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The Role of Artificial Intelligence and Blockchain Technology in Crisis Management, Startup Growth, and Sustainable Future

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Abstract

This study examines the impact of artificial intelligence (AI) and blockchain technology on crisis management, startup growth, and sustainability in the Indian business landscape. Using a quantitative, cross-sectional research design, data was collected from 123 research and development (R&D) employees across various enterprises. The study employs Partial Least Squares Structural Equation Modeling (PLS-SEM) to analyze relationships between key constructs. The results indicate that AI plays a crucial role in enhancing crisis management and business resilience ($\beta = 0.553$, $p = 0.000$), while effective crisis management positively influences long-term sustainability ($\beta = 0.272$, $p = 0.000$). Additionally, blockchain technology is a key driver of startup growth ($\beta = 0.684$, $p = 0.000$), and growing startups significantly contribute to a sustainable future ($\beta = 0.689$, $p = 0.000$). The findings highlight the transformative potential of AI and blockchain in navigating business uncertainties, fostering innovation, and driving sustainable development. The study offers practical implications for business leaders, policymakers, and entrepreneurs in leveraging emerging technologies for long-term resilience and success.

Keywords: artificial intelligence; blockchain technology; crisis management; startup growth

1. Introduction

In an era defined by rapid technological advancements and unprecedented global challenges, the integration of cutting-edge technologies such as artificial intelligence (AI) and blockchain has become indispensable for fostering sustainable development and organizational resilience (Irfan et al., 2024). AI, with its capabilities in data analytics, automation, and predictive modeling, has emerged as a transformative tool for enhancing decision-making, operational efficiency, and strategic planning. Its ability to process vast amounts of data in real-time enables organizations to identify patterns, predict outcomes, and make informed decisions, even in high-pressure situations (Friedman & Ormiston, 2022). Similarly, blockchain technology, known for its decentralized, transparent, and secure nature, has revolutionized industries by enabling trust, accountability, and innovation (Ameen et al., 2022). By providing an immutable and tamper-proof ledger, blockchain ensures transparency in transactions, reduces fraud, and enhances operational efficiency (Taherdoost, 2022). Together, these technologies hold immense potential to address complex challenges, particularly in the realms of crisis management and sustainable growth.

The global business landscape, including India, is increasingly shaped by crises such as economic instability, climate change, and pandemics, which demand innovative solutions to ensure organizational survival and

long-term sustainability (Rauniyar et al., 2023). Crises, while disruptive, also present opportunities for organizations to innovate, adapt, and build resilience. For instance, the COVID-19 pandemic highlighted the importance of agile crisis management strategies and the role of technology in enabling business continuity. In this context, startups, as agile and innovative entities, play a pivotal role in driving economic growth and addressing socio-environmental challenges. Startups are often at the forefront of technological innovation, developing solutions that address pressing global issues such as climate change, resource scarcity, and social inequality (Cai & Hong, 2024). However, their success often hinges on their ability to manage crises effectively and leverage advanced technologies to achieve sustainable growth (Agarwal et al., 2021). Despite the growing recognition of AI and blockchain as enablers of innovation and resilience, there is a notable gap in research exploring their combined role in enhancing crisis management and fostering startup growth for a sustainable future.

This study seeks to address this gap by examining the interplay between AI, blockchain technology, crisis management, startup growth, and sustainable development in the Indian context. India, as one of the fastest-growing economies in the world, presents a unique setting for this research. With a thriving startup ecosystem and a rapidly evolving technological landscape, the country is well-positioned to leverage AI and blockchain for addressing its unique socio-economic and environmental challenges. However, the adoption of these technologies in crisis management and sustainable growth remains underexplored, particularly in the context of startups.

