Intelligence, and Sustainability Engagement

Dynamic capabilities theory explains how firms sustain competitiveness in changing environments through sensing opportunities, seizing them, and reconfiguring organizational resources (Shuen, Feiler, & Teece, 2014; Teece, 2007). Advances in artificial intelligence increasingly support these processes by enabling real-time environmental monitoring, predictive analytics, and data-driven experimentation. Rather than functioning as an isolated technological asset, AI strengthens sustainability-related sensing and decision-making routines, thereby enhancing the transformation of environmental initiatives into strategic action (Ganuthula, 2025). Conceptualizing AI-enabled sustainability engagement as a digitally augmented dynamic capability clarifies how technological intelligence contributes to adaptive organizational outcomes (Torrent-Sellens, Enache-Zegheru, & Ficapal-Cusí, 2025). This perspective extends existing sustainability research by positioning digital capability as an enabler of long-term transformation rather than operational efficiency alone.

BUSINESS, TECHNOLOGY & INNOVATION STUDIES JOURNAL (BTISJ)
ISSN 3110-9411

Volume 2, Issue 1, January–March 2026

Taken together, the NRBV and dynamic capabilities perspective provide a unified explanation for the proposed model. The NRBV explains why sustainability engagement matters strategically, because environmental capabilities can become sources of competitive and adaptive advantage. Dynamic capabilities theory explains how that advantage is realized, through sensing, seizing, and reconfiguring processes. AI strengthens these processes by improving data-driven environmental interpretation and strategic responsiveness. On this basis, sustainability engagement is expected to enhance green innovation capability, which then enables firms to build organizational resilience.

In this study, artificial intelligence is conceptualized not as an independent technological resource but as a digital augmentation mechanism embedded within sustainability related sensing, seizing, and reconfiguring processes. This positioning aligns AI with the micro-foundations of dynamic capabilities, allowing sustainability engagement to operate as an environmentally oriented strategic capability enhanced by digital intelligence rather than as a purely technological construct. Importantly, artificial intelligence is not modeled as an independent technological capability in this study. Rather, it is conceptualized as a digital augmentation mechanism embedded within sustainability engagement processes. This approach reflects the view that AI strengthens sensing and seizing routines that are already oriented toward environmental strategy, rather than constituting a separate strategic resource. Treating AI as an embedded augmentation mechanism avoids construct redundancy and ensures conceptual alignment with capability-based environmental strategy theory.

This conceptual positioning ensures construct clarity and theoretical consistency. AI is not measured as an independent technological capability but as a digital augmentation mechanism embedded within sustainability engagement processes. Treating AI in this manner avoids construct redundancy and aligns measurement with dynamic capabilities theory, where technological systems strengthen sensing and reconfiguration routines rather than operate as isolated strategic assets (Li, Teece, Baskaran, & Chandran, 2025; Teece, 2007). This distinction is important to prevent over-specification of digital constructs and to maintain theoretical coherence within environmental strategy research. The hypotheses are organized into three groups: (1) direct relationships between sustainability engagement, green innovation capability, and organizational resilience; (2) the mediating role of green innovation capability; and (3) the moderating roles of dynamic managerial capability and environmental turbulence.

Green Innovation Capability as a Mediating Mechanism

A critical pathway linking sustainability engagement to resilience lies in green innovation capability (Larabi, 2025; Zhang, Teng, Le, & Li, 2023). Eco-innovation research demonstrates that environmental strategies create strategic value when embedded within innovation processes that reshape products, production systems, and knowledge integration routines (Dangelico et al., 2017; Ding, 2023). Innovation enables firms to convert sustainability intent into operational transformation, thereby enhancing flexibility and recovery capacity under disruption. Without such capability, sustainability initiatives risk remaining symbolic and disconnected from core organizational processes. Accordingly, sustainability engagement is expected to strengthen green innovation capability, which in turn enhances organizational resilience (Bianchi et al., 2022).

BUSINESS, TECHNOLOGY & INNOVATION STUDIES JOURNAL (BTISJ)
ISSN 3110-9411

Volume 2, Issue 1, January–March 2026

AI-enabled sustainability engagement enhances green innovation capability by strengthening resource orchestration, environmental knowledge integration, and predictive sensing mechanisms. When sustainability initiatives are supported by AI-driven analytics, firms are better able to identify ecological inefficiencies, anticipate regulatory shifts, and coordinate cross-functional innovation processes. These sensing and seizing activities facilitate environmentally oriented product and process innovation consistent with sustainability-driven dynamic capability development (Liang & Li, 2023).

Recent research also emphasizes the role of green innovation capability as a critical mechanism through which sustainability strategies influence organizational performance. Firms that develop environmentally oriented innovation capabilities are better able to create eco-friendly products, improve resource efficiency, and respond to environmental regulations (e.g., Chen et al., 2022; Singh et al., 2023). Such capabilities are increasingly viewed as key drivers of sustainable competitive advantage in environmentally dynamic industries. Green innovation capability refers to a firm's ability to develop environmentally friendly products, services, and operational processes that reduce environmental impact while improving organizational performance. Green innovation capability contributes to organizational resilience by enabling firms to redesign production systems, reduce environmental vulnerabilities, and reconfigure resource flows during disruption. Innovation-driven adaptability strengthens recovery capacity and operational continuity under turbulence (Borah, Dogbe, Dzandu, & Pomegbe, 2023).

H1: AI-enabled sustainability engagement positively influences green innovation capability.
H2: Green innovation capability is positively associated with organizational resilience.
H3: Green innovation capability mediates the relationship between AI-enabled sustainability engagement and organizational resilience.

Managerial and Environmental Boundary Conditions

The effectiveness of sustainability-driven innovation depends on both managerial capabilities and environmental context (Oshilalu, 2024). Dynamic managerial capability reflects leaders' ability to integrate knowledge, orchestrate resources, and reconfigure organizational assets in response to change (Bianchi et al., 2022; Browder et al., 2024). Managers possessing strong dynamic capabilities are better positioned to translate sustainability initiatives into innovation outcomes through cross functional coordination and strategic investment, thereby strengthening the sustainability and innovation relationship.

External environmental conditions further shape adaptive outcomes (Esangbedo et al., 2024). Environmental turbulence, characterized by rapid technological, regulatory, and market change, increases uncertainty and risk of disruption. Under such instability, adaptive capabilities generate greater strategic value because firms must continually adjust structures and processes (Zhou et al., 2019). Consequently, the positive effect of green innovation capability on organizational resilience should be stronger in highly turbulent environments.

Dynamic managerial capability refers to managers' ability to sense opportunities, make strategic decisions, and reconfigure organizational resources in response to environmental change. In the context of sustainability engagement, managerial capability plays a crucial role in transforming sustainability initiatives into innovation outcomes. While sustainability engagement provides

BUSINESS, TECHNOLOGY & INNOVATION STUDIES JOURNAL (BTISJ)
ISSN 3110-9411

Volume 2, Issue 1, January–March 2026

strategic direction and organizational commitment toward environmental practices, the successful translation of these initiatives into green innovation requires managerial interpretation, coordination, and resource orchestration. Managers with strong dynamic capabilities are better able to integrate sustainability knowledge, mobilize technological resources, and align organizational processes toward environmentally oriented innovation. Therefore, when dynamic managerial capability is high, the positive effect of AI-enabled sustainability engagement on green innovation capability is expected to become stronger.

Environmental turbulence refers to the degree of unpredictability and rapid change in technological, regulatory, and market conditions. Under highly turbulent environments, firms face greater uncertainty and disruption, making adaptive capabilities increasingly valuable. Green innovation capability allows firms to redesign products, processes, and operational routines in environmentally sustainable ways, which enhances their ability to respond to unexpected environmental and regulatory pressures. In stable environments, the benefits of innovation capability may be less visible because firms can rely on established routines. However, when environmental turbulence is high, firms must rely more heavily on innovation capabilities to maintain operational continuity and strategic adaptability. Consequently, green innovation capability becomes a more critical driver of organizational resilience under turbulent conditions.

