7th Bangladesh Conference on Industrial Engineering and Operations Management
December 21-22, 2024
Publisher: IEOM Society International, USA DOI: 10.46254/BA07.20240231
Published: December 21, 2024

The Impact of Blockchain-Enabled Dynamic Alignment and Integration to Enhance Organizational Resilience: The Mediating Role of Green Innovation

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Abstract

In an era of heightened environmental volatility and sustainability challenges, blockchain-enabled dynamic capabilities and green innovation are emerging as key drivers of resilience for organization. While its effectiveness in supply chain management is well acknowledged**,** empirical studies examining the effects of blockchain-enabled dynamic capabilities on organizational resilience have been underrepresented in the existing operation management literature. To address this gap, we draw on the dynamic capabilities view of firms to develop and test a model that examines how blockchain technology can optimize and integrate organizational capabilities, enabling companies to quickly adapt and innovate in response to changing market conditions. Blockchain-enabled Dynamic Capabilities—facilitated through alignment and integration—empower organizations to adapt and respond swiftly, driving green initiatives that enhance their ability to withstand disruptions and maintain stability in uncertain environments. We have developed a theoretical framework that explains how the blockchain enabled dynamic capability, under the mediating influence of green innovation, helps build organizational resilience for unprecedented crises. In this context, environmental dynamism intensifies the impact of green innovation on organizational resilience, highlighting the need for adaptable strategies integration that allow firms to thrive amid uncertainty and maintain a competitive edge. We tested our theoretical model using a survey of 152 individuals working in the manufacturing industry in Bangladesh. Our findings demonstrate that blockchain facilitates greater operational efficiency, fosters sustainability, and improves the overall adaptability of firms in volatile environments. Furthermore, this empirical study extends the dynamic capability view by demonstrating how blockchain aligns organizational processes to better navigate dynamic contexts. From a managerial perspective, the research underscores the potential for blockchain to enhance decision-making, streamline operations, and maintain a competitive advantage, offering valuable insights for firms operating in uncertain and rapidly changing markets.

Keywords
Blockchain-enabled dynamic capabilities, Green Innovation, Organizational Resilience, Dynamic Capability View

1. Introduction
In order to adapt to changes quickly and change their structures as needed, companies are being forced to reevaluate their dynamic supply chain capabilities due to the growing uncertainties and complexity of operating in a digital environment (Cohen and Kouvelis 2021; Naughton et al. 2020; Queiroz et al.2023; Ivanov 2023). Major crises, such as the COVID-19 pandemic, have introduced substantial volatility and disruption to supply chains (Craighead et al.

2020; Gereffi et al. 2022; Ye et al. 2022; Shen and Sun 2023). This introduces the need for transparency and visibility in the supply chain.

According to Andrei and Horst (2024), it has been projected that blockchain will have a disruptive and revolutionary effect on the national (e. g. currency), organizational (e. g. supply chain, marketing, and finance), and individual (e. g. investing, speculation, and peer-to-peer transactions) levels. The circumstance prompts an evaluation of blockchain-enabled dynamic capabilities in an organization's supply chain management. Collaboration is hampered by a number of issues, including insufficient funding, opportunistic behavior, a misalignment between corporate policies and technology, and conflicting goals. (Dubey et al. 2020a, 2021a; Quiroz et al. 2022; Modgile et al. 2020). Distributed ledger technologies, particularly blockchain, are among the critical driving technologies of the fourth industrial revolution (Wamba & Queiroz, 2022). With its many tremendous advantages, blockchain has the potential to revolutionize the way many industries operate. (Ali et al. 2020; Aoun et al. 2021). Hence, blockchain-enabled dynamic capabilities comprising alignment and integration can be a vital point for the supply chain.