2. Literature Review and Hypotheses Development

AI has emerged as a transformative force in modern business environments, offering unparalleled capabilities in data analysis, automation, and decision-making (Gill et al., 2019). In the context of crisis management, AI plays a pivotal role in enhancing organizational resilience by enabling proactive risk identification, real-time monitoring, and efficient resource allocation. For instance, AI-powered predictive analytics can analyze vast datasets to detect early warning signs of potential crises, allowing organizations to implement preemptive measures and mitigate risks effectively (Jaaffar et al., 2023). During crises, AI facilitates rapid response by automating decision-making processes and providing actionable insights, thereby reducing the impact of disruptions (Purnomo et al., 2021). Beyond crisis management, AI drives business growth by optimizing operational efficiency, enhancing customer experiences, and fostering innovation (Chamola et al., 2020). AI-driven tools, such as chatbots, personalized marketing algorithms, and supply chain optimization systems, enable businesses to streamline operations and deliver value to customers (Senadjki et al., 2023). Moreover, AI empowers organizations to identify new market opportunities, develop innovative products, and gain a competitive edge. The integration of AI into business strategies not only strengthens crisis management capabilities but also creates a foundation for sustainable growth by enabling data-driven decision-making and operational excellence (Dogo et al., 2019). Thus, it is hypothesized that AI significantly enhances crisis management and contributes to business growth, positioning organizations for long-term success.

H1: AI positively influences crisis management and business growth

Effective crisis management is a critical determinant of organizational resilience and long-term sustainability, particularly in an era characterized by global challenges such as climate change, economic instability, and pandemics (Sharma et al., 2022). Organizations that excel in crisis management demonstrate the ability to adapt to disruptions, protect stakeholder interests, and maintain operational continuity. These capabilities not only ensure survival during crises but also create opportunities for growth by fostering trust and confidence among stakeholders (Antoniol & Ferrari, 2021). Business growth, in turn, provides the resources and momentum needed to invest in sustainable practices and innovations. For example, growing companies are more likely to adopt eco-friendly technologies, reduce carbon footprints, and contribute to social well-being (Bărbulescu et al., 2021). The synergy between crisis management and business growth enables organizations to navigate uncertainties while aligning their strategies with sustainability goals (Bărbulescu et al., 2021). By integrating sustainable practices into their growth strategies, organizations can address environmental, social, and economic challenges, contributing to the achievement of global sustainability objectives. Therefore, it is

hypothesized that effective crisis management and business growth are critical drivers of a sustainable future, enabling organizations to thrive in a rapidly changing world.

H2: Crisis management and business growth positively contribute to achieving a sustainable future

Blockchain technology has revolutionized the way businesses operate, offering innovative solutions to longstanding challenges such as data security, transparency, and operational efficiency (De Villiers et al., 2021). For startups, blockchain provides a robust technological foundation that enhances credibility, reduces costs, and fosters innovation (Raji, 2022). Its decentralized and immutable nature ensures trust and accountability, which are crucial for building credibility in competitive markets (Rani et al., 2024). Startups leveraging blockchain can streamline financial transactions, enhance supply chain transparency, and improve customer trust through secure and verifiable records (Kalenzi, 2022). Additionally, blockchain enables smart contracts, which automate agreements and reduce administrative costs, allowing startups to focus on scaling their operations (Pedreño et al., 2021). By adopting a futuristic approach to blockchain, startups can overcome traditional barriers to growth, such as funding constraints and operational inefficiencies, while positioning themselves as innovative leaders in their industries (Darwish, 2023). Blockchain also facilitates access to global markets by enabling secure and transparent cross-border transactions, further accelerating startup growth. Consequently, it is hypothesized that blockchain technology significantly accelerates startup growth by providing a robust technological foundation for scalability, innovation, and global competitiveness.

H3: The adoption of a futuristic approach to blockchain technology positively impacts startup growth

Startups are increasingly recognized as key drivers of sustainable development due to their agility, innovation, and ability to address pressing global challenges (Tyagi et al., 2020). As startups grow, they often adopt business models that prioritize environmental, social, and economic sustainability (Ressin, 2022). For instance, many startups focus on developing renewable energy solutions, circular economy practices, and inclusive technologies that align with global sustainability goals (Deyanova et al., 2022). The growth of startups also stimulates economic development by creating jobs, fostering innovation ecosystems, and attracting investments (Peng et al., 2020). Furthermore, startups are more likely to embrace disruptive technologies and sustainable practices, setting new standards for responsible business conduct (Menon & James, 2022). By scaling their operations and impact, startups play a pivotal role in driving the transition toward a sustainable future. Their ability to innovate and adapt enables them to address complex challenges, such as climate change, resource scarcity, and social inequality, while contributing to economic growth and societal well-being (Khan et al., 2024). Thus, it is hypothesized that startup growth is a critical enabler of sustainability, contributing to the achievement of long-term environmental, social, and economic goals.