H4: Dynamic managerial capability positively moderates the relationship between AI-enabled sustainability engagement and green innovation capability.

H5: Environmental turbulence positively moderates the relationship between green innovation capability and organizational resilience.

Overall, the proposed framework explains resilience as the outcome of a capability-building process. AI-enabled sustainability engagement represents an environmentally oriented strategic capability grounded in the NRBV. Through the dynamic capabilities processes of sensing, seizing, and reconfiguring, this capability is translated into green innovation capability. Green innovation capability then enables firms to adapt operations, products, and resource configurations in ways that strengthen organizational resilience. Dynamic managerial capability and environmental turbulence act as boundary conditions that influence the strength of this transformation process.

Integrating these arguments, AI-enabled sustainability engagement is conceptualized as an environmentally oriented strategic capability that strengthens sensing and decision-making processes (Torrent-Sellens et al., 2025). Green innovation capability represents the reconfiguration mechanism through which environmental strategy reshapes products, processes, and resource allocations (Bianchi et al., 2022). Organizational resilience reflects the strategic outcome of these transformations, capturing adaptive stability under ecological and technological disruption. Dynamic managerial capability and environmental turbulence operate as boundary conditions that determine when sustainability-driven innovation translates into adaptive advantage (Zhang et al., 2023). This integrated framework situates sustainability within a digitally augmented environmental strategy perspective consistent with both the NRBV and dynamic capabilities theory. The hypothesized relationships and overall research framework are illustrated in Figure 1.

Based on the theoretical arguments presented above, this study proposes a moderated mediation model in which AI-enabled sustainability engagement influences organizational resilience through green innovation capability. Dynamic managerial capability strengthens the transformation of

BUSINESS, TECHNOLOGY & INNOVATION STUDIES JOURNAL (BTISJ)
ISSN 3110-9411

Volume 2, Issue 1, January–March 2026

sustainability engagement into innovation capability, while environmental turbulence intensifies the impact of green innovation capability on organizational resilience. Figure 1 presents the conceptual model.

Based on the theoretical arguments discussed above, this study proposes an integrated conceptual framework explaining how AI-enabled sustainability engagement contributes to organizational resilience. The framework suggests that sustainability engagement supported by digital technologies enhances green innovation capability by enabling firms to identify environmentally oriented opportunities and develop eco-efficient products and processes. Green innovation capability, in turn, strengthens organizational resilience by improving firms' ability to adapt to environmental disruptions and regulatory changes. Furthermore, the framework proposes that dynamic managerial capability strengthens the transformation of sustainability engagement into green innovation capability, while environmental turbulence intensifies the effect of green innovation capability on organizational resilience.

Figure 1 illustrates the proposed conceptual model. AI-enabled sustainability engagement represents the primary strategic capability influencing organizational resilience through the mediating mechanism of green innovation capability. Dynamic managerial capability and environmental turbulence act as boundary conditions that strengthen the relationships between key constructs.

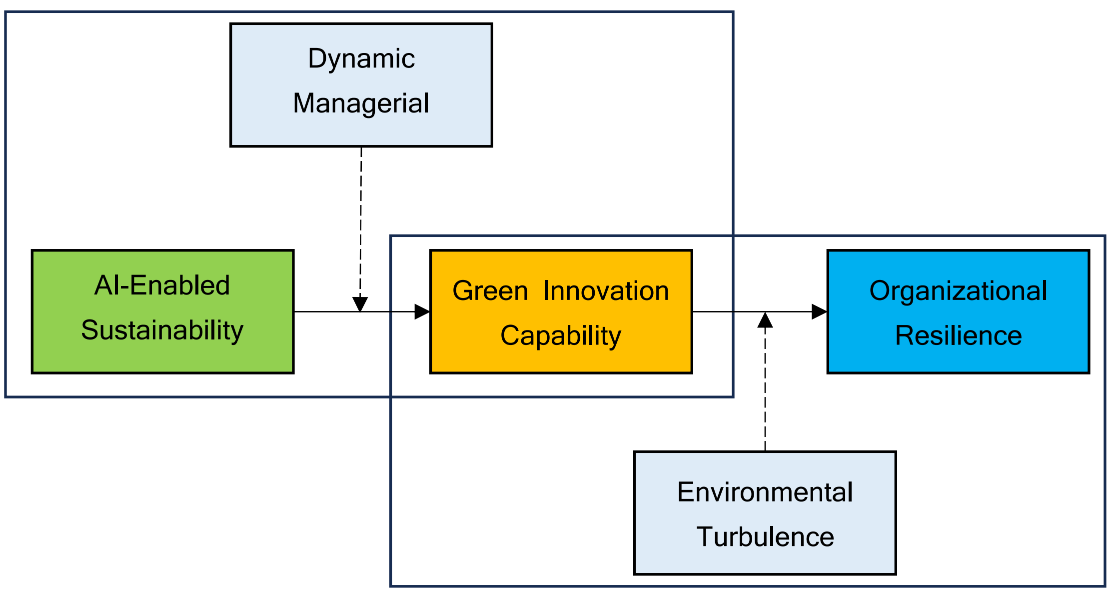

Figure 1. Research Model

Methodology

Research Design and Sample

BUSINESS, TECHNOLOGY & INNOVATION STUDIES JOURNAL (BTISJ)
ISSN 3110-9411

Volume 2, Issue 1, January–March 2026

This study adopts a time lagged, multi country survey design to examine how AI-enabled sustainability engagement influences organizational resilience through green innovation capability under varying managerial and environmental conditions. Temporal separation of measurement reduces common method bias and strengthens causal inference. A 12-month time lag was selected because innovation capability development and resilience reconfiguration typically unfold over medium-term strategic cycles rather than short-term operational intervals.

The empirical context consists of industrial firms operating in Canada, the United States, and Mexico, representing heterogeneous regulatory environments, technological maturity, and exposure to environmental disruption. Firms employing fewer than fifty employees were excluded to ensure the presence of formalized sustainability and innovation structures. Data were collected from senior executives responsible for sustainability, innovation, or digital transformation, as these informants possess accurate knowledge of organizational capabilities and strategic processes. The demographic and organizational characteristics of the sampled firms are summarized in Table 1.

Several procedural remedies were implemented to reduce potential common method bias. First, respondents were assured of anonymity and confidentiality to minimize evaluation apprehension. Second, the questionnaire clearly indicated that there were no right or wrong answers and that responses would be used only for academic research purposes. Third, measurement items for predictor and outcome variables were separated in different sections of the questionnaire to reduce respondents' tendency to provide consistent answers. These procedural steps follow recommendations in survey research methodology to reduce common method variance. Data were collected from managers working in manufacturing and technology-oriented firms that have adopted digital technologies and sustainability initiatives. Respondents included senior managers, sustainability officers, and operations managers with knowledge of organizational innovation and environmental practices. The survey was conducted in 2024 using an online questionnaire distributed through professional networks and industry contacts.

A total of 3,200 firms were contacted using commercial business directories and national industrial registries, yielding 894 usable responses at Time 1 and 812 matched responses at Time 2, corresponding to an effective response rate of 25.4%. Early and late response comparisons revealed no significant differences across key variables, suggesting that non-response bias is unlikely. Missing data were minimal and addressed using expectation maximization imputation.