New opportunities for innovation in the production and delivery process have been made possible by the recent development in the integration of precision equipment and innovative digital manufacturing technologies into processes (Guo et al. 2022). The main features of green technologies are systematic, eco-prevention-focused, economic compliance, and enhanced effectiveness (Jansson 2011; Skare & Riberio Soriano 2021). Unfortunately, the existing operations management literature has not provided sufficient insights into this issue, mainly because it has focused on environment and sustainability, without paying enough attention to how blockchain-enabled dynamic capabilities are leveraged to pave green innovation.

So, in our first area of focus, we will examine the direct relationship between blockchain-enabled dynamic capabilities and green innovation. As how the benefits from blockchain-enabled dynamic capabilities through alignment and integration have not been understood properly, our first research question is (RQ1): What are the effects of blockchain-enabled dynamic capabilities on green innovation?

Researchers and practitioners have paid more attention to organizational resilience in recent years. Three stages of organizational resilience have been distinguished by scholars: before, during, and after disturbances. (Huang et al. 2023). Under these circumstances, companies need to build resilience that aids in "being alert to adapt to and respond to changes brought by a supply chain disruption effectively and efficiently (Ambulkar S et al. 2015)". Organizational resilience - which refers to, "the adaptive capability of the supply chain of an organization to prepare for unexpected events, respond to disruption and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function" - is an essential dynamic capability (DC) in facing disturbances. Our second area of focus is to explore how blockchain enabled dynamic capabilities can enhance the organizational resilience with green innovation. The existing literature needs to provide an adequate theory-driven explanation of how blockchain help build organizational resilience in crises. Our goal is to provide an empirical contribution to the literature on the role of blockchain enabled dynamic alignment and integration in encouraging green innovation, ultimately through achieving resilience, by addressing a research question based on theory. Our next research question is (RQ2): What are the effects of blockchain enabled dynamic capabilities on organizational resilience under the mediating effect of green innovation?

The volatility and unpredictability of external market conditions, which can have a substantial impact on organizational performance and strategic decision-making, are referred to as environmental dynamism (Miller & Friesen, 1983; Schilke, 2014). Through the lens of dynamic capability view (DCV), we contribute to the literature how green innovation can sense, seize the opportunity and reconfigure the situation and achieve organizational resilience. Our last research question is (RQ3): What is the effect of environmental dynamism in the path linking green innovation and organizational resilience?

In order to successfully accomplish our objectives, we arranged the remaining portions of our paper as follows. The study's theoretical foundation will be covered first, with a primary emphasis on the process of developing hypothesis from the existing literature and research gap. The main concepts of green innovation, organizational resilience, and dynamic capacities offered by blockchain will also be clarified, and the study hypotheses will be presented. We then present the research setting: companies in various manufacturing sectors, our construct measures, the sampling strategy, individuals working in companies in India (n = 152), and the data collection process. After that, we present the data analysis through PLS-SEM to validate the model with the hypotheses. And at the final section, we discuss about the theoretical and managerial implication of the research including future directions.

1.1 Objectives

This research has several objectives. The objectives are:

- To explore the relationship of blockchain enabled capabilities and green innovation.
- To explain the effect of blockchain enabled capabilities on organizational resilience under the mediating effect of green innovation.
- To contribute to the theory exploring the mediating role of environmental dynamism in the path linking green innovation and organizational resilience with the practical implications.

2. Literature Review

2.1 Theory Development

Dynamic capability (DC) is defined as the organizational "ability to integrate, build, and reconfigure internal and external resources/competences to address, and possibly shape, rapidly changing business environments" (Teece, 2012, p. 1395). DC is also known as higher order capability (Teece 2014), and was proposed by Teece et al. (1997) as an extension of the resource-based view (RBV) to explain firms' competitive advantage in volatile markets and highly dynamic, changing environments (Winter 2003; Teece, 2012; Eckstein et al. 2015). The dynamic capabilities framework is based on three key characteristics (Lee and Rha, 2016). First, supply chain capabilities must include the ability to sense both opportunities and threats. Sensing encompasses activities such as scanning, learning, and interpreting, both within and outside the organization (Teece 2007). This capability enables an organization to anticipate supply and demand dynamics and respond effectively and efficiently to customer needs by implementing appropriate strategies to mitigate supply chain risks Secondly, supply chain capabilities must also include the ability to seize opportunities. Supply chain capabilities must include the ability to seize opportunities. Seizing involves the implementation of strategies and ensuring effective execution (Teece 2007, p. 22). Additionally, organizations must be capable of reconfiguring through the continuous renewal and transformation of their routines. In this context, the learning capability serves the function of the seizing capability as described by Teece (2014). According to Wilhelm et al. (2015, p. 329), learning capability is defined as "the firm's ability to develop means and tools to efficiently confront environmental changes and opportunities that may arise."