H4: Startup growth positively drives the realization of a sustainable future.

Figure 1 shows the research model.

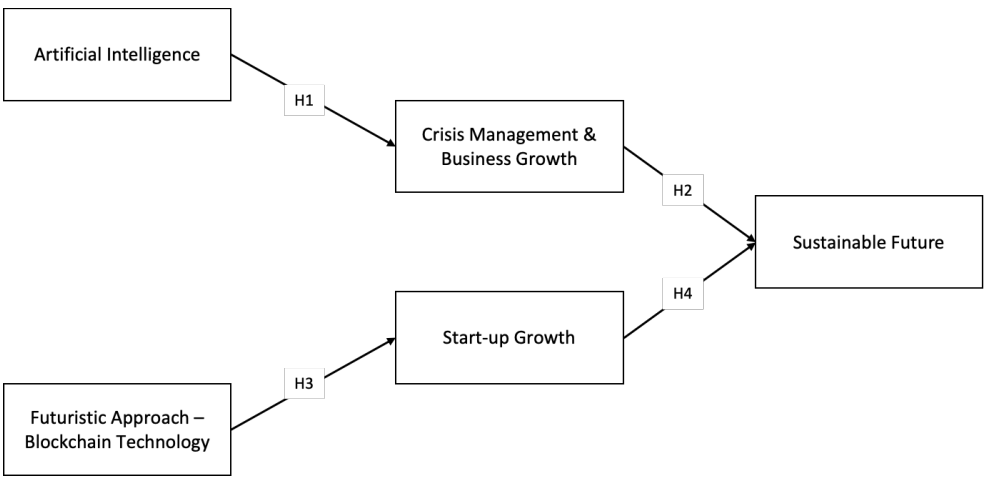

Figure 1. Research model.

3. Methodology

This study adopts a quantitative, cross-sectional research design to investigate the relationships between AI, blockchain technology, crisis management, startup growth, and sustainable future in the context of India. The research design is well-suited for capturing data at a single point in time, enabling the exploration of relationships between the variables under investigation. The statistical population for this study comprises 537 enterprises operating in India, with a focus on employees in research and development (R&D) roles. A convenience sampling technique was employed to select participants, ensuring accessibility and feasibility in data collection. The sample size was determined using Cochran's formula, resulting in a sample of 224 R&D employees, which is considered statistically adequate for achieving reliable results and minimizing sampling errors.

Primary data was collected through a structured questionnaire in November 2024, the items of which were developed based on a systematic literature review to ensure alignment with established theoretical frameworks and measurement scales (Table 1). The questionnaire utilized an 8-item Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), to measure the study variables. Prior to the main data collection, a pilot study involving 30 participants was conducted to assess the clarity, reliability, and validity of the questionnaire. Feedback from the pilot study was used to refine the questionnaire, ensuring its effectiveness in capturing the intended constructs. Of the 250 questionnaires distributed, 123 were deemed complete and suitable for further analysis, providing a robust dataset for the study.

Data analysis was conducted using SmartPLS (Partial Least Squares Structural Equation Modeling), a powerful tool for analyzing complex relationships in research models. SmartPLS is particularly suited for this study due to its ability to handle small to medium sample sizes and its robustness in estimating path coefficients and model fit indices. Structural equation modeling (SEM) was employed to test the hypotheses, as it allows for the simultaneous examination of multiple relationships between variables. The sample size of 123 respondents meets the requirements for SEM, adhering to the guideline of being five to ten times larger than the total number of questionnaire items, ensuring the statistical power needed to detect significant relationships.

Table 1. Constructs and items.

Constructs	Items
Sustainable Future	SF1: Clean energy and advanced technology are essential for a sustainable future.
	SF2: Environmental monitoring plays a key role in driving sustainability forward.
Artificial Intelligence	AI1: AI transforms data into valuable insights, enhancing decision-making.
	AI2: AI accelerates automation and improves operational efficiency.
Start-up Growth	ST1: Innovation and agility are the core drivers of start-up growth.
	ST2: Risk-taking and entrepreneurial spirit foster start-up success.
Crisis Management & Business Growth	BG1: Effective crisis management helps organizations identify and mitigate threats using structured strategies.
	BG2: A strong crisis communication strategy is crucial for sustaining business growth.
Futuristic Approach – Blockchain Technology	FA1: Market expansion and diversification enhance blockchain adoption success.
	FA2: Blockchain improves operational efficiency and scalability for future-ready businesses.