Table 1. Sample characteristics

Characteristic	Category	Percentage / Mean
Country	Canada	33.0%
	United States	37.1%
	Mexico	29.9%
Industry	Manufacturing	34.5%
	Industrial services	25.7%
	Logistics & transport	21.6%
	Energy & utilities	18.2%
Firm size	Mean employees	286

BUSINESS, TECHNOLOGY & INNOVATION STUDIES JOURNAL (BTISJ)
ISSN 3110-9411

Volume 2, Issue 1, January–March 2026

Firm age	Mean years	18.4
Respondent role	Senior executive/manager	100%

Measurement Development

All constructs were operationalized as reflective multi-item measures using seven-point Likert-type response scales ranging from strongly disagree to strongly agree. Measurement items were adapted from validated prior literature, reviewed by academic experts, and pilot-tested with industry managers to ensure clarity and contextual relevance. To maintain cross national consistency, the questionnaire underwent translation procedures and back translation procedures.

AI-enabled sustainability engagement was modeled as a first order reflective construct integrating sustainability strategy with AI-driven analytics capability. Green innovation capability captured the firm's ability to develop environmentally oriented products and processes. Organizational resilience reflects adaptive capacity and recovery ability under disruption. Dynamic managerial capability measured leadership cognition and resource orchestration, while environmental turbulence captured perceived instability in technological, regulatory, and market conditions. The constructs, number of measurement items, and conceptual definitions are presented in Table 2, and the full measurement items are provided in Appendix A.

All constructs in this study were measured using previously validated scales adapted from prior research in sustainability, innovation, and organizational resilience literature. Items were measured using a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. AI-enabled sustainability engagement was measured using items adapted from sustainability strategy and digital transformation literature. Green innovation capability was measured using established scales capturing firms' ability to develop environmentally friendly products and processes. Organizational resilience was measured using items reflecting adaptive capacity and recovery ability under environmental disruptions. Dynamic managerial capability was measured using scales reflecting managerial sensing, decision-making, and resource orchestration abilities. Environmental turbulence was measured using items capturing perceived technological and market uncertainty. All measurement items were slightly adapted to reflect the context of digital sustainability practices.

Table: Measurement Constructs and Sources

Construct	**Number of Items**	**Example Item**	**Source**
AI-enabled Sustainability Engagement	5	Our organization uses digital technologies to support sustainability initiatives	Adapted from Dubey et al. (2019); Bag et al. (2021)
Green Innovation Capability	4	Our firm develops environmentally friendly products and processes	Chen et al. (2006)
Organizational Resilience	4	Our organization can quickly adapt to unexpected disruptions	Lengnick-Hall et al. (2011)

BUSINESS, TECHNOLOGY & INNOVATION STUDIES JOURNAL (BTISJ)
ISSN 3110-9411

Volume 2, Issue 1, January–March 2026

Dynamic Managerial Capability	4	Managers effectively reconfigure organizational resources to respond to change	Adner & Helfat (2003)
Environmental Turbulence	3	Technological changes in our industry are unpredictable	Jaworski & Kohli (1993)

Reliability, Validity, and Measurement Invariance
Measurement quality was assessed using partial least squares structural equation modeling (PLS-SEM) criteria. Indicator loadings were generally above 0.70, although two indicators with slightly lower loadings were retained due to theoretical relevance and acceptable composite reliability. Composite reliability values exceeded 0.70, and average variance extracted values surpassed 0.50, confirming convergent validity. Discriminant validity was supported through heterotrait–monotrait ratios below 0.85. Because the study uses a multi-country sample, measurement invariance was examined using the MICOM procedure, which confirmed configural and compositional invariance across countries, enabling meaningful cross group comparison. Detailed measurement statistics and discriminant validity matrices are reported in Appendices B and C.
The reliability and validity of the measurement model were assessed using standard PLS-SEM criteria. Internal consistency reliability was evaluated using Cronbach's alpha and composite reliability, with all values exceeding the recommended threshold of 0.70. Convergent validity was assessed using the average variance extracted (AVE), which exceeded the recommended threshold of 0.50 for all constructs. Discriminant validity was evaluated using the Fornell–Larcker criterion and heterotrait–monotrait ratio (HTMT), confirming that all constructs were empirically distinct.

Structural Model Estimation
Hypotheses were tested using PLS-SEM, which is appropriate for prediction-oriented research involving moderated mediation and complex causal relationships. Structural paths were estimated using bootstrapping with 5,000 resamples to obtain robust standard errors and confidence intervals. Mediation effects were evaluated using indirect effect confidence intervals and variance accounted for criteria, while moderation effects were examined through mean centered interaction terms and simple slope analysis. Model fit and predictive performance were assessed using the standardized root mean square residual (SRMR), normed fit index (NFI), Stone–Geisser Q^2, and PLSpredict procedures.

Control Variables, Robustness, and Endogeneity
To isolate hypothesized relationships, the analysis included controls for firm size, firm age, industry type, country effects, and R&D intensity. Endogeneity concerns were examined using Gaussian copula procedures, and multicollinearity was assessed through full collinearity variance inflation factors below conservative thresholds. Additional robustness checks included alternative regression estimation and country level multi group comparison. Detailed robust diagnostics are summarized in Appendix D.
Reverse causality concerns are mitigated by the time-lagged research design, which separates measurement of sustainability engagement and innovation capability from subsequent resilience

outcomes. Because resilience reflects adaptive capacity following environmental disruption, it is theoretically and temporally positioned as an outcome rather than an antecedent of sustainability engagement. Together with Gaussian copula diagnostics, the temporal design strengthens confidence that the observed relationships reflect directional strategic effects rather than spurious correlation.

Ethical Considerations and Common Method Bias

The research complied with institutional ethical standards for survey-based organizational studies. Participation was voluntary, confidentiality was assured, and informed consent was obtained from all respondents. Procedural remedies included temporal separation of measurement, respondent anonymity, and psychologically separated questionnaire sections. Statistical assessment further indicated that common method variance was unlikely to threaten validity. Harman's single factor test showed that no single factor accounted for the majority of covariance, and full collinearity variance inflation factors remained below conservative thresholds, consistent with recommended PLS-SEM diagnostics. Together, these procedural and statistical controls suggest that common method bias does not materially affect the study's findings.

Results

Sample Overview

The final matched sample consisted of 812 industrial firms across Canada (33.0%), the United States (37.1%), and Mexico (29.9%), spanning manufacturing, industrial services, logistics, and energy sectors. Firms employed an average of 286 employees and had operated for 18.4 years, indicating established organizational structures suitable for sustainability and innovation initiatives. All respondents held senior managerial roles with direct responsibility for sustainability, innovation, or digital transformation, supporting the reliability of perceptual measures.

Descriptive Statistics and Correlations

Table 3 presents the means, standard deviations, and Pearson correlations among the study constructs. Correlation magnitudes remain below conservative multicollinearity thresholds, indicating acceptable discriminant validity at the bivariate level. The strongest association appears between green innovation capability and organizational resilience, whereas the relationship between environmental turbulence and AI-enabled sustainability engagement is comparatively weak, consistent with turbulence functioning as a contextual rather than direct strategic factor.

Table 3. Descriptive statistics and correlations (N = 812)

Construct	Mean	SD	1	2	3	4	5
1. AI-enabled sustainability engagement	4.78	1.16	—				

BUSINESS, TECHNOLOGY & INNOVATION STUDIES JOURNAL (BTISJ)
ISSN 3110-9411

Volume 2, Issue 1, January–March 2026

2. Green innovation capability	4.49	1.12	.53***	—			
3. Organizational resilience	4.61	1.05	.36***	.57***	—		
4. Dynamic managerial capability	4.74	1.08	.44***	.48***	.41***	—	
5. Environmental turbulence	4.18	1.19	.18*	.26***	.29***	.24**	—

*p < .05, **p < .01, ***p < .001

Measurement Model Assessment

Indicator reliability, internal consistency, and convergent validity were evaluated using PLS-SEM measurement criteria. Most outer loadings exceeded 0.70, although two indicators with slightly lower loadings (0.68 and 0.64) were retained because composite reliability and average variance extracted remained above recommended thresholds. Overall composite reliability ranged from 0.86 to 0.91, and AVE values exceeded 0.50, confirming convergent validity. The detailed outer loadings and reliability statistics are reported in Table 4.