2.2 Theoretical Framework Development

The foundation of our concept is the connection between green innovation and blockchain-enabled dynamic capabilities, which improves organizational resilience under the moderating influence of environmental dynamism and the mediating effect of green innovation, as illustrated in Figure 1. Blockchain enables organizations to build their supply chain capabilities for higher competitiveness (Madhwal & Panfilov 2017). In general, it is "a disruptive technology for the design, organization, operations, and general management of supply chains" (Saberi et al. 2019, p. 2120). By accelerating business processes and improving their speed, visibility, and dependability, this technology creates value for its customers (Sheel & Nath 2019). Green innovation refers to "the production, application or exploitation of a good, service, process, organizational structure or management or business method that is novel to the firm and results in a reduction of environmental risk" (Ma et al. 2018). According to earlier research, alignment, flexibility, and agility are antecedents of visibility, trust, and information integration. It means a lack of trust among supply chain partners, lack of information integration, and lack of visibility are the main barriers to business procedure integration and alignment. Therefore, we propose:

H1a: Blockchain enabled dynamic alignment positively influences green innovation.

H1b: Blockchain enabled dynamic integration positively influences green innovation.

According to Modgil et al. (2021), organizational resilience is the firm's capacity to withstand and bounce back from a disturbance in a timely and efficient manner. To reduce the operational and financial losses brought on by SC disruptions, Tukamuhabwa et al. (2015) outlined resilience as a critical attribute that SCs must embrace. The literature indicates that organizational resilience is multifaceted and extremely complicated, with a wide range of components. Nevertheless, a great deal of research has been done to determine the necessary conditions for constructing organizational resilience. Both the possible advantages and difficulties of implementing blockchain-enabled dynamic capabilities are now the focus of research (C. S. Singh et al. 2019). But research has also shown that implementing blockchain-enabled dynamic capabilities can have positive effects on a number of performance metrics, including supply chain relationships, product safety, process efficiency, transaction cost, and ordering time (M. M. Queiroz et al., 2019). Our hypotheses, based on the previous discussions, are these:

H2a: Blockchain enabled dynamic alignment positively influences organizational resilience.
H2b: Blockchain enabled dynamic integration positively influences organizational resilience.

In accordance with indicators, such as environmental, social, and economic performance, various industries have embraced and converted their activities into green operations (Jahanshahi et al. 2020). Researchers have recently discovered a variety of green innovation facilitators and barriers in manufacturing companies (Han & Chen 2021). According to earlier research, the degree to which groups or people are likely to approve a new technology can be summed up as the acceptance of green innovation (Jahanshahi et al. 2020). Thus, we propose:

H3: Green innovation positively influences organizational resilience.

A firm's external environment's variations and uncertainties are referred to as environmental dynamism (ED) (Schilke, 2014a). According to Schilke 2014a, ED is a crucial part of dynamic capacities view (DCV) theory, which holds that different DCVs have different effects on performance (Chen et al. 2015). The benefits of DCV rely on the context in which these talents are applied as well as on long-standing organizational practices. Therefore, we propose:

H4: Environmental Dynamism positively influences organizational resilience.

Based on the preceding discussions, we hypothesize that:

H5a: Blockchain enabled dynamic alignment positively influences organizational resilience under the mediating effect of green innovation.
H5b: Blockchain enabled dynamic integration positively influences organizational resilience under the mediating effect of green innovation.