4. Results

The demographic profile of the sample (n=123) provides a clear representation of participants' characteristics across various categories (Table 2). In terms of gender distribution, the sample consists of 61% males and 39% females, indicating a moderate gender balance with a slightly higher representation of male respondents. Regarding age groups, the largest proportion of respondents (42.3%) falls within the 31–40 years range, followed by 36.6% in the 20–30 years category. A smaller percentage (16.3%) belongs to the 41–50 years group, while only 4.9% are above 50. This distribution suggests that most participants are in their early to mid-career stages. Education levels show a highly qualified sample, with 56.9% holding a postgraduate degree and 18.7% having a PhD or doctorate. Additionally, 24.4% of the respondents possess an undergraduate qualification, reflecting a well-educated group of professionals. The industry representation indicates a strong presence

from the Technology/IT sector, comprising 40.7% of the sample. Other sectors include Healthcare (16.3%), Finance/Banking (14.6%), Manufacturing (12.2%), and various other industries (16.3%). This highlights a dominance of technology-driven fields in the study. In terms of work experience, a significant portion (44.7%) has between 5 to 10 years of experience, while 32.5% have less than 5 years, and 22.8% possess over a decade of experience. This distribution suggests a mix of emerging and experienced professionals. Finally, the majority of participants (65%) hold R&D specialist roles, followed by 24.4% in managerial positions and 10.6% in other roles.

Table 2. Demographic profile of the sample.

Demographic Variable	Category	Frequency	Percentage (%)
Gender	Male	75	61.0%
	Female	48	39.0%
Age Group	20–30 years	45	36.6%
	31–40 years	52	42.3%
	41–50 years	20	16.3%
	Above 50 years	6	4.9%
Education Level	Undergraduate	30	24.4%
	Postgraduate	70	56.9%
	PhD/Doctorate	23	18.7%
Industry Sector	Technology/IT	50	40.7%
	Healthcare	20	16.3%
	Manufacturing	15	12.2%
	Finance/Banking	18	14.6%
	Others	20	16.3%
Work Experience	Less than 5 years	40	32.5%
	5–10 years	55	44.7%
	More than 10 years	28	22.8%
Role in Organization	R&D Specialist	80	65.0%
	Managerial Position	30	24.4%
	Other Roles	13	10.6%

The measurement model assessment establishes the reliability and validity of the constructs used in the study (Table 3). Cronbach's alpha values for all constructs exceed the recommended threshold of 0.7, indicating strong internal consistency among the items measuring each construct. Specifically, values range from 0.721 to 0.796, confirming that the indicators within each construct are well-correlated and measure a unified concept. Composite reliability (CR) values also surpass 0.7 across all constructs, further validating the reliability of the model. CR values range from 0.724 to 0.839, demonstrating that each construct consistently measures its intended theoretical concept. The closeness of CR and Cronbach's alpha values suggests a good balance between internal consistency and reliability.

Average variance extracted (AVE) values for all constructs are above 0.7, with the lowest being 0.782 and the highest reaching 0.831. These results confirm strong convergent validity, indicating that a significant portion of variance in the observed items is explained by their respective constructs rather than measurement error. This ensures that each construct effectively represents the underlying theoretical concept. Furthermore, all item loadings within each construct exceed the recommended threshold of 0.7, reinforcing the strength of the measurement model. High factor loadings indicate that individual items strongly correlate with their corresponding constructs, further supporting the reliability and validity of the scale used.

Table 3. Measurement model.