To assess potential common method bias, Harman's single-factor test was conducted. The results showed that the first factor accounted for less than 50% of the total variance, suggesting that common method bias is unlikely to be a major concern in this study. In addition, variance inflation factor (VIF) values were examined, and all values were below the recommended threshold of 3.3, further indicating that common method bias does not significantly affect the results. Following recent methodological recommendations, full collinearity VIF values were also examined and were all below the threshold of 3.3, indicating that common method variance is not a serious concern.

Table 4. Outer loadings and reliability statistics

Construct	Item	Loading	CR	AVE
AI-enabled sustainability engagement	A1	.82		
	A2	.85		
	A3	.76		
	A4	.68		
	A5	.73	.90	.64
Green innovation capability	G1	.84		
	G2	.80		
	G3	.75		
	G4	.64	.88	.60
Organizational resilience	R1	.87		
	R2	.83		
	R3	.78		

BUSINESS, TECHNOLOGY & INNOVATION STUDIES JOURNAL (BTISJ)
ISSN 3110-9411

Volume 2, Issue 1, January–March 2026

	R4	.74		
	R5	.71	.91	.67
Dynamic managerial capability	M1	.81		
	M2	.77		
	M3	.73		
	M4	.69	.86	.57
Environmental turbulence	T1	.79		
	T2	.74		
	T3	.71	.86	.62

Discriminant validity was further supported by HTMT ratios below 0.85 (see Appendix C).

Structural Model Evaluation

Structural relationships were estimated using bootstrapped PLS-SEM (5,000 resamples). Model-fit statistics indicated acceptable fit (SRMR = 0.058; NFI = 0.91), while predictive relevance values were positive ($Q^2 = 0.29$ for green innovation capability and $Q^2 = 0.24$ for organizational resilience). The model explained 47% of the variance in green innovation capability and 43% in organizational resilience. Structural path coefficients and effect sizes are reported in Table 5. These R^2 values indicate moderate explanatory power and are comparable to or exceed those reported in recent environmental capability and sustainability innovation studies published in Business Strategy and the Environment (Luo et al., 2024; Qalati, Siddiqui, & Magni, 2024), suggesting that the proposed moderated mediation framework captures substantively meaningful strategic variance.

Table 5. Structural path coefficients and effect sizes

Path	**β**	**t**	**p**	**f²**
Sustainability → Green innovation	.52	11.94	< .001	.27
Green innovation → Resilience	.39	9.11	< .001	.19
Sustainability → Resilience	.11	1.71	.087	.03

These findings support H1 and H2, while the direct sustainability and resilience path remains marginal. The effect sizes further indicate substantive strategic relevance. The sustainability and innovation path exhibits a medium effect ($f^2 = .27$), suggesting that AI-enabled sustainability engagement meaningfully contributes to capability development. The innovation and resilience relationship demonstrates a moderate effect ($f^2 = .19$), indicating that green innovation capability plays a practically significant role in shaping adaptive outcomes. In contrast, the direct sustainability and resilience path shows a small effect ($f^2 = .03$), reinforcing the interpretation that resilience emerges primarily through innovation-based capability transformation rather than direct sustainability orientation alone.

Mediation Analysis

BUSINESS, TECHNOLOGY & INNOVATION STUDIES JOURNAL (BTISJ)
ISSN 3110-9411

Volume 2, Issue 1, January–March 2026

Bootstrapping results indicate a significant indirect effect of sustainability engagement on resilience through green innovation capability (β = .20, 95% CI [.15, .26]). Because the direct effect remains marginally significant, the mediation pattern represents complementary partial mediation, supporting H3 and indicating that resilience emerges primarily through innovation-based capability development.

Moderation Analysis

Interaction effects were tested using mean-centered product terms. Dynamic managerial capability strengthens the sustainability and innovation relationship (β = .15, p = .008), with the slope increasing from .39 at low managerial capability to .63 at high capability. Environmental turbulence amplifies the innovation and resilience relationship (β = .12, p = .021), with slopes rising from .33 to .51 under high turbulence. These interaction patterns are illustrated in Figure 2. Figure 2. Moderating effects of dynamic managerial capability and environmental turbulence on structural relationships which shows steeper positive slopes under conditions of high dynamic managerial capability and high environmental turbulence, respectively.

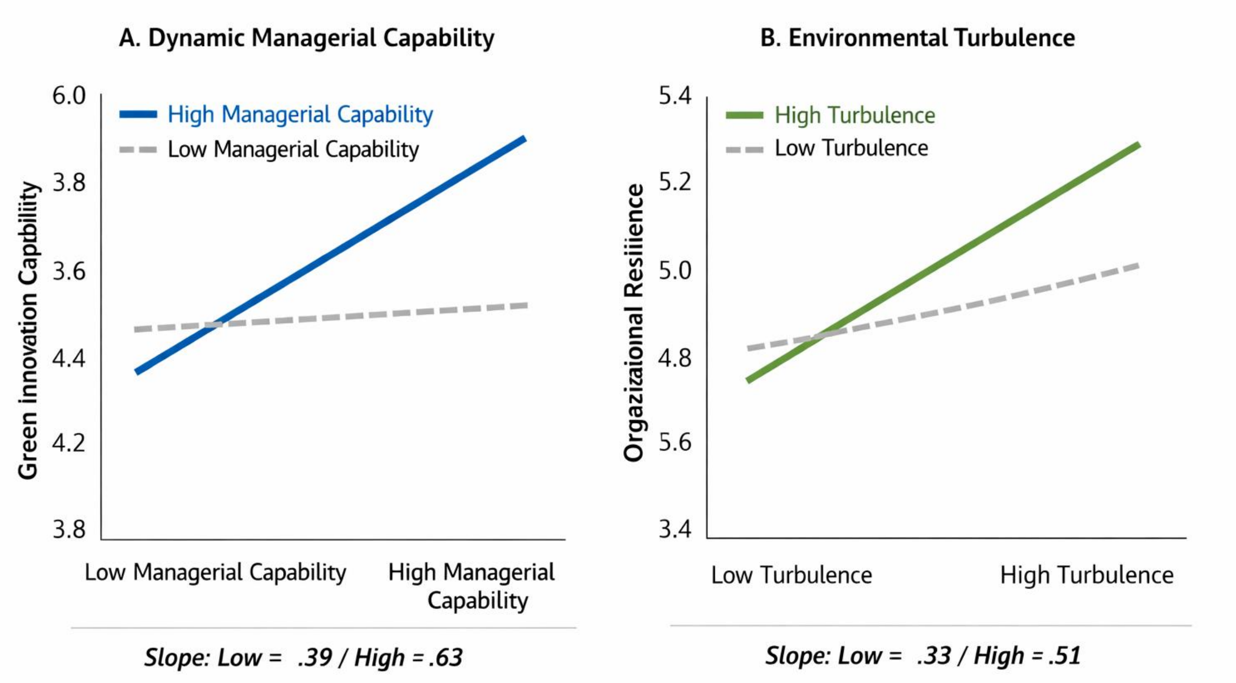

Figure 2. Moderating effects of dynamic managerial capability and environmental turbulence on structural relationships.

Control Variables

Control variables were included to isolate the hypothesized strategic relationships from alternative structural explanations. Firm size may enhance resilience through resource slack and diversification capacity, while firm age can generate both experiential learning and structural rigidity. R&D intensity captures baseline innovation orientation independent of sustainability engagement. Industry and country controls account for sector-specific environmental regulation

ISSN 3110-9411

Volume 2, Issue 1, January–March 2026

and institutional differences across North America. Including these controls strengthens confidence that the observed effects reflect sustainability-driven capability development rather than structural firm characteristics.