In response to the world's increasingly turbulent developments, organizations are quickly addressing environmental and competitive concerns, including environmental turbulence, and looking into economic prospects (Teece et al., 1997). Consequently, the link between green innovation and competitive advantage is weakened or even eliminated by sudden environmental changes. Hence, addressing environmental dynamism is crucial for long-term benefits since it aids the company in accessing, adapting, and implementing dynamic environmental changes. By employing environmental dynamism to understand their environmental problems, businesses can achieve high profit, customer demand, and environmental sustainability (Eisenhardt et al., 2000). Therefore, we propose:

H6: Environmental dynamism has a positive moderating effect on the paths connecting green innovation and organizational resilience.

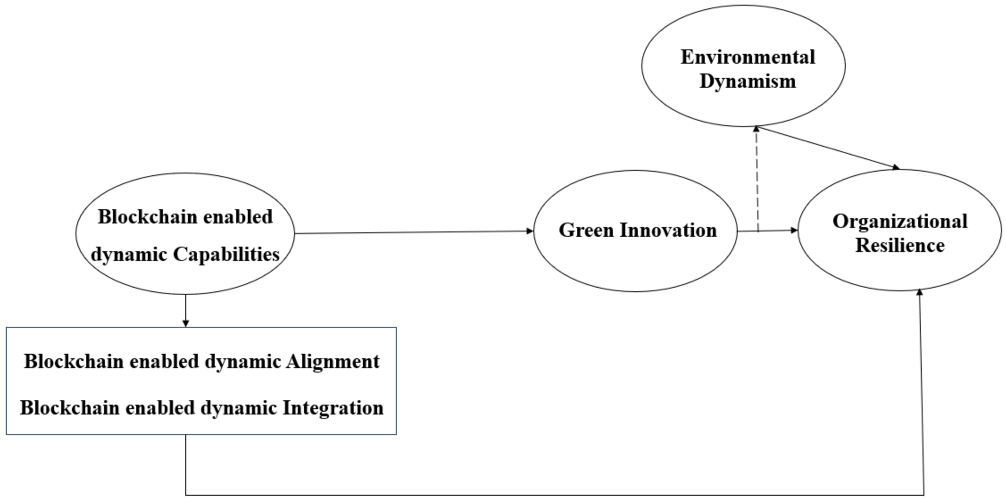

Figure 1. Theoretical Framework

3. Research Methods

3.1 Research Design

We surveyed manufacturing organizations based in Bangladesh for quantitative data. We chose the four industry sectors Food, Apparel Manufacturing, Cement manufacturing, and Pharmaceutics manufacturing because blockchain are quite common, with companies typically relying on several vendors that supply raw materials and provide logistics services, IT support, and sales and services. The demographic profile of respondents includes industry, firm size, firm age, designation, and tenure in the organization. Manufacturing industries frequently navigate external pressures, including disruptions and unpredictable demand due to pandemics or other crises. We ensure that surveyed organizations have recent experience managing such disruptions, as this context emphasizes the importance of Environmental Dynamism (ED) in moderating relationships within the supply chain.

3.2 Survey Questionnaire Design

We designed measurement items for each construct based on established literature. For example, we included six items that align with our theoretical framework to measure. The survey questionnaire was designed using Google Forms, incorporating measurement items drawn from existing literature. To accurately assess respondents' perspectives, a 7-point Likert scale was employed, ranging from 1 (strongly disagree) to 7 (strongly agree). Then it was verified or modified through Pilot Test by experts from different organization. The distribution of the survey was conducted through email, facilitating efficient data collection from respondents.

3.3 Sample and Data Collection

We emailed the survey to individuals in the 324 selected companies and sent two reminders to those who had yet to return the surveys at least two weeks after the initial email. We finally received 152 completed questionnaires (response rate = 44.44 %). We tested for non-response bias (NRB) and calculated the t-statistics ($p > 0.05$) between early and late waves. Our analyses concluded that NRB is not a major issue in our study, and we can safely proceed with our data analysis.