Constructs	Cronbach's alpha	Composite reliability	Average variance extracted (AVE)
AI	0.739	0.771	0.791
Crisis Management & Business Growth	0.721	0.724	0.782
Futuristic Approach – Blockchain Technology	0.747	0.839	0.791
Sustainable Future	0.788	0.816	0.823
Start-up Growth	0.796	0.797	0.831

The results of the structural model evaluation indicate significant relationships among the study's constructs, as reflected in the path coefficients (Beta values), standard deviations, T-statistics, and P-values. All hypotheses (H1–H4) are supported based on statistical significance (Table 4). The path from AI to crisis management & business growth (BG) shows a Beta value of 0.553, indicating a strong positive influence. The T-statistic of 8.407 (above the threshold of 1.96) and a P-value of 0.000 confirm that this relationship is statistically significant, leading to the acceptance of H1. This suggests that AI plays a crucial role in enhancing crisis management and business growth by providing advanced decision-making and predictive capabilities. The relationship between crisis management & business growth (BG) and sustainable future (SF) is also significant, with a Beta value of 0.272 and a T-statistic of 4.593. The P-value of 0.000 supports the acceptance of H2, indicating that effective crisis management strategies contribute positively to a sustainable future by enabling organizations to mitigate risks and adapt to challenges. The impact of futuristic approach – blockchain technology (FA) on start-up growth (ST) is the strongest among all relationships, with a Beta value of 0.684 and a T-statistic of 14.817. The P-value of 0.000 confirms the significance of H3, suggesting that blockchain technology plays a critical role in fostering innovation, operational efficiency, and market expansion, thereby driving start-up growth. Lastly, the path from start-up growth (ST) to sustainable future (SF) demonstrates a Beta value of 0.689, the highest in the model, with a T-statistic of 15.489. The P-value of 0.000 confirms the acceptance of H4, emphasizing that start-up growth significantly contributes to a sustainable future by promoting innovative solutions, clean technology, and long-term economic resilience.

Table 4. Path coefficients.

Paths	Beta	Standard deviation	T statistics	P values	Hypothesis
AI -> BG	0.553	0.066	8.407	0.00	H1 accepted
BG -> SF	0.272	0.059	4.593	0.00	H2 accepted
FA -> ST	0.684	0.046	14.817	0.00	H3 accepted
ST -> SF	0.689	0.044	15.489	0.00	H4 accepted

The R-square (R^2) values indicate the proportion of variance explained by the independent variables in the structural model (Figure 2). The crisis management & business growth (BG) construct has an R^2 of 0.306, meaning that 30.6% of its variance is explained by AI. This suggests a moderate explanatory power, implying that while AI plays a role in crisis management and business growth, other external factors may also contribute. The start-up growth (ST) construct has an R^2 of 0.468, indicating that 46.8% of its variance is explained by the futuristic approach – blockchain technology (FA).