Control-variable estimates indicate that firm size shows a small positive relationship with organizational resilience ($\beta = .09$, $p = .038$), whereas firm age exhibits a negative but non-significant association ($\beta = -.05$, $p = .214$). R&D intensity positively influences green innovation capability ($\beta = .12$, $p = .026$), while industry and country dummies are not statistically significant. The magnitude of these control effects remains substantively smaller than the primary structural paths, reinforcing that the observed relationships reflect sustainability-driven strategic capability development rather than structural firm characteristics or industry conditions, consistent with capability-based environmental strategy theory (Hart, 1995; McDougall et al., 2019).

Multi Group Analysis

Because sustainability strategy and environmental regulation vary across national institutional contexts, multi-group analysis was conducted to assess potential cross-country heterogeneity in structural relationships. Differences in regulatory intensity, ESG enforcement, and technological infrastructure across Canada, the United States, and Mexico could theoretically moderate sustainability-driven capability development.

PLS-MGA comparisons across Canada, the United States, and Mexico reveal no statistically significant differences in primary structural paths ($p > .10$), indicating that the hypothesized relationships operate consistently across the sampled North American contexts. As measurement invariance was established using the MICOM procedure, cross-country comparisons are statistically meaningful. The absence of significant cross-national differences suggests that AI-enabled sustainability engagement functions as a broadly applicable strategic capability across North American institutional environments, reinforcing the generalizability of the proposed framework.

Robustness and Endogeneity Tests

To ensure the stability and credibility of the structural results, multiple robustness and endogeneity diagnostics were conducted. First, potential endogeneity concerns were examined using Gaussian copula procedures, following Park and Gupta (2012). The copula terms were not statistically significant, indicating that unobserved heterogeneity or omitted variable bias does not materially affect the estimated relationships. In addition, the time-lagged research design—separating measurement of sustainability engagement and innovation capability from subsequent resilience outcomes—reduces the likelihood of reverse causality and strengthens directional inference.

Second, multicollinearity and common method bias were assessed using full collinearity variance inflation factors (VIFs). All VIF values ranged between 1.7 and 2.6, remaining below the conservative threshold of 3.3 recommended for detecting common method variance in PLS-SEM (Kock, 2015). These results suggest that collinearity does not inflate structural path estimates.

Third, alternative model specifications were examined to test the robustness of the hypothesized causal ordering. Models reversing the sustainability–resilience relationship and excluding the mediation structure produced weaker explanatory power and inferior indirect effects, reinforcing the theoretical logic of sustainability-driven innovation as the primary pathway to resilience.

Finally, out-of-sample predictive validity was evaluated using PLSpredict procedures. Prediction errors for the endogenous constructs were lower than those generated by linear benchmark models, indicating superior predictive performance of the moderated mediation structure. This finding suggests that the proposed model captures nonlinear strategic interactions more effectively than simplified regression approaches.

Collectively, these robustness checks indicate that the empirical findings are stable across alternative specifications, free from substantive endogeneity bias, and demonstrate both explanatory and predictive validity. The results therefore provide strong support for the strategic interpretation that AI-enabled sustainability engagement enhances organizational resilience primarily through green innovation capability under appropriate managerial and environmental conditions.

Discussion

The purpose of this study was to examine how AI-enabled sustainability engagement contributes to organizational resilience through green innovation-capability within a dynamic capabilities framework and under varying managerial and environmental conditions. The empirical findings provide consistent support for the proposed moderated mediation structure while also clarifying the magnitude and limits of sustainability's adaptive impact. Sustainability engagement significantly enhances green innovation capability, and innovation in turn strengthens organizational resilience. However, the direct relationship between sustainability engagement and resilience is only marginal, indicating that resilience emerges primarily through innovation-based capability development rather than sustainability orientation alone. This pattern aligns with resilience conceptualizations emphasizing adaptive learning and resource reconfiguration rather than symbolic environmental commitment (Liang & Li, 2023).

These findings contribute to sustainability strategy research by reframing sustainability outcomes away from short-term financial performance toward long-term adaptive capacity. Earlier sustainability and performance studies produced inconsistent conclusions partly because performance indicators capture immediate efficiency gains while overlooking resilience-related capabilities. By demonstrating that sustainability engagement operates mainly through green innovation capability, the study supports arguments that sustainability generates enduring strategic value through capability development and long-term orientation (de Medeiros & Saurin, 2025). The complementary partial mediation observed here helps reconcile prior mixed evidence by showing that sustainability can influence resilience both indirectly through innovation and directly but weakly through preparedness and stakeholder trust.

The study also advances dynamic capabilities theory by clarifying the role of artificial intelligence in sustainability-driven adaptation. Rather than functioning as an independent technological construct, AI operates as an enabling mechanism that strengthens sensing, seizing, and reconfiguring processes embedded within sustainability engagement. This positioning aligns with the foundational view that adaptive advantage depends on the orchestration of organizational processes rather than isolated resources (Shuen et al., 2014; Teece, 2007). Empirically, the results indicate that AI-supported sustainability initiatives are more likely to translate into innovation capability, which then supports resilience. This evidence extends emerging scholarship on digital intelligence in organizations by demonstrating its relevance for environmental strategy and adaptive stability, not merely operational efficiency.

The moderating effects further refine understanding of when sustainability-driven innovation produces resilience. Dynamic managerial capability strengthens the sustainability and innovation relationship, confirming that leadership cognition and resource orchestration are essential for converting sustainability intent into operational transformation (Bianchi et al., 2022; Browder et al., 2024). At the same time, environmental turbulence amplifies the innovation and resilience link, indicating that adaptive capabilities generate greater strategic value under unstable technological and regulatory conditions (Zhou et al., 2019). Together, these boundary conditions highlight that sustainability-based resilience is context dependent, emerging most strongly when managerial capability and environmental instability jointly necessitate adaptive change.

From a managerial perspective, the findings suggest that sustainability initiatives should be viewed not primarily as compliance or reputation mechanisms but as investments in adaptive capability. Firms seeking resilience should integrate sustainability strategy with AI-enabled analytics and embed these efforts within systematic innovation processes. Leadership capability becomes equally critical, as managers must coordinate knowledge, allocate resources, and guide transformation under uncertainty. Importantly, the modest direct effect of sustainability on resilience indicates that symbolic sustainability without innovation is unlikely to yield substantial adaptive benefits.

These findings are particularly relevant in the context of intensifying climate regulation, ESG disclosure requirements, and carbon-transition policies across North America. As regulatory volatility increases, firms must develop environmental capabilities that extend beyond compliance toward adaptive transformation. The results suggest that AI-enabled sustainability engagement may serve as a strategic mechanism for navigating policy uncertainty while simultaneously strengthening innovation-driven resilience.

Nevertheless, the proposed model may be less applicable to micro-enterprises or firms operating in low-digital or minimally regulated environments where formalized sustainability systems and AI-enabled analytics infrastructure are absent. The framework therefore reflects capability-driven environmental strategy in structured organizational contexts characterized by regulatory exposure and technological investment, rather than informal or resource-constrained settings.

Despite these contributions, several limitations highlight opportunities for advancing environmental strategy research in digitally enabled sustainability contexts. Although the time-lagged design improves causal inference, longitudinal panel data would better capture dynamic capability evolution and resilience trajectories over time. The reliance on perceptual measures may introduce subjective bias, suggesting future integration of objective environmental or disruption-recovery indicators. Additionally, while the multi-country sample enhances generalizability, the absence of significant cross-national differences indicates a need for future studies to examine institutional or regulatory moderators more explicitly. Further research could also explore

BUSINESS, TECHNOLOGY & INNOVATION STUDIES JOURNAL (BTISJ)
ISSN 3110-9411

Volume 2, Issue 1, January–March 2026

nonlinear or threshold effects of AI-enabled sustainability, as digital capability investments may generate diminishing or accelerating adaptive returns across different maturity stages.