4. Data Analysis

We employed WarpPLS 7.0, which estimates factors to address the PLS-SEM method's conventional flaws (Kock, 2019). The management research community has given PLS-SEM a lot of attention as a helpful technique for developing theories (Akter et al. 2017).

4.1 Measurement properties of constructs

The measurement model was used to evaluate the indicator loadings, average variance extracted (AVE) and composite reliability (CR). The loadings for all reflective items above the 0.6 criteria (except for OR1 and ED5), the AVE was greater than the 0.5 criteria and the CR was greater than 0.7. However, there is no higher-order construct in our model. It was noted that not all the indicators (i.e. questions in the data collection instrument) are necessary or useful in characterizing the various constructs in the model.

Table 1. Constructs, measurement items and their loadings

Construct	Measurement Items	Factor Loadings	Cronbach's α (CA)	Composite reliability (CR)	Average variance extracted (AVE)
Blockchain enabled dynamic Alignment	BCA1 BCA2 BCA3 BCA4 BCA5 BCA6	0.767 0.894 0.883 0.734 0.866 0.866	0.904	0.907	0.667
Blockchain enabled dynamic Integration	BCI1 BCI2 BCI3 BCI4 BCI5	0.844 0.824 0.678 0.868 0.781	0.880	0.895	0.624
Green Innovation	GI1 GI2 GI3 GI4 GI5 GI6	0.849 0.907 0.908 0.89 0.956 0.876	0.943	0.957	0.767
Organizational Resilience	OR1 OR2 OR3 OR4 OR5 OR6	0.432 0.877 0.782 0.726 0.828 0.784	0.822	0.862	0.540
Environmental Dynamism	ED1 ED2 ED3 ED4 ED5	0.875 0.678 0.756 0.756 0.598	0.779	0.845	0.572

Convergent validity is the degree to which a measure positively correlates with alternative measures of the same construct, measured by the average variance extracted (AVE). It indicates how much of the data is explained by each construct, relative to their groups of variables. An AVE >0.50 indicates that the construct explains more than half of the variance of its indicators. Table-1 shows that the AVE varies from 0.540 to 0.767, reflecting that the constructions explain more than Half of the variance in their indicators. Therefore, the model converges to an acceptable outcome and convergent validity has been obtained.

These results demonstrate that the construct indicators employed in the survey instrument are consistent and generated trustworthy data.
Discriminant validity evaluates the extent to which a construct is experimentally different from others. This is measured either cross loadings or the Fornell-Larcker criterion (Henseler et al., 2009). The square root of each construct's AVE should be larger than its maximum correlation with other constructs. The findings in Table 2 indicate that this requirement has been satisfied.

Table 2. Discriminant Validity-Fornell-Larcker Criterion

Construct	**Blockchain enabled dynamic Alignment**	**Environmental Dynamism**	**Blockchain enabled dynamic Integration**	**Green Innovation**	**Organizational Resilience**
Blockchain enabled dynamic Alignment	0.845				
Environmental Dynamism	0.066	0.768			
Blockchain enabled dynamic Integration	0.460	0.178	0.829		
Green Innovation	0.310	0.156	0.687	0.766	
Organizational Resilience	0.255	0.285	0.465	0.366	0.855

Overall, the results demonstrate that the measurement model is appropriate, since the latent variables are reliable, consistent, and predictive enough to measure the required variables. After determining that the measurement model fits the assessment criteria, the following step is to assess the structural model's validity and predictive capabilities.

Table-3 demonstrates that there are several direct relationship hypotheses, and they are all supported. Blockchain enabled dynamic alignment has highly and significantly influenced on green innovation as $\beta = 0.33$, $t = 5.786$ and $p < 0.01$. Thus, our hypothesis H1 is accepted. Therefore, the remaining direct relationships are validated.