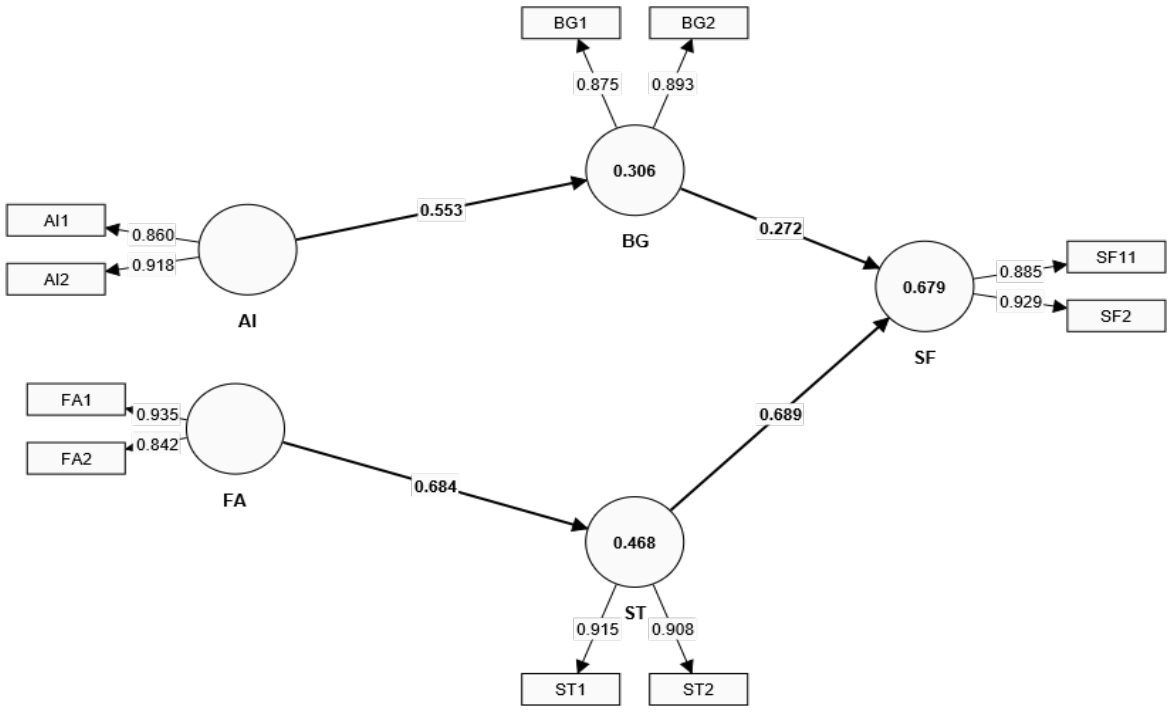

Figure 2. Structural model.

This represents a moderately strong relationship, showing that blockchain technology significantly contributes to start-up growth. However, additional factors could further strengthen its predictive power. The sustainable future (SF) construct has the highest R^2 at 0.679, meaning that 67.9% of its variance is explained by start-up growth (ST) and crisis management & business growth (BG). This strong explanatory power highlights the importance of start-up growth and effective crisis management in achieving sustainability.

The model fit assessment evaluates how well the proposed structural model represents the observed data (Table 5). Several key indicators, including SRMR, d_ULS, d_G, Chi-square, and NFI, are analyzed to determine the adequacy of the model. The Standardized Root Mean Square Residual (SRMR) value is 0.078 for the saturated model and 0.133 for the estimated model. SRMR values below 0.08 indicate a good model fit, suggesting that the saturated model is within the acceptable range. However, the estimated model slightly exceeds the recommended threshold, indicating room for improvement in model specification. The d_ULS (Squared Euclidean Distance) and d_G (Geodesic Distance) values measure the discrepancy between the empirical and model-implied correlation matrices. In the saturated model, d_ULS is 0.333, and d_G is 0.357, indicating a good fit. However, in the estimated model, d_ULS increases to 0.966, and d_G rises to 0.54, suggesting some deviation from the ideal fit, which may require further refinement in model relationships or parameter estimation. The Chi-square values are 280.878 for the saturated model and 342.808 for the estimated model. A lower Chi-square value typically indicates a better fit. The difference in Chi-square values suggests that the estimated model has a higher degree of misfit compared to the saturated model, which may imply that some relationships or paths in the model need further adjustments.

Table 4. Model fit.

	Saturated model	Estimated model
SRMR	0.078	0.133
d_ULS	0.333	0.966
d_G	0.357	0.54
Chi-square	280.878	342.808
NFI	0.645	0.567

5. Discussion

The findings of this study highlight the critical role of AI, blockchain technology, crisis management, and start-up growth in fostering a sustainable future. The strong and positive path coefficient ($\beta = 0.553$) confirms that AI significantly influences crisis management & business growth. AI-driven solutions enhance business resilience by identifying potential threats, improving decision-making, and streamlining operational efficiency. The results align with prior research indicating that AI-based predictive analytics, automated risk assessments, and machine learning algorithms can help organizations anticipate crises, develop preemptive strategies, and ensure business continuity (Farahani et al., 2022). This relationship underscores the importance of AI adoption in modern business environments, particularly in industries that require rapid responses to market fluctuations, cybersecurity threats, and financial risks (Chowdhury, 2024). The results indicate that crisis management & business growth has a positive and significant impact on a sustainable future (SF) ($\beta = 0.272$). This suggests that organizations that prioritize structured crisis management frameworks, proactive risk mitigation, and resilience strategies are more likely to achieve long-term sustainability (Giuggioli & Pellegrini, 2023). Effective crisis management enables businesses to maintain stability, build stakeholder trust, and implement sustainable business practices (Bărbulescu et al., 2021).