Managerial Implications

From a managerial perspective, the findings indicate that sustainability initiatives should be designed as capability-building investments rather than symbolic environmental commitments. Integrating AI-enabled analytics into sustainability strategies enhances firms' ability to anticipate ecological risks, coordinate green innovation, and maintain operational continuity under disruption. Moreover, leadership capability plays a critical role in translating sustainability intent into adaptive innovation outcomes, particularly in turbulent regulatory and technological environments. Managers should therefore align environmental strategy, digital intelligence, and innovation governance to strengthen long-term organizational resilience.

The findings highlight the strategic importance of integrating digital technologies with sustainability initiatives to enhance organizational adaptability. Specifically, the results indicate that AI-enabled sustainability engagement significantly improves green innovation capability, suggesting that digital technologies strengthen firms' ability to transform environmental commitments into innovation outcomes. This finding supports the argument that sustainability strategies can generate competitive and adaptive advantages when supported by digital analytics and technological capabilities. By leveraging AI technologies, firms can analyze environmental data, optimize resource use, and identify opportunities for eco-efficient product and process innovations.

Furthermore, the results demonstrate that green innovation capability plays a critical mediating role in translating sustainability engagement into organizational resilience. This suggests that sustainability initiatives alone may not directly improve resilience unless they are operationalized through innovation-oriented capabilities. Firms that actively develop green innovation capabilities are better positioned to redesign products, processes, and operational systems in response to environmental disruptions. As a result, innovation capability becomes a key mechanism through which sustainability-oriented strategies contribute to long-term organizational adaptability.

Theoretical Contributions

This study advances environmental strategy research by integrating the NRBV and dynamic capabilities theory into a unified explanation of sustainability-driven resilience. Specifically, the study conceptualizes AI-enabled sustainability engagement as an environmental capability that acquires strategic value when enacted through sensing, seizing, and reconfiguring processes. In this framework, AI strengthens the micro-foundations of sustainability strategy rather than functioning as a stand-alone technological resource. The findings further show that green innovation capability is the key transformation mechanism through which sustainability engagement is converted into organizational resilience, while dynamic managerial capability and environmental turbulence determine the conditions under which this process becomes more effective.

More broadly, this study advances environmental strategy research by integrating digital transformation and dynamic capabilities into a unified resilience framework. By integrating environmental strategy, digital transformation, and dynamic capabilities into a unified resilience framework. While prior BSE research has examined green innovation, ESG performance, and environmental turbulence independently (Dangelico et al., 2017; Torrent-Sellens et al., 2025), this study connects these streams by demonstrating how digitally augmented sustainability capabilities generate adaptive advantage under ecological and technological instability. This integrative perspective advances understanding of how environmental strategy evolves in the era of artificial intelligence and regulatory volatility.

The findings provide several practical insights for managers seeking to strengthen organizational resilience through sustainability and digital transformation. First, managers should treat sustainability engagement not merely as a compliance requirement but as a strategic capability that can drive innovation and long-term adaptability. Organizations should integrate digital technologies such as artificial intelligence, data analytics, and environmental monitoring systems into sustainability initiatives to enhance decision-making and operational efficiency.

Second, firms should invest in developing green innovation capability by encouraging cross-functional collaboration between sustainability teams, R&D departments, and technology specialists. Such collaboration allows organizations to convert sustainability objectives into concrete innovations in products, processes, and resource management.

Third, organizations should strengthen dynamic managerial capabilities by enhancing leadership skills related to digital transformation and sustainability strategy. Managers who can effectively sense environmental opportunities, interpret technological information, and reconfigure resources are better positioned to translate sustainability initiatives into innovation outcomes.

Finally, firms operating in highly turbulent environments should prioritize innovation-driven sustainability strategies because green innovation capability becomes particularly valuable for maintaining resilience under uncertain technological and regulatory conditions. Overall, this study demonstrates that the integration of digital technologies and sustainability strategies can create innovation-driven capabilities that strengthen organizational resilience in turbulent environments.

From a managerial perspective, the findings suggest several concrete actions that organizations can take to strengthen sustainability-driven innovation and resilience. First, managers should integrate artificial intelligence and data analytics into sustainability monitoring systems to track energy consumption, emissions, and resource utilization in real time. Second, organizations should establish cross-functional sustainability innovation teams that combine expertise from environmental management, operations, and digital technology departments. Such teams can facilitate the translation of sustainability goals into green products and process innovations. Third, leadership development programs should focus on strengthening dynamic managerial capabilities by training managers to interpret environmental data, evaluate sustainability investments, and reconfigure organizational resources in response to technological and regulatory change. Finally, firms operating in turbulent environments should prioritize innovation-driven sustainability strategies, as the results indicate that green innovation capability becomes particularly important for maintaining organizational resilience under conditions of uncertainty.

Limitations and Future Research

Despite its contributions, this study has several limitations that provide opportunities for future research. First, the study relies on cross-sectional survey data, which limits the ability to make strong causal inferences. Future research could employ longitudinal designs to examine how sustainability engagement and green innovation capability evolve over time and how these changes influence organizational resilience.

Second, the data were collected from a single survey source, which may raise concerns related to common method bias despite the procedural and statistical remedies applied. Future studies could collect data from multiple respondents within the same organization or combine survey data with archival or objective performance measures to strengthen the robustness of the findings.

Third, this study focuses on AI-enabled sustainability engagement as a driver of green innovation capability and resilience. Future research could explore additional digital technologies such as big data analytics, blockchain, and Internet of Things (IoT) systems that may further enhance sustainability-driven innovation.

Finally, future research could examine industry-specific dynamics and cross-country differences in sustainability and innovation practices. Institutional factors, regulatory environments, and cultural contexts may influence how organizations adopt sustainability-oriented digital technologies and how these initiatives contribute to organizational resilience.

Conclusion

This study investigated how AI-enabled sustainability engagement contributes to organizational resilience through green innovation-capability within a dynamic capabilities framework and under varying managerial and environmental conditions. Using time lagged survey data from 812 industrial firms across North America, the findings demonstrate that sustainability engagement enhances resilience primarily through innovation-based capability development, while the direct sustainability and resilience relationship remains marginal. These results clarify why prior sustainability and performance research has produced inconsistent evidence by showing that sustainability generates long-term adaptive value mainly through capability transformation rather than immediate outcomes, consistent with resilience-oriented perspectives such as Liang and Li (2023) and strategic sustainability arguments advanced by de Medeiros and Saurin (2025).

The study further contributes by positioning artificial intelligence as an enabling mechanism that strengthens sensing, seizing, and reconfiguring processes embedded within sustainability engagement, thereby extending the dynamic capabilities view articulated by Teece (2007). In addition, the moderating roles of dynamic managerial capability and environmental turbulence highlight that sustainability-driven resilience is context dependent, emerging most strongly when leadership orchestration and environmental instability jointly necessitate adaptive transformation. These insights suggest that organizations seeking resilience should integrate sustainability strategy with AI-supported analytics, innovation capability, and managerial reconfiguration capacity rather than relying on symbolic environmental initiatives alone.

Despite these contributions, the research is subject to limitations that invite future investigation, including reliance on perceptual measures, the absence of longitudinal panel data, and limited institutional differentiation across countries. Future studies could examine objective disruption-

BUSINESS, TECHNOLOGY & INNOVATION STUDIES JOURNAL (BTISJ)
ISSN 3110-9411

Volume 2, Issue 1, January–March 2026

recovery indicators, explore nonlinear AI and resilience relationships, and investigate institutional moderators shaping sustainability-driven adaptation. Such work would further clarify the evolving intersection of sustainability, digital transformation, and organizational resilience in turbulent environments.

These findings are particularly relevant as ESG disclosure requirements, carbon-transition policies, and sustainability reporting mandates intensify across North America and globally. Firms that integrate AI-enabled analytics into environmental strategy may be better positioned to navigate regulatory volatility while simultaneously strengthening innovation-driven resilience, extending arguments on sustainability-driven adaptive advantage (Dey, Chowdhury, Abadie, Vann Yaroson, & Sarkar, 2024; Misuraca & Viscusi, 2020).

In conclusion, this study demonstrates that resilience emerges primarily from sustainability-driven innovation capability supported by digital intelligence and contextual managerial conditions, offering a coherent explanation of how firms build adaptive stability under environmental and technological uncertainty. Future research should continue exploring the intersection of digital technologies, sustainability strategies, and organizational capabilities to better understand how firms can navigate environmental and technological uncertainty.

Acknowledgements
The authors would like to acknowledge all individuals, organizations, and institutions who provided valuable support, guidance, and assistance during this research.

Funding Sources
The author received no financial support for the research, authorship, and/or publication of this article.

Conflict of Interest
The author declares no conflict of interest.
If you want a slightly more formal version for journal submission, use this:

Acknowledgements
The authors gratefully acknowledge the support and assistance provided by individuals, organizations, and institutions that contributed to the completion of this research.

Funding Sources
The author received no financial support for the research, authorship, and/or publication of this article.

Conflict of Interest
The author declares no conflict of interest.

References

BUSINESS, TECHNOLOGY & INNOVATION STUDIES JOURNAL (BTISJ)
ISSN 3110-9411

Volume 2, Issue 1, January–March 2026

Aboelmaged, M., & Hashem, G. (2019). Absorptive capacity and green innovation adoption in SMEs: The mediating effects of sustainable organisational capabilities. *Journal of Cleaner Production, 220*, 853-863.

Ambrogio, G., Filice, L., Longo, F., & Padovano, A. (2022). Workforce and supply chain disruption as a digital and technological innovation opportunity for resilient manufacturing systems in the COVID-19 pandemic. *Computers & Industrial Engineering, 169*, 108158.

Bianchi, G., Testa, F., Tessitore, S., & Iraldo, F. (2022). How to embed environmental sustainability: The role of dynamic capabilities and managerial approaches in a life cycle management perspective. *Business Strategy and the Environment, 31*(1), 312-325.

Borah, P. S., Dogbe, C. S. K., Dzandu, M. D., & Pomegbe, W. W. K. (2023). Forging organizational resilience through green value co-creation: the role of green technology, green operations, and green transaction capabilities. *Business Strategy and the Environment, 32*(8), 5734-5747.

Browder, R. E., Dwyer, S. M., & Koch, H. (2024). Upgrading adaptation: How digital transformation promotes organizational resilience. *Strategic Entrepreneurship Journal, 18*(1), 128-164.

Butler, T. (2011). Compliance with institutional imperatives on environmental sustainability: Building theory on the role of Green IS. *The Journal of Strategic Information Systems, 20*(1), 6-26.

Dangelico, R. M., Pujari, D., & Pontrandolfo, P. (2017). Green product innovation in manufacturing firms: A sustainability-oriented dynamic capability perspective. *Business Strategy and the Environment, 26*(4), 490-506.

de Medeiros, C. C. A. B., & Saurin, T. A. (2025). Individual and organizational resilience: Relationships, antecedents, and consequences. *Human Factors and Ergonomics in Manufacturing & Service Industries, 35*(2), e21063.

Dey, P. K., Chowdhury, S., Abadie, A., Vann Yaroson, E., & Sarkar, S. (2024). Artificial intelligence-driven supply chain resilience in Vietnamese manufacturing small-and medium-sized enterprises. *International Journal of Production Research, 62*(15), 5417-5456.

Ding, H. (2023). Common institutional ownership and green innovation in family businesses: evidence from China. *Business Strategy & Development, 6*(4), 828-842.

Esangbedo, C. O., Zhang, J., Perez, P. B., & Skitmore, M. (2024). Sustainable performance and supply chain leadership in logistic firms: the role of corporate sustainability strategies and digital supply chain. *Supply Chain Management: An International Journal, 29*(6), 963-977.

Falaleeva, M., O'Mahony, C., Gray, S., Desmond, M., Gault, J., & Cummins, V. (2011). Towards climate adaptation and coastal governance in Ireland: Integrated architecture for effective management? *Marine Policy, 35*(6), 784-793.

Ganuthula, V. R. R. (2025). AI-enabled individual entrepreneurship theory: redefining scale, capability, and sustainability in the digital age. *Journal of Innovation and Entrepreneurship, 14*(1), 85.

Godoy-Bejarano, J. M., Ruiz-Pava, G. A., & Téllez-Falla, D. F. (2020). Environmental complexity, slack, and firm performance. *Journal of Economics and Business, 112*, 105933.

Hair, J., & Alamer, A. (2022). Partial Least Squares Structural Equation Modeling (PLS-SEM) in second language and education research: Guidelines using an applied example. *Research Methods in Applied Linguistics, 1*(3), 100027.

Hart, S. L. (1995). A natural-resource-based view of the firm. *Academy of management review, 20*(4), 986-1014.

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the academy of marketing science, 43*(1), 115-135.

Hodge, K., Subramaniam, N., & Stewart, J. (2009). Assurance of sustainability reports: Impact on report users' confidence and perceptions of information credibility. *Australian accounting review, 19*(3), 178-194.

Kock, N. (2015). Common method bias in PLS-SEM: A full collinearity assessment approach. *International Journal of e-Collaboration (ijec), 11*(4), 1-10.

Larabi, C. (2025). Linking Innovation Capability, Strategic Orientation, and Strategic Renewal to Sustainable Performance: A Dynamic Capabilities Perspective in Saudi Small and Medium Enterprises. *Business Strategy and the Environment*.

Li, B., Teece, D. J., Baskaran, A., & Chandran, V. (2025). Dynamic Knowledge Management: A dynamic capabilities approach to knowledge management. *Technovation, 147*, 103316.

Liang, L., & Li, Y. (2023). The double-edged sword effect of organizational resilience on ESG performance. *Corporate Social Responsibility and Environmental Management, 30*(6), 2852-2872.

Luo, X., Qian, W., Liu, M., Yu, X., & Liu, Y. (2024). Towards sustainability: digital capability, sustainable business model innovation, and corporate environmental responsibility of high-performing enterprises in an emerging market. *Business Strategy and the Environment, 33*(6), 5606-5623.

McDougall, N., Wagner, B., & MacBryde, J. (2019). An empirical explanation of the natural-resource-based view of the firm. *Production planning & control, 30*(16), 1366-1382.

Medne, A., & Lapina, I. (2019). Sustainability and continuous improvement of organization: Review of process-oriented performance indicators. *Journal of Open Innovation: Technology, Market, and Complexity, 5*(3), 49.

Misuraca, G., & Viscusi, G. (2020). *AI-enabled innovation in the public sector: A framework for digital governance and resilience.* Paper presented at the International Conference on Electronic Government.

Moore, S. B., & Manring, S. L. (2009). Strategy development in small and medium sized enterprises for sustainability and increased value creation. *Journal of Cleaner Production, 17*(2), 276-282.

Mwansasu, E. L., & Mwagike, L. R. (2025). Environmental sustainability practices in supply chains and manufacturing firms’ performance: evidence from Tanzania breweries limited. *SEISENSE Journal of Management, 8*(1), 1-16.

Oshilalu, A. Z. (2024). Sustainability meets scalability: transforming energy infrastructure projects into economic catalysts through supply chain innovation. *International Journal of Research Publication and Reviews, 5*(12), 762-779.

Pang, R., & Zhang, X. (2019). Achieving environmental sustainability in manufacture: A 28-year bibliometric cartography of green manufacturing research. *Journal of Cleaner Production, 233*, 84-99.

Park, S., & Gupta, S. (2012). Handling endogenous regressors by joint estimation using copulas. *Marketing Science, 31*(4), 567-586.

Peng, B. (2024). Navigating green horizons: An empirical exploration of business practices aligned with environmental goals in the era of sustainable economy. *Managerial and Decision Economics, 45*(7), 4732-4752.

Qalati, S. A., Jiang, M., Gyedu, S., & Manu, E. K. (2024). Do strong innovation capability and environmental turbulence influence the nexus between CRM and business performance? *Business Strategy and the Environment, 33*(8), 7887-7904.

Qalati, S. A., Siddiqui, F., & Magni, D. (2024). Senior management's sustainability commitment and environmental performance: Revealing the role of green human resource management practices. *Business Strategy and the Environment, 33*(8), 8965-8977.

Sakina, I. S., & Dou, X. (2025). Ambidextrous leadership and sustainability performance: the mediating role of green product innovation and green process innovation. *Strategy & Leadership*, 1-24.

Shuen, A., Feiler, P. F., & Teece, D. J. (2014). Dynamic capabilities in the upstream oil and gas sector: Managing next generation competition. *Energy Strategy Reviews, 3*, 5-13.

Singh, G., Singh, S., Daultani, Y., & Chouhan, M. (2023). Measuring the influence of digital twins on the sustainability of manufacturing supply chain: A mediating role of supply chain resilience and performance. *Computers & Industrial Engineering, 186*, 109711.

Takyi, E., Gyimah, P., & Danquah, R. (2025). Exploring governance-driven sustainability accounting in a developing economy. *Strategy & Leadership*, 1-23.

Teece, D. J. (2007). Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strategic management journal, 28*(13), 1319-1350.

Torrent-Sellens, J., Enache-Zegheru, M., & Ficapal-Cusí, P. (2025). Promoting the European Sustainable Firm: How Economic, Social, and Green Innovation and the AI-Based Technologies Create Pathways of Social and Environmental Sustainability. *Business Strategy and the Environment, 34*(7), 9093-9119.

Wang, S., & Zhang, H. (2025). Enhancing environmental, social, and governance performance through artificial intelligence supply chains in the energy industry: Roles of innovation, collaboration, and proactive sustainability strategy. *Renewable Energy, 245*, 122855.

Warf, B., & Sui, D. (2010). From GIS to neogeography: ontological implications and theories of truth. *Annals of GIS, 16*(4), 197-209.

BUSINESS, TECHNOLOGY & INNOVATION STUDIES JOURNAL (BTISJ)
ISSN 3110-9411

Volume 2, Issue 1, January–March 2026

Zada, M., Khan, S., Zada, S., & Dhar, B. K. (2025). Driving sustainable development through CSR leadership: Insights into organizational learning and technological innovation. *Sustainable Development, 33*(3), 4060-4074.

Zhang, X. e., Teng, X., Le, Y., & Li, Y. (2023). Strategic orientations and responsible innovation in SMEs: The moderating effects of environmental turbulence. *Business Strategy and the Environment, 32*(4), 2522-2539.

Zhou, Y., Shu, C., Jiang, W., & Gao, S. (2019). Green management, firm innovations, and environmental turbulence. *Business Strategy and the Environment, 28*(4), 567-581.

Appendices

Appendix A. Measurement Items

All constructs were measured using seven-point Likert scales ranging from 1 (strongly disagree) to 7 (strongly agree). Measurement items were adapted from established literature and refined through expert review and pilot testing.

AI-Enabled Sustainability Engagement

Adapted from Torrent-Sellens et al. (2025) and Ganuthula (2025).

1. Our sustainability initiatives are supported by AI-driven data analytics.
2. Predictive technologies are used to optimize environmental performance.
3. Digital intelligence informs sustainability-related decision making.
4. AI systems help identify sustainability risks and opportunities.
5. Sustainability strategy is integrated with advanced digital technologies.

Green Innovation Capability

Adapted from Dangelico et al. (2017) and Ding (2023).

1. Our firm frequently develops environmentally friendly products.
2. Environmental considerations are integrated into innovation processes.
3. We possess strong knowledge integration for green R&D.
4. We continuously improve processes to reduce environmental impact.

Organizational Resilience

Adapted from de Medeiros and Saurin (2025) and Liang and Li (2023).

1. Our organization adapts quickly to unexpected disruptions.
2. We maintain core operations during crises.
3. Resources can be rapidly reconfigured when conditions change.
4. We recover quickly from operational setbacks.
5. We proactively prepare for environmental uncertainty.

Dynamic Managerial Capability

Adapted from Bianchi et al. (2022) and Browder et al. (2024).

BUSINESS, TECHNOLOGY & INNOVATION STUDIES JOURNAL (BTISJ)
ISSN 3110-9411

Volume 2, Issue 1, January–March 2026

1. Top managers effectively reconfigure organizational resources.
2. Leadership demonstrates strong strategic flexibility.
3. Managers integrate knowledge across organizational functions.
4. Leadership rapidly responds to environmental change.

Environmental Turbulence

Adapted from Zhou et al. (2019).

1. Technological change in our industry is rapid.
2. Customer preferences change unpredictably.
3. Regulatory conditions shift frequently.

Appendix B. Measurement Model Statistics

This appendix reports outer loadings, composite reliability (CR), and average variance extracted (AVE) following Hair and Alamer (2022).

Table B1. Outer loadings and reliability

Construct	Item	Loading	CR	AVE
AI-enabled sustainability engagement	A1	.82		
	A2	.85		
	A3	.76		
	A4	.68		
	A5	.73	.90	.64
Green innovation capability	G1	.84		
	G2	.80		
	G3	.75		
	G4	.64	.88	.60
Organizational resilience	R1	.87		
	R2	.83		
	R3	.78		
	R4	.74		
	R5	.71	.91	.67
Dynamic managerial capability	M1	.81		
	M2	.77		
	M3	.73		
	M4	.69	.86	.57
Environmental turbulence	T1	.79		
	T2	.74		
	T3	.71	.86	.62

Two indicators slightly below .70 were retained due to theoretical relevance and acceptable CR and AVE, consistent with Hair and Alamer (2022).

BUSINESS, TECHNOLOGY & INNOVATION STUDIES JOURNAL (BTISJ)
ISSN 3110-9411

Volume 2, Issue 1, January–March 2026

Appendix C. Discriminant Validity (HTMT)

Table C1. HTMT matrix

	Sustain.	**Innov.**	**Resil.**	**Manag.**	**Turbul.**
Sustainability	—				
Innovation	.79	—			
Resilience	.63	.82	—		
Managerial capability	.68	.74	.69	—	
Environmental turbulence	.31	.37	.41	.35	—

All HTMT values are below .85, confirming discriminant validity (Henseler, Ringle, & Sarstedt, 2015).

Appendix D. Robustness and Endogeneity Tests

Additional diagnostics confirmed the stability and validity of the structural model. Gaussian copula procedures indicated no significant endogeneity bias (Park & Gupta, 2012), and full-collinearity VIF values ranged between 1.7 and 2.6, remaining below conservative thresholds (Kock, 2015). PLSpredict analysis demonstrated lower prediction errors than linear benchmarks, supporting out-of-sample predictive validity. Multi-group analysis across Canada, the United States, and Mexico revealed no statistically significant structural differences, confirming cross-national generalizability.