Table 3. Results of Direct Hypotheses

Hypotheses	**Hypotheses' Paths**	**Path Coefficient**	**T statistics**	**P values**	**Outcomes of assessment**
H1a	Blockchain enabled dynamic Alignment -> Green Innovation	0.33	5.786	0.000	Accepted
H1b	Blockchain enabled dynamic Integration -> Green Innovation	0.35	6.983	0.001	Accepted

H2a	Blockchain enabled dynamic Alignment -> Organizational Resilience	0.22	2.87	0.005	Accepted
H2b	Blockchain enabled dynamic Integration -> Organizational Resilience	0.273	3.235	0.000	Accepted
H3	Green Innovation -> Organizational Resilience	0.783	6.245	0.000	Accepted
H4	Environmental Dynamism -> Organizational Resilience	-0.234	4.672	0.003	Accepted

Table 4. Indirect hypotheses' result (mediation)

Hypotheses	**Hypotheses' Paths**	**Path Coefficient**	**T statistics**	**P values**	**Types of Effect**	**Decision**
H5a	Blockchain enabled dynamic Alignment -> Green Innovation-> Organizational Resilience	-0.089	3.122	0.012	Partial Mediation	Accepted
H5b	Blockchain enabled dynamic Integration -> Green Innovation-> Organizational Resilience	0.265	4.546	0.001	Partial Mediation	Accepted

Table 4 demonstrates the following results. Green innovation is a significant mediator between digital technologies and organization sustainability practices as $\beta = -0.089$, $t = 3.122$ and $p < 0.05$. Thus, the hypothesis H5a is accepted.

Table 5. Indirect hypotheses' result (moderation)

Hypotheses	**Hypotheses' Paths**	**Path Coefficient**	**T statistics**	**P values**	**Outcomes of assessment**
H6	Environmental Dynamism x Green Innovation-> Organizational Resilience	0.234	2.563	0.021	Accepted

Table 5 demonstrates that the continuous moderator environmental dynamism significantly and positively moderates between green innovation and organizational resilience as $\beta = 0.234$, $t = 2.563$ and $p < 0.05$. Hence, our hypothesis H6 of moderating effect is accepted.

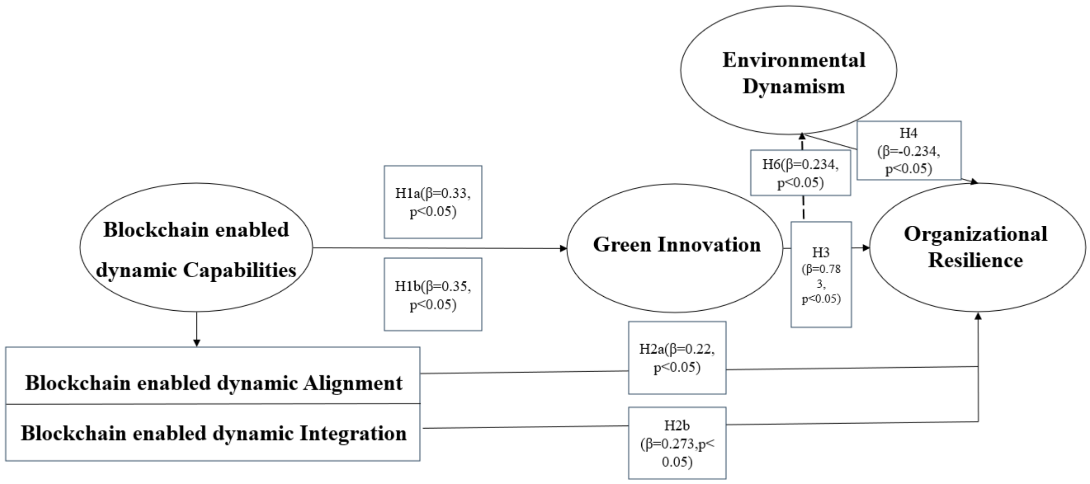

Figure 2. Final Model

5. Results and Discussion

Through the lens of the dynamic capability approach, this study examines the interactions among green innovation, organizational resilience, and blockchain enabled dynamic capabilities. The study emphasizes the strategic importance of blockchain in promoting innovation and adaptability in the face of environmental dynamism by verifying the proposed links. The results extend our theoretical and practical understanding of how blockchain technology might improve resilience and sustainability. We move into the constraints, policymakers, and theoretical ramifications below, as well as potential future study avenues.