Blockchain technology plays a significant role in driving start-up growth ($\beta = 0.684$), demonstrating its potential to enhance market expansion, security, and operational efficiency. The results suggest that start-ups leveraging blockchain can achieve greater scalability, transparency, and cost-efficiency, leading to higher innovation rates and competitive advantage (Mercuri et al., 2021). The decentralized nature of blockchain reduces dependency on traditional intermediaries, allowing start-ups to streamline processes, improve trust in financial transactions, and facilitate cross-border trade (Khan et al., 2024). The results indicate that start-up growth significantly contributes to a sustainable future ($\beta = 0.689$). This strong relationship highlights the role of entrepreneurial innovation, agility, and risk-taking in achieving long-term sustainability. Start-ups that embrace green technologies, ethical business practices, and digital transformation are more likely to create

sustainable economic opportunities, reduce environmental impact, and promote social well-being (Darwish, 2023).

The findings of this study have significant theoretical, managerial, and policy implications, emphasizing the role of AI, blockchain technology, crisis management, and start-up growth in fostering sustainability and business resilience (De Villiers et al., 2021). The study extends existing theories on technology adoption, crisis management, and sustainable business growth, reinforcing that AI enhances decision-making and risk mitigation, blockchain drives efficiency and transparency, and start-ups play a critical role in achieving sustainability goals. It also aligns with resource-based and dynamic capability theories, suggesting that organizations leveraging AI and blockchain can develop unique competitive advantages (Chowdhury, 2024). Future research can explore moderating factors such as regulatory frameworks and industry-specific challenges to deepen the understanding of these relationships. For business leaders, this study provides actionable insights into leveraging AI and blockchain for crisis management, business growth, and sustainability. Managers should focus on integrating AI-driven decision-support systems, predictive analytics, and automation tools to improve operational efficiency and crisis response mechanisms (Kalenzi, 2022). The strong relationship between blockchain technology and start-up growth indicates that entrepreneurs should adopt decentralized solutions, smart contracts, and secure digital transactions to drive market expansion and operational efficiency (Tyagi et al., 2020). Additionally, organizations should incorporate green innovation, ethical supply chain management, and circular economy principles to ensure long-term success (Raji, 2022). Investors and venture capitalists should prioritize funding technology-driven start-ups that align with sustainability goals.

From a policy perspective, the study underscores the need for governmental support, regulatory frameworks, and industry incentives to promote AI adoption, blockchain integration, and sustainable entrepreneurship. Governments should encourage AI adoption in crisis management by funding AI-driven risk assessment tools and cybersecurity frameworks, while also ensuring blockchain-based start-ups have a favorable regulatory environment that supports data privacy, financial security, and smart contract legality. Additionally, tax incentives and grants should be provided to sustainable start-ups focusing on renewable energy, environmental conservation, and ethical business practices. Education and workforce training programs should be enhanced to equip professionals with skills in AI, blockchain technology, and sustainability-driven business strategies. Organizations must also prioritize digital transformation and sustainability-focused innovation to remain competitive in a rapidly evolving business environment. The results suggest that companies should invest in AI-powered decision-making tools to enhance risk prediction and crisis management, adopt blockchain for secure transactions and transparent supply chain management, and integrate sustainability into corporate strategies to align business growth with social responsibility and environmental conservation. Additionally, fostering collaboration between start-ups, established firms, and policymakers can create a technology-driven, resilient, and sustainable business ecosystem.

6. Conclusion

This study highlights the significant role of AI, blockchain technology, crisis management, and start-up growth in fostering business resilience and sustainable development. The findings confirm that AI enhances decision-making and automation, blockchain technology drives efficiency and transparency, and crisis management plays a critical role in ensuring long-term business sustainability. Moreover, start-up growth is significantly influenced by blockchain-driven innovation, reinforcing the importance of technological advancements in shaping the future of businesses. The path coefficient results demonstrate strong relationships between the studied variables, emphasizing that organizations leveraging AI for crisis management can enhance business resilience, while those integrating blockchain technology can accelerate start-up growth and market expansion. The model fit indices further validate the robustness of the proposed framework, ensuring the reliability of the findings. Additionally, the R-square values indicate that a substantial proportion of variance in business growth, start-up success, and sustainability is explained by the independent variables, reinforcing the theoretical strength of the model. The study contributes to existing literature by bridging the gap between emerging technologies and sustainable business practices, offering valuable insights for scholars, practitioners, and policymakers. Organizations must embrace AI-driven analytics, blockchain-enabled operational models,

and proactive crisis management strategies to remain competitive and future-proof their businesses. Policymakers should also facilitate the adoption of digital transformation initiatives by establishing supportive regulations and financial incentives for technology-driven start-ups.

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