5.1 Implications for Theory

By including blockchain-enabled capabilities into its framework, this study makes a substantial contribution to the dynamic capability view (DCV). The study expands DCV to include the strategic role of blockchain in boosting adaptability and innovation by emphasizing how dynamic alignment and integration allowed by blockchain promote green innovation. Theoretical discussion of DCV is further enhanced by the moderating effect of environmental dynamism, which provides a deeper understanding of how external influences impact the relationship between green innovation and organizational resilience. These observations close a large gap in the literature and offer a solid theoretical foundation for investigating how blockchain technology, sustainability, and organizational performance interact.

5.2 Implications for Practitioners and Policymakers

This study offers important insights that policymakers and practitioners may use to promote sustainable practices and strengthen organizational resilience in sectors that are vulnerable to environmental uncertainty. Governments and regulatory agencies can help businesses improve their dynamic capabilities, especially in dynamic alignment and integration, by promoting regulations that encourage blockchain usage. Furthermore, encouraging green innovation through grants, tax breaks, or regulatory requirements can motivate businesses to implement sustainable practices and technologies. The significance of environmental dynamism should also be acknowledged by policymakers, who should offer flexible frameworks that let businesses prosper in unstable environments. This paper offers a road map for creating strategic policies that support sustainability objectives and technological breakthroughs, thereby enhancing both environmental and economic resilience.

5.2 Limitations and Future Scopes

This study's findings are context-specific and may not be generalizable across all industries or regions. Respondent bias may be present due to the dependence on survey-based data. Furthermore, elements that can have an impact on the relationships under study were overlooked, such as stakeholder participation and corporate culture. Subsequent investigations may examine blockchain's attributes, such traceability and transparency, in various settings. Further insights into the long-term impacts of blockchain technology on green innovation and organizational resilience could be obtained by performing longitudinal research and extending the model to incorporate elements such as regulatory settings or organizational culture.

6. Conclusion

This study significantly advances our knowledge of how organizational resilience, green innovation, and blockchain enabled dynamic capabilities interact. The study's accomplishments show how blockchain-enabled features, particularly dynamic alignment and integration, are essential for promoting green innovation. Additionally, the study shows that green innovation plays a crucial role in mediating the relationship between organizational resilience and blockchain-enabled capabilities, underscoring its revolutionary potential to improve sustainability. The moderating effect of environmental dynamism adds a subtle layer to the theoretical framework by highlighting the ways in which outside forces might affect these interactions. Its integration of blockchain-enabled capabilities with the dynamic capability view to investigate their effects on resilience and sustainability is what makes this research distinctive. The study fills important gaps in the literature and provides a thorough framework for further research by introducing and confirming the moderating effect of environmental dynamism and the mediating role of green innovation. In practice, the results enable institutions and decision-makers to use blockchain technology to accomplish sustainability objectives and increase resilience to environmental shocks. The study provides opportunities for scholars to investigate the multidisciplinary relationships among sustainability practices, strategic management, and blockchain technology. Although the study admits its shortcomings, its conclusions offer a strong basis for developing theory and practice in this developing field. For researchers, the study opens avenues for exploring interdisciplinary connections between blockchain technology, strategic management, and sustainability practices. While the study acknowledges its limitations, its findings provide a solid foundation for advancing theory and practice in this evolving domain. Future research could build on these insights to explore additional dimensions and validate the framework across diverse industries and regions.

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Biographies